Challenging inequity in mathematics education: Sharing teachers’ pedagogical rationale with learners

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Background

Whilst other differences in achievement (e.g. between boys and girls) have narrowed, socio-economic disadvantage remains the most decisive factor in determining success in school mathematics (Jorgensen 2016). This is despite recent government policies aimed at highlighting and reporting differences in attainment and, since the introduction of the ‘pupil premium’ in 2011, targeting resources at disadvantaged children. ‘Progressive’ teaching approaches, characterised by open-ended activities, collaboration between learners and an emphasis on developing problem-solving and reasoning skills, have been shown to lead to more equitable outcomes and greater levels of engagement amongst pupils (Boaler, 2008; Wright, 2016; 2017).

However, there is a danger that the relatively unstructured nature of progressive teaching approaches 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. In a study in the United States, Thule Lubienski (2004) describes how less wealthy students were further disadvantaged by progressive teaching approaches as the lack of structure meant they were less able to recognise the intentions of the teacher, e.g. by failing to notice hints and clues and by missing the point of class discussions. Bernstein (2000) argues that children from disadvantaged backgrounds, because of their upbringing, are generally less able to decipher the ‘rules of the game’, i.e. the ‘recognition rules’ (identifying relevant meaning from tasks) and ‘realisation rules’ (formulating appropriate and legitimate responses).

This provides something of a dilemma for mathematics teachers committed to addressing inequity in their classrooms: should they avoid progressive approaches altogether or explore ways to make pedagogical rationale more explicit to learners? The focus of this paper is on developing strategies that mathematics teachers might use to make pedagogy more visible to learners, in order to help all students recognise their intentions as teachers, when adopting progressive approaches to teaching.

I report on an ongoing participatory action research project in which I am collaborating with two teacher researchers, Tiago and Alba, who share my interest in developing progressive teaching approaches and exploring issues of equity in mathematics classrooms. The project is situated in a comprehensive secondary (age 11 to 18) school in North London with a relatively high proportion of disadvantaged students (approximately 30% of students qualified for the pupil premium grant in 2016-17). The school’s mathematics department has recently incorporated a series of problem-solving activities into its scheme of work and is gradually moving away from a rigid setting structure in Year 7 towards mixed attainment grouping. The school has a current focus on developing ‘oracy’, which in the mathematics department includes encouraging students to express their reasoning through ‘think-pair-share’ strategies.

I start by presenting strategies developed by Tiago and Alba in their work with two mixed attainment Year 7 mathematics classes. These are exemplified by a rich
problem-solving activity that I used with delegates who attended the workshop I ran at the BCME 9 workshop. The strategies used alongside these activities, aimed at making the pedagogical rationale of teachers more visible to students, are the same as those used by the teacher researcher in the project. I go on to highlight the potential of these and similar strategies for addressing inequities in mathematics education by considering some of the early findings from the research project.

**Strategies for making teachers’ pedagogical rationale more visible to students**

The following rich problem-solving activity was similar to one used by Tiago and Alba with their Year 7 students, although here I have substituted the flags they used with different examples aimed at providing an appropriate level of mathematical challenge to participants in the workshop. Participants were asked to work in pairs and to choose one flag from the seven I provided for them (see figure 1), each printed off on A4 paper. They were asked first to think individually about how to find the area of different-coloured shapes appearing in the flag. They were then encouraged to discuss their ideas with their partner and consider whether there was more than one way of finding this area, before sharing their ideas with the rest of the group.

![Flags](figure1.png)

Figure 1: Flags of Republic of Congo, South Korea, Switzerland, Senegal, Seychelles, Bahrain, Sudan.

There is nothing remarkable about this open-ended, problem-solving task, or about the ‘think-pair-share’ approach that was used to introduce it, both of which were employed routinely by Tiago and Alba in their teaching practice prior to their involvement in the project. However, the following two strategies that I used alongside the activity, which were originally employed by the teacher researchers with their Year 7 students, had not previously been a focus of their practice. Both strategies were designed to make explicit the rationale behind their pedagogy.

Strategy 1: Participants in the workshop were asked to be ready to present their partner’s ideas on their behalf, rather than to present their own ideas. This was followed up with a discussion prompted by the question: “Why do you think I asked you to present your partner’s ideas rather than your own?” Suggestions put forward by participants included how this requirement would encourage students to listen more intently to each other’s arguments, be more open to each other’s ideas, and to ask follow-up questions if they did not fully understand, all of which would contribute towards deepening understanding. Students would also be motivated to think carefully about how to explain their solutions and thinking to each other in a way that enabled their partner to present their ideas confidently and coherently on their behalf, thus focusing on high quality mathematical communication.

Strategy 2: As participants presented each other’s ideas, I recorded summary notes in one of two unlabelled columns in a table, that I had previously drawn on the
board, without revealing at this stage the reason for doing so (which was to make a clear distinction between ‘reasoning’ and ‘working out’). Examples of the type of statements I recorded (relating to the flag of Seychelles) are shown in figure 2 below.

