During her PGCE course Lorna decided to use a Bowland maths resource to stimulate some lessons and ran up against some puzzling problems and questions, so she emailed her tutor.

Dear Anne

I have attached my lesson plan and resources for my ‘rich task’ lesson, which I mentioned to you on Thursday. I put it all together myself but got the idea of looking at maths in music from looking at a Bowland maths lesson.

One thing I changed about the Bowland set-up was to cut out some of the things that I expected would send us off into conversation which wasn’t about maths. For example, they suggested asking the students to design and conduct an experiment to test the hypothesis that ‘music makes your heart beat faster’ and this was meant to cover 2 lessons. As I only had one lesson, I kept designing such an experiment as an extension task, partly thinking I won’t have enough time and partly because I was thinking, ‘this is science not maths’.

I kept the Bowland suggestion of discussing the qualities of two pieces of music to open the lesson and took it as a way to lead into talking about tempo but in my lesson evaluation, I wrote that I should have cut this bit out. I wished I had simply begun the lesson with: ‘How could we measure the tempo of a piece of music?’ and gone straight into looking at beats per minute. This was because I didn’t feel we got onto the maths fast enough. But Thursday’s PGCE session made me wonder whether this evaluation was right as it seemed you were encouraging us to allow things to go off on tangents so that students learn to see maths in context and watch us as we model identifying which directions are mathematical and which aren’t so that they can see where their maths is helpful in solving complex problems.

On the other hand, wouldn’t it have been better to ‘get going on the maths’ as it was only a one-off lesson? This then opens a difficult question about how we can make rich tasks work in a ‘one learning objective per lesson’ school culture as, in this sense, every lesson is a one-off.

In general, with regards to using contexts, I think it relies heavily on students seeing the point of it. In the opening moments of the lesson I heard a student say, ‘Are we doing music or maths?’ perhaps because they didn’t really see the point of what I was doing?

Reflecting on my teenage experiences, I wouldn’t have found more motivation in the idea that I was discussing pizza than if you had given me the straight maths in a worksheet format because the motivation to problem solve surely comes out of the problem being real? I think I would have ‘seen through it’. I would have looked for the maths I recognised in the problem, assumed I was meant to spot it and do it, and if kids in my classroom do the same, I won’t be surprised because they will have accurately interpreted my hope, that they find the maths which is relevant to the situation and do it. The pizza aspect wouldn’t have impressed me.

Perhaps I was just a very boring, assessment driven, student but the children I am teaching now might be too.

This aside, thinking about my lesson again, lots of learners got stuck trying to do questions 1-4 of the worksheet. I had to re-word the questions for many of them. Can you see why? Did I get too abstract too fast? This is why I asked what you thought.

Lorna

Dear Lorna

In the session on Thursday when we talked about modelling I was encouraging people to think about the difference between letting students discuss whatever the situation triggers for them and closing the task down so that, as you say, they ‘get going on the maths’ more quickly. The point about the Bowland case studies is that they are intended...
to spread over several lessons, and this gives space for the exploration of what is maths and what is not maths. You seem to have ‘this is music’ and ‘this is science’ competing here with ‘this is maths’ and whether this matters or not depends on how your school sees the mathematics curriculum. If it is really a ‘one objective per lesson’ culture then of course discussing a range of differences between musical types will not fit, but all the advice about engaging students in mathematics points towards a different culture in which lesson sequences are more exploratory and open-ended. The support for this, and the support for using contexts to motivate mathematics, comes from the Ofsted report of 2008 ‘Understanding the score’; the QCA publication ‘Engaging mathematics for all learners’; and the new National Curriculum; and several other sources.

However, I believe you are still right to be concerned about getting to the maths, because after all you are a mathematics specialist and the fact that you are also interested in the creative arts is a bonus, not an ‘instead of’. The work of the Freudenthal Institute is important in this discussion because they talk about the difference between a ‘model-of’ and a ‘model-for’. The power of maths is in developing mathematical descriptions of situations by looking at them mathematically, that is the model-of, and using such models as tools to create, conjecture, develop new objects, and to reach new mathematical understandings, those are the models-for.

