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Recognising the benefits of progressive pedagogies for promoting equity and social justice in the mathematics classroom

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School closures arising from the COVID-19 have highlighted inequities in society, as well as schooling, and hence provide an opportunity to re-engage with the debate over the mathematics curriculum. We argue that progressive pedagogies are an essential part of a socially just mathematics curriculum, and that making these pedagogies more visible to learners can address concerns that they might further marginalise students from disadvantaged backgrounds. We draw on the findings from the Visible Maths Pedagogy research project that outlines strategies that can be successfully used for making the teacher's pedagogic rationale explicit to learners.

Introduction

The recent COVID-19 pandemic has served to heighten public awareness of existing inequities and injustices within education, and more widely in society, as their consequences have become more visible. Marmott et al. (2020) describe how the pandemic has disproportionately affected those from disadvantaged social groups in England, amplifying inequalities that have grown significantly over the past decade. They highlight how "shockingly high COVID-19 mortality rates among British people who self-identify as Black, Bangladeshi, Pakistani and Indian" can be largely attributed to living in more deprived areas and crowded housing, and being exposed to greater risks of contracting the virus at work, conditions which "are themselves the result of longstanding inequalities and structural racism" (p. 6). After emerging from the pandemic, they warn against attempting to re-establish the status-quo that existed before, with its extensive inequalities in income, health and wellbeing.

School closures resulting from the pandemic in England, beginning in March 2020 and January 2021, and the shift to online teaching, had a disproportionately large impact on the attainment of students from disadvantaged backgrounds, with their families having significantly less time and resources than others to support their learning (Muller & Goldenberg, 2020). This was evident in the differing levels of access to resources and participation rates amongst social groups. More than three times as many families from low-

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income households as high-income families reported their children not having adequate access to the electronic devices needed for studying (Montacute & Cullinane, 2021), and teachers from the most deprived schools reported a much higher proportion of students without an adequate Internet connection (The Sutton Trust, 2021). Children from wealthier families were reported as being twice as likely as others to participate in daily live or recorded online teaching sessions, and to spend much more time learning. Twice as many teachers in the most deprived schools (as those in affluent schools) reported a significant drop in the quality of work received from students (Cullinane & Montacute, 2020).

Hodgen et al. (2020) highlight how the closures of schools, and the transfer of mathematics teaching to online platforms, resulted in significantly lower participation and engagement rates amongst low-attaining and disadvantaged students. They warn that this is likely to further increase gaps in mathematics attainment between these groups and other students. They found that the emergency responses of schools to the pandemic (in contrast to well-planned distance learning approaches) resulted in remote teaching that reduced the level of scaffolding and support provided, and severely restricted mathematical learning experiences, particularly those of low-attaining students. There were very limited opportunities for students to receive feedback, interact with teachers and other students, discuss their mathematical ideas with others, and to engage with metacognitive tasks.

Whilst COVID-19 is likely to exacerbate inequalities in educational outcomes, we should not forget that things were far from perfect before the pandemic struck. Whilst collaborative and discursive learning experiences (as highlighted above) were noticeably absent during the recent school closures, they were often sadly lacking from many mathematics classrooms prior to this. Many students experienced school mathematics as passively learning rules and procedures without any clear purpose, with few opportunities to work collaboratively, and encountering content which they found boring and irrelevant (Nardi & Steward, 2003). High levels of alienation and disengagement amongst some learners have been accompanied by a persistent and strong association between students' socio-economic status and their level of mathematical achievement and participation (Boaler, Altendorf, & Kent, 2011). Since school mathematics acts as a critical filter in determining access to higher education and better-paid jobs, these differences in achievement serve to limit social mobility and reproduce patterns of inequality in society (Jorgensen, 2016).

The shortcomings of the remote mathematics teaching approaches imposed on teachers through the emergency response to the school closures therefore highlights the need to re-evaluate existing practices in mathematics teaching. Marmott et al. (2020, p. 4) argue that, in emerging from the recent lockdown in England:

> There is an urgent need to do things differently, to build a society based on the principles of social justice; to reduce inequalities of income and wealth; to build a wellbeing economy that puts achievement of health and wellbeing, rather than narrow economic goals, at the heart of government strategy; to build a society that responds to the climate crisis at the same time as achieving greater health equity.

We offer a similar argument, from a mathematics education perspective, that the COVID-19 pandemic offers an opportunity to re-engage with the debate over the mathematics curriculum and to renew calls for a genuinely engaging and empowering mathematics curriculum that challenges the inequities and injustices that have become increasingly apparent in schools, and which continue to plague our society.

