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Published

2004

Conference Title

Educating: Weaving research into practice. Proceedings of the 2nd Annual International Conference on Cognition, Language and Special Education Research.

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The Professional Development Needs of Primary Teachers in Teaching Mathematics

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This paper presents the results of a survey conducted in 2003 to assess the professional development needs and preferences of primary teachers across Queensland in relation to the teaching and learning of mathematics. In brief, the results of the survey show that the majority had experienced little or no professional development in mathematics in the previous two years, yet they are eager to participate in such events. The paper describes the range of the teachers' prior professional development experiences, their willingness to embark on future professional development programs, their preferences for topics to be covered in professional development, and their preferences for the timing and location of such professional development programs. The paper also analyses variations in these preferences in terms of teachers' geographical location, school size, and years of teaching experience. These results are also discussed in the light of the implementation of a new syllabus in Years 1 to 10 Mathematics, and the introduction of benchmark numeracy testing.

Background

The importance of professional development

Although there have been exaggerated claims (e.g., by Castle & Aichele, 1994) that the professional development (PD) of mathematics teachers has the power to transform the entire field of education, there is sufficient evidence in the education literature to suggest that PD does play a significant role in improving teachers' practice and 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). Reporting on a study of the influence of compulsory numeracy testing on the teaching of primary mathematics, Nisbet (2004) concluded that professional development must be recognised for its potential for changing teacher practice significantly, and for the better, and its important role in improving numeracy outcomes in schools. In his study, it was found that exposure to professional development exhibited more influence on teachers' practices than teacher experience, and was a significant positive variable in their use of state-wide numeracy test results to identify and assist students experiencing difficulties, and to modify their teaching practice in the light of the results.

The effectiveness of professional development

It has been well established that 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 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 on-going 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 and Cooper, (2003), observed that success was associated with issues such as teacher ownership, continuity over time, 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 ten key principles of making professional development more effective, including addressing issues of concern and interest largely (but not exclusively) identified by the teachers themselves, enabling teachers to gain a substantial degree of ownership by their involvement in decision making, and 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.

Determining professional development needs

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 literature includes studies of PD where account was taken of the teachers' own perceptions of their professional development 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 to have PD 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 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 assess the PD needs of primary teachers across the state on the teaching and learning mathematics, their interest in embarking on such PD, and their preferences for the format for such PD.

Methodology

This study was conducted by survey method. The data analysed in this paper were obtained from a questionnaire on teachers' attitudes, beliefs and practices relating to the state-wide Year 3, 5, & 7 Numeracy Tests (Nisbet, 2004). The questionnaire also contained items relating to how much numeracy PD teachers had undertaken in the last two year, 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. Other items related to background variables such the teachers' grade level, the extent of their teaching experience, the geographical location of the school, and school size (i.e., number of pupils).

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

questionnaires were sent to the schools (having estimated the number of teachers in each school from the data on pupil numbers). Although the response rate was small (121 responses i.e., 24.2%), the sample was representative of teachers' year level and position (Year 1 to Year 7, principal, deputy, & mathematics coordinator), teaching experience (from 1 year to 40 years), geographical location (Brisbane i.e., capital city, provincial city, rural & remote), and school size (small, medium and large schools).

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 what 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

Overview

The data present a picture of primary teachers across the state who have had little or no professional development (PD) in mathematics and numeracy issues in the previous two years. They indicated that they are keen to be engaged in PD, and would willingly attend PD events for one or two days, as long as they're held in school time or on students-free days. They prefer to have PD in their own schools or at nearby schools. The most popular topics for PD are issues in teaching mathematics such as using technology, learning about the new syllabus, and problem solving in mathematics.

Extent of PD in mathematics in past 2 years

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. Although there were differences across geographical locations (e.g., the means for teachers in Brisbane schools and remote schools were 2.13 days and 1.57 days respectively), these differences were not significant.

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 high level of 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%), $\chi^2(15, N = 121) = 44.78, p = .000$.

Preferred format of PD

Duration

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, $\chi^2(15, N = 121) = 29.96, p = .012$.

Time held

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, $\chi^2(3, N = 121) = 11.07, p = .011$.

Location

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, $\chi^2(3, N = 121) = 19.61, p = .000$. Only 28% of the teachers responded positively to having PD on the internet, and that was fairly consistent across schools and levels of experience. 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.

Preferred topics for PD

As shown in Table 1 and Figure 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 – one nominated "assessment techniques", another nominated "assessment and reporting" and the third nominated 'practical demonstrations with new ideas and take-home resources'.

Differences across schools

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%), $\chi^2(2, N = 121) = 6.09, p = .048$.

Differences among teachers

Similarly, the extent of PD undertaken and the desire for further PD was fairly uniform across teachers – from those with little experience to those with many years experience.

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. Compulsory numeracy benchmark testing has been in operation for nine years – a state-based Year 6 test since 1996 and the federally-initiated Year 3, 5, & 7 Tests since 1998 – and a new syllabus for Years 1 to 10 Mathematics has recently been developed and adopted state-wide, yet half of the teachers surveyed reported having had no professional development in mathematics/numeracy in the previous two years. If large-scale PD was 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 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 some teachers of mathematics 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 prefer it to happen in their own schools. However, it is clear that 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. 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 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.

Given that over the last 10 years numeracy skills have been subject to much debate and scrutiny, resulting in increased pressure being placed on primary schools to improve numeracy outcomes (Nisbet, 2004), and that the levels of teachers' prior PD reported in this study are low, it would be a proper response for employing authorities 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.

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.

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