

# REFORM-ORIENTED TEACHING PRACTICES: A SURVEY OF PRIMARY SCHOOL TEACHERS

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*In line with international recommendations, reform-oriented approaches have been promoted through the Working Mathematically strand of the curriculum for primary school children in New South Wales. Evidence suggests that teachers engage differently with these recommendations depending on their knowledge and beliefs about the role of working mathematically in learning mathematics. Through a self-report survey, this preliminary investigation identified the use of reform-oriented practices. Many teachers reported using such practices and actively plan learning experiences that incorporate a range of processes including reasoning and communicating. However, some respondents appeared to be more informed than others.*

## INTRODUCTION

Recent curriculum documents typically promote reform-oriented approaches and recognise the importance of engaging students in worthwhile mathematics through a range of processes. For example, the *Standards* of the National Council of Teachers of Mathematics [NCTM] (NCTM, 2000) includes problem solving, reasoning and proof, communication, connections, and representations. Similar processes are included in the latest mathematics syllabus for primary school students in New South Wales [NSW] (Board of Studies NSW [BOSNSW], 2002). The Working Mathematically strand incorporates five interrelated processes – questioning, applying strategies, communicating, reasoning and reflecting.

These processes underpin problem solving; a life skill that is universally considered central to the mathematics curriculum (NCTM, 2000). When such processes are successfully implemented, learning experiences “allow learners to think and create for themselves ... discuss their interpretations and develop shared meanings” (Sullivan, 1999, p. 16). The teacher’s role is not trivial (Schoen, Cebulla, Finn & Fi, 2003). The teacher needs to choose tasks that engage students in higher order thinking and sustain engagement (Henningsen & Stein, 1997), help students make links between mathematical ideas (Askew, Brown, Rhodes, Johnson & Wiliam, 1997), and meet the needs of the full range of students in classrooms.

Given the centrality of working mathematically in the new mathematics syllabus (BOSNSW, 2002), and the assertion that not all teachers have embraced it (Hollingsworth, Lokan, & McCrae, 2003), it is critical to explore the extent to which it is being adopted and integrated into teachers’ practices. It is also essential to identify cases of exemplary practice and to provide advice to teachers about the issues that might constrain their efforts to implement the reform elements of this new syllabus.

## SITUATING THE RESEARCH IN AN INTERNATIONAL CONTEXT

It has been argued that the use of non-routine problems and problem-centred activities form the basis of classroom activity in a reformed or inquiry-based classroom (Clarke, 1997; Schoen et al., 2003). There has been substantial advice to teachers to teach problem-solving skills and to use problems as a focus of learning in mathematics (Wilson & Cooney, 2002). Such advice has been accompanied by considerable efforts through preservice and inservice programs to change teaching practices from more traditional approaches to contemporary or reformed methods (e.g., Schifter, 1998).

Investigations into the implementation of reform, or standards-based curriculum (NCTM, 2000), have been undertaken in the United States over recent years. Two studies have particular relevance for this investigation. Schoen et al. (2003) used observation criteria for reform-teaching practices that include open-ended questions, time to learn from investigations, as well as pair and small-group work. Ross, McDougall, Hogaboam-Gray and LeSage (2003) developed a 20-item survey based on nine dimensions of standards-based teaching that include several aspects of the focus of this study (student tasks, discovery, teacher's role, interaction and assessment). While the survey was found to have reliability and validity, the authors advise the use of observations to confirm teacher self-report data.

While teachers may have good intentions and plan to implement reform-oriented approaches, there is evidence that teachers in Australian contexts have not responded to this advice (Hollingsworth et al., 2003), with the suggestion that the culture of schooling and particular teachers' beliefs hinder the implementation of problem-solving approaches in classrooms (McLeod & McLeod, 2002; Stigler & Hiebert, 1999). There is a significant body of research indicating that teacher's knowledge and beliefs about the discipline of mathematics, teaching mathematics, and learning mathematics impact on classroom practice (Wilson & Cooney, 2002). In particular, Stigler and Hiebert (1999) argued that the differences between American and Japanese approaches to teaching mathematics could be explained by differences in teachers' beliefs.

However, it has also been determined that other constraints can impact on teachers' efforts to implement the working mathematical processes. In her investigation of reform in primary schools involved in the *Count Me In Too* professional development program, Bobis (2000) noted teachers' concerns about time, availability of resources and classroom management issues. Similarly, a study into primary school teachers' problem-solving beliefs and practices by Anderson, Sullivan & White (2004) identified several constraints including assessment and reporting practices, parent's expectations, students resistance to new approaches, system requirements of curriculum implementation, and large-scale testing regimes. Jaworski (2004, p. 18) describes such demands as "sociosystemic factors" suggesting that teachers have to regularly grapple with the tensions and issues that arise in their contexts.

One particular issue for teachers is planning reform-oriented experiences that maintain engagement and cater for the needs of all students (Henningsen & Stein, 1997). There is evidence from the TIMSS 1999 Video Study (Hollingsworth et al., 2003) that teachers plan to use different teaching strategies to teach higher achieving students compared with lower achieving students. However, even with higher achieving students, there was little use of higher-level processes or opportunities for reasoning as emphasised in the Working Mathematically strand. While teachers generally support reform-oriented teaching (Anderson et al., 2004), they appear to have difficulty operationalising it (Ross et al., 2003).

It is possible that teachers may not have an image of what this reform approach looks like in practice, or it may be that particular contextual factors interfere with their intentions. An ongoing concern of the problem-solving research has been the need for descriptions of classrooms where effective practice is occurring with an exemplification of the key role of the teacher (e.g., Clarke, 1997). Identifying successful teachers and providing rich descriptions of their efforts might support implementation for others, particularly if these teachers are able to overcome militating factors.

To investigate the implementation of reform-oriented teaching in NSW classrooms, the research questions for the study include:

1. Which reform-oriented teaching practices do primary school teachers report using?
2. Which particular teaching practices do primary teachers report using for each of the five processes of working mathematically?
3. What knowledge and beliefs distinguish teachers who successfully implement Working Mathematically?
4. How do teachers who successfully implement Working Mathematically cater for the needs of all students in the classroom?

Previous research suggests that teacher self-report surveys provide a relatively accurate picture of classroom practice but that there are some aspects of practice—particularly in the case of working mathematically—that cannot be easily measured in this way (Ross et al., 2003). For this reason, a combination of survey, interview and case study (including classroom observations) approaches were utilised in the study to explore teachers' understandings of working mathematically and their implementation of the various processes of the strand. Only results from the survey component will be discussed in this paper.

## **METHODOLOGY – SEEKING THE EVIDENCE**

A survey was used to determine whether teachers' 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).

There were three main parts to the survey. Part A was designed to collect essential background information about respondents and their school contexts. Part B was adapted from the Ross et al. (2003) instrument for measuring the extent to which primary teachers implement reform-oriented teaching practices. It contains 20 Likert items with a 5-point response scale ranging from Strongly Agree to Strongly Disagree. To guard against response bias, seven of the items were worded so that their scoring would be reversed. Ross et al. (2003) provide evidence of the instrument's reliability and validity. Using Cronbach's  $\alpha$ , a measure of internal consistency, they obtained a reliability coefficient of  $\alpha = 0.81$  in two independent studies. Part C of the survey contained four open-ended questions that explicitly focussed on teaching practices associated with working mathematically.

The aim of the survey was to produce a tentative picture of teacher beliefs and commitment to reform-based teaching practices, and to distinguish teachers—specifically those reporting the incorporation of working mathematically into their teaching—for inclusion in the interview component of the study. Approximately 100 surveys were sent to 12 primary schools located in the Sydney, metropolitan area that had been identified as supporting reform-oriented approaches. Descriptive statistics were used to analyse the items on the survey requiring quantitative responses (Parts A and B). The open-ended items in Part C were analysed according to emergent themes.