Your problem with this music work was that you wanted to get quickly to the abstract models but the only justification you could think of for this is some intuitive anxiety about the mathematics and the objective-led curriculum. I think you have a much stronger reason which is that your job is to educate students to see the world mathematically. Seeing musical differences as mathematically describable is the first stage of this, and it matters because this allows mathematical ways of comparison to be used, which means the use of mathematics to make a ‘model-of’. You still need time to get students to use this ‘model-of’ as a ‘model-for’ new thinking. This final shift to using the model for something new is what makes mathematics worth learning, and what makes these case studies worth spending time on – but you have to try to get to the final bit, in my view, otherwise you are not teaching maths. Without the final step you would be teaching science or teaching music and using maths to help you.

I do not think that all the Bowland case studies are about this final shift, and I do not think that fitting Bowland studies into objective-led lesson formats and sequences allows this complicated process to play out fully.

You ask about whether your questions are too abstract too soon and this too is part of the ‘how long should this take?’ question. As one student indicated – is this maths or is it music? If you want them to shift to the abstract ideas – the model-for – you need to take time in class to support this shift and convince them that it is worthwhile to draw out abstract ideas from the music experience. These seem to be good questions for whole class or small group discussions.

Finally, a task is not rich unless the teacher and students engage with it in rich, multiple, deep ways and this too takes time if students are used to working in assessment-led ways. This may mean you have to give them different objectives explicitly, e.g. ‘the point of this lesson is to find out how many ways we can represent difference, and how many of these are mathematical’.

Does this help? You are trying to change a culture here, and using it to examine your own assumptions – but there are challenges here for everyone else as well and you are spot on with some of your observations.

Anne

Dear Anne

The first time I read this email, I didn’t really understand what you meant by ‘models-of’ and ‘models-for’ but now I do, I think. You can find maths in a context by making a mathematical model of it, such as plotting a graph of ‘beats per minute’ in the case of music, then using this graph to find out more would turn it into a ‘model-for’. So the skill we are trying to teach through such lessons is the use of mathematical tools to find out more about the world? That’s interesting and makes me want to work more in this way. I think I have only used Bowland materials before as a way of providing a basis for abstraction. I was using them to find a starting point from which to extract mathematical principles that I thought the students would already know and understand, and thereby motivate and enable the abstraction. However, the idea of ‘models-for’ establishes the value of such tasks in a new way, in a way that has not touched into my experience of school mathematics before, which is exciting.

In addition, such a skill has to be taught with the use of real-life contexts such as those offered by Bowland. Where I was using them as an alternative to non-contextual starting points, this paints contextual tasks in as an essential, not an alterna-
e, approach to teaching mathematics for how else can we teach the skill of making and using mathematical models?

It does make me feel a bit worried though as I haven’t done very much modelling before. I focused on Pure Mathematics at university and I made very little progress on the few modelling tasks we have had in the PGCE course although I think perhaps, with the chance to work on my own, I might have got further.

In your reply, you don’t mention what I said about the falsity of the situations we ask students to work with disenchanting the students. With this in mind, I endeavoured to find a real problem for my year 9s to investigate. To engage them with a Handling Data unit, I decided to ask them to research and present on an aspect of school life. They either took a topic from a list I put together or chose their own. We’re mid-way through the project now and they are going to present their findings to a panel of PGCE students. I hope that the thought that the views they collect and present will influence the practice of the future teacher workforce will motivate them throughout this project. It would be interesting to see whether it has helped in this way. Perhaps I should ask the other PGCE students when we finish the project?

The project has created a small stir in the department. While the students were collecting data, the headteacher and her visitor, the School Improvement Partner, popped in and also the Head of Maths has asked me to present on what I did at the next department meeting. He sees this as an example of a ‘rich task’ and he is trying to introduce this kind of approach into the department, but I am not sure that he saw more than just students moving around the room. This made me wonder what the working definitions of ‘rich task’ are. I have found:

- ‘low threshold, high ceiling’
- ‘something which hits several of the key processes’
- ‘teaching through real-life contexts’

Do you think it’s a problem that there do seem to be different ideas about what we’re aiming for out there? Communicating the heart of it is important if teachers are to remain creatively in charge of what happens in the classroom as otherwise satisfying the public drive for rich tasks will be only about doing the tasks that are described in the relevant documents. I love the creative side of it so I would always want that to stay a feature of secondary teaching.

