Searching for classroom RATs (Rich Assessment Tasks)

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To implement the national profile for reporting student mathematical achievement requires alternative assessment strategies. A team of classroom teachers was brought together to prepare a package of rich assessment tasks (RATs), evaluated for their potential in assessing mathematical performance and aligning the profile. The search process highlighted issues as the need to match assessment to the classroom context, and the changing role of teacher and students through varying assessment procedures, resulting in production of tenets for developing and evaluating RATs.

Background

With the advent of the *National Statement on Mathematics for Australian Schools* (Australian Education Council, 1990), there has been increased emphasis on broadening approaches to teaching and learning mathematics in order to achieve the goals of school mathematics. The stated goals of school mathematics are that students will develop confidence and competence for dealing with situations involving mathematics in their daily lives and positive attitudes towards mathematics; be able to use mathematics to solve problems, communicate mathematically, and utilise modern mathematical tools and techniques; and experience the investigative process through which mathematical ideas have developed (Australian Education Council, 1990). Similarly, of the goals for school mathematics the National Council for Teachers of Mathematics (NCTM)(1989, p. 4-5) have stated that " today's society expects schools to insure that all students have an opportunity to become mathematically literate, are capable of extending their learning, have an equal opportunity to learn, and become informed citizens capable of understanding in a technological society." In order to achieve such goals, a variety of teaching approaches are advocated, including directed teaching, activity-based learning, discussion, application and problem solving, and open investigations (Australian Education Council, 1990; Cockcroft, 1982; Department of Education, Qld, 1987).

The organisational structure of various mathematics curriculum documents has seen the specification of components other than content/concept topics (e.g. number, measurement, space) including processes (e.g. justifying, inferring, validating) and affects (persistence, confidence, interest and enjoyment)(Department of Education, Qld 1987); mathematical reasoning, communication, problem solving, connections (NCTM, 1989); attitudes and appreciations, mathematical inquiry, choosing and using mathematics (Australian Education Council, 1990); working mathematically (Australian Education Council, 1994). With the inclusion of such strands within the mathematics curriculum, it would appear that teachers need to construct teaching and learning situations alternative to directed teaching approaches in order to provide students with opportunities to be engaged in and develop such mathematical processes.

With calls for variety in instruction for school mathematics there has been corresponding calls to make mathematics assessment match the teaching and learning process (e.g. Australian Education Council, 1990; Clarke, 1992; Department of Education, Qld, 1987; NCTM, 1989;Stenmark, 1989). Assessment has a significant influence on students' learning of mathematics, as Boud (1995, p. 3) has stated "every act of assessment gives a message to students about what they should be learning and how they should go about it." Assessment communicates to students what the teacher values most in the curriculum, thus, what the teacher emphasises and regularly assesses will be what students consider important aspects of instruction (Lester and Kroll, 1991). Therefore, if such processes as problem solving, communicating, reasoning, are valued mathematics goals and an integral part of the mathematics curriculum, then assessment must provide students with feedback on how well they are moving toward achieving such goals, while simultaneously communicating to students their value in the study of mathematics.

According to NCTM (1989), assessment in mathematics serves two functions; it is as a means of providing students with information on their achievements in mathematics, and it informs the teacher, providing direction for further teaching. As they have stated, "assessment should provide a biography of students' learning, a basis for improving the quality of instruction" (p. 203). Therefore, students and teachers are key stakeholders in the assessment process. It is the teacher's role to ensure that assessment is meaningful for students, and not a confidence deflating exercise. As Clarke (1995) has stated, "the purpose of assessment is to make explicit children's achievements, celebrate their achievements with them, then help them to move forward to the next goal." The notion of assessment as a celebration is a novel perspective, but aligns descriptions of change in emphasis in assessment in mathematics. As suggested by NCTM (1995), assessment should be concerned with what students know and how they think, rather than informing them of what they don't know; of providing potential for students to apply a number of mathematical ideas rather than testing isolated mathematical skills via exercises and work problems; of enabling students to respond mathematically in a variety of ways, including written, oral, symbolic forms; of providing opportunities for students to demonstrate their mathematical knowledge continually rather than restricting assessment to specific times on specific days.

In order to build a holistic picture of students' mathematical abilities, rather than focussing on areas of weakness, gathering of data from a variety of sources is required. Enabling students to engage in cooperative problem solving and open investigations for assessment purposes can provide teachers opportunities to collect data on which to draw together other fragmented assessment data into a cohesive picture (Stenmark, 1989). As Lovitt (1994, p. 5) has stated, problem solving and investigations, "by their nature can allow us to see how a pupil is developing in ways that fixed closed sets of exercise never can." The difficulty in using such problems for assessment purposes, Clarke and Reed (1992, p. 23) have suggested, is due to individual teacher's conceptions of the discipline of mathematics. As they have stated, there is a "conflict of paradigms between a conception of mathematics as a catalogue of distinct and disjoint skills assessed by targeted test items, and a conception of mathematics as a network of behaviours which are not acquired hierarchically, are not practiced independently, and cannot meaningfully be assessed in isolation from one another." Problem solving tasks as assessment items, Clarke and Reed have contended, provide truer indications of students' mathematical knowledge and understanding, because it is in such situations that students choose the mathematics they wish to use, not procedures they have studied prior to a formal test/exam. Observing students selecting mathematics thus provides a deep insight into the effectiveness of the teaching and learning process.

Of the assessment situation itself, Clarke (1992) has starkly distinguished the difference between formal and informal assessment, stating that *formal assessment* "involves the cessation of instruction, typically for the whole class, while the assessment 'event' is held"; contrasting *informal assessment* as the "collection of information about students' learning coincident with instruction, without disrupting the learning process." (p. 157). Clarke has further added that informal assessment should not necessarily be interpreted as unstructured, unfocused, unplanned, ad hoc, or non-legitimate. It appears that formal assessment in one means of gathering data on students' mathematical performance, but informal assessment is an ongoing process which melds fluently with the teaching and learning situation. Thus, gathering information about students' mathematical knowledge and ability in an informal, yet structured way, can occur whilst students are engaged in investigations and problem solving activities. Informal assessment then, enables a variety of assessment procedures to be utilised, such as observation schedules, checklists, student self-evaluation and reflective writing, mathematical reports, group investigations (Stenmark, 1989). In this way assessment aligns the teaching situation.

As previously stated, current mathematics curriculum documents, in describing the goals of school mathematics, provide a framework for curriculum development, stressing the importance of using a variety of teaching and assessment practices in order to achieve stated goals. Companion to the national statement on mathematics for curriculum development (Australian Education Council, 1990) has been the advent of the national profile (Mathematics - A curriculum profile for Australian School, Australian Education Council, 1994) as a framework for recording and reporting student achievement in mathematics. Developed at a national level, it has been adopted in varying degrees throughout states of Australia. In Queensland schools, the national profile was adopted completely in 1994, and retitled "Student Performance Standards in mathematics for Queensland schools" (Curriculum Corporation, 1994) and acronymed SPS. The national profile (SPS in Queensland), while aligning with the organisation of the national statement, is fundamentally different to the organisation of the Queensland Years 1-10 mathematics syllabus (Department of Education, Qld, 1987). As a reporting framework the national profile requires that student performance be assigned a level (on a scale of 1-8, with 1 being the lowest) for each of the six strands of *working mathematically*, *space*, *number*, *measurement*, *chance and data*, *algebra*. In 1995, Queensland state school teachers of Years 1-8 were directed to report on student achievement in the three strands of *space*, *number*, and *measurement*. Thus, by its very structure, the national profile required changes to the reporting practices employed by teachers in Queensland schools. It may be expected that a mandated change to reporting practices through the implementation of SPS would meet with a lot of teacher resistance, and this has been found to be the case (Bleicher, Cooper, Dole, Nisbet, & Warren, 1996). However, as Lovitt (1994) has suggested, the national profile does provide a type of curriculum audit framework, because the profile strand of *working mathematically* must become an integral part of teaching and learning. If teachers cannot determine the level to which students in their classrooms, for example, can apply problem solving strategies, test conjectures, investigate and explore problems, verify conclusions, then students have not been given the opportunity to do so. Of the national profile, he has stated "I like them. They seem [to me] like one of the last pieces of a big jigsaw, legitimising and confirming many of the fragments of educational growth over the past many years and importantly bringing those fragments together in a way that allow us to get an overview of the whole classroom process"(p. 4). Teachers found that, in order to report on student mathematical achievement using SPS, assessment data from, for example, traditional pen and paper tests, was difficult match to SPS outcomes.

To assist teachers with implementing SPS, systemic inservice was provided to teachers in Queensland state schools. In an effort to further support teachers to implement the national profile, the Queensland Association of Mathematics Teachers/Professional Development Project (QAMT/PDP) sought to produce a package of rich assessment tasks (RATs) which had been trialled in classrooms and found to provide rich data on students' mathematical performance, and thus align with SPS. This paper reports on this project in which practicing classroom teachers were brought together for the purpose of writing rich assessment tasks; tasks which had been developed and trialled at a 'grass-roots' level by teachers for students in their own classroom. This report addresses two main dimensions of the project: (i) particular episodes which influenced the process of developing and evaluating alternative assessment tasks; and (ii) teachers' perceptions of their changing role as a result of implementing alternative forms of assessment. A summary of the writing process is presented in the form of tenets for developing and evaluating RATs.

The study

The study was qualitative, using participant observation (Spradley, 1980). The researcher was co-ordinator of the writing team, participating in the writing process, and observing the team as it interacted, as well as providing guidance and direction for all team meetings. The writing team consisted of twelve teachers (6 female, 6 male) representing 12 primary schools in a regional cluster. The teachers had been nominated by their school principal to participate in the project. The years of teaching experience of the team ranged 3 to 35 years; 3 teachers were currently teaching in the lower school (Years 1-3), 4 teachers were currently teaching in the middle school (Years 4-5), and 5 teachers were currently teaching in the upper school (Years 6-8). The team meetings were held at a venue removed from the teachers' school situation. Each full-day team meeting was organised into 3 sessions. The first session was a whole group discussion/feedback session where participants described assessment initiatives trialled, and discussed issues relating to alternative assessment in mathematics. The search for rich assessment tasks (RATs) began in the second session. In groups, participants perused mathematical resources and brainstormed ideas for assessment tasks which could be used in the classroom. In the third session, having taken ideas from session 2, the participants worked either individually or in pairs to plan for implementation of the tasks developed in their classrooms. The trialing of tasks was by participants in their own classrooms, and results reported back to the group at the next meeting. There were four team meetings in all for the duration of the project, which spanned 4 months of the school year. Data for this study was collected by observation, fieldnotes and by gathering of teachers' work in progress.

Results and discussion

The process of trialing assessment tasks

The process of developing and trialing alternative assessment tasks highlighted particular issues as (i) the need to give students experience with novel tasks before using them for assessment purposes; (ii) the need to trial tasks with pupils to assess the value of the tasks for assessment purposes; (iii) the individual teacher's need to feel comfortable with alternative tasks, and how familiar assessment tasks can be built on to provide stepping-stones for implementing more open investigation; (iv) how alternative activities enabled students to demonstrate mathematics connections; and (v) how tasks developed by others, unrelated to any teacher's classroom context were trialled as 'activities' rather than assessment tasks. Each of these issues will be discussed under the following headings: (i) *familiarising students with mathematical investigations*; (ii) *trialing tasks*; (iii) *starting small, taking "risks"*; (iv) *valuable assessment data from "chaos"*; and (v) *teacher-made tasks; other tasks.*

Familiarising students with mathematical investigations: Upon implementation of certain investigative tasks developed, it was found that little mathematical data could be collected. One team member developed a Number activity for her Year 3 class involving manipulation of numbers shown on 3 dice. For this group activity, the students were required to roll 3 dice, and operate on the 3 numbers shown (using addition, subtraction, multiplication, and/or division) in an effort to reach a designated total. A record sheet was provided for the children to write their mathematical sentences and keep a running total of their score. As the activity was novel to the children, the teacher found that she was required to assist children in completing their record sheet, help children check their calculations, adjudicate on the legitimacy of the dice throwing, and so on. The teacher had anticipated that she could gather important information on children's mathematical performance as the students engaged in the activity, particularly by noting which children could competently operate on the numbers, which children used problem solving strategies, which children showed evidence of using mental computation. The teacher evaluated this activity as a fun and worthwhile mathematical activity, which gave all students an opportunity to work in groups. As an assessment task, the teacher found that it yielded little useable information as she had no time for observation of students' performance. Upon reflection of the classroom trial of this task, the teacher made modifications to the worksheet and the rules of the game. Through retrialing, the teacher found than the task provided the type of data she had anticipated to gather in the first instance.

Trialing tasks: Some tasks trialled were found to be unchallenging to students, or students did not provide depth of response anticipated by the teacher. One teacher developed a measurement activity related to a golf course. The task required students to measure distances to putting greens on a scale drawing of a golf course, to plot their course, and to throw a dice to get to the flag. The teacher produced a high quality game board plan of the golf course, detailing bunkers and water hazards. Upon implementing this activity, the teacher found that the students totally disregarded any measuring, and completed their round of golf by engaging in little mathematical calculation. In evaluating this activity, the teacher reported that, for his Year 6 class, it yielded little information about his students' measurement and number ability. The need to trial a task in order to determine its richness appeared to be an important element in the process. As the team member noted, "It is sometimes difficult to initiate tasks. What seems good here [writing team meetings] doesn't always translate into the classroom."

Starting small, taking "risks": The project encouraged participants to 'take risks' by trialing alternative teaching and assessment ideas in their classrooms. For one teacher, allowing students to engage in totally open investigations for assessment purposes was a quite daunting prospect, at odds with her teaching style. This teacher found that by modifying slightly an existing assessment task she used in her classroom, much information on children's mathematical performance could be obtained. The teacher presented her Year 3 class with a story situation about Jimmy Joker and Paula Pepperpot who had a tomato growing competition. In this story, Jimmy got two plants to grow, and Paula got three plants to grow. Jimmy had eight tomatoes on each plant, and Paula had four tomatoes on each plant. The students were required to answer a number of mathematical questions derived from the story. The teacher provided space for the students to provide reasons for their answers. One student responded that "Jimmy Joker" grew the most tomatoes; that Jimmy and Paula would each receive "6" tomatoes if they shared them equally; that if they sold their tomatoes for 2c each, Jimmy would make "6c" and Paula would make "16c"; and that if Jimmy and Paula ate 5 tomatoes, there would be "1" tomato each to give their own 'mum'. One student's reasons are presented in figure 1. Upon analysis of this particular student's response the teacher gained insight into the child's knowledge of decimal representation of money; of counting in two's; of addition, subtraction, division facts; the division concept, and written computation; knowledge which would not have been evident if only numerical answers had been written. By taking this first step in experimenting with alternative assessment forms, this teacher found that she could find out much more about her students' mathematical knowledge and understanding, and this assisted her begin to utilise more open investigations. As she stated: "I am introducing more varied and challenging tasks, not all for assessment purposes."

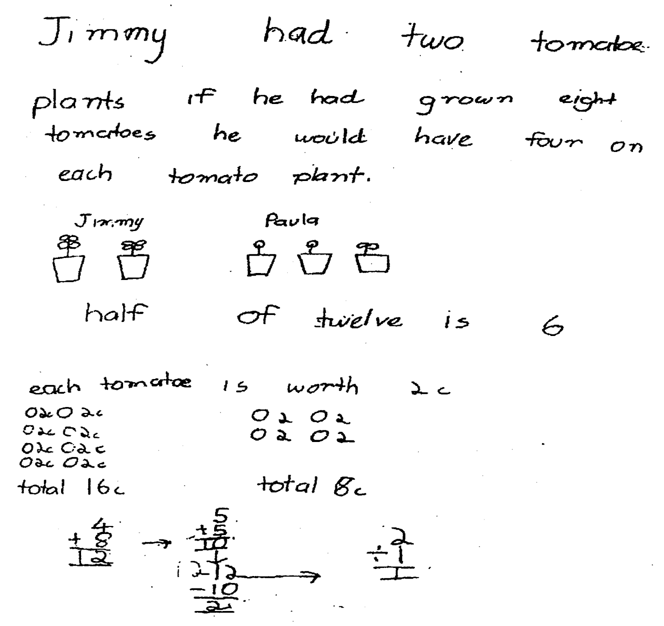

Figure 1. Student response to a mathematical assessment task

Valuable assessment data from "chaos": As a result of trialing alternative tasks in the classroom 'surprising' evidence of students' mathematical knowledge appeared. One teacher developed a "Smarties" task for Year 8 students, trialled while students were studying a unit on Percent. In groups, the students were provided with a box of Smarties and asked to explore the contents, presenting information in any way they wanted. Out of the chaos the classroom was plunged into as a results of providing such a stimulus, one student spontaneously revealed understanding of ratio knowledge, writing the ratio of one colour Smartie to that of each of the others, and actually simplifying the ratios. The teacher observed that, of the two students working, only one was writing ratios while her partner watched. The teacher watched as the 'ratio writer' explained to her partner what she was doing. Adding this as an anecdotal note to the student's written response, the teacher found that evidence of this student's ratio understanding was obtained.
Teacher-made tasks; other tasks: During the project, team members were provided with ideas for tasks, which had been developed from various stimuli, including fairy stories, household goods, everyday children's experiences. The tasks were deliberately open to be suitable for a range of year levels. Writing team members were asked to adapt and trial any of the tasks in their classrooms. It was found that few team members actually trialled these tasks, or if they did, the activities were merely presented to students at times additional to classroom mathematics lessons, and students were given little direction on how to go about the activity. For example, one task, entitled "Does your shoe fit?" was designed for students to investigate the area of their foot and their shoe. Many students, in responding to the title of the task, answered "Yes", or "No". It was apparent that tasks 'out of context' in a teacher's mathematics program were not readily explored by teachers for assessment purposes. Thus, teacher-generated tasks that link directly to the mathematics program appear to be more easily trialled and evaluated by teachers in terms of richness for assessment purposes.

The process of change in teachers involved in writing and trialing assessment tasks

Throughout the course of the project meetings, teachers found that both their role and that of their students altered as they trialled alternative assessment tasks. Teachers' reported that they felt their role had become one of an observer of children, as suggested by the following comments:

> " [I make] keener observations of children as they work on assessment tasks."
> " [I am] more observant and understanding of the capabilities of the students. Less teacher direction."
> "[I am] looking at activities and seeing the children's responses to them."

Teachers perceived that alternative forms of assessment required students to write about their mathematical experiences. This change to the student role in mathematics necessitated that teachers provide students with opportunities to acquire such skills. The following comments show awareness of this dimension to the student role in assessment:

> " I now have 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 have an] awareness of children's difficulties when writing responses - this is a whole new ball game for them."
> " Children at present are having difficulty writing responses or explanations to activities, but I'm sure it will be practice makes perfect."

Reporting on how their involvement with the project had influenced teaching and assessment practices, it appears that the project enabled a change to more variety in assessment to take place. The following comments by team members provide this evidence:

> " By using the tasks designed at the meetings, I have used more group collaboration to find solutions, I now give more time to working through

problem areas with my children."
" [I now] use more ways in which students are given opportunities to verbalise and explain the outcomes of mathematics situations."
"I now try to include open ended tasks which require written assessable answers."
" [I am] directing my assessment away from the end of unit test to a program incorporated into my teaching program."

The product

At the conclusion of the project, approximately 50 assessment tasks had been trialled in classrooms, with approximately 25 suiting the purposes of the publication. The tasks were identified as RATs: due to their yielding a lot of data on student performance across a range of strands and substrands; they allowed all students in the classroom to respond across a range of levels; the activities were rated as worthwhile learning activities in their own right; and the students enjoyed working on the activities. The number of RATs produced for exemplary purposes was less than anticipated by the project initiators, and also by one team member, who stated that the "output in actual task writing has not been as great as expected."

As a result of working with the RAT writing team, the project co-ordinators developed eleven tenets (and their corollaries) for RAT (rich assessment task) development and evaluation (Dole & Tansley, 1996), which provide a summary of key issues in the process of searching for classroom RATs. The tenets are based on conclusions drawn from the RAT writing process. The first four tenets relate to the student in the assessment process; RAT tenet 5 relates to teaching, learning, and assessment and the mathematics curriculum, RAT tenets 6-8 relate to the teacher in the assessment process, and RAT tenet 9 cautions against collecting a RAT and labelling it as 'THE assessment task'. RAT tenets 10 and 11 are separated from the first 9 RAT tenets, as they specifically address assessment and reporting schemes. The tenets (and corollaries) are as follows:

1. A RAT allows students to reason mathematically, using logic and mathematical verification. *(Corollary: assessment tasks requiring students to find a single, correct answer are not RATS).*
2. A RAT enables students to draw together their mathematical knowledge. *(Corollary: assessment tasks requiring rehearsed performance are not RATs).*
3. A RAT is sufficiently novel to allow students to enjoy working mathematically. *(Corollary: assessment tasks which students find boring are not RATs).*
4. A RAT should be a worthwhile activity in its own right. *(Corollary: assessment tasks which do not promote student learning are not RATs).*
5. A RAT should reflect what really counts in learning and doing mathematics. *(Corollary: assessment tasks which test isolated mathematical skills are not RATs).*
6. A RAT integrates seamlessly into the learning environment. *(Corollary: assessment tasks which are unnatural to a teacher's teaching style are not RATs)*
7. A RAT is efficient of teachers' time. *(Corollary: assessment tasks which yield little data are not RATs).*
8. A RAT enhances teaching. *(Corollary: assessment tasks which are used for purely summative purposes are not RATs).*
9. A RAT has a limited life expectancy. *(Corollary: assessment tasks which have passed their shelf life are not RATs).*
10. A RAT allows performance across various strands. (Corollary: assessment tasks aimed at particular strands are not RATs).
11. A RAT allows performance at various levels. *(Corollary: assessment tasks aimed at a particular level are not RATs).*

Conclusion

Involvement of teachers in a RAT writing team appears to have assisted teachers explore issues in implementing alternative assessment tasks in their mathematics classrooms, and assisted in helping them adopt a more *informal* (Clarke & Reed, 1992) approach to mathematics assessment. Developing and evaluating RATs for the classroom is not a simple task. As a result of this project, it can be seen that for a task to be deemed a RAT, it must be trialled in the classroom. To be adequately trialled in a classroom, it must link with a teacher's mathematics program and the teacher's style of teaching. To explore the richness of the RAT requires change in both the teacher's and students' role in the assessment situation. Searching and implementing RATs in the classroom is an evolving process.

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