

Teacher Collaboration in Developing Rich Assessment Tasks in Mathematics as a Professional Development Activity

Shelley Dole

University of Tasmania Launceston

Steven Nisbet

Griffith University Mt Gravatt

Elizabeth Warren

*Australian Catholic University
Mitchelton*

Tom J Cooper

*Queensland University of Technology
Kelvin Grove*

In a context of system-wide changes to mathematics assessment, primary (elementary) school teachers were brought together to develop a package of exemplary assessment tasks, rich in potential to provide data on students' mathematical understanding and knowledge, and relating to a new assessment framework. Through involvement in writing, the teachers were able to guide their own professional development and consequently improve their teaching and assessment practices. The writing team situation provided teachers with support, feedback, and opportunities for reflection; as well as assisting them to gain confidence in using and understanding the assessment framework. This paper reports the teachers' reactions to the collaborative writing process and evaluates the effectiveness of collaborative developments, of this form, as professional development. The teachers' responses to the program indicate that it was effective in improving confidence, knowledge and understanding with respect to mathematics teaching, learning and assessment because it provided opportunities for support, feedback and reflection on trials of ideas in classrooms.

Traditional teaching strategies produce a shortfall in mathematics learning that requires changes in curricula and teaching practices (Heckman & Weissglass, 1994). Teachers tend to change their practice as a consequence of changing their beliefs and attitudes (Clarke & Hollingsworth, 1994; Cooney & Shealy, 1995), and resist change due to these beliefs and attitudes as well as their experience (Grimison, 1993; Mousley, 1991). Teachers change their beliefs and attitudes when they observe an improvement in their students' performance as a result of their teaching (Berliner, 1986). The implication of this literature is that, to change practice, teachers should be exposed to new teaching ideas and encouraged to trial the ideas in their own classes. If the trial produces positive results, it is likely that the teachers' beliefs and attitudes will change, leading to a change in teaching practice.

This position is supported by Guskey (1985), Guskey and Sparks (1991) and Smylie (1988), who found that the effectiveness of professional development is enhanced if teachers have opportunities to trial new ideas in their own classrooms, assess student understanding, and share feedback with colleagues. Similarly, de Lange (1992) found that an integrated approach, which provides teachers with time to experiment, gain experience, build confidence and focus on assessment, was crucial to the success of professional development projects. The implication of this is that professional development programs will be more successful if activities are

of a collaborative style rather than top-down transmission style. Collaboration can provide the necessary network of support and learning. Meador (1995) argued that collaboration facilitates professional development, and can enhance teachers' efficacy beliefs that Brownell and Pajares (1996) found were the highest predictors of reported success in teaching.

Research into professional development for change in teaching practice (e.g., Borko, 1997; Clandinin & Connelly, 1991; McLaughlin, 1990) has proposed the following principles for effective professional development:

1. Teachers' prior beliefs and attitudes are important elements in the change process.
2. Worthwhile and enduring change is a slow process that requires commitment and risk from teachers.
3. Collegial support in the form of regular meetings and discussions is an important factor to the change process.
4. Experience and reflection are necessary for effective change and input is needed from sources outside the schools to facilitate this reflection and to clarify and introduce different ways of considering situations.
5. Teachers' perceptions of successful and improved student learning is crucial to the success of the change process.
6. Teachers need experience with new strategies before they will change their attitudes and beliefs about them (awareness and knowledge of new strategies is not sufficient for their adoption in the classroom).
7. Senior school staff support and commitment is a crucial component of successful school change.

Of course, there can be different levels of success in professional development and teacher change. Clarke and Hollingsworth (1994) proposed that teacher change can be viewed from six different perspectives:

- change as training, where professional development programs provide teachers with appropriate teaching skills and/or where inappropriate teaching practices are identified and corrected in an "evangelistical" manner (p. 154);
- change as adaptation, where teachers change as a result of a change to the working environment (e.g., increased class size, new school policy);
- change as personal development, where teachers themselves identify their own needs and seek to develop additional skills and strategies to improve their classroom performance;
- change as local reform, where teachers work together to change their working environment;
- change as systemic restructuring, where teachers must respond to and implement change imposed by external bodies; and
- change as growth or learning, where teachers come together as a group to discuss and work through issues of significance to initiate and sustain change.

