

Visible Maths Pedagogy: do students understand teachers' intentions?

Tiago Carvalho, Alba Fejzo and Pete Wright explore how to make pedagogy more visible and the impact it has on all students' engagement and progress in mathematics.

Two years ago, we began collaborating in a research project with the aim of developing strategies teachers could use to make their pedagogy more visible to students. This project is ongoing. We report here on the results of our collaboration so far, focusing on the teaching approaches we are using and the strategies we developed to make them more visible. We also describe the processes and methodologies we have been using which are part of a model of professional development we are formulating. We start with the latter.

The context is an inner London community school, diverse in its intake, with a relatively high proportion of students benefiting from free school meals. The three of us share a concern for issues of social justice and decided to engage with research in this area. We describe our teaching approaches as progressive. These approaches are characterised by open-ended activities, collaboration between learners and an emphasis on developing problem-solving and reasoning skills. These can lead to more equitable outcomes and greater levels of engagement amongst students (Boaler 2008). However, as described by Lubienski (2004), there is also a danger that their relatively unstructured nature can further disadvantage children from less wealthy backgrounds who are more likely to misinterpret the intentions of the teacher or to miss the point of the lesson. We engaged with Lubienski's research at the start of the project and we decided to check how our students were interpreting our intentions when we used these progressive pedagogies. The results were revealing, giving us confidence to continue to explore this theme.

How do we do it?

The work we report on here is based on a Participatory Action Research (PAR) methodology, which in practice means that three of us collaborate and reflect critically on our practice and think of ways to develop it in a systematic way. In the first year we worked with our own mixed attainment classes of 11-12-year-old students. These students remained the focus of the project for the next two years. We used a series of plan-teach-evaluate action research

cycles to experiment with the strategies we came up with.

The planning phase of each cycle starts with a meeting to present and discuss research selected as relevant to the aims of the project. We then meet again to identify the teaching approaches and related pedagogy we want to focus on and to create specific strategies to make the pedagogy visible. We also agree on the methods to be used to evaluate the impact of the strategies. During the teaching phase of each cycle, we plan and teach a lesson to our classes where these strategies are tried out. We also collect data to inform the evaluation phase of the cycle. In the last phase, we meet again to evaluate the success of our strategies in making our pedagogies visible to our students.

The methodology we employ includes a variety of initiatives that have been consistently used in each cycle:

- *Video-record lessons* enables a key element of reflection during the evaluation phase. We developed a protocol for video-stimulated-reflection based on our own interpretation of research in this area. This consists of each teacher viewing the recording of both the lesson they have taught, and the same lesson taught by the other teacher, whilst pre-selecting one key moment from each lesson to facilitate discussion. These key moments are then played back and reflected upon during the evaluation meeting.
- *Peer-observe lessons* where the strategies are tried out. The teacher peer-observing operates the video-recorder and keeps a focused timeline of the lesson to facilitate video-stimulated reflection.
- *Student surveys* are conducted at the end of the research lesson or on the following days with all students from both classes. These include questions related to students' awareness of the rationale behind the strategies as well as students' perceptions of their own success in that lesson.

- *Interview target students* from disadvantaged backgrounds. Each year three students from each class have been selected and have been interviewed for each cycle by their own teachers. These interviews have been audio-recorded, transcribed, coded and are a key part of the analysis work which is ongoing. We believe that the students being interviewed by their teachers, instead of an unfamiliar person, allows them to express themselves more openly. We have been developing techniques to interview our own students by making them feel comfortable to express themselves fully whilst not leading them in a particular direction.

What do we do?

Since the beginning, our approach has been to start by identifying progressive teaching approaches that we already use in our practice. This makes us reflect more deeply on the pedagogy involved and why and when we should be using such teaching approaches. It then leads to questioning whether students are aware of the pedagogy and buy into it. We then think of strategies to make the pedagogies more visible. Very often these strategies tie in with ways of facilitating a discussion for students to reflect on the teacher's pedagogic rationale.

At the time of the first cycle we were using think-pair-share (TPS) activities, as part of a whole-school initiative to promote student thinking-time and to develop their oracy. In mathematics, students were encouraged to think about a mathematical problem first, then discuss how they might approach it with their partners and finally share their findings with the class. However, in our classes, instead of asking for students to share their own thinking we decided to ask students to share their partner's thinking instead. We hoped to shift the focus from the sharing of their own ideas to listening to and understanding the ideas of others. Until the first cycle we had never shared with the class the rationale behind TPS. So, we designed a lesson where we carried out TPS in this alternative way and at the end we conducted a survey where one of the questions was, "Why do you think the teacher asked you to explain your partner's thinking and not your own?"

The results were surprising. 90% of our students said our intentions were to check they were listening. A typical response was, "I think it was to see if you listen to your partner".

Only 10% of students realised our true intent. Some

responses that reflect this were, "Because it helps you to understand different opinions on the maths problems and different paths to the answer" or, "Because you can get two different perspective[s] and it may help you finalise your idea".

Following that lesson, we decided to have a discussion with our classes about why we used TPS the way we did. Since then we have noticed that, in becoming more aware of our true intentions, students have begun to engage more with TPS.

