

## **Professional development for problem solving: a dialogue with one teacher**

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It is generally accepted that it is important that problem solving is taught in schools. However, it is well recognised that teachers lack confidence in teaching problem solving in mathematics and that professional development may support them in developing their confidence and skills. One approach to providing such professional development is through the use of curriculum materials, such as those produced by the Mathematics Assessment Project (MAP). This paper reports on a small research study, which explored one teacher's professional development as he used the MAP materials.

**Keywords: Problem-solving, resources, tasks, professional development.**

### **Introduction**

Internationally, mathematics curricula are increasingly emphasising the development of problem-solving skills. However, there is evidence that problem solving is generally not well taught in schools (Eurydice 2011; Ofsted 2012) and that professional development for teachers in this area is needed.

It is within this context that our research for the Mathematics Assessment Project (MAP) is taking place. MAP develops resources for teachers (see <http://map.mathshell.org.uk/materials/index.php>), some of which are specifically designed to support the teaching of problem solving. Broadly our research aims to explore how the problem-solving resources are used in UK classrooms.

The MAP research is based in Nottingham, England and is taking place in the academic year 2012 – 2013. It involves 8 teachers in 3 schools. All these teachers were given resources for 25 problem-solving lesson units, developed by MAP, and were asked to choose between 6 and 10 lesson units to teach. This paper reports on a small study within the MAP research which focused on one teacher over two lessons. The specific questions the study aims to address are:

- How did the teacher choose and use the resources?
- Is there any evidence of the teacher's professional learning and/or changes in the teacher's practice over time? (If so, can we relate any changes to the use of the materials?)

### **Researching professional development**

There is a substantial research literature related to professional development of teachers of mathematics. Fr22/05/2013 22:57:00om this literature there are perhaps three main points to draw out as relevant to this study.

Firstly, it seems to be crucially important to find ways to encourage teachers to try out new things in their classrooms. For example, the RECME study (Joubert et al. 2010) recommended not only that teachers should try out new things, but also that professional development initiatives 'give permission' to the teachers to do so.

Secondly, there is some evidence that curriculum materials such as textbooks can influence the professional development of teachers (Remillard 2007; Davis and Krajcik 2005; Collopy 2003). This relates to Eraut's (2004) idea of professional learning as a by-product of working, whereby teachers learn by teaching. In this case, if teachers are using new and different curriculum materials, not only are they trying out something new but they are also learning and developing professionally.

Thirdly, it is notoriously difficult to 'measure' professional development, or to provide evidence that professional learning has taken place (Muijs and Lindsay 2008; Goodall et al. 2005). Many programmes of professional development require teachers to fill in so-called 'happy sheets' which are essentially teachers' self-reporting immediately after the professional development event has taken place. They tend not to relate teacher learning to the aims of the professional development and are unable to measure change in the teacher's classroom practice (Goodall et al. 2005).

### **MAP problem-solving materials**

The materials take the form of pdf documents and a supporting PowerPoint presentation. The pdf materials include guidance for teachers, providing detailed step-by-step suggestions for what the teacher might do at every stage of the lesson, such as timings for each stage and questions teachers could ask. It can thus be seen as a kind of professional development.

Each lesson unit has four sections: formative assessment, main task, sample student work and reflection. If all sections are covered, the lesson unit may take two or three class periods.

In the first section, the formative assessment (also called pre-assessment), the students are given the task and asked to make a start on it individually. The purpose of this is to alert the teacher to common difficulties the students have in relation to the task. The teacher then collects the students' scripts and writes a set of questions, possibly taken from the 'common issues' table provided with the materials, on each student's script. These questions are designed to provide the students with targeted support for the next time they attempt to solve the problem.

In a subsequent lesson the pupils work collaboratively on the problem, usually to produce a poster. The intention is that they will take into account the feedback they have received on their individual attempts, discuss the best approach, and then complete the task together. The guide strongly suggests that the poster should include both the solution and an explanation of the method.

Students are then given samples of work from another class which are usually chosen to demonstrate different approaches or to highlight misconceptions. Students should look at a piece of sample student work and then answer the questions below, such as "what could Kodie do to improve the presentation of her work".

Finally, the students reflect on how they worked by answering a set of questions. For example, they are asked to compare their work to the sample responses they looked at in the previous phase of the lesson.

