

Curriculum and the Reality of Primary Teachers

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Over the years, national mathematics curricula have tended to be imposed on New Zealand teachers without regard to their realities. As a means of (potentially) informing future curriculum development the study reported here sought to do two things: (1) identify the actual concerns held, and mathematics teaching difficulties encountered, by classroom teachers, and (2) find ways to support the teachers in addressing these concerns and difficulties. The six month collaborative project with staff in a small urban primary school revealed some insights into difficulties experienced by teachers, the process of teacher professional development in mathematics, and possible directions for mathematics curriculum development.

Just eight years ago Ellerton and Clements (1994) characterised politically-driven mathematics curriculum changes in Australia at that time as a "... national curriculum debacle". New Zealand has had a similar experience. The last mathematics curriculum documents developed democratically with primary teachers were published in 1985 and 1987 (Department of Education, 1985, 1987). These documents had been in the hands of teachers only a short time when the New Zealand Ministry of Education required them to implement a new mathematics curriculum (Ministry of Education, 1992). This new curriculum document was written under private contract and, although the contractor and his team did their best within serious constraints, the resulting 'Mathematics in the New Zealand Curriculum' has been characterised as a document of contradictions (Gillingham & Begley, 2001) which can be seen to exist within a broader curriculum of social control (Codd, 1999).

In our experience this traditional and dominant process of central control, curriculum imposition, and avoidance of rigorous critique (Klein, 1990) is still being used in New Zealand, although there are strong indications that some Ministry of Education staff recognise that teachers are central figures in curriculum development considerations. In this respect, Gillingham and Begley (experienced primary school teachers) have recommended, in curriculum development efforts in mathematics, "... cognisance must be taken of primary school teachers' actual classroom reality, particularly their understanding of mathematics and their teaching of it" (2001, p. 44). This is similar to the conclusion reached by Harnett and Naish (1993, p. 346), "... there can be no educational advance without classroom teachers. They do the work of education and their knowledge, imagination, sensitivities, and skills are central to that advance. And that means that teacher development is too."

We therefore considered it important to try to understand the mathematics teaching world of classroom teachers. This paper describes some first steps in this project emanating from an opportunity to engage with a small sample of teachers in mathematics professional development.

Theoretical Perspective

Our theoretical perspective encompassed ideas about curriculum, learning and professional development. With respect to curriculum, we believe that it is "... a socially-constructed cultural artefact" (Carr, 1998, p. 330), that in the final analysis it is constructed in the classroom by teachers and students (Chandler, 1992; Remillard, 1990) in a negotiated, co-emergent way (Davis, Sumara & Kieren, 1996), and that its primary purpose is to promote (participatory) democratic values (Biddulph, Taylor & Biddulph, 2000; Carr, 1998; Ministry of Education, 1992). The implication of this broad view of curriculum was that we conceived our role to be one of supporting the teachers to see themselves as classroom curriculum developers in their own right, rather than as mere implementers of someone else's curriculum.

In terms of learning and professional development, we construed teacher professional development as adult learning. Although our recent ideas about learning had their genesis in social constructivism and humanistic learning theory (Biddulph & Carr, 1999) they have increasingly been informed by the principles of enactivist learning. We have therefore used the conceptual framework of enactivism (Davis, 1996; Davis & Sumara, 1997; Reid, 1996,) to both shape our work with the teachers involved in our study, and to interpret our data. We outline some features of enactivism below.

Enactivism presents an ecological view of learning; that is, all learning is considered to be interactive, interrelational and interdependent, and is influenced by biological, social and historical factors. Learning is not about getting knowledge across the big divide that Descartes believed separated the mind from the body (Lakoff & Johnson, 1999) but rather it is about making sense of our actions and interactions – with others, with our environment, and with our personal histories. In essence this means that the world comes into existence for us only in and through our ongoing and ever-changing interactions with, and interpretations of, our physical and social environment. As such, a classroom (and indeed a school staff group) has the property of being an 'autopoietic' system, that is, a complex, dynamic and spontaneously self-organising system (Reid, 1996). It develops and changes as a whole rather than on an individual basis within that setting. In practice, enactivism involves working in a collaborative, collegial-type way and listening constructively (Davis, 1996; Mason, 1998) in order to sensitively support and challenge perceptions.