Progressive pedagogies, equity and social justice

This paper focuses on the adoption of what we refer to as 'progressive' pedagogies. By this, we mean teaching approaches that: embrace collaboration and discussion amongst students, involve posing rich and challenging open-ended problems that require students to make decisions about the direction their learning takes, recognise multiple solutions to problems, encourage students to articulate their reasoning, and welcome errors and misconceptions as learning opportunities (Boaler, 2008; Swan, 2006). Progressive pedagogies are accepted by many authors as an essential element of a mathematics curriculum that promotes equity and social justice. Evidence shows that they motivate and engage a wider range of learners, not just those with a predisposition towards learning mathematics that is fostered through their privileged upbringing, and they provide the mathematical agency that is needed by learners to solve problems they may come across in their future lives (Bartell et al., 2017; Gutstein, 2006; Skovsmose, 2011; Xenofontos, Fraser, Priestley, & Priestley, 2020).

Tensions and contradictions in curriculum reform over recent decades have been evident in the debate, and often heated exchanges (particularly in the US and UK), between equity-minded mathematics educators and those, from more conservative ideological positions, who advocate more traditional teaching approaches (Schoenfeld, 2004; Wright, 2012). Perhaps more worrying is the recent growth in popularity of teacher-led pedagogies advocated by those who claim to be motivated by concerns for equity. These approaches are often justified by claims that the relatively unstructured nature of progressive pedagogies renders them invisible to learners. Thus, students from less wealthy backgrounds, who generally find it more difficult to decipher the rules of the game in the mathematics classroom (Bernstein, 2000), are likely to be further disadvantaged by progressive pedagogies, for which it is not always clear what students must do to be successful (Lubienski, 2004).

Teacher-centred approaches that have become increasingly popular in recent years include Direct/Explicit Instruction in the US (Doabler & Fien, 2013; Rosenshine, 2012) and Mathematics Mastery in the UK (Drury, 2018). These approaches share the premise that effective learning depends upon teachers presenting concepts in highly structured and unambiguous ways. The use of carefully selected examples, demonstrating small conceptual steps, is designed to avoid cognitive over-load and to ensure students draw correct inferences. Whilst Mathematics Mastery has been associated with modest improvements in overall attainment (Jerrim & Vignoles, 2015), students are given little opportunity to develop agency through engaging with open-ended problem-solving tasks. Direct Instruction, which is often targeted at lower-attaining students or those from disadvantaged backgrounds, places greater emphasis on maintaining a fast pace, regular guided practice and the routine use of testing (Doabler & Fien, 2013; Rosenshine, 2012). It shares many of the problems associated with other teacher-led pedagogies including the disengagement and disempowerment of learners (Ewing, 2011; Gutstein, 2006; Nardi & Steward, 2003).

Muller and Young (2019) have called for a renewed emphasis on ‘powerful knowledge’, drawing on Bernstein’s (2000) notion of abstract, specialised and coherent knowledge that enables learners to extend their horizons. However, they highlight how teacher-centred approaches often focus on a narrow interpretation of curriculum as a list of topics that lacks coherence and ignores issues of pedagogy. They argue that powerful knowledge should be more than an assortment of isolated propositions and must include an understanding of ‘disciplinary meaning’, i.e., how propositions become accepted within the discipline. For school mathematics to be empowering, therefore, students need to develop an appreciation of how new knowledge is generated by mathematicians and how this becomes accepted through argumentation and debate amongst peers (Ernest, 1991). This means providing students with experiences that reflect the processes mathematicians go through in solving real-life problems, including: working collaboratively, following new lines of inquiry, posing problems, making conjectures, making assumptions to simplify the problem, deciding which tools/methods to use, interpretating/explaining/justifying solutions to others (Mason, Burton, & Stacey, 1985). Progressive pedagogies aim to provide precisely those experiences described above and should therefore be regarded as invaluable for students in generating powerful mathematical knowledge.

However, there remains the risk that students from less privileged backgrounds might be further disadvantaged by the invisibility of progressive pedagogies (Lubienski, 2004). Rather than using this as an excuse for adopting teacher-centred pedagogies, we argue that those seeking a genuinely equitable and empowering mathematics curriculum should adopt progressive pedagogies whilst seeking strategies for making these more visible to learners. This is the aim of the project described below.

