Teachers holding back from telling

A key to student persistence on challenging tasks

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Anne Roche and Doug Clarke discuss the importance of developing students' persistence in relation to problem solving during the use of challenging tasks. They provide a useful list of strategies that teachers can use to encourage persistence amongst their students.

We report here on our work with primary teachers to increase persistence as students engage with challenging mathematics tasks as part of the *Encouraging Persistence Maintaining Challenge* project (EPMC). We developed sequences of tasks in various topic areas for Grades 5 and 6, which require students to connect different aspects of mathematics, to devise solution strategies for themselves, and to explore more than one pathway to solutions. We surveyed teachers on their strategies for encouraging student persistence, before and after the experience of teaching some challenging tasks which we had provided to them. In this article, we provide examples of the kinds of challenging tasks project teachers are using with students, and share teacher insights on helpful strategies for encouraging persistence.

Introduction

For many years, the importance of problem-solving in mathematics education has been well recognised. As Thompson, Battista, Mayberry, Yeatts and Zawojewski (2009) noted,

> Good problems challenge students to develop and apply strategies, serve as a means to introduce new concepts, and offer a context for using skills. Problem solving is not a specific topic to be taught but permeates all mathematics. (p. 2)

In recent years, there has been a greater emphasis in research and curriculum documents on the important role played in problem solving by challenging or cognitively demanding tasks (Stein, Smith, Henningsen & Silver, 2009).

We use the term 'persistence' to describe the category of student actions that include concentrating, applying themselves, believing that they can succeed, and making an effort to learn.

Sullivan, Cheeseman, Michels, Mornane, Clarke, Roche and Middleton (2011) characterised challenging tasks as those which require students to:

- plan their approach, especially sequencing more than one step;
- process multiple pieces of information, with an expectation that they make connections between those pieces, and see concepts in new ways;
- engage with important mathematical ideas;
- choose their own strategies, goals, and level of accessing the task;
- spend time on the task;
- explain their strategies and justify their thinking to the teacher and other students; and
- extend their knowledge and thinking in new ways (p. 34).

We believe that all students should experience challenging tasks, but sometimes teachers are reluctant to pose challenging tasks to students, and this is compounded by students' reluctance to engage with those tasks (Pogrow, 1988; Roche, Clarke, Sullivan & Cheeseman, 2013; Sullivan, Clarke & Clarke, 2013).

Our current project

The *Encouraging Persistence Maintaining Challenge* project (EPMC) is researching a range of issues, including the kinds of teacher practice which might encourage students to persist when working on challenging tasks in mathematics. The EPMC is a collaborative project involving university researchers and classroom teachers in Victorian and Tasmanian schools.

Examples of our challenging tasks

Teachers met with the project team for two full days in February 2013, with four or five teachers attending from each school. An overview of the project was given, and teachers were provided with ten challenging tasks, in the form of detailed lesson notes. For the 36 primary teachers, the focus was on tasks involving the content areas of multiplication and division at Years 5 and 6. All lessons were written using the structure shown in Appendix 1 for the lesson Missing Number Multiplication. Each lesson has what we have come to call a main task, and this is often accompanied by an introductory task and consolidating tasks. An important feature of the documentation is the inclusion of enabling prompts (for students who have difficulty making a start on the main task) and extending prompts (for students who find the main task quite straightforward; see Sullivan, 2011).

To give a further sense of the kinds of tasks in these lessons, we include the main task from two other lessons:

- from *Patterns without Remainders.*
  Some people came for a sports day. When the people were put into groups of 3, there was one person left over. When they were lined up in rows of 4, there were two people left over. How many people might have come to the sports day?
- from *Working with a Calculator with a Broken Button*.
  For each expression, write two different expressions that show how to use a calculator with the '4' button broken to do the calculations:
  234 × 9
  314 ÷ 3
  Teachers were asked to teach as many of these tasks as possible before returning to share their experiences and student work samples with the larger group in June. Teachers were discouraged from telling the students how to solve the problems, and asked to ensure that students had plenty of time to work on the tasks.

Insights from teachers

At different points in the project, we have collected information from teachers on their experiences.

Primary teachers' insights prior to teaching the challenging tasks

In February, before any professional learning input from the research team and the opportunity to trial challenging tasks, teachers were asked to respond to a question, framed as follows:

Sometimes when students struggle with a mathematics task, they choose not to persist. What kinds of things do you believe a teacher could do in the planning stage of a lesson and during the lesson that would help those students to persist? Please record as many as you can.