In adopting an enactivist perspective we considered that we were likely to learn as much from our interactions with the teachers as they from us (Dawson, 1999). In addition, in terms of professional development, we recognised that providing support over a relatively extended period of time, offering alternatives for consideration, and encouraging the teachers to be thoughtfully reflective were all consonant with our theoretical framework of democracy and enactivism.

Methodology

This study involved both professional work with teachers in a school, and concurrent collection of qualitative data related to that work. The data consisted of field notes written by the authors during the meetings with the teachers, together with written records of joint work. The field notes and written materials were regularly compiled into Working Papers, many with the teachers as joint authors, which were shared with all participants as they

were produced. A total of 11 Working Papers resulted from the collaborative work. This paper draws extensively from those Working Papers.

The principal of a small urban primary school in a New Zealand provincial city invited us to support the school staff in their mathematics professional development efforts. There were six main classroom teachers in the study and all participated most of the time. The principal was also able to join in most of our deliberations. The teachers represented a range of experience from very little (being first or second year teachers) to very experienced. At least initially, they also appeared to vary in their commitment to the professional development programme.

The children attending the school were from a low socio-economic area of the city, and comprised a cultural mix with more than half being Maori. There was a high proportion of transient children. The school catered for children from Years 1-8 (approximately 5 to 12-year-olds).

Meetings with the teachers occurred at least fortnightly for most of the time, and covered a six month time span from roughly mid-May to mid-November 2001. The meetings were normally held from 3:30pm until 5:00pm on the day set aside for a whole staff meeting. The meetings began with the teachers sharing with us their concerns and difficulties, but gradually moved on to pairs of teachers and university staff trying to identify key mathematics ideas across the school class levels in the areas of number, algebra, measurement, geometry, statistics and probability. During this time, all participants came together for the last part of each session to share, discuss and question what they had managed to do to date.

Prior to our first visit to the school we discussed among ourselves what our part would be during the meetings, given our theoretical perspective and our desire to achieve democratic-type power relationships with the staff. This philosophy pointed to us being teacher colleagues of the school staff rather than outside 'experts', handing over to the teachers as much control and responsibility for the professional development process as possible (Dawson, 1999), and acting as their assistants by keeping records of our deliberations. We therefore implemented these features. We have all had ongoing experience working in classrooms with children so we could identify fairly readily with what the teachers were saying and how they were feeling. In addition, the first author had already built up a close working relationship with several of the teachers having had several groups of preservice teachers working with children in their classes in mathematics over the previous 12 months.

Results and Discussion

Our data revealed a number of major themes. Here we describe and discuss five of them. Frequently our text includes terms used by the teachers, but we do not highlight these. Rather, in keeping with our theoretical perspective, we prefer to let the authenticity of the teachers' voices emerge 'naturally'.

1. Need to understand the mathematics and gain a sense of 'progression'

From our first meeting, the importance of needing to understand the mathematics emerged several times in the teachers' comments. At the outset they acknowledged that teacher knowledge of mathematics is important and they stated explicitly that they felt they could benefit from gaining further understanding. The need to gain more understanding of the mathematics was also reflected in questions asked by the teachers several weeks into the professional development programme. For example, one teacher's question about

whether fractional numbers could be 'even' numbers led to an exploration of the various number systems, which in turn led to an interesting discussion about the fact that the sum of $1 + 1$ could be numbers other than 2, such as 10 (base 2) or 0 (modular system), something that the teachers had never considered. This exploration, and other similar ones, also represented our quiet challenging of the teachers' belief that there is just one right answer to any mathematical problem.

The importance of understanding the mathematics also came through in the teachers' desire to gain a sense of 'progression' of mathematics ideas across the school. This was raised in the first professional development session and became an ongoing theme - to the extent that the last four months of the programme were devoted to identifying the mathematics ideas that they could reasonably expect most children to have developed in number, geometry, algebra, measurement, statistics and probability by the end of the 2nd, 4th, 6th and 8th year of their schooling. This seeking of a sense of 'progression' stemmed partly from the teachers urgent need to cater mathematically for the numbers of transient children who appeared in their classes.