## RESULTS

Forty surveys were returned. Background information provided by teachers (Part A of the survey) indicated that there was a fairly even representation from each of the grade levels from Kindergarten to Year 6. Similarly, there was an even spread of years of teaching in each of the groups 1-5, 6-10, 11-15, 16-20, and 21 and beyond.

To assist analysis of Part B of the survey, the percentage of teachers indicating that they agreed (including strongly agreed), were unsure, and disagreed (including strongly disagreed) with each statement in the survey was calculated. While there is insufficient space to report the results for each item, we have selected some for discussion to support our analysis and complement the data provided in the open-ended response component of the survey. It must be emphasised, that we intended to use the information gained from the quantitative component as 'tentative', providing starting points for further exploration in the interview and observation components of the project.

As a whole, respondents seemed to be very well aware of what the reform-based movement recommends regarding the teaching and learning of mathematics. For example, 97.5% of respondents indicated that they agreed or strongly agreed with Items 1 and 3 ("I like to use maths problems that can be solved in many different ways", and "when two students solve the same maths problem correctly using two

different strategies, I have them share the steps they went through with each other” respectively).

Contrary to the general trend of responses, which were consistent with views expressed by reform-oriented curriculum documents, only 19.7% of respondents disagreed with Item 16 (“I like my students to master basic mathematical operations before they tackle complex problems”). This type of response is contrary to current curriculum documents that advocate the teaching of mathematics through or via problem-solving approaches (e.g., BOSNSW, 2002). Whether teachers are aware of such recommendations or simply disagree with them, it is clear that the majority of our respondents report not implementing such practices. More information on this issue may be gained during the interview component of the study.

Related to this view of mathematics, a quarter of teachers responding to the survey indicated that they considered “A lot of things in maths must simply be accepted as true and remembered” (Item 15). Similarly, 27.5% of respondents indicated their agreement with Item 19: “If students use calculators they don’t master the basic maths skills they need to know”. Both these responses are indicative of a more traditional view of mathematics. That is, mathematics is seen as little more than a series of facts, rules and procedures that must be learned.

While teachers rarely used the ‘unsure’ category, two statements attracted high percentages of responses in this category. 30.7% of respondents indicated that they were unsure of Item 12 (“Creating a set of criteria for marking maths questions and problems is a worthwhile assessment strategy”) and 27.5% were unsure of Item 18 (“Using computers to solve maths problems distracts students from learning basic maths skills”). The reasons for the higher than expected percentages of ‘unsure’ responses for each of these items, will be explored in follow-up interviews.

Part C required respondents to list the “specific teaching strategies” they use for each of the five processes of Working Mathematically. Descriptions of three of these processes are presented in Table 1 with samples of teachers’ responses.

Process	Description of the Process (BOSNSW, 2002a, p. 19)	Sample Teacher Response
Questioning	Students ask questions in relation to mathematical situations and their mathematical experiences.	Children work together in groups and solve maths problems, which encourage them to ask questions. (23)
Reasoning	Students develop and use processes for exploring relationships, checking solutions and giving reasons to support their conclusions.	Provide opportunities to compare and contrast results of an investigation – expect/encourage explanation of process/product (3)
Reflecting	Students reflect on their experiences and critical understanding to make connections with, and generalisations about, existing knowledge and understanding.	Building upon known concepts, using skills to extend understandings. Applying knowledge to everyday situations (18)

Table 1 Sample responses to three processes in Working Mathematically

The majority of the 31 teachers, who responded to Part C, seemed to be familiar with each process and the associated teaching practices recommended in reform documents. However, some respondents appeared to be more informed than others. To identify those teachers, an adaptation of the Schoen et al. (2003, p. 236) observation criteria for reform teaching practices was used to rate the responses. These criteria (presented below) were used to make holistic judgements about participants' reported level of implementation of reform-oriented practices.

