Introducing challenging tasks:
Inviting and clarifying without explaining and demonstrating




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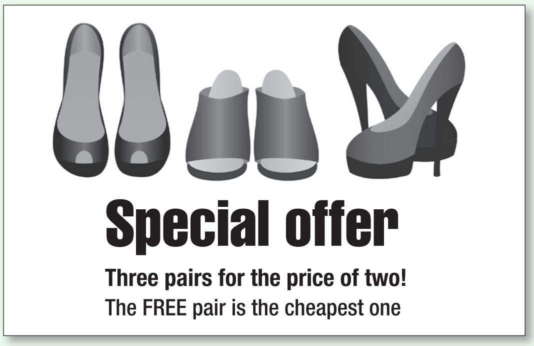
Introducing challenging tasks in such a way that makes them accessible, rather than daunting, to students is a challenge for teachers. Solving challenging tasks involves students having to grapple with the problem. The role of the teacher is to motivate and clarify the problem rather than showing students how to solve the problem.

The beginning of a lesson sets the scene for all that is to follow. As part of our recent research, we have been examining the features of challenging tasks and ways to introduce them as the focus of lessons. Together with teachers and students in the Encouraging Persistence and Maintaining Challenge (EPMC) project we are investigating a range of issues. In particular we are interested in the kinds of teacher practice which might encourage students to persist when working on challenging tasks in mathematics (Sullivan, Cheeseman, Michels, Mornane, Clarke, Roche, & Middleton, 2011). We have noticed that the way that a problem solving task is established at the outset of the lesson is a key to initiating mathematical exploration by students.

Reflecting on experiences in the project we realised that introductions to lessons are one of the stumbling blocks for teachers. A genuinely difficult aspect of implementing challenging problem solving tasks is imagining the way each task could be effectively introduced to students so that they could engage with it and persist to find a solution. Also there seemed to be a fine line between presenting the task so that it was challenging yet accessible rather than challenging and overwhelming. So the question arose: How do you introduce a lesson based on a challenging task so that you pose the problem clearly without explaining or demonstrating the way to find a solution?

The university team gave advice to project teachers through the accompanying documentation of the tasks that were central to the project. Our general approach to the introduction of the lesson was to make it short, sharp and focused so that students' thinking would be connected to the problem but in such a way that would not 'give the game away'.



Carly and Jenny go shopping for a pair of shoes. Jenny chooses one pair for \$110 and another for \$100. Carly chooses a pair that costs \$160. When they go to pay, the assistant says that there is a sale on and they get three pairs of shoes for the price of two pairs. Give two options for how much Jenny and Carly should pay. Explain which of these options is fairer.

Figure 1. Shopping for shoes: an example of a challenging task.

Our rationale

We believe that an important part of maintaining the challenge of the task is for students to make decisions about how to approach the problem. These decisions involve understanding what the task is asking of them; accessing relevant mathematical knowledge; making a plan; and beginning. In this way mathematical reasoning is in the hands of the student. As a result, a range of solution strategies is also likely to be used by students. Describing and analysing the effectiveness of these strategies adds another dimension to the lesson. Students learn to appreciate and evaluate different thinking. In the concluding stage of the lesson when the focus returns to the mathematical purpose and conceptual underpinning of the lesson, diverse solution paths can be examined. In this way the focus of the lesson is on student thinking and mathematical reasoning, not on following a given procedure.

During the professional development days with the teachers—a key element of the research project, we modelled the approach we were advocating to provide a prototype of action for each task. We launched straight into the task without pre-teaching, reviewing skills, or providing an explanation, or a demonstration of how to solve the task. We allowed plenty of time to work through a task then we debriefed it and discussed possible student responses. We were very explicit about our expectation that students may feel unsettled initially and introduced the phrase 'entering the zone of confusion' to label this uneasy phase of problem solving. We also advocated discussing with students the need to persist with the difficult tasks.

What is known about the introductory phase of lessons?

The initial phase of a lesson is described by writers in different ways, for example, as the set-up phase or the launch of the lesson but each term refers to the first part of the lesson when the problem is introduced.