In the planning stage, teachers could…
During the lesson, teachers could…

Teachers were given seven lines for each stem, with a verbal encouragement to put one thought on each line, for as many of the lines as they wished to complete. The 36 primary teachers responded with 172 suggestions for the planning stage and 164 suggestions for during the lesson, an average of 4.6 and 4.4 respectively per teacher. These were grouped into categories by the research team. In Tables 1 and 2, the most frequently occurring categories are listed, with illustrative comments to elaborate the kinds of

Table 1. Most common strategies in the planning stage for encouraging persistence on challenging tasks.

Strategy for the planning stage	Number of comments	Percentage of all comments (*n*=172)	Illustrative comments
Differentiation	46	26.7%	• Make variations to tasks to suit the needs of the children. • Consider extending/enabling prompts.
Nature of tasks	25	14.5%	• Develop a task that is open ended. • Careful task selection.
Grouping	18	10.5%	• Ensure working groups are mixed ability. • Group children according to ability.
Resources	18	10.5%	• Concrete material. • Plan and collect all equipment needed.
Teacher knowledge - Content	18	10.5%	• Understand the curriculum above and below level. • Be aware of misconceptions.
Teacher knowledge - Students	11	6.4%	• Understand student learning styles. • Ensure s/he knows where students are at.

Table 2. Most common strategies during the lesson for encouraging persistence on challenging tasks.

Strategy for during the lesson	Number of comments	Percentage of all comments (*n*=164)	Illustrative comments
Discussion/questioning/ sharing	38	23.2%	• Encouraging students to discuss mathematics. • Question students to investigate their thinking.
Differentiation	21	12.8%	• Use enabling prompts. • Make changes to the activity to best suit each child.
Grouping	20	12.2%	• Allow students to work with a partner to share strategies. • Use flexible groupings, kids learn from each other.
Culture	16	9.8%	• Discuss persistence when it gets tough. • Reinforce that taking risks/making mistakes is a normal part of learning.
Teacher enthusiasm/ encouragement	13	7.9%	• Praise, encourage students by focusing on what they do know. • Present positively – enthuse students.
Teacher monitoring students	13	7.9%	• Monitor progress of each student/group closely. • Check in with all students.

responses for each category, for the planning stage, and during the lesson, respectively.

For both the planning and during the lesson stages, many teachers focused on differentiating the tasks provided to students by the preparation of prompts, and by grouping arrangements. Interestingly, grouping suggestions of some teachers focused on mixed ability, while others suggested groups of similar ability. Differences between the comments in the two stages were the emphasis on careful choice of tasks and resources, taking into account the teachers' knowledge of individuals in relation to the content in the planning stage; and encouraging students to share their thinking, the development of a classroom culture, providing encouragement and enthusiasm, and monitoring students while they are working on the task, during the lesson.

Of course, there are some strategies which are more appropriately addressed during planning (e.g., choice of tasks), and during the lesson (e.g., the teacher monitoring students), respectively.

Primary teachers' insights after teaching up to ten tasks

In June, following the chance to try out up to 10 challenging tasks, teachers were given a verbal encouragement to provide only one thought, their most important change in practice that was different from the way they planned and taught previously. Tables 3 and 4 show the most frequently occurring categories. Of course, the request for just one response led to a smaller number of responses than earlier in the year. For this reason, percentages are not used here.

Possibly the most interesting difference in the data from before the teaching of the lessons (February) and after (June) was the emphasis on 'holding back'. In the June survey, 10 out of the 35 comments related to the teacher talking less, teaching less, or allowing students to struggle. Although this number is not large, it is important to remember that it represents a large proportion of responses out of 35.

Overall, the greatest change in the kinds of strategies offered by teachers after the experience of teaching the challenging tasks appears to be a focus on holding back from telling students how

Table 3. Most common new strategies in the planning stage for encouraging persistence.

Strategy in the planning stage	Number of teachers (*n*=35)	Illustrative comments
Differentiation	10	• Have the prompting questions already to use during the session, rather than waiting for a particular misunderstanding to occur. • I have planned what I will say to enable/challenge. This has been a change as previously I would do this as I am working with students on tasks.
Nature of tasks	7	• More problem solving activities. Plan more tasks that they need to think about instead of telling them what was wanted. • I would probably now give much harder tasks so that everyone had a level of confusion.
Holding back	3	• Not telling them what to do. • Not planning to 'teach' the concept first but waiting for the need to arise. Purposeful learning.

Table 4. Most common new strategies during the lesson for encouraging persistence.