Assessment and Collaborative Writing

Assessment is a prominent component in current reforms in mathematics teaching practice (Borko, 1997). There is a strong connection between curriculum and assessment in increasing student achievement (as Neapolitan, 1997, found in her study of lead teachers). Changes to constructivist teaching approaches appear to increase the use of alternative assessment (Brosnan, 1994).

A common way in which assessment becomes part of reform programs is in terms of collaborative writing of assessment tasks (e.g., Borko, 1997; Cooney & Shealy, 1995). This collaboration appears to have a strong impact on teaching practices as well as assessment practices (Cooney & Shealy, 1995). As Borko (1997) summarised when discussing the results of an assessment writing program, most mathematics teachers "modified their instructional programs to include a greater emphasis on problem solving, conceptual understanding and student explanations" (p. 233). The changes in teaching practice as a result of collaborative writing appear to be mediated by the teachers' beliefs (Cooney & Shealy, 1995). Again, as Borko (1997) has summarised, "When beliefs remain unchanged, teachers typically either ignore ideas ... or they inappropriately assimilate new ideas" (p. 237).

The central features of teacher-writing programs, for assessment or other purposes, are that teachers work together in groups with a mentor, supporting each other as they write (e.g., Blau, 1988). When these programs focus on the development of curriculum ideas, they generally involve the teachers in trialing their ideas in classrooms and, therefore, receive feedback from both the students and the writing group. The sharing and discussion involved in the collaborative act ensures that the participating teachers reflect on their writing both before and after the trials. For example, the Santa Barbara Classroom Discourse Group (1995) demonstrated that teachers are able to establish communities of collaborative writers and that these communities can produce effective curriculum materials and increased general confidence in teaching. As Heckman and Weissglass (1994) stated, "Learning occurs within the context of cooperation. The gains of the individual feed the gains of the group" (p. 32).

This paper

The interesting aspect of collaborative writing and trialing of assessment materials is that the teachers are involved in many of the activities that the literature on teacher education indicates support change and development (Borko, 1997; Guskey, 1985; Guskey & Sparks, 1991; Smylie, 1988). This conclusion is confirmed by research studies involving collaborative writing of assessment tasks (Borko, 1997; Cooney & Shealy, 1995).

This paper reports on the effectiveness of the professional development of one group of teachers who were brought together to develop open-ended mathematical activities which could be used to assess a wide spectrum of levels and types of mathematics knowledge (such activities are called *rich assessment tasks*). The paper evaluates the effect of the collaborative writing process on teachers' knowledge, beliefs and confidence with respect to assessment and teaching in mathematics.

Method

The methodology used in the study was participant observation (Spradley, 1980). One member of the research team established the role of participant observer with a group of teachers. She organised and facilitated the group's meetings. The level of involvement was what Spradley (1980) called *active participation*; in this case, the researcher interacted fully with the teachers.

Context

In Australia, performance based assessment for mathematics was proposed in the *Mathematics: A Curriculum Profile for Australian Schools* (Australian Education Council, 1994), a Federal Government document describing a framework for recording and reporting student performance in mathematics. The Profile was based on the *National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991) which organised the mathematics curriculum into six strands (Number, Space, Measurement, Chance and Data, Algebra, and Working Mathematically) with eight student performance levels spanning the compulsory school years 1–10. The Profile was adopted as an assessment and reporting framework by the Education Department in the state of Queensland, and retitled as *Student Performance Standards in Mathematics for Queensland Schools* (Department of Education, Queensland, 1994).

The implementation of the Standards in Queensland schools was problematic in many ways. First, the organisational structure of the Standards was fundamentally different from that of the existing *Year 1-10 Mathematics Syllabus* (Department of Education, Queensland, 1987). Second, teachers found that mapping student assessment data onto the Standards was not a simple task; the new assessment criteria required alternative forms of assessment to traditional pencil and paper tests (Bleicher, Cooper, Dole, Nisbet, & Warren, 1996). Hence, the introduction of the Standards required teachers to view the mathematics syllabus from a different perspective, and to expand their range of assessment practices to include strategies such as practical work, student observation, investigations and projects. Thus, the implementation of the Standards in Queensland met with a lot of teacher resistance (Bleicher, et al., 1996).