Boaler (2002) argued that the teacher should lead a whole class discussion to introduce the task and, in doing so, should "decide on the degree of support or structure the students need" to begin to solve the task (p. 248).

Jackson and her colleagues (2011) described whole class discussion during the task-posing phase of lessons prior to students working on the task. The intent of the discussion was characterised as:

> ...supporting students in understanding the cultural suppositions of the task scenario and in developing situation-specific images of mathematical relationships described in the task statement (p. 26).

Jacobs and Morita (2002), in comparing American and Japanese teachers' views of videotaped lessons used the term "teacher's presentation of mathematical content or an assignment" (p. 164) to label the first stage of a lesson. The study found that American teachers favoured demonstration of the solution in the presentation of mathematics.

By contrast the lesson structure proposed by the EPMC was similar in many regards to 'typical' Japanese mathematics instruction (Stigler et al., 1999; Stigler & Perry, 1990) where the teacher poses an open-ended problem, the students work on it, and the students then present their ideas and together they construct a generalised solution. In the 'ideal' Japanese lesson posited by Jacobs and Morita (2002) this initial stage of the lesson was one where the specific nature of the open-ended problem was considered carefully, the problem was actively discussed by the class, plenty of time was provided, and students were provided with appropriate manipulatives. This lesson structure resonates with our approach in the EPMC.

Researchers have studied the impact of different types of introductions. For example, Cobb and Jackson (2011) found that many teachers 'proceduralise' problems when they launch them—thus removing the problem solving objective and converting the problems to exercises in applying a procedure. This is a finding with serious consequences in the light of the statement by Jackson, Garrison, Wilson, Gibbons and Shahan (2011) who found that "what happens in the set-up phase of instruction as consequential for students' opportunities to engage in rigorous mathematical activity"(p. 57). The rigorous mathematical activity is only stimulated by maintaining the challenge and the cognitive demand of the task.

In Ontario, Canada (Small, 2013) teacher materials called the phases of lesson planning "minds on", "action!" and "consolidate/debrief" (p. 73). This terminology may help to specify the purpose of the introductory phase of a lesson where the intent is to allow students to connect to the topic. "It may be a warm-up activity, a provocative question for students to consider, or some other device to get students 'hooked'" (p. 73). In terms of our approach in the EPMC, the tasks used two main techniques to stimulate minds on: an activity that in some way 'warmed up' student thinking for the task ahead, or simply plunged students into the challenging question that was the main task. It is important to emphasise here that the introductory tasks we designed were not a rehearsal for the main task but they were intended to get students thinking in a potentially productive way for what would follow and to clarify language.

Jackson, Garrison, Wilson, Gibbons, and Shahan (2013) found when the lesson setup supported a common language to describe contextual features and mathematical relationships of the task and the cognitive demand of the task was maintained, the concluding whole-class discussions were characterised by higher quality opportunities to learn.

To plunge straight into a challenging task can be rather daunting for teachers. Stein and her colleagues (2009) described teachers in their study feeling uncomfortable with students struggling. Perhaps there is an element of this discomfort in wanting the introduction of the lesson to go well but we think it may also be due to the habits and traditions of other models—we want to say old models—of mathematics teaching. The 'old' model we are thinking of here is the show a problem, demonstrate the working of that problem and its solution, and pose more of the same style of problem for the students to work through by the demonstrated method. Kilpatrick, Swafford, and Findell (2001), in discussing a teaching vignette, described this kind of teaching as constructing the lesson in such a way that the students' path through the mathematics involves tightly constraining both the content and the students' encounters with it.

The challenging tasks devised and implemented in the EPMC project did not lend themselves to this model of mathematics teaching. The structure of the documented lessons took the general form: a main task, with the discretionary use of enabling prompts and/or extending prompts (Sullivan, 2006; Sullivan, 2011), and a consolidating task was proposed. A summary discussion or report-back session was also required to describe solution strategies and to elicit the conceptual content of each lesson.

The introduction in practice

Some project teachers were comfortable with our recommendation to "hold back from telling" students too much in advance of them working on the task (see, e.g., Roche & Clarke, 2014). Others felt that the task needed full explanation and in their usual classroom practice they would demonstrate a possible place to start the task.

Members of the project team observed teachers teach the tasks we were trialling in the EPMC. The introductory phase of the lessons raised some questions as to why the model we had demonstrated was not always used by project teachers. It seems tricky to get the introduction 'right'—to tell enough without telling too much and thereby reduce the challenge of the tasks. Stein and Lane (1996) found that teachers had an orientation to reducing the cognitive demand of tasks. In an attempt to get everyone started on a task, we sometimes observed teachers explaining ways to solve the task in advance. The third author noted a range of practices:

> I saw a teacher simply reading through the task as each of the students had the task sheet in their hands and could follow along with her. With a quick moment for any questions, she sent them off to get started. Another teacher [with reference to the Shopping for Shoes task] prompted a discussion about the types of deals the students were aware of in stores or online, like "50% off; buy 1 get 1 half price; 4c off fuel" She continued this discussion into whether all deals were good deals? In a different lesson I saw [one of the fractions tasks] the teacher was determined to do a lot of teacher directed explanation before the task even began.

As the reader can see, these practices ranged from little introduction to a lot of explanation. Teachers' written reflections revealed a range of behaviours. Two teachers reported on providing a lot of information to students prior to their engagement in the tasks:

> Giving the children lots of simple examples prior to giving them the actual problem.

> Checking more carefully if students understand the mathematical ideas before beginning a task.

> There was always some form of modelling at the beginning using similar/different numbers. My students would quickly become disengaged if they thought things seemed too difficult but once there were modelled aspects or if they see a few different strategies they're keen to attempt [the problem].

Another teacher described a much more restrained approach:

> Not planning to 'teach' the concept first but waiting for the need to arise.

It was clear from both observations and teachers' self-reports that introductions to the lessons involving challenging tasks varied greatly. Nevertheless, many project teachers did as we had recommended and quickly launched their students into challenging tasks and allowed time for them to struggle and to persist.

For example, analysis of a videotape of a project classroom revealed that the teacher launched the lesson in less than four minutes. During that brief time, she used the interactive whiteboard as a tool to:

- establish the purpose of the lesson and her intended outcomes (1 min 15 sec);
- describe her expectations in terms of student output and behaviours (1 min 20 sec); and
- complete an introductory task with students which rehearsed a format used in the main task and illustrated multiple correct answers (54 sec).

She then presented the main task for the students to read and think about, she read the problem aloud to help students interpret it, asked whether there were any questions, and provided the problem on paper. The entire setting up of the challenging task took a little over five minutes. The way it was done was unrushed and thorough and the task was clarified without any explanation, demonstration or pre-teaching.

When teachers posed the challenging task to their students and allowed them time to struggle, they often used teaching techniques to encourage persistence which they found useful. For example:

> Stopping students and just asking "what they did to start the task that helped".

> Around the 15 minutes mark, allow selected students to do a mini share—this is what I'm doing—to encourage students to rethink or take another direction.

> Once they had worked for 5 minutes by themselves it was time to talk to a buddy so they could share their thinking together. With some pairings the children did persist for longer and achieved some success.

What we have learned

Although we are not proposing the introduction should look the same in every lesson, there are nevertheless some general principles about the introduction to problem solving tasks which have emerged from our work.

Based on our experience of teaching students challenging tasks and of observing others work with such problems, we advocate the following in the introduction:

- inviting students to participate in challenging tasks and telling them that we know they may find the mathematics difficult;
- preparing students for the need to persist to come through the zone of confusion;
- attempting to connect the task with students' experience;
- using manipulatives where appropriate;
- explaining to students expectations in terms of their output and behaviours, including the type of thinking in which they are expected to engage and what they might later report to the class;
- communicating enthusiasm about the task, including encouraging the students to persist with it;
- holding back from telling students how to do the task; and
- clarifying the task without explaining it (Clarke, 1995) or demonstrating a solution method.

In this way we believe students can be supported to 'dive into' some challenging mathematics. We have found that the students surprise their teachers by what they can achieve and sometimes they surprise themselves as well.

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