<table>
<thead>
<tr>
<th>Turn the flag upside down to make it easier to find areas.</th>
<th>Area of triangle = ( \frac{1}{2} \times \text{bh} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The blue and yellow triangles have the same base and height so they have the same area.</td>
<td>Base of blue/yellow/red triangle = ( 24.6 \div 3 = 8.2 \text{ cm} )</td>
</tr>
<tr>
<td>We need to check this by measuring and not assume it.</td>
<td>Height of flag is half its width. Height = ( 24.6 \div 2 = 12.3 \text{ cm} )</td>
</tr>
<tr>
<td>The red quadrilateral can be divided into two triangles.</td>
<td>Area of each triangle = ( \frac{1}{2} \times 8.2 \times 12.3 = 50.43 \text{ cm}^2 )</td>
</tr>
<tr>
<td></td>
<td>Area of each triangle = ( 24.6 \times 12.3 \div 6 = 50.43 \text{ cm}^2 )</td>
</tr>
</tbody>
</table>

Figure 2: Examples of the type of statements recorded in the table (for the flag of Seychelles)

Once the table was complete, I posed the question: “What is the difference between the statements in the two columns of the table?” After some discussion, I then asked: “What do you think was the purpose of separating ‘reasoning’ and ‘working-out’ in the table?” This led to further discussion about the distinction between reasoning and working-out and how recognising this difference would enable learners to respond appropriately to the request to “give reasons for your answers” (not uncommon in mathematics lessons or examinations). Thus the intentions of the teacher become an explicit focus for discussion and consideration by the learners.

The strategies described above are aimed at making pedagogies visible that would otherwise remain implicit (and often not at all transparent) to learners. There are other questions that I could have asked in order to provide similar insight for learners into the rationale behind various pedagogical decisions that I made, such as: “Why did I choose these particular 7 flags? Why did I let you choose which ones to look at? Why did I ask you to work in pairs?” Such questions might be posed at the start of the lesson, in order to help learners recognise, and respond appropriately to, the teachers’ intentions during that lesson, or at the end of the lesson, in order to prepare learners for achieving mathematical success in future lessons.

**Early findings from the research project**

At the time of writing this paper, only one action research cycle had been completed so the findings reported below are based on an initial and limited analysis. It was noticeable from the responses to the first set of surveys, at the beginning of the project, that students often did not appreciate the intentions of the teacher in adopting progressive teaching pedagogies. They frequently misread the objective of teaching approaches, aimed at enhancing mathematical learning, as enforcing compliance, e.g. they assumed that being asked to present their partner’s ideas was an implicit way of enforcing listening. Through holding open discussions relating to the rationale for adopting such pedagogies, the teacher researchers (Tiago and Alba) observed how students began to more fully appreciate their purpose, e.g. they began to recognise the value of engaging with others’ ideas for enhancing their own learning.

The teacher researchers described how they had initially felt wary about devoting significant amounts of lesson time to discussing the rationale behind their
teaching strategies with students. They were concerned about reallocating time that would otherwise have been spent engaging directly with mathematical activities and about how students would respond to this. However, after several weeks in which they periodically incorporated such discussions into their teaching practice, they began to appreciate the benefits of doing so as a wider range of students appeared able to respond appropriately to problem-solving tasks and to consequently become more successful at grasping mathematical concepts. They were surprised by the students’ willingness to engage with the idea of discussing teaching strategies and the extent to which they accepted this as a valuable component of their mathematical learning.

Another positive and unanticipated benefit of the first action research cycle was the stimulus it provided for the teacher researchers to reflect critically on their own classroom practice. Discussing their own reasons for adopting particular teaching approaches with students prompted them to re-evaluate many of the previous assumptions and premises underlying their pedagogies. Using the student surveys and video-stimulated reflections as evidence to evaluate their lessons encouraged them to focus on how all students responded to their teaching, including those who routinely under-achieve in mathematics and might otherwise have been overlooked.

Conclusion

From an initial analysis of the early stages of the research project, it appears that making teachers’ pedagogical rationale more visible to learners offers potential for addressing inequities in mathematics classrooms. This paper has highlighted particular strategies that can be adopted alongside progressive pedagogies in order to help all students recognise the intentions of the teacher and hence to respond appropriately and achieve greater success in mathematics. It offers a positive way forward for teachers who believe that adopting collaborative and problem-solving approaches to learning fosters greater mathematical understanding, and who are also committed towards closing the gap in attainment between advantaged and disadvantaged students. It offers a means for teachers to critically reflect on existing practice in order to identify and address factors contributing towards the under-achievement of disadvantaged students in mathematics classrooms.

References


Jorgensen, R. (2016). *The elephant in the room: Equity, social class, and mathematics*. In P. Ernest, B. Sriraman, & N. Ernest (Eds.), *Critical mathematics education* (pp.127-146). Charlotte, NC: Information Age


Visible Maths Pedagogy research project: https://visiblemathspedagogy.wordpress.com/ #visiblemathspedagogy