1. The teacher uses open-ended questions to facilitate student thinking and exploration.
2. Students monitor their own work instead of always seeking out the teacher as the authority.
3. Students are given enough time to learn from investigations.
4. Class organisations (i.e., whole-class presentation or discussion, pair or small-group work, and individual work) match expectations for each part of the lesson.
5. Pairs or small groups of students work collaboratively.
6. Manipulative materials are available.
7. The teacher focuses on understanding of the big mathematical ideas by questioning understanding and using problem-solving strategies.

Using these criteria, the response of each participant to the open-ended question was judged as excellent, good, fair, or poor according to the number of criteria that were explicitly addressed. From this, the responses of two participants were rated as excellent, five as good, 17 as fair, and 7 as poor. The responses from those teachers who were rated as fair or poor were either limited in information, repetitive in the practices employed, or suggested that more traditional practices were typically used. For example, an experienced teacher of a Year 3/4 class reported that she uses a "whole class focus first then one to one – needs lots of examples and practise, concrete material or practical applications" for Applying Strategies. This individual focus was repeated for Reflecting with the additional strategy of "sometimes we meet as a group at the board and discuss" for "students who are experiencing difficulties or simply don't understand". These comments were consistent with her responses to the reform-oriented practices in Part B of the survey. Again, this data provides tentative information as respondents may not have given much thought to their responses or they may not have had sufficient time to think deeply about their practice. However, this process helped to identify participants for the interviews and classroom observations.

Ten survey respondents (25%) indicated their willingness to participate in the follow-up interview component of the study. Data from all parts of the survey were considered to develop initial 'profiles' of these teachers so as to determine which teachers we should include. Eight of these teachers had profiles that were very closely aligned with the practices recommended by reform-oriented documents. All

eight indicated that they explicitly planned for Working Mathematically either all of the time or at least for approximately 70% of their mathematics lessons. Interestingly, the three teachers with profiles considered to be closest to reform-oriented practices, teach at the same school. The interview component will hopefully reveal if there are any contextual factors operating at the school that may contribute to such a result.

The responses of the other two teachers who volunteered to participate in the interview component of the study were among those respondents who showed least consistency or familiarity with reform-based practices. One teacher indicated that she did not explicitly plan for Working Mathematically, while the other indicated that she planned for approximately 90% of her lessons. Again, what this planning actually entails will be explored further in the interview component of the study.

## DISCUSSION AND FURTHER RESEARCH

Considered together, the qualitative and quantitative data gained from the survey provide tentative information (Wilson & Cooney, 2002) and a starting point from which we can now continue to explore aspects of teachers' practices. It would appear that the majority of these teachers support reform-oriented teaching approaches that promote working mathematically in primary classrooms, particularly in a self-report survey. While most responses were consistent for both sections of the survey, a careful reading of the open-ended responses suggests that this may not be what is implemented in practice. Further exploration through interviews and observations is required before in-depth claims can be made.

The next step in our project is to explore particular teacher's practices in detail to form a picture of the successful implementation of working mathematically for *all* students and how teachers confront the sociosystemic factors operating in school contexts. As Wilson and Cooney (2002, p. 131) propose

in-depth studies of individuals emphasise the value of telling stories about teachers' professional lives and what shapes those lives ... good stories are not simply descriptions but are grounded theoretical constructs that have the power to explain what is described.

The knowledge gained from this project has the potential to impact on the implementation of working mathematically in classrooms. It will clarify for teachers what working mathematically actually looks like and provide models of best practice. It will present teachers with evidence that *all* students are able to participate in challenging experiences regardless of their performance on tasks that assess basic skills in mathematics. It will provide teachers with strategies to cope with the tensions and issues that may impede implementation of the Working Mathematically strand.

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