The Visible Maths Pedagogy (VMP) research project

The Visible Maths Pedagogy (VMP) research project was a collaboration between an academic researcher (Pete – the first author of this paper) and two teacher researchers (Alba and Tiago – the co-authors) based in Stoke Newington School (a non-selective and ethnically-diverse secondary school in London with an above-average proportion of students from disadvantaged backgrounds). The mathematics department already made extensive use of progressive pedagogies, had recently developed its scheme of work to include more open-ended rich tasks, and was in the process of moving towards mixed-attainment teaching groups. The research project aimed to explore strategies for making progressive pedagogies more visible to learners and their impact on students’ mathematical engagement and achievement. The methodology and findings from the project have been reported elsewhere (Wright, Carvalho, & Fejzo, 2020; Wright, Fejzo, & Carvalho, 2020). In this paper we describe some of the strategies that were developed, and draw on selected findings from the project, to highlight the benefits of making progressive pedagogies more visible for promoting equity and social justice in the mathematics classroom.

The strategies devised by the research team focused on prompting discussions with students around the pedagogic rationale for the progressive teaching approaches adopted. During cycle 2, for example, the teacher researchers asked students to present their solutions to an open-ended problem to the rest of the class, whilst using 'scribing' to write down exactly what each student said, regardless of whether it was correct or not. The teacher researchers then asked follow-up questions that aimed to draw out any ambiguities/errors in students' solutions. In order to prompt students to consider the reasons for adopting this teaching approach, i.e. enabling students to decide whether a solution is acceptable and to recognize errors and misconceptions for themselves, the teacher researchers then prompted a whole-class discussion by asking questions of the form: 'Why do you think I asked you to ...?'

During Cycle 3, students were again asked to present their own solutions to an open-ended problem to others. This was followed by a whole-class discussion in which the teacher researchers facilitated agreement amongst students on what a 'model solution' would look like, which was then copied down by all students and used as a reference point for solving similar problems. During Cycle 4, students were provided with a series of questions, e.g., 'What is the question asking me? What information do I already have?' These questions were contained within a text box, printed on card, and laminated (hence the teaching approach was referred to as 'boxing up'). Again, the strategies for making the pedagogic rationale more visible included prompting a discussion around the purpose of using these approaches. For instance, for 'boxing up' the teacher researchers asked: 'Why is this useful? What does this question allow you to do?' However, during Cycles 3 and 4, the teacher researchers also made use of a card sort strategy that involved providing students with a series of statements, some of which were considered primary reasons for using each teaching approach, others potentially valid reasons not considered primary, and the remainder invalid reasons. Students were asked to discuss which statements they thought most closely reflected the teacher's reasons, and to arrange the statements in order with these at the top. For the 'boxing up' approach, the following six statements were used: 'So I can make a plan to help me', 'So I can identify the key information in the question' (both primary reasons); 'So I can share my ideas with other students', 'So I can recognise similarities and differences between problems to solve a problem' (both potentially valid reasons); 'So I can work through all the problems more quickly', 'So I can focus on my work without being distracted by others' (both invalid reasons).

Findings

In this section, we present selected findings from the project that are most relevant to the argument in this paper. More fuller accounts of the project findings, together with details of the research methodology and analytical framework, are published elsewhere (Wright, Carvalho, & Fejzo, 2020; Wright, Fejzo, & Carvalho, 2020).

The strategies were tried out during 'research lessons' as part of four action research cycles carried out over two academic years between 2017 and 2019. The first two cycles (completed during the first year of the project) involved working with two mixed-attainment Year 7 (age 11–12) classes taught by Tiago and Alba. Cycles 3 and 4 involved two mixed-attainment Year 8 classes containing some, but not all, of the students who participated in the first year (the classes were reorganised at the end of Year 7). As part of the evaluation of the strategies, Tiago and Alba conducted interviews, shortly after the final three research lessons, with 3 students from each of their own classes. The interview questions focused on exploring the extent to which students appreciated the teacher's pedagogical rationale and how to engage with progressive teaching approaches in achieving mathematical success. As we were particularly interested in the impact of the strategies on disadvantaged students, these students were chosen from those identified as 'pupil premium', a measure of socio-economic deprivation used to allocate additional resources to schools in England.

Only two students, Keira (in Alba's class) and Neal (in Tiago's class), were selected to be interviewed in both Year 7 and Year 8. Both students were of black Afro-Caribbean heritage (note black Afro-Caribbean boys were identified by the school as an under-performing group). Keira was of average attainment (compared with others in the school), engaged well in lessons, and was generally articulate, although she sometimes struggled with accessing questions because of literacy/comprehension difficulties. Neal was of below-average attainment and was a more reluctant learner. He lacked confidence and often needed encouragement to engage with activities. Both students were more comfortable with closed tasks than open tasks. We have chosen to present data from the interviews of these two students to exemplify the findings from the project. Whilst the responses of Keira and Neal reflected those of other students interviewed, the impact of the project on Keira and Neal in the second year was more noticeable than others. This might be because the interviews provided further opportunities for both students to reflect on the teacher's pedagogic rationale.

Most students, including those from disadvantaged backgrounds, exhibited high levels of engagement and enjoyment, and described themselves as being successful during the research lessons. Initially, most students attributed this enjoyment/success to factors commonly associated with teacher-led approaches, e.g., completing large amounts of work, and getting answers correct. However, by the end of the project, there appeared to be a small shift towards attributing enjoyment/success to engaging with the progressive teaching approaches employed during the research lessons:

> I think I did really good, because I was, like, annotating in my work [...] when you were telling us to annotate [...] everything you did, like, I was doing as well. (Keira, Cycle 2)

Neal began to see collaborating with others as integral to his own success:

> Well, I did pretty good [...] because me and [another student] [...] we did our own separate question. And then after we just worked it out together, after, to see if how we got the same answer, and then what method we did and see what's the easier method. (Cycle 2)

Both students appeared to enjoy the opportunity to engage with, and solve, more challenging problems:

> I liked [...] the questions were [...] well, some of them were easy, but then some of them were tricky, I did like a lot of working out for it. (Neal, Cycle 2)
>
> I enjoyed it because [...] for me, I like learning about [...] I like getting pushed. So, when you were asking us questions, and it, like, it helped us, like, push ourselves. (Keira, cycle 4)

At the start of the project, it was common for students to misinterpret the teacher's intentions in employing progressive pedagogies, often viewing these as attempts to seek compliant behaviour from students. However, over the course of the project, students exhibited a growing appreciation of the teacher's pedagogic rationale and were more likely to accurately identify and articulate the primary reasons given by teachers for adopting progressive approaches.

During Cycle 2, for example, Keira identified correctly that the main purpose of the 'scribing' approach was to enable students to identify errors for themselves:

> And by writing everything we've said, that will help, not just, like, the person, it will show everyone, like, where it went wrong. Instead of, like, you telling us, and that, we can learn from our mistakes.

Whilst Neal did not mention errors or misconceptions. Instead, he referred to the purpose of 'scribing' as encouraging students to focus on the method for solving a problem rather than the answer (which might be considered a valid reason but not identified by the teacher researchers as a primary reason):

> But then it doesn't really matter if it's correct or not [...] their working out might be correct, but it's just that they, maybe, done something wrong at the end.

During cycle 3, Keira correctly identified a primary purpose of the 'model solution' approach as encouraging students to discuss and compare each other's ideas:

> So, like, um [...] if we're working in partners, and it's like we're deciding on a method to use, we can say 'this one is more efficient to use because of this'.

Neal also identified (correctly) primary purposes for the 'model solution' approach, i.e., to promote mathematical communication and independent problem solving:

> And then someone who has the correct answer could explain, like, how they got the answer, and put it into, like, more detail. [...] If you get something like similar, like, you could just flip back and like check 'Oh, how did you do that? How do I do [...] how do I answer the question?' Yeah.

Similarly, during Cycle 4, both students clearly articulated the main purposes of the 'boxing up' approach, i.e., to enable students to identify the key information they need to solve a problem and to appreciate the value of planning:

> And so, like, say if you're stuck, and you're like 'OK, so I don't know what the question's asking me', you can look at the green box and see: 'OK, look what I have already, what is it [...] what is the question about? What is the important key information about the question?' (Keira)
>
> Like planning's very important [...] you always have to plan before you start the work because then you, like, don't rush through it quickly. Because it wouldn't really, like, clearly make sense to you. (Neal)

Conclusion

In this paper, we have argued that the recent COVID-19 pandemic has highlighted the need for a genuinely engaging and empowering mathematics curriculum that can address issues of equity and social justice in the mathematics classroom. We have outlined how progressive pedagogies are an essential component of such a curriculum as they provide learners with the awareness of disciplinary meaning that they need to develop powerful mathematical knowledge. The findings from the VMP research project reaffirm other research findings (e.g., Boaler, 2008; Gutstein, 2006) that demonstrate the benefits of progressive pedagogies in enhancing the motivation and engagement of a wider range of students, particularly those from disadvantaged backgrounds, and enabling them to experience greater success in mathematics lessons. The project highlights strategies that are effective in making progressive pedagogies more visible to learners, by providing students with a greater appreciation of their teacher's pedagogic rationale. Some authors have claimed that progressive pedagogies can lead to students from less privileged backgrounds being further disadvantaged (Lubienski, 2004). This paper makes a significant contribution to the debate around equitable mathematics teaching approaches through highlighting how this risk can be avoided by making progressive pedagogies more visible to learners.

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