In that first cycle we also tried out a second teaching approach and a strategy to make it visible. The teaching approach was to separate reasoning from working out by using a simple table. We drew a vertical line on the board and asked students to offer solutions to a problem which required geometrical reasoning. We recorded "reasoning" contributions from students on one side of the line and "working-out" contributions on the other side. Our goal was to provide students with tools to tackle new-style examination questions that require students to explain their reasoning. We wanted students to be able to distinguish between giving reasons and showing how they worked out the answer. To make this approach visible, we asked students to label each side and to reflect on why we would want to separate the two. Students suggested labelling one side as "calculations" or "working out" and the other as "explanations", "method" or "why we're doing what we're doing." Through discussion we were also able to draw out why it is important to distinguish the two.

In our second cycle, we decided to continue to explore misconceptions between spoken and mathematical languages. We tried out two different teaching approaches:

1. Scribing for students when presenting ideas
2. Sorting/classifying problems into different types

The first one involved writing on the board everything a student would say. This would include both correct and incorrect answers. The idea was to draw out ambiguities and highlight informal language, discussing mathematical alternatives. At the same time, we asked students to improve their solutions by annotating their answers possibly in a different colour. The second approach was to sort ratio problems into different types of problem: sharing a quantity in a given ratio, finding a quantity given a ratio and finding an equivalent ratio. Using TPS we encouraged students to reflect on why we were

using both approaches by asking, “Why might it be important to sort ratio problems into different types” or, “Why do you think I was writing everything you said even if it was incorrect?” We then shared our ideas and discussed them as a class.

Having a discussion immediately before or after using those strategies appeared to make our students more aware of our reasons for using them, in turn raising levels of engagement. During our post-lesson evaluation meeting we also agreed that introducing one teaching approach and allowing time to discuss its rationale in the same lesson was the ideal format for future cycles.

Second year

We began our second year of the project with a meeting to both reflect on the first year and look ahead to the next year. We refined our protocol for video-stimulated reflection to facilitate a meaningful and evidence-based discussion. We decided to identify two key episodes from each lesson to help evaluate the success of the strategies used. We also decided to administer surveys to each of our classes before the third and after the fourth cycles to allow us to evaluate any progress during this second year.

In the third cycle (first cycle of year two) we came up with two teaching approaches we wanted to try out with our students:

1. To generate a model solution to a problem through discussion
2. To use the model solution as a reference point to solve other problems

We used these teaching approaches in the context of teaching substitution for the first time to the students. We showed them a question that could be expressed algebraically using several different methods. Through questioning and TPS, combining previous strategies that our students were now accustomed to, we discussed the different methods students had used before negotiating with the class a model solution, which students were then asked to copy down.

The strategy we used to make these pedagogies more visible involved a card sort with twelve statements that we created in our planning meeting. This comprised our primary reasons for adopting the teaching approaches, some other potentially valid reasons, but not those we considered primary, and some invalid reasons. Students were asked to discuss, in pairs, and rank these reasons according

to which they thought best reflected our rationale. In planning the lesson, we thought carefully about when would be the best time to share with students our reasons for generating a model solution. We agreed that it was important that in this case a brief discussion was held prior to the card sort. This was to allow students to understand the value of model solutions and therefore use them in their subsequent practice work. We also wanted to make sure students were buying into the strategies straight away and understanding and making our intentions explicit was key with this strategy.

For cycle four, we wanted to reuse the card sort, but in a more refined and effective way. We felt that we could simplify and improve the format of the card sort to make it more accessible to our students. We reduced the card sort to six statements. We also simplified the language. We used it in conjunction with only one teaching approach this time instead of two, to make it easier for our students to notice the approach and respond without any barriers or complications to understanding it. In the meantime, we also established that the card sort is useable in any lesson where you are trying to make your intention as a teacher more visible.

The teaching approach we decided to use this time was the *Boxing up* method, introduced to us by Helen Hindle at a workshop she led at a mixed attainment mathematics conference. *Boxing up* includes four sets of questions, the first of which we decided to use in the lesson (see the first green box in figure 1). Our thought process was if students could get into the habit of asking themselves, “What is the question asking me? What information do I already have?” every time they explored a problem-solving activity, this would help them to identify the key information needed and to devise a plan to solve the problem. These were the two primary reasons for using this teaching approach. We presented students with a series of problems on probability tree diagrams. We printed off and laminated the green box and encouraged students to write on this their responses to the questions before they solved the problems in their books. We made our reasons explicit as we taught the lesson and before students carried out the card sort strategy as the plenary.

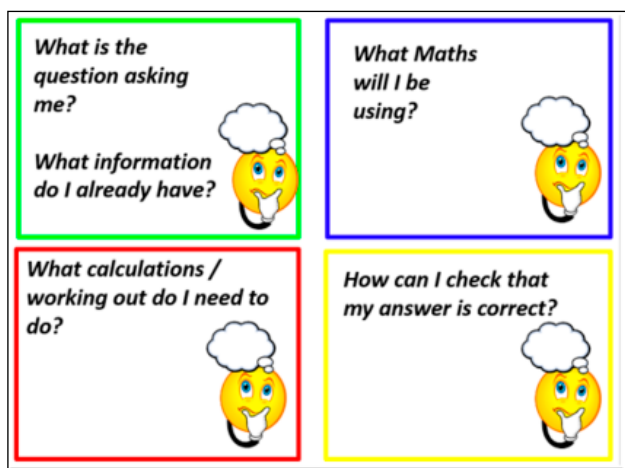


Figure 1: *Boxing up*.

At the end of the lesson, students ranked the reasons for using the *Boxing up* questions (see figure 2) and we had a class discussion about their answers.

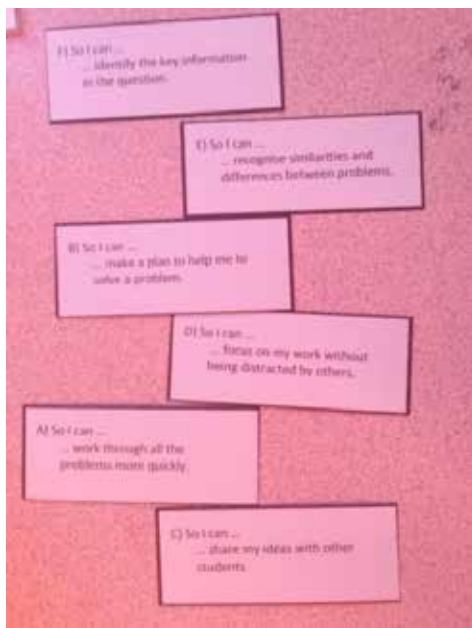


Figure 2: Student rankings.

Between cycle three and four, we had the opportunity to engage with and present findings on two further research studies that were considered key to our project at this point. One on how culture and power can be considered to establish a model of equitable instruction and another discussing the importance of critical reflection to support the transformation of teaching. We had a discussion around data collection, specifically on how to effectively conduct interviews and carry out surveys. This means our project keeps growing in two ways, coming up with new strategies to try out in our classrooms and continuously reflecting on and refining our model of professional development. A cycle of development

that encourages both us and our students to be reflective and continually growing in our roles.

What are the findings so far?

We continued to collect data from our students through surveys, audio-recorded interviews with the same target students and from observing how students engaged with the activities in the lessons themselves in each cycle. We are yet to complete a full data analysis of the year two cycles however we can summarise some preliminary findings. We found that students continued to enjoy having the opportunity to discuss why we do what we do in class. They are valuable conversations to have and to take time to do in lessons. This was consistent with the response we had after the first year's cycles, with students being more on board with us and why we used these pedagogies in the classroom. As a result, this seemed to positively affect the level of engagement in the classroom over time.

We found that students understood the reasons we used the green box method and were able to rank the primary reasons at the top. Interestingly, Tiago's class ranked the "making a plan" reason as the top reason, whereas Alba's class ranked the "identifying key information" statement as being the top reason. From our video-stimulated reflection meeting it became clear that this was due to slight changes in how we presented the reasons and the emphasis we put on each.

In the surveys, students also show a more developed understanding behind some questions such as, "What does the teacher do to help you be more successful?". One student's response was, "He teaches us methods like the boxing up method to assure that we have an understanding of what the question is asking us". Another student responds to the same question by writing, "She asks me questions that take(s) time to think about and also helps us to come up with model solutions which really helps us in maths". It was encouraging for us to see that students were making these references to the teaching approaches themselves without any prompting.

The audio-recorded interviews were a way of zoning into the understanding of students from disadvantaged backgrounds. They gave more detailed responses that showed a very good understanding of why we used the model solution/copying down approach/green part of *Boxing up* method. For example, "[it helps you] understand more ... highlight key information and get rid of the irrelevant information". We also felt

that the simplification of the card sort both in terms of the language used and using less statement cards, helped in the fourth cycle as students showed better understanding both during the class discussions and in their card sort arrangements. This contrasted with results from cycle three where a few students still seemed to misunderstand the point of the model solution and copying it down.

Looking ahead

Given that our findings so far show that our students have a better understanding of the pedagogy we use in the classroom because of the strategies we employ, we feel encouraged to keep exploring and come up with new strategies. We are now about to embark on cycle five (third year) on the project and we are excited to see how far we can go with it. Moreover we have recently been awarded a grant from SHINE which, with the support of our school and mathematics department, will allow us to begin disseminating on a wider scale. We plan to do this by first collaborating in trios with other mathematics teachers in our department and eventually with other schools. We also plan to write materials to support the use of the model of professional development we have been using. The aim is for these materials to be used by mathematics teachers to explore a theme of their choosing in their own classrooms. More on this on our blog as we develop those materials,

which we update with each cycle (See www.visiblemathspedagogy.wordpress.com)

This model has worked so well for us because it fits seamlessly with what a reflective teacher does anyway in their day-to-day teaching. We believe that, given the resources, other teachers can do the same in their practice, with the aim of improving their students' learning experience and outcomes too.

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