I enjoyed reading the QCA document ‘Engaging ...’. I especially liked the idea of asking students to design objects with human proportion in mind, such as buildings/furniture. Perhaps this is because I am in a data handling frame of mind and I can see that this would require students to interpret statistics about human proportion. It has also given me another idea. Recently, I went to an Institute for Mathematics and its Applications (IMA) conference where a representative of the Science, Technology, Engineering and Mathematics Programme (STEM) was asking members of the IMA to sign up to support mathematics learning in schools, that they might bring some of their mathematical work into the classroom. Perhaps product designers and architects could help with such a project? I think bridging the school/work mathematics gap is difficult when teachers do not necessarily know what maths happens in the workplace.

Another thing that has struck me is the change that this approach would bring into lesson planning. There would be no point in planning a lesson until the previous lesson has happened. Skill in planning would heavily rely on picking up the mathematical threads that emerge in each lesson. This is an exciting way to work but very different to what’s encouraged in general in the profession I think, which is to be very organised and very planned ahead. With these curriculum changes, the best teachers may be those who only plan the night before!

With my year 9s I spent two lessons asking them to look in newspapers and find graphs. For each graph they found, they had to evaluate its effectiveness in representing the data it was intended to communicate and re-represent it in a better way if they could. In response to the latter part, one group drew a bar chart to replace a line graph depicting the rise and fall of sugar prices. I tried to comment at the time that I preferred the line graph, since one could make more readings from it. However, I don’t think it was very clear so I began the next lesson by explaining it better and now several students have referred to this point in the two homeworks produced since. I’m sure the fact that it was a point of learner confusion in the previous lesson helped that.

You mentioned the aim of trying to help students see maths in the world. This task with year 9s has really helped me do that. When I see different kinds of graphs in the newspapers I jump to read them and find out what they’re about. So I think this task does fit with that aim because if it’s had that effect on me, to open my eyes to how graphs are used in the media, it’s possible it has with the students.

Finally, returning to the problem of ‘Is it music or maths?’ – I actually spoke to another teacher the
other day who said (without me mentioning it first) that she got exactly the same comment in her classroom when she used this resource! I appreciate your idea for finding a different kind of objective within what we’re doing. I think this will be important for the students too, as they adjust to a new exploratory culture in the mathematics classrooms.

Later:

Dear Anne

I have been reflecting on my last email and thinking I was on my high horse a bit. But looking back at the three ‘definitions’ is useful:

I think that the first is what every lesson in general should be, accessible to all with much for students to attain as they persevere with and work with their teacher and other mathematicians in the classroom. I think I would see the high ceiling as something purely mathematical, a generalisation (perhaps structural) in words or algebra. However, perhaps this is too narrow; it only emphasises pure mathematics. You said a task was rich if students engage in rich, multiple, deep ways. Need it be multiple? If they find one deep thread of mathematics in it, I’d be happy. Right now, I can’t find a list of the key processes but I think which a task ‘hits’ is not determined by the task, by but the students and the teacher in the classroom. Most tasks could go anyway depending on the skill of the teacher in questioning and discussion and the interest of the students. And finally, teaching through real-life contexts is effective to get to the heart of mathematical modelling and to motivate students into working on mathematics (depending on how ‘real’ the context appears to students). But I think this approach is limited since some concepts in maths are concepts about concepts and so the higher points of abstraction in mathematics (which should be found around the high ceiling of a rich task) don’t come out of teaching through real-life contexts.

I guess one key point, is although the richness does seem to depend on the teacher and students, the bare bones of a task does have a role to play as well – so what, is the basic DNA/bare bones of a rich task?

Lorna

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1 See www.bowlandmaths.org.uk
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