One reason for the resistance was that the implementation of the Standards required a change in teachers' classroom practices. Therefore, to assist this change in practice, Australian Government funding was provided for professional development that provided teachers with teaching, assessment and reporting methods related to the Standards.

One of the projects to receive funding is the focus of this paper. It sought to produce a package of assessment tasks which had been trialed in classrooms and found to provide rich data on students' mathematical performance. The purpose of the package was to provide teachers with ideas for assessment and to exemplify how mathematical activities, alternative to pen and paper timed tests, could be used in the classroom for assessment purposes. Trialing of the tasks was included to enable the richness of the tasks to be evaluated. It was hoped that the package could be a resource for teachers implementing the Standards. It was also anticipated that

involvement in the project would provide the teachers with an opportunity to become more familiar with the Standards.

Subjects

The teachers in this study were 12 primary school teachers (six female and six male) and two group facilitators, one of whom was the researcher. The teachers volunteered for the project as a result of a letter sent to schools. Although the Standards document was written for Years 1 to 10, only primary teachers replied to the letter.

Data collection

Data were collected through *field notes* based on the researcher's observations and ad hoc or conversational group interviews, plus an end-of-program *feedback survey* to ascertain the effect of the collaborative writing process on the teachers. The feedback survey covered positive and negative aspects of the program, changes in teaching and assessment practices, attitudes to the Standards assessment and reporting framework, effectiveness of the support networks, suggestions for improvement, and confidence in conducting similar programs.

Procedure

The twelve teachers and the two facilitators met together four times over a four-month period during the school year. The meetings each lasted a whole day and were organised in a three-session format as follows.

1. *An opening discussion session:* at the first meeting, the teachers discussed assessment issues, and in the second, third and fourth meetings they shared their experiences in trialing the newly-written assessment tasks.
2. *A brainstorming session:* at the first, second and third meetings, the teachers brainstormed new assessment ideas and techniques in small groups, and at the last meeting they refined the assessment tasks.
3. *A trial-planning session:* at the first, second and third meetings, teachers planned the trials of the assessment ideas from the second session, and at the final meeting they organised final writing and publishing of the set of tasks.

This session format afforded the opportunity for teachers to share their classroom experiences of trialing new ideas and techniques of assessment with critical friends/colleagues. At the end of the final meeting, the teachers completed the feedback survey.

Results

Data were collated and analysed using a constant comparative method (Guba & Lincoln, 1989). The field notes of the observations and interviews were collated and summarised. The survey responses were collated, categorised and summarised and combined with field notes to give a rich description of the professional development

activities. Themes emerged through the discussion and re-examination of the entire corpus of data that helped explain the relationship between the professional development activity and the kinds of classroom experiences and attitudes reported by teachers.

This analysis is reported in six parts. First, to contextualise the analysis, the teachers' responses to the collaborative writing process in the meetings are briefly described. Then, to structure the reporting of the results, the teachers' reactions to the collaborative writing as a professional development are presented under the headings relating to the five major components of the process. These components are inherent to the structure of the collaborative writing process: (a) it provides teachers with *support*; (b) it offers *feedback*; (c) it allows opportunities for *reflection*, particularly with respect to classroom practice; (d) it increases teachers' *confidence* in their own ability to write their own assessment tasks; and (d) it improves *knowledge* and *understanding* of profiles, assessment and reporting.

The Meetings

Overall, the teachers reported that their knowledge and confidence grew in richness and depth over time, meeting by meeting. The teachers believed that the meetings were worthwhile and were important as learning experiences. They also appreciated the opportunities to trial ideas in their classrooms. They valued both the meetings and the trials, and stated that the positive experiences in the early meetings provided the motivation to attend subsequent meetings. They were able to prepare assessment tasks that they were happy to use in their own classrooms (Dole, 1996). In the third and fourth meetings, teachers expressed feelings of belonging to a valued group of colleagues. In the final meeting, the unanimous feeling of the group was the wish for such meetings could continue throughout the whole school year. In working with her colleagues, one participant commented that, "To recognise the wealth of collective knowledge is exhilarating".

