Visible pedagogy and challenging inequity in school mathematics

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This paper reports on the initial findings of a research project aiming to explore ways of addressing concerns regarding the persistent gap in mathematics achievement between children from different socio-economic backgrounds and low levels of engagement of significant numbers of students with school mathematics. It argues that such concerns can be addressed without the need to abandon a commitment towards progressive teaching approaches. It highlights the potential of adopting a critical model of participatory action research for challenging existing classroom practices that contribute towards reproducing inequities in mathematics education. It demonstrates how developing strategies for making progressive pedagogies more visible offers students the chance to become more aware of the intentions of the teacher and what they need to do to be successful in school mathematics.

Keywords: Inequity, participatory action research, school mathematics, visible pedagogy.

Introduction

This paper reports on the initial findings of a research project which aimed to develop strategies to address the large gaps in mathematics achievement existing in schools between children from different socio-economic groups. Evidence suggests that 'progressive' teaching approaches, which involve providing opportunities for students to work independently and collaboratively on solving open-ended problems, can lead to higher levels of engagement and more equitable outcomes amongst mathematics students. However, there is also a danger that their relatively unstructured character 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. The project aimed to develop strategies teachers can use to make their pedagogy more visible, so that all students are able to recognise their intentions as teachers, and to identify research processes and methods that enable this to happen.

Background

Wide gaps in achievement in school mathematics persist worldwide between children from different socio-economic backgrounds. There is evidence of a strong and persistent correlation between students' attainment and participation in school mathematics and their family income (Boaler, Altendorf, & Kent, 2011). 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 the case in England despite recent government policies aimed at highlighting and reporting differences in attainment and, since the introduction in 2011 of the 'pupil premium' (based on eligibility for free school meals), targeting resources at poorer students. Since mathematics qualifications play a critical role in regulating access to higher-paid employment, under-performance in school mathematics restricts the social mobility of disadvantaged children and contributes towards the reproduction of inequality from one generation to the next (Jorgensen, 2016).

Concerns have also been expressed for a number of years over the quality of mathematics teaching. Traditional teacher-led approaches, based on routine use of repetitive closed tasks, have been blamed

for an alarming decline in students' attitudes towards mathematics as they progress through secondary school, causing them to opt out of further study (Williams & Choudhury, 2016). Learning of mathematics is too often limited to memorising and practising procedures with little understanding of their application, purpose or underlying concepts (OFSTED, 2012; Foster, 2013), resulting in many children (and adults) continuing to exhibit alienation from mathematics (Nardi & Steward, 2003). In contrast, more 'progressive' teaching approaches, characterised by open-ended activities, collaboration between learners and an emphasis on developing problem-solving and reasoning skills, can lead to more equitable outcomes and greater levels of engagement amongst all students (Boaler, 2008; Wright, 2017). There is a growing consensus amongst the mathematics education community that a more relevant and engaging mathematics curriculum is needed, with a greater focus on open-ended tasks, problem-solving and conceptual understanding (ACME, 2011; Hodgen, Foster, Marks, & Brown, 2018; NCETM, 2008; OFSTED, 2012). This is reflected in the renewed focus on reasoning and problem solving in the revised National Curriculum in England (DFE, 2013).

However, some researchers have highlighted a formidable challenge for mathematics teachers concerned with issues of equity who wish to adopt progressive teaching approaches. Barrett (2017) warns of the danger of denying students access to 'powerful knowledge' in an attempt to widen access to school mathematics by emphasising 'everyday knowledge'. In a study in the United States, Lubienski (2004) describes how the relatively unstructured nature of progressive teaching approaches resulted in disadvantaged children being less likely than others to recognise the intentions of the teacher, for example 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', that is the 'recognition rules' (identifying relevant meaning from tasks) and 'realisation rules' (formulating appropriate and legitimate responses). This poses 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? Classroom-based studies exploring whether making pedagogies more visible can address issues of inequity have been mostly limited to science education (Morais & Neves, 2017) and literacy (Bourne, 2004). This project focuses on developing strategies for making teachers' pedagogy more visible to learners in mathematics classrooms, to help all students recognise their intentions when adopting progressive approaches to teaching. It seeks ways to enable all students to be successful in mathematics, whilst embracing progressive pedagogies.

Methodology

The project adopts a Participatory Action Research (PAR) methodology, that is a collaborative approach to research in which academics aim to carry out research 'with', rather than 'on', research participants. PAR recognises how 'academic researchers', with their expertise in conducting research, and 'teacher researchers', with their detailed knowledge of the classroom, each have a distinct, but essential, role to play. It seeks positive social change, through generating knowledge that is of greater relevance to practitioners, whilst developing a deeper understanding of 'theory-in-practice' amongst teachers (Brydon-Miller & Maguire, 2009). In contrast to conventional mathematics educational research, which is often conducted in artificial situations (Skovsmose, 2011), PAR pays closer attention to challenges, constraints and opportunities teachers experience on a day-to-day basis. It can offer a

systematic and critical approach to research based on clearly-defined processes including: reflecting critically on current practice in relation to research literature; articulating an alternative vision; trying out new approaches whilst taking account of realities and practical constraints; analysing outcomes of these trials to evaluate the feasibility of the alternative vision (Andersson & Valero, 2016).

Practitioner-led research is often criticised as lacking rigour and being limited in scale (Myhill, 2015). In a recent review of practitioner-led collaborative research in mathematics education, Robutti et al. (2016) reported how most studies failed to theorise 'collaboration', relying instead on theories relating to a 'community' in which it is assumed to take place. Much practitioner-led research has been criticised for lacking a critical element, either because it involves general agreement in advance of the intended outcomes, or because the focus is left open for practitioners to decide, without questioning the legitimacy of existing modes of practice (Kemmis, 2009). Critical reflection requires teachers to view their own practice as problematic, and to question the consequences of their actions, in relation to wider historical, cultural and political values and beliefs (Hatton & Smith, 1995; Liu, 2015). It is driven by external support and stimulus, which is seen as essential for challenging existing practice and without which collaborative inquiry is likely to perpetuate existing practice through the process of 'alignment' with accepted norms (Jaworski, 2006). Critical action research involves partners working together to "change their social world collectively, by thinking about it differently, acting differently, and relating to one another differently" (Kemmis, 2009, p. 471).

This project aimed to develop, refine and evaluate research processes and methods that facilitate effective collaboration and critical reflection amongst academic and teacher researchers. This is seen as particularly important when applying PAR to the mathematics classroom situation where existing practice has proved otherwise resistant to change. Research methods employed during the project include the joint design of student surveys and interviews (to be implemented by the teachers themselves), carrying out peer observations, and making use of video-stimulated reflection to evaluate lessons (Geiger, Muir, & Lamb, 2016). The project was innovative in that it sought to make the collaborative and critical characteristics of such methods and processes explicit.

Research design

The research project was situated in a comprehensive secondary (age 11 to 18) school in North London with an above-average proportion of disadvantaged students (approximately 30% of students qualified for the 'pupil premium grant' in 2016-17 compared with a national average of 27%). The two-year project was initiated in November 2017. This paper reports on initial findings from the first year of the project. The project was a collaboration between myself, as academic researcher, and two teacher researchers, Tiago and Alba, who shared an interest in developing progressive teaching approaches and exploring issues of equity in mathematics classrooms. (I will refer to the three of us collectively as the 'research group'.) The school's mathematics department had recently incorporated a series of problem-solving activities into its scheme of work and was gradually moving away from a rigid setting structure towards mixed attainment grouping in the lower years. There was a whole-school focus on developing 'oracy', which in the mathematics department included encouraging students to articulate and communicate their reasoning through 'think-pair-share' strategies (thinking about a problem as an individual, before sharing with a partner and then the whole class).

The focus of the study was to explore strategies teacher researchers could use to make their pedagogy more visible, that is to help all pupils recognise their intentions as teachers when adopting progressive approaches to teaching secondary mathematics. In so doing, it was hoped to develop strategies that might be effective in reducing the large gaps in mathematics achievement existing between children from different socