Constraints and Opportunities When Using Content-specific Open-ended tasks

Peter Sullivan
Monash University
<peter.sullivan@education.monash.edu.au>

After teacher learning sessions on open-ended tasks, teachers trialed such tasks in their classes, and then completed a survey, the results of which are reported here. It seems that the teachers collectively could adequately define open-ended tasks, could give illustrative examples, and could articulate both opportunities and constraints. This knowledge allows teachers to plan to take advantage of opportunities and to minimise the constraints.

A Rationale for Open-ended Tasks

An assumption underlying each of the three tasks types in the Task Types and Mathematics Learning (TTML) project is that the nature of teaching and what students learn is defined largely by the tasks that form the basis of their actions. In this case, we argue that working on open-ended tasks (type 3 in our project) can support mathematics learning by fostering operations such as investigating, creating, problematising, communicating, generalising, and coming to understand procedures.

There is substantial support for this assumption. Examples of researchers who have argued that tasks or problems that have many possible solutions contribute to mathematics learning include those working on problem fields (e.g., Pehkonen, 1997), and the open approach (e.g., Nohda & Emori, 1997). It has been suggested that opening up tasks can encourage pupils to investigate, make decisions, generalise, seek patterns and connections, communicate, discuss, and identify alternatives (Sullivan, 1999).

Specific studies that support use of open-ended tasks include Stein and Lane (1996) who noted that student performance gains were greater when "tasks were both set up and implemented to encourage use of multiple solution strategies, multiple representation and explanations" (p. 50). Likewise, Boaler (2002) compared the outcomes from working on open-ended tasks in two schools. In one school, the teachers based their teaching on open-ended tasks and in the other traditional text-based approaches were used. After working on an "open, project based mathematics curriculum" (p. 246) in mixed ability groups, the relationship between social class and achievement was much weaker after three years, whereas the correlation between social class and achievement was still high in the school where teachers used traditional approaches. Further, the students in the school adopting open-ended approaches "attained significantly higher grades on a range of assessments, including the national examination" (p. 246).

Two aspects of our project are of interest here. First, we wanted to know what teachers took from our professional learning sessions and how they interpreted our input. Second, we were interested in what they learned from classroom trials of exemplars of the tasks.

In R. Hunter, B. Bicknell, & T. Burgess (Eds.), *Crossing divides: Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 1). Palmerston North, NZ: MERGA.

The Content-specific Open-ended Tasks that are the Focus of our Project

In addition to the openness described above, type 3 tasks are also *content-specific* in that they address the type of mathematical topics that form the basis of textbooks and the conventional mathematics curriculum. Teachers can include these as part of their teaching without jeopardising students' performance on subsequent internal or external mathematics assessments. The definition that we used with our project teachers was:

> Content specific open-ended tasks have multiple possible answers, they prompt insights into specific mathematics through students discussing the range of possible answers, An example is:
>
>> A group of 7 people went fishing. The mean number of fish caught was 7, the median was 6 and the mode was 5. How many fish might each of the people have caught?
>
> Such tasks allow unambiguous focus on specific aspects of mathematics while still allowing opportunities for creativity and active decision making by students with the advantage that one task can be applicable to wide levels of understanding.

The project is/has been exploring the nature of the learning based on such open-ended tasks, the opportunities that such tasks offer to students, and the constraints that the tasks create for teachers. After the teachers had worked with the respective task types, they completed a survey which asked them questions on these issues. Their unstructured responses were inspected, categorised, and summarised, and are reported in the following.

The Teachers' Definitions of the Tasks

We were interested to determine how the teachers interpreted the experiences provided by their participation in the project. On a survey, completed after working with type 3 tasks, the teachers were asked:

> If you were explaining to a group of teachers about to use tasks of this type, how would you describe this type of task?

Nearly all of the teacher responses referred to the possibility of multiple answers using terms such as "multiple answers-multiple methods", "there are a numbers of strategies for finding an answer", "not only one answer" and "explore a variety of outcomes".

Many responses also referred to the ways the tasks can be suitable for students of differing readiness, such as "allow students to work at their own level", "use strategies at their own level of understanding, and "access to a range of ability levels".

Various teachers also commented on the emphasis that might be placed on student responses such as "(a need to) focus on sharing strategies", "making generalisations and seeing patterns", and "translating insights into mathematical expressions".

In other words, many teachers were able to restate to us the purposes and operation of the tasks in the language and form that we had suggested.

Some Examples of the Tasks that Teachers Valued

In the survey, the teachers were asked "of the tasks of this type that you have tried in your class this year, which worked best". They were also invited to describe the "next two best tasks". Not only did no particular tasks emerge as more popular, but the most striking feature of the responses was the diversity of tasks that were valued. Examples of tasks that were mentioned by more than one teacher were:

A closed rectangular box is tied up with 1 metre of ribbon. If the bow takes 30 cm of ribbon, what might be the dimensions of the box?

Using the map on *google earth*, plan a walk around the school that is 4 km long.

What might be the missing numbers? $\_\ \_ \times 8\ \_ = \_\ \_\ 0$

These three tasks are appropriate exemplars of this type in that there is a variety of possible responses to each, the range of responses can be interrogated by students and teachers, the students have to make choices in finding one or more solutions, and the problems are not solved by the application of a procedure.

There were also examples such as the following suggested:

How much water is wasted by the school drinking taps over a year?

This has some characteristics of open-ended tasks in that the students have to make active decisions on what is important and how to collect data, and there would be sense of personal ownership. The task also has many characteristics of type 2 tasks (see D. Clarke, this volume) in that it addresses a practical context. The task is also similar to interdisciplinary tasks, which is our fourth type.

The teachers' responses indicate that their suggestions of open-ended tasks are compatible with the material they had been presented with in teacher learning sessions.

The Advantages of Open-ended Tasks as Seen by the Teachers

In our teacher learning sessions we have emphasised the following potential advantages of using open-ended tasks: there is considerable choice in relation to strategies and solution types; generalised responses and patterns can be found; there are opportunities for class discussion about the range of approaches used; and the range of solutions found can lead to an appreciation of their variety and relative efficiencies. Teachers were asked:

What do you see as the advantages of using this task type in your teaching?"

The most common responses related to the choices that students make about their approach to tasks, such as "how various students go about solving maths problems", "every student has a chance to solve it in their own way".

Many responses related to the nature of the students' thinking such as "encourages students to broaden their thinking", "creativity", "opens up possibilities", "students think more deeply", and on a slightly different note "encourages students to persist".

Teachers also commented on the ways the tasks can be accessed by all students such as "all achieve some success", "can cater for range of abilities", and "work at their own level". Having used such tasks in the classrooms, these responses suggest not only compatibility with the perspectives that we presented to them, but also further interpretations that were derived from practice, with emphasis on the idiosyncratic ways that students respond, and teachers' intention to support students individually.

The Constraints on the Use of Open-ended Tasks as Seen by the Teachers

In the teacher learning sessions we discussed the potential constraints posed by such tasks, especially the resistance that some students have to taking the risks that such tasks present (see Desforges & Cockburn, 1987). In the survey, the teachers were asked

What makes teaching using this task type difficult? What are challenges in using this type of task?

The most common response related to the issue we had addressed, that is that some students prefer more closed tasks. Teachers comments included “some students are not risk takers”, “challenge for the students who want to go straight to an answer”, “requires thinking”, and ”the hard thinking and little direction can be confronting for some kids”.

Other aspects of students’ response that may be connected to their unfamiliarity of such tasks were “students who don’t want to put in any effort”, “some find difficulty finding an entry point”, “their need for confidence” and “some students don’t know where to start”.

Some teachers clearly saw such tasks as more difficult noting that some students might experience difficulties such as “limited mathematical knowledge”, and “not all students have the right level of learning”.

There were pedagogical aspects mentioned such as “not always sure what maths will come out of it”, “correcting the different solutions”, “holding back on explanations”, and “being ready for what arises”.

There were also planning considerations mentioned such as “finding the tasks” and “needs additional resources”.

These responses clearly arise from reflection by teachers on the use of such tasks in their own classrooms. It is possible that the constraints might act as a deterrent to the use of such tasks. A significant aspect of our project is to explore the obstacles these constraints represent and to develop ways of working with our teachers to overcome them.

Conclusion

After participating in teacher learning sessions on this task type, on a survey teachers gave adequate definitions and useful examples, could identify the advantages of the tasks, and articulated some constraints associated with their use. While it is possible that their responses were merely reproducing what had been said to them, their comments did seem to be derived from their practice. The hypothetical definitions and recommendations about implementation aligned with their experience, and it seems that teachers are both ready to take advantage of opportunities, and aware of the potential constraints they may experience.

References

Boaler, J. (2002). *Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning.* Mahwah, NJ: Lawrence Erlbaum.

Desforges, C., & Cockburn, A. (1987). *Understanding the mathematics teacher: A study of practice in first schools*. London: The Falmer Press.

Nohda, N., & Emori, H. (1997). Communication and negotiation through open approach method. In E. Pehkonen (Ed.), *Use of open-ended problems in mathematics classrooms* (pp. 63–72). Department of Teacher Education, University of Helsinki.

Pehkonen, E. (1997). Use of problem fields as a method for educational change. In E. Pehkonen (Ed.) *Use of open-ended problems in mathematics classrooms* (pp. 73–84). Department of Teacher Education, University of Helsinki.

Stein, M. K., & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason and analysis of the relationship between teaching and learning in a reform mathematics project. *Educational Research and Evaluation, 2*(1), 50–80.

Sullivan, P. (1999). Seeking a rationale for particular classroom tasks and activities. In J. M. Truran & K. N. Truran (Eds.) *Making the difference. Proceedings of the 21st annual conference of the Mathematics Educational Research Group of Australasia* (pp.15-29). Adelaide.