Support

All of the teachers indicated that having the opportunity of sharing their successes and difficulties from their own classroom experiences, was a highly appreciated aspect of the activity. For most, this was a new experience; they had very rarely been afforded the opportunity of sharing their teaching experiences with colleagues at any length in the past. This support for sharing became a valued aspect of the model. All of the teachers agreed that the genuine interest shown by their colleagues in listening to each other's classroom experiences was highly motivating and supportive.

The following comments from the teachers illustrate this view and indicate how the teachers perceived the collegial support provided at meetings:

meeting and working with teachers from other schools was a highlight

the relaxed atmosphere made it easy to express all concerns about mathematics teaching and learning

within a professional environment, being able to share resources, ideas and concerns was very supportive

It was evident that teachers developed increased self-efficacy and confidence in their teaching and assessment skills. They also stated that they now believed they could successfully add new teaching and assessment techniques to their repertoire.

Feedback

The teachers consistently expressed their appreciation of the advice and constructive criticism they received from colleagues at the meetings. They felt that receiving immediate feedback through the meetings not only helped future planning, but also added to the belief that colleagues were interested in one another's work. They stated that they would have been disappointed if the sharing of experiences had stopped.

The teachers clearly expressed the view that the 'bottom line' or an important issue for them was whether their practice made a difference to student learning in their classrooms. Time available for the activities was always a constraint in this matter. The teachers needed enough time during classroom activities to be able to perceive improvements in student outcomes, whether the activities were especially identified for assessment or not. Instances where student interaction during an assessment activity was immediately perceived as positive were particularly motivating for the teachers. The teachers perceived interactions as positive if they believed that there was an improvement in the nature of student response elicited in such situations.

The following comments from the teachers illustrate the importance they gave to feedback:

It provided an opportunity to obtain feedback advice on assessment tasks.

It re-affirmed my beliefs about teaching, learning, and assessing.

My ideal was always that teaching and learning tasks could be used for assessment, but that 'nervousness' of 'that it may not be enough' has been allayed more.

I'm more selective - willing to discard activities which are limiting in results.

Feedback made me think more carefully about what I am assessing and adjust tasks to suit

[Feedback] has given me more ideas on how to assess and set tasks that are relevant.

Reflection

The structure of the professional development activities was such that the teachers were given opportunities to share with their colleagues the tasks they had written and their students' responses to these tasks. This sharing encouraged reflection, both on the assessment practices and on the collaborative writing process itself. This had two outcomes. The reflection on assessment provided the teachers with a depth of understanding that they would not have otherwise gained and improved the quality of the written products. The reflection on the process highlighted the positive role of the other teachers and the success of the program. This in turn improved the morale of the teachers and promoted confidence and self-esteem. The following comments from the teachers support these points:

I am aware of not limiting the students to what they can demonstrate they are capable of doing (i.e. certain forms of writing assessment as those which appear in the sourcebook).

While trying to ensure the basic facts and concepts are thoroughly covered, I am introducing more varied and challenging tasks – not all for assessment.

I have gained more of an insight into assessment and how it affects me and my teaching style.

I'm more aware of varying abilities.

I now have the children write more of what they verbalise during maths lessons because I see this skill as being a vital part of documentation and it must be taught so that children gain experience in it.

I am aware of children's difficulties when they write responses – this is a whole new ball game for them.

I use more ways in which students are given opportunities to verbalise and explain the outcomes of math situations.

Confidence

The professional development activities provided the teachers with a sense of reassurance. They became aware that their own personal feelings of insecurity in implementing the Standards were not uncommon amongst fellow teachers. They also became aware that their efforts towards implementing the project were as good as most teachers. This gave rise to increased confidence. The following comments confirm this point:

realisation that you are not alone (mathematics wise)

the ultimate ego boost of seeing that what you're doing is OK

appreciating that the same difficulties are faced by others

to discover that people have the same concerns as I have

to know that other teachers were experiencing the same difficulties as oneself is encouraging and supportive

exchanging fears and frustrations [the meetings] have increased my awareness of fellow teachers' problems in applying SPS [Student Performance Standards] to their teaching

Knowledge and Understanding

The teachers commented that they found the exercise of writing the tasks a professional development process that had a positive influence on their knowledge and understanding of the Standards. This is supported by the following comments:

definitely clarified the link between the syllabus and the Standards' outcomes

demonstrated a more effective method of data collection

I have oscillated from negative to positive, to negative to positive, to reserved positive as I have had more involvement with the Standards

probably my attitude is more positive than previously

because I am much more familiar with the Standards, I no longer find it threatening reaffirmed (rather than changed); I'm on the right track. [Meetings have] certainly made [the Standards] less ominous, not to be dreaded; boosted confidence, even raised enthusiasm.