### **The study**

John is an experienced teacher and this is his second year teaching the observed class. Prior to the beginning of the research, he told us that his reasons for participating in the project were to improve collaboration between pupils, find ways to address misconceptions and to give more effective feedback. Moreover, he explained that he

hoped that the materials would provide him with a model that could be used with other classes.

This study explored how John used the materials and looked for evidence of changes in his practice. The focus is therefore on the teacher, not the students.

We observed John teach two MAP tasks, each consisting of two lessons. The data included video from each lesson, interviews with the teacher after each lesson and a questionnaire completed by the teacher at the beginning of the project. Before finalising our paper, we also shared our emerging findings with John and asked for his comments and feedback.

## **What happened**

The first task chosen was ‘Gold Rush’: students work out how prospectors can maximize the area in which they dig for gold when they have a fixed perimeter. This task is often known as the ‘sheep pen’ task. John explained that he chose the task because he thought all students would be able to engage immediately with it and that “it has the potential to make use of a number of representations: calculations, diagrams, formulae, graphs” (Lesson 1).

The second task chosen was ‘Counting Trees’: students estimate the number of old and new trees, represented by circles and triangles respectively, in a diagram of 50 rows by 50 columns. John said that he chose this lesson because the mathematics was straightforward enough to allow all students to engage with the task. He said he hoped “the simplicity of the task allowed the class to work on creating and communicating a clear method and considering assumptions, skills which weren't well executed in our last task - Gold Rush” (Lesson 2).

As explained above, the resources for the lesson unit comprise four main activities for students: formative assessment, main task, critiquing sample students’ work and individual reflection. The results presented below follow this four-part structure.

In both lesson units, the students completed the formative assessment task and John wrote questions and comments on each student’s script. Whereas his comments in the feedback for Gold Rush task were mostly generic suggestions in the form of statements (e.g. “Take care to explain your method... so that someone who hasn’t seen the problem before can follow and understand”), in the Counting Trees task he asked more questions related to the context of the task, (e.g. “Does the section you counted represent the whole farm?”). All the comments and questions were John’s own “as a response to what students did” (summative interview), not taken from the ‘common issues’ table.

In both the lesson units, the students approached the task again collaboratively to produce a poster. Overall, John seemed to be disappointed by the activity, stating that he had noticed that the students did not really seem to use the formative feedback he had given them and that they did not appear to collaborate to produce a better solution:

“There is little evidence in the students’ work to show that they paid much attention to the feedback....I’m not sure how much they collaborated to produce a better solution .... sometimes they just chose the method from the previous lesson that one of the pair used.” (Lesson 2)

He said that he thought that the students had pre-conceptions about the value of collaboration and that he would like to “...truly get across the idea that together they may come up with a better solution.” (Summative interview).

He also said that in the first of the two lessons, the students had produced solutions but very little attention had been given to methods, although he had given explicit instructions to write a method for the solution on the poster,

“I was surprised by the students’ inability (or lack of motivation) to write out a method for the task.” (Lesson 1)

This had led to the deliberate choice of second task. In introducing this task, he had highlighted the idea of methods in his introduction to the task:

“We’ve spoken about methods, we’ve spoken about assumptions. So I’d like to see those kind of things starting to appear on the posters today.” (Lesson 2)

It seems that this approach was successful and that “[a]lmost all pairs showed their method clearly on the poster, often breaking it into numbered steps.” (Lesson 2) However, even after this success, John appears to think that there is value in further emphasising methods, and suggested the idea of method as stand-alone activity.

“It will definitely be useful to go over the idea of a method as a stand alone activity...we may be able to try and devise methods for three or four investigations without doing the investigations themselves. Looking at examples of good and bad methods would also be useful.” (Summative interview).

For the Gold Rush task, John first handed out one piece of sample student work, asking the students to “read through what she’s done so that you can understand”. He went on to say that they should not “quickly skim through” and that they should then write answers to the questions relating to the work. The class then discussed the sample work before going on to look at all the other three samples in the same way.

For the Counting Trees task, the teacher did not use the samples of work provided but instead created his own ones. His samples were created to address two misconceptions he had noticed amongst his class and used diagrams with far fewer trees so that “students could count the trees quickly to highlight the misconception” (Lesson 2).