Strategy during the lesson	Number of teachers (*n*=35)	Illustrative comments
Discussion/ questioning/ sharing	11	• Asking lots more questions; e.g., So where could you go from there? Can you explain how you got here? What could you do next? Are you sure that's correct? • Students share more of their thinking more of the time. Students are learning more from sharing with each other, rather than listening to me.
Holding back	10	• I model less at the beginning of lessons. • I am more careful to hold back and not give the strategy which could help in the initial stage of the maths task.
Culture	9	• I am a lot more willing to say to a student, "I know this is hard, I want it to be hard you need to go and think a bit more about (some specific context)" • Using phrases such as, "Yes this is hard", "Zone of confusion", "I want you to have a go first", "I'm not going to help you for 10 minutes", "Prove it to me", "How do you know it is correct?".

to solve problems and giving them more time to think about and work on the tasks.

It is worth commenting that an instruction to teachers to "hold back from telling" would be simplistic. While Hiebert and colleagues (1997) noted that "intervening too much and too deeply … can easily cut off students' initiative and creativity, and can remove the problematic nature of the material" (p. 9), this does not imply a move away from any type of teacher telling and leaving students to flounder unnecessarily. For example, there are types of telling that stimulate students' mathematical thoughts "via the introduction of new ideas into a classroom conversation" (Lobato, Clarke & Ellis, 2005, p. 101). Finding the balance between allowing students to struggle with important mathematics and supporting their developing understanding is not easy. Nor is it easy to define in terms of what teachers should say or do.

Conclusion

From our experiences in using the tasks described in this article and in considering insights from teachers and the project team, we offer the following list of strategies for encouraging persistence on challenging tasks (Cheeseman, Clarke, Roche & Wilson, 2013; Sullivan, Clarke, Clarke & Roche, 2013):

- some attempt is made to connect the task with students' experience;
- ways of working are explained to students, including the type of thinking in which they are expected to engage and what they might later report to the class;
- the teacher communicates enthusiasm about the task, including encouraging the students to persist with it, but holds back from telling students how to do the task;
- classroom climate encourages risk taking, teachers expect students to succeed, errors are part of learning, and students can learn even if they do not complete the task;
- the lesson is structured to ensure that students have adequate time to work on the challenging task;
- processes and expectations for recording are made clear, including encouraging students to make appropriate notes along the way;
- the teacher moves around the class, predominantly observing students at work, selecting students who might report and giving them a sense of their role, intervening only when necessary to seek clarification of potential misconceptions, to support students who cannot proceed, and to challenge those who have completed the task; and
- there is time allowed for lesson review so that students see the strategies of other students and any summaries from the teacher as learning opportunities.

Student persistence is important. As one student wrote in a written reflection: "We do learn more when we're confused and we've got to work our way out of it."

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Appendix

Missing Number Multiplication

I did a multiplication question correctly for homework, but my printer ran out of ink.
I remember it looked like:

$$2\_\_ \times 3\_\_ = \_\_\_\_ 0$$

What might be the digits that did not print? (Give as many answers as you can)

Rationale for the lesson

Mathematics is fundamentally about patterns and the patterns can help us to understand key ideas. There are also important patterns in, for example, the numbers when multiplied that have an answer that ends in a 0.

Year level

Year 5–6

Particular pedagogical considerations

Explain that each line represents a digit (that is, the first number has 2 digits). As a first prompt for those who finish, ask whether they have all the possible answers. Encourage students to be systematic about how they record their answers.

For the students

Sometimes solving multiplication and division problems is about finding patterns. In this case the focus is on what numbers when multiplied have an answer that ends in 0.

Enabling prompt

Change the format of the calculation to the following:

$$\_\_ \times \_\_ = \_\_ 0$$
$$35 \times \_\_ = \_\_\_\_ 0$$

Extending prompt

Change the format of the calculation to the following:

$$\_\_ \times \_\_ 0 \times 3\_\_ = \_\_\_\_ 0$$

Consolidating task

I did a multiplication question correctly for homework, but my printer ran out of ink.
I remember it looked like:

$$1\_\_ \times 4\_\_ = \_\_\_\_ 2$$

What might be the digits that that did not print? (Give as many answers as you can.)

Some possible student solution strategies

20 × 30 (or 31, or 32, or 33, and so on up to 39) will work
So will 20 (or 21, or 22, or 23, and so on up to 29) × 30
Then 25 × 32 (or 34, or 36 or 38) will work
Likewise 22 (or 24, or 26, or 28) × 30 will work