In the midst of our work identifying the main mathematics ideas (we worked in teams of two, one teacher and one of us on each mathematics strand) several interesting developments occurred. For instance, most of the teachers gradually became involved to the extent where they were genuinely seeking to understand the mathematics more deeply. An experienced teacher working with the first author at one point made the comment that it was all coming back to her now. What she meant was that the mathematics ideas which she had been familiar with in the 1980s were re-emerging in her consciousness as we worked at identifying the major number concepts at the primary level. This was intriguing to say the least! Why had she 'lost' this understanding? Discussion with this teacher and the others revealed that they found the work of identifying the key mathematics ideas particularly rewarding, and they were feeling a sense of relief at beginning to get a sense of the big picture of the mathematics ideas - after having been buried for years in the perceived myriad of learning outcomes and achievement objectives in the mathematics curriculum document (Ministry of Education, 1992). One used the metaphor of previously not seeing the mathematical wood for the achievement objective trees.

2. Complexity of teaching mathematics

The teachers discussed how teaching children can be a real challenge, particularly the children in their school, many of whom apparently lack motivation, are in emotional turmoil, and appear to have big 'holes' or gaps in their mathematical understanding. The teachers were also concerned that they did not have quick ways of identifying such 'holes' and indicated that they were looking to us for guidance. In the end we were able to help them develop their own solution to this problem, namely the 'progression' of mathematics chart mentioned above. At the same time they recognised that if they really listened to children's ideas and determined the strategies they were using then it could have the effect of raising expectations of what the children are capable of understanding. They also began to recognise that teacher questioning improves when teachers know where they are going mathematically, that is, when they know the mathematics and are aware of the 'progressions'. They realised too that encompassing both of the above enables them to have more meaningful interactions with the children.

Early in our meetings the teachers commented on the confusing array of resources in mathematics education, and some added that they had found safety in one commercially

produced, structured mathematics programme. However, they did express some reservations about whether it was actually meeting the learning needs of their children.

A growing understanding that children's mathematics learning is not instant, that it takes time for ideas and intellectual strategies to become stable, that sense-making is at the heart of mathematics learning, and that it is therefore possible to begin with problems rather than so-called skills, led one teacher on her own initiative to develop a mathematics unit along these lines. The unit was not planned in its entirety in advance; rather aspects evolved as children's input was sought. This teacher also came to realise that periodically stepping aside from the course of the problems in the unit to give children specific help with aspects of the mathematics was still an important part of teaching.

Overall, the teachers came to express the view that if teaching is constantly informed by children's ongoing learning and learning needs in mathematics then it is a complex process. This differed from their earlier perception that teaching mathematics involved pursuing the behaviourist-type objectives (translated into measurable learning outcomes) found in the current New Zealand mathematics curriculum document.

3. A critical approach to curriculum documents is needed

As early as the third professional development session, the teachers were beginning to express concerns about the achievement objectives in the New Zealand mathematics curriculum document and considered that they could be a hindrance to thinking about and teaching mathematics because they seemed to be either too broad or too specific to provide the guidance they sought. These concerns were confirmed in the teachers' minds as they tried to make use of the curriculum document to help identify the key mathematics ideas that children could be expected to develop at two-year intervals across the school. They found that the document had statements whose meaning eluded them, or important ideas were obscured in the verbiage, or key ideas were omitted entirely (for example, in the algebra strand).

These experiences suggested to the teachers that they should not accept the mathematics curriculum document as some kind of 'bible'. Instead, in the interests of their children's mathematics learning, they considered that they should approach it quite critically and think about the mathematics in their own terms.

4. Growing confidence

The teachers' growing confidence in themselves as professionals emerged in several ways. For example, as mentioned above, they began to feel that it is imperative that they do not accept without question mathematics materials, official or otherwise; they now realised the need to adopt a far more critical stance, even though it felt rather daring at first. This developing understanding, however, also enabled the teachers to observe that, whether it is officially recognised or not, true curriculum development is really a shared effort between the Ministry of Education and themselves as front-line professionals.

Other evidence of growing confidence was the recognition that they had a lot of expertise among themselves. They began to feel comfortable about both sharing their ideas and asking questions to further their understanding. Interestingly, they considered that their expertise was complemented by our expertise. It is noteworthy that the format for the display of key mathematics ideas across the school was constructed by one of the teachers. Almost all of the teachers found it to be a powerful format in that it enabled a vertical view of what mathematical understandings they might expect from children in two-year age bands, and at the same time permitted a horizontal perspective of the 'progression' of mathematics across their primary school in terms of the strands of number, geometry and

so forth. As one teacher said, without the sense of 'progression' provided by the chart, it is all too easy to become narrowly focussed on just the mathematics that is supposedly relevant for your single class.

Further evidence of growing confidence was the remark of one teacher (who gradually became an enthusiastic participant) that investigating one strand in depth provided an experience of how it might be possible to focus on the other mathematics areas in the same kind of depth.

5. The professional development process

As a result of their experiences in the six month professional development programme the teachers provided a number of insights into the development process itself. We have already mentioned the growing teacher realisation that they had considerable expertise to contribute, particularly relating to the reality of their children and their classrooms, and how they felt that this complemented the expertise that we ourselves provided. In their eyes, we were able to access relevant articles and mathematics education resources, and provide personal support and encouragement to enable them to make decisions about mathematics education in their school appropriate for their children.

The teachers said that their growing realisations were helped considerably by having their ideas recorded and available to them regularly in Working Paper form. This surprised us because we had never thought about this possibility. From the teachers' comments it seems that the Working Papers gave legitimacy to their ideas, facilitated reflection of the issues involved, and evoked ideas about further development.

We also learnt from the teachers that they now favour longer-term professional development support (of the kind we had engaged in) because they found that it allowed them to explore in some depth issues that matter to them. On reflection this makes good sense because, as we recognised, the teachers carry all sorts of other responsibilities, and the call on their time is such that to ask them to be totally focussed during a short professional development course is somewhat unrealistic.

Furthermore, most of us concluded that professional development is quite complex because as it evolves we become aware of new dimensions that need to be examined; hence the professional development programme can take new and unanticipated directions. In our case it was clear to the teachers that we had still not addressed the issues of mathematical processes (especially problem solving), assessment, and effective ways of helping children learn the major concepts that were identified.

Conclusion

Although somewhat sketchy, we think that our limited data are quite illuminating. For example, there is a strong indication that curriculum change that proceeds without research into teacher and classroom reality runs serious risk of being ineffective. It is somewhat ironic that previous Ministry of Education curriculum initiatives intended to increase children's achievement, seem to have had the effect of stifling teachers' professional understanding and turning the teaching of mathematics into an extremely technical and problematical task.

The complexity of curriculum development also surfaces. We agree with the teachers that effective curriculum development requires a partnership between education authorities and teachers (Fullan, 1993). Our data suggest that, at the very least, teachers need to be consulted about the structure of future mathematics curriculum documents to determine

whether the teachers are likely to take ownership of them in ways that do justice to children's learning in mathematics.

The complexity of professional development is also evident. The insights provided by the teachers themselves on this issue are significant, in our view. From an enactivist perspective, the evolving, recursive (Pirie & Martin, 2000) and reflective (Irwin, Britt & Ellis, 1993) nature of professional development apparent in this study, and the need "... to acknowledge the authenticity of the context in which teachers work" (Moon, 1998), stand in stark contrast to the packaged, contract delivery model so favoured in New Zealand over the last 10 years. To add to the complexity, we recognise the importance of the conclusion reached by Tzur, Simon, Heinz and Kinzel (2001, p. 250) that "Teachers' perspectives consist of intricately related webs of understanding of which little is known, particularly as these perspectives have evolved in relation to current mathematics education reform efforts." Perhaps the enactivist foundation of our facilitation provides an alternative approach to professional development in mathematics education that needs serious consideration. In our experience it provides for the significant features of successful professional development identified by Garet, Porter, Desimone, Birman and Yoon (2001), namely (i) a sustained and intensive programme, (ii) collective participation of teachers from the same school, (iii) encouragement of professional communication among teachers, (iv) opportunities for active learning, (v) activities linked to teachers' experiences, and (vi) a focus on content knowledge.

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