

Reform-Oriented Teaching Practices and the Influence of School Context

Janette Bobis
University of Sydney
j.bobis@edfac.usyd.edu.au

Judy Anderson
University of Sydney
j.anderson@edfac.usyd.edu.au

Survey and interview data were used to explore the understandings and use of reform-based teaching approaches of three primary teachers from the same school. The beliefs and practices of the teachers were closely aligned to those recommended in local and international reform-based curriculum documents and to the practices of each other. The data provide insight into contextual factors that facilitate reform-oriented teaching practices within the school setting. Interestingly, it seems that the same structures supporting innovative practice can also foster misunderstandings in teachers' knowledge about reform-based practices.

Introduction

Recent international comparative tests, such as the Third International Mathematics and Science Study [TIMSS], have created great debate about the impact of different teaching styles of mathematics teachers from various countries. In particular, the TIMSS video study (Hollingsworth, Lokan & McCrae, 2003) indicated that teachers from countries like Japan, that perform well on such tests, seem to employ teaching strategies that resemble the reform-oriented practices reflected in reform-based curriculum documents (e.g., National Council of Teachers of Mathematics [NCTM], 2000). These reform-oriented approaches recognise the importance of instruction that encourages the development of a range of processes, such as, problem solving, reasoning and proof, communication, and reflection.

Research in Australia surrounding the New South Wales [NSW] Quality Teaching document (NSW Department of Education and Training, 2003) has identified instructional practices characteristic of effective teachers of mathematics. These include the teaching of higher-order thinking and a focus on understanding as students learn mathematics, thus reinforcing the universal effectiveness of reform-based teaching practices. Practical advice for teachers as to how to implement such practices has been readily available for some time (e.g., Clarke, 1997). However, there is evidence that teachers in Australian contexts have not responded to this advice (Hollingsworth et al., 2003) despite their good intentions to implement reform-oriented approaches. It is unclear whether teachers simply do not have an image of what this reform approach looks like in practice, or whether particular contextual factors interfere with their intentions.

In most Australian state-based curriculum documents, reform-oriented approaches to teaching mathematics are incorporated into 'process' strands, such as the Working Mathematically strand in the new mathematics syllabus for primary school students in New South Wales [NSW] (Board of Studies [BOSNSW], 2002). The Working Mathematically strand of the NSW mathematics syllabus incorporates five interrelated processes — questioning, applying strategies, communicating, reasoning and reflecting. These processes are intended to permeate all aspects of teaching mathematics and, as such, have been embedded in the content sections of the syllabus document. Descriptions of these five processes are presented in Table 1 and provided a useful framework for

analysing teachers' understandings of Working Mathematically in the current study.

Table 1

The Five Interrelated Processes of the Working Mathematically Strand

Process	Description of the Process (BOSNSW, 2002, p. 19)
Questioning	Students ask questions in relation to mathematical situations and their mathematical experiences.
Applying Strategies	Students develop, select and use a range of strategies, including the selection and use of appropriate technology, to explore and solve problems.
Communicating	Students develop and use appropriate language and representations to formulate and express mathematically ideas.
Reasoning	Students develop and use processes for exploring relationships, checking solutions and giving reasons to support their conclusions.
Reflecting	Students reflect on their experiences and critical understanding to make connections with, and generalisations about, existing knowledge and understanding.

Given the centrality of reform-oriented approaches in the new mathematics syllabus (BOSNSW, 2002), it is important to identify cases where reform-oriented practices are actively encouraged across groups of teachers within the school context.

Reform-Oriented Practices and the School Context

Collectively, research has shown that teachers are more likely to change their teaching practices if they: understand the thinking strategies of children (Bobis, Clarke, Clarke, Thomas, Young-Loveridge, Wright & Gould, 2005); are given time to reflect and discuss their teaching (Jaberg, Lubinski, Aeschleman, 2004); work in a collegial environment (Taylor, 2004); and situate professional learning experiences in the workplace (Glazer & Hannafin, 2006). For each of these things to occur within the school context, certain support structures and conditions need to exist.

Taylor (2004, p. 219) highlights “collegial interaction” as a key feature of schools wanting to implement and sustain extensive reform. He refers to collegiality as the “existence of high levels of collaboration among teachers, the product of teachers working together on a common project toward some common goal” (p. 220). Taylor provides a framework for analysing the capacity of a school for supporting reform through collegial interaction. The framework consists of four aspects or “pillars of support” (p.223): (1) *contextual catalysts* which include all the elements that impact on the interactions of staff, from leadership style to physical structures in the school; (2) *the identification of colleagues* with whom a teacher selects to work more closely with; (3) *the alignment of philosophies* where teachers who work collaboratively on projects share common beliefs; and (4) *the ownership of interaction* where teachers working together give equal value to the interaction.