Two main points emerge in terms of sample student work. The first one is that the teacher seems to be becoming more selective in choosing sample student work. Secondly, he is using sample student work to address misconceptions rather than to illustrate a range of approaches.

In both lesson units, John asked the students to write reflections on the work they had done the previous lesson while he was handing out the work. He explained that this activity, which was not included as an activity in the teacher guide, was designed to keep the students busy while he was handing out work and also to help them recall what the activity was about. In both lesson units the students were also asked to complete the questions related to how they had worked provided with the materials.

John reported that in general the students’ reflections tend to be vague and generic. For example he stated that: “What they write is mostly generic and generally very brief.” He said that he thought “[i]t may be useful to practise this skill in isolation” (Summative interview).

### ***Overall observations***

There is some evidence of John’s professional learning in terms of a) a more critical and selective approach to the resources b) developing awareness of which aspects of

his teaching he would like to work on and c) using some of the pedagogical approaches embedded in the resources within other areas of his teaching.

In terms of a) above, John has begun to critique the resources, saying, for example, “I think the pre-assessment can be useful ... I question the efficiency...” and “this lesson just involves them repeating what they did the previous lesson but on a poster.” He has commented that the timings given in the guidance could be more flexible and that the sample student work might include some more sophisticated examples with better questions:

“The structure of the questions for the sample work doesn’t always help”

In terms of b) above, John has begun to identify areas for his own development. For example, in the interviews following both lessons, he explained that he felt that he was not able to check what all groups were doing and suggested that he might “need to find a way to monitor the progress of all groups.” Whilst appearing to value the reflections both at the beginning of the main task and the end of the whole lesson unit, saying that “I would like them to do that better” in the summative interview, he also seemed to recognise that he might need to find ways to support them more in doing this. For example he said that “... their reflections at the start of the second lesson may need more scaffolding” and suggested that he might explore the use of samples of other students’ reflections to help them.

In terms of c) above, and related to this idea of using samples of other students’ reflections, there is some evidence that John may now be adopting the idea of asking students to critique other students’ work more generally:

“I consider using sample student work more often” (Summative interview).

There is also evidence that there may be a shift in the ways in which he provides formative feedback influenced by the use of the materials, saying that “this is helping push me in the right direction” (Summative interview).

## **Discussion and conclusion**

This research took place over a short period of time and John was experienced in teaching problem solving. Observations of his lessons prior to the use of the MAP resources suggested that he already used pedagogical approaches roughly in-line with those suggested by the MAP resources. For both these reasons, it is unlikely that we would be able to provide evidence of major (and sustained) professional development or changes in classroom practice for John.

However, we claim that there is some evidence of both professional development and changes in practice. For example, whereas in the first lesson John followed the lesson plan and teacher guidance closely, in the second he adapted, and added to, the resources. His critiques of the resources demonstrate that he is now engaging with them at a deeper level and is developing the confidence to adapt them for use with his own classes. His identification of areas of his practice on which he would like to improve demonstrate an awareness of his own professional development needs, which is, in our view, further evidence of professional development. Finally, there do seem to be some changes in his practice more generally, as evidenced by his comment on formative feedback above.

This study is the starting point for further research with John. We believe that using the materials has already made a difference to John’s teaching of problem-solving and to his professional learning more generally and will continue to do so. Crucially, however, it seems that these changes and learning are in line with John’s

reported aspirations. Further, although John came to the project with experience and expertise, it seems important that taking part in the project has in some way legitimised his trying out new things and reflecting on what happened which, as we pointed out in the short literature review above, is key to successful and effective professional development.

A second point made in the literature review above was that it is difficult to evaluate professional development. We agree that it is, and that it is particularly difficult to provide evidence of sustained change and of change directly related to the professional development initiative. However, we believe that we have been able to provide evidence that the professional development embedded in the MAP materials has been effective through close and careful observation of John's practice and through the dialogue we have had with him. Further we think we can claim that there is a relationship between John's learning and change and the MAP resources.

To conclude, we acknowledge the value of John's contribution to the project in terms of his considered, thoughtful and frank reflections on his teaching and on the materials he has been using. Further, we need to find ways in which the MAP team can best use the results of the research with John and others to inform the future development of materials for use in problem-solving lessons.

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