I understand the positive aspect of the Standards, that is, children's control over assessment, children's responsibilities for assessment, and assessment of what children can do.

a broader understanding of the Standards' levels and strands, and therefore confidence in assigning levels to students' work.

Discussion and Conclusions

The findings support the conclusion that participation in the collaborative writing activity was an effective means of changing teacher practice and increasing confidence. In particular, participation in the collaborative writing professional development process appears to be a viable means for effecting change in practice, while, at the same time, nurturing teacher confidence.

Simplistically, the introduction of the Standards aligns with Clarke and Hollingsworth's (1994) fifth perspective, change as systemic restructuring, where the location of change is external and the teacher's role is that of implementer. The object of change is the curriculum, and the character of the professional development programs is systemic. However, as Clarke and Hollingsworth argued, the perspectives are not mutually exclusive and systemic restructuring may cause teachers to change in accordance with other perspectives. This seemed to be the situation in the collaborative writing professional development activities. Teachers appeared to be undertaking the activities for personal development (third perspective). They also went through an adaptation process (second perspective) as a consequence of involvement in the professional development. However, overall, the project acted at the highest perspective of change identified by Clarke and Hollingsworth (1994), change as growth and learning.

The reasons for the project being effective in terms of change appear to be that all seven factors that promote effective professional development identified by Borko (1997), Clandenin and Connelly (1991) and McLaughlin (1990) are satisfied by the process of teachers' collaborative writing. Especially prominent were the following principles:

1. Collegial support in the form of regular meetings and discussions is an important factor to the change process.
2. Experience and reflection are necessary for effective change and input is needed from sources outside the schools to facilitate this reflection and to clarify and introduce different ways of considering situations.
3. Teachers' perceptions of successful and improved student learning is crucial to the success of the change process.

4. Teachers need experience with new strategies before they will change their attitudes and beliefs about them (awareness and knowledge of new strategies is not sufficient for their adoption in the classroom).

The teachers were clearly influenced by the strong perception that their practice made a difference to student learning in their classrooms. The time element proved to be important; it was optimal for teachers to be able to perceive an improvement in student outcomes during classroom activities, whether they were especially highlighted for assessment or otherwise. Especially motivating were instances of students interacting directly with the teacher in the context of activity-based assessment tasks in ways perceived by the teacher to be an improvement on the kind of interaction formerly elicited in such situations.

Overall, the results support the following three conclusions:

1. The collegial support of the collaborative writing process resulted in increased confidence for the teachers with respect to their teaching and assessment practices in mathematics.
2. The collegial feedback from the classroom trials and discussion with other teachers improved the teaching and assessment ideas of the teachers.
3. The teachers' individual reflections on classroom practice stimulated by the collaborative writing process improved both the teaching and assessment practices of the teachers and students' learning outcomes.

The attitudes and beliefs of the teachers, particularly their confidence and self-esteem, were positively influenced by their participation in the program. Hence, the results of this study support the findings of Clarke and Hollingsworth (1994) and Cooney and Shealy (1995) that changes in teaching practice are preceded by changes in attitudes and beliefs. Further, the results support the findings of Berliner (1986) that beliefs and attitudes change when student outcomes are seen to improve, and the findings of Borko (1997) and Guskey and Sparks (1991) that trialing and sharing are crucial for effective professional development.

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Authors

Shelley Dole, School of Education, PO Box 1214, University of Tasmania, Launceston TA 7250.

Steven Nisbet, Faculty of Education, Griffith University, Mt Gravatt QLD 4111.
E-mail: <S.Nisbet@edn.gu.edu.au>

Elizabeth Warren, School of Education, Australian Catholic University, PO Box 247, Everton Park QLD 4053. E-mail: <E.Warren@mcauley.acu.edu.au>

Tom J. Cooper, Centre for Mathematics and Science Education, Queensland University of Technology, Kelvin Grove QLD 4059. E-mail: <tj.cooper@qut.edu.au>