The support structures and conditions for creating contexts in which reform is more likely to occur as suggested by Taylor provide a framework in which we might analyse the features of school environments for their capacity to implement reform-based teaching practices.

Methodology

The research reported in this paper was part of a larger study designed to investigate the implementation of reform-oriented teaching practices by NSW primary teachers. The original study used a combination of survey, interview and case study approaches to explore teachers' understandings of Working Mathematically and their implementation of the various processes of the strand. A survey, adapted from Ross, McDougall, Hogaboam-Gray and LeSage (2003), was initially used to determine the extent to which teachers' beliefs and self-reported practices reflect those advocated in reform-oriented curriculum materials produced locally (e.g., BOSNSW, 2002) and internationally (NCTM, 2000). In particular, it focused on specific teaching strategies associated with each of the five processes of the Working Mathematically strand in the *Mathematics K-6 Syllabus* (BOSNSW, 2002). Major findings of the survey component of the study have been reported in more detail elsewhere (see Anderson & Bobis, 2005), but are briefly presented here to help contextualise the current report.

In brief, it was found that the majority of teachers surveyed reported using reform-oriented practices and actively plan learning experiences that incorporate a range of processes from the Working Mathematically strand. However, most reported experiencing difficulty in developing students' abilities in some aspects of the Working Mathematically strand, particularly with the higher-order thinking processes involving questioning and reflection.

The survey was also used to distinguish teachers—specifically those reporting the incorporation of Working Mathematically into their teaching—for inclusion in the interview component of the study. Data from the survey were used to develop initial 'profiles' of teachers so as to determine how closely their beliefs and reported practices aligned with those recommended by reform-oriented documents. Interestingly, the three teachers with profiles indicating strongest support for reform-oriented practices taught at the same school. Two of these teachers were also among ten survey respondents who indicated their willingness to participate in the follow-up interview component of the study. It was decided to include both teachers in the interview component so as to gain insight into the socio-systemic factors (Jaworski, 2004) that facilitate such practices in teachers within the school context, at the same time, providing insight on any shared understandings of the Working Mathematically strand and its implementation.

Results and Discussion

This section summarises the profiles of three survey respondents. The profiles were compiled to explore their understandings of Working Mathematically processes and the use of reform-based teaching approaches associated with their implementation. The section also presents findings from interviews with two of these teachers. The interview data was initially intended to validate the profiles for particular teachers and to provide further insight into these teachers' understandings of the Working Mathematically strand. However, with both interviewees working in the same school, the data also provided insight into contextual factors operating in the school setting and influential in the implementation of reform-based approaches to teaching mathematics.

The School Setting

The school in which all three teachers teach is a comprehensive local government primary school with approximately 550 students. Situated in a northern suburb of the Sydney metropolitan area, it has had a partnership with the University of Sydney since 1952. The partnership involves the school's ongoing support for the University's teacher education programs with regular visits from student teachers to observe lessons, participate in seminars and undertake both research and practical teaching experiences.

In the past five years, the school has been involved in two major professional learning experiences that have helped shape individual teacher's approaches to teaching mathematics. First, the NSW Department of Education and Training numeracy project, Count Me In Too, has been operating in the school for more than four years. Count Me In Too [CMIT] is a professional development program that focuses on developing an understanding of children's thinking strategies in relation to early number concepts (see Bobis et al., 2005 for details of the program). Second, at the end of the previous year and for the first half of the current year, the teachers had also been involved in a Quality Teaching project where government funding was made available to the school to develop units of work with the support of an academic partner. The lessons in the unit were developed to incorporate the quality teaching dimensions of Intellectual Quality, Quality Learning Environment, and Significance (NSWDET, 2003), each of which comprises a set of elements that have much in common with Working Mathematically processes. For example, Intellectual Quality includes the elements of deep knowledge, higher order thinking and substantive communication.

Teacher Profiles

Alison, Annette and James all teach in the first three years of primary school (Kindergarten, Year 1 and Year 2 respectively). Each teacher had been teaching between 6 and 10 years. Annette and James had both been teaching at the current school for several years and worked collaboratively on implementing the Count Me In Too [CMIT] numeracy program for more than three of those years. While Alison had only been at the school for seven months, she was familiar with CMIT from her previous school and had worked collaboratively with Annette and James to implement it since her arrival at the school.

In relation to reform-oriented practices, Alison, James and Annette's 'profiles' revealed considerable support for the approaches listed on the survey. Their knowledge about Working Mathematically was mixed. Each indicated that *applying strategies* involved using a range of materials and strategies to explore concepts and solve problems, that *communicating* required sharing and the appropriate use of language, and that *reasoning* encompassed the comparison of strategies, and justification of possible solutions. Hence, the teachers' understandings of these processes were in accord with those described in state syllabus documentation (see Table 1). However, they each indicated understandings about two particular processes — *questioning* and *reflecting* — that were not aligned with those presented in syllabus documentation. Like other teachers who responded to the survey (see Anderson & Bobis, 2004 for a detailed discussion of the survey results), responses from all three indicated that they considered *questioning* to involve students responding to the teachers' questions. They also indicated a shared belief that *reflecting* required sharing and

“reflecting” on solutions rather than connecting with other knowledge. It is possible that their professional conversations have reinforced these views.

Interview Component

Separate 30 minute, semi-structured interviews were held with Alison and Annette approximately three months after they had completed the surveys. Initially, the discussions focused on their planning and implementation of Working Mathematically. As each interview proceeded, it became apparent that there were particular contextual factors, which appeared to support the implementation of Working Mathematically and reform-oriented practices in the school. Each interview is described briefly before the common elements are presented.

Alison’s interview validated her ‘profile’ developed from survey data. It further revealed a commitment to embedding working mathematically into her everyday practice and a belief that working mathematically provides the purpose for doing mathematics. She indicated that the implementation of a range of teaching approaches for Working Mathematically reflects good pedagogy, or reform-oriented practices. She considered Working Mathematically enhanced the development of children’s “deep understanding” of mathematics and provided opportunities for the “ongoing assessment of children’s thinking”. In relation to the implementation of Working Mathematically processes, she stated:

Our classes start with a whole class focus initially, which will be looking at applying strategies ... doing a lot of mental maths to develop understanding and with questioning to try to develop an idea from the children’s prior knowledge. I think it is very important at the end, when they come back together to reflect as it allows them to reason and to think about what they have been doing, to think of why they have been doing it, why we have been using it.

Alison also believes that the processes are integrated rather than separate and that she does not normally plan to implement them separately. While she believes that “all children can learn mathematics”, she indicated that some have “deeper knowledge” than others. Her programming aims to meet the needs of all children through open-ended questions, with a desire “not to try to cram so much in” as is dictated by a crowded syllabus document. A conflict was revealed between following the syllabus, which covers all content areas, and teaching for understanding. However, she considered integrating mathematics with other areas of the curriculum (e.g., art) saved valuable time. She also considered it important to make connections to the children’s “outside world” as this “provides excitement and enjoyment” and the “kids love that”.

Annette’s interview confirmed her reported beliefs about the importance of Working Mathematically because “it opens up a whole new scope of possibilities”. She indicated that it is critical to “know your kids well” in order to support their needs. Encouraging children to share their understandings of mathematics in a variety of group settings allows Annette to assess and plan future learning experiences. She also described the significant impact of the CMIT numeracy project on the way she taught and assessed mathematics. In particular, she noted an increased focus in her teaching on children’s thinking strategies and the use of an individual clinical interview to assess children’s levels of understanding. Grouping children with “like minded peers” supports the development of number knowledge, but in the other strands of the syllabus, she stated “I would tend to do it in mixed ability groups and I will actually give them challenges through working

mathematically”.

The school’s involvement in the Quality Teaching project was described at length, with Annette frequently interchanging comments about Working Mathematically processes with comments about the Quality Teaching elements. It was evident that she could clearly identify a connection between the implementation of Working Mathematically and good pedagogy as described in the Quality Teaching documents (NSWDET, 2003).

As a team leader in her school, Annette frequently referred to the importance of developing teachers’ knowledge about quality teaching and Working Mathematically. She described the collaborative development of a rubric to support teachers’ assessment of Working Mathematically. While this exercise would have provided a valuable opportunity for teachers to discuss their understanding of the processes involved, it is unfortunate that Annette did not refer to the syllabus outcomes (BOSNSW, 2002, p. 19) as these provide a useful framework for assessment across stages of development.

In line with Taylor’s pillars of support, both Alison and Annette described key features of the school, which they believed enhanced the implementation of reform-oriented practices. Involvement in the Quality Teaching project provided valuable time for reflection on practice, sharing teaching approaches, planning units of work, and the development of deeper understanding of many aspects of mathematics and pedagogy. As this was undertaken in stage-based collaborative teams, Alison, Annette and James worked together as part of a group of Kindergarten to Grade 2 teachers. Discussions about implementing Working Mathematically afforded opportunities to clarify understandings and plan new experiences for the children. Annette indicated that she “was really happy with the dynamics of the team” but she was disappointed that the activities in the unit did not place mathematics in a context to make it more meaningful for the children. As a result of her advice, the unit was further developed to investigate “Areas in Our School”— thus, situating the learning more clearly in the school.

The lack of a mandated textbook also supported reform-oriented practices according to both teachers. Annette believes that learning is enhanced with the use of concrete materials although she commented that the state-based (standardised) tests undertaken by children in Grade 3 require practise in reading and interpreting written items as well as written recording of answers. For this reason, teachers in the K–2 team agreed to modify their instructional practices to ensure children were familiar with recording their work in a format appearing on state-based testing materials. Similarly, Alison was concerned that textbooks and worksheets constrained children’s thinking and recording. Her students use a book for recording so that they need to decide “how am I going to do it, where do I start, what is the best way of laying it out”.

Summary and Conclusion

The study reported here aimed to explore teachers’ understandings of Working Mathematically processes and the use of reform-based teaching approaches associated with their implementation. The profiles of three teachers from the same school were presented. The beliefs and practices of Alison, Annette and James were closely aligned to those recommended in local and international reform-based curriculum documents and to the practices of each other. The interview data confirm the existence of several key factors that have been linked in previous studies concerning environments supportive of changes to teaching practices. In summary, these factors included: collegial interaction (Taylor, 2004)

characterised by contextual factors such as Annette's leadership style, the provision of time for teams of teachers to interact on collaborative projects and to discuss philosophical as well as practical aspects of their teaching. Interestingly, it seems that the same structures supporting innovative practice can also foster misunderstandings in teachers' knowledge about reform-based practices, as was the case with the three teachers' understanding of *questioning* and *reflection* within the Working Mathematically strand. This is a significant point and raises questions about professional learning that is exclusively situated within the workplace.

References

- Anderson, J. & Bobis, J. (2005). Reform-oriented teaching practices: A survey of primary school teachers. In H. Chick & J. Vincent (Eds.), *Proceedings of the 29th conference of the International Group of the Psychology of Mathematics Education* (pp. 26-72), Melbourne: University of Melbourne
- Board of Studies NSW (BOSNSW) (2002). *Mathematics K-6 Syllabus*. Sydney: BOSNSW.
- Bobis, J., Clarke, B., Clarke, D., Thomas, G., Wright, R., Young-Loveridge, J. & Gould, P. (2005). Supporting teachers in the development of young children's mathematical thinking: Three large scale cases. *Mathematics Education Research Journal*, 16(3), 27-57.
- Clarke, D. M. (1997). The changing role of the mathematics teacher. *Journal for Research in Mathematics Education*, 28(3), 278-308.
- Glazer, E. & Hannafin, M. (2006). The collaborative apprenticeship model: Situated professional development within school settings. *Teaching and Teacher Education*, 22, 179-193.
- Hollingsworth, H., Lokan, J., & McCrae, B. (2003). *Teaching mathematics in Australia: Results from the TIMSS 1999 Video Study*. Camberwell, VIC: Australian Council for Educational Research.
- Jaberg, P., Lubinski, C., & Aeschleman, S. (2004). Developing a support system for teacher change in mathematics education: The principal's role. In R. Rubenstein & G. Bright (Ed.), *Perspectives on the teaching of mathematics* (pp. 229-238), Reston, Va.; NCTM.
- Jaworski, B. (2004). Grappling with complexity: Co-learning in inquiry communities in mathematics teaching development. In M. J. Høines & A. B. Fuglestad (Eds.), *Proc. 28th Conf. of the Int. Group for the Psychology of Mathematics Education* (Vol. 1, pp. 17-36). Bergen, Norway: PME.
- National Council of Teachers of Mathematics (NCTM) (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.
- New South Wales Department of Education and Training (2004). *Count Me In Too Professional Development Package*, Sydney: DET.
- New South Wales Department of Education and Training (2003). *Quality teaching in NSW public schools: A discussion paper*. Sydney: NSWDET.
- Ross, J. A., McDougall, D., Hogaboam-Gray, A., & LeSage, A. (2003). A survey measuring elementary teachers' implementation of standards-based mathematics teaching. *Journal for Research in Mathematics Education*, 34, 344-363.
- Taylor, P. (2004). Encouraging professional growth and mathematics reform through collegial interaction. In R. Rubenstein & G. Bright (Ed.), *Perspectives on the teaching of mathematics* (pp. 219-228), Reston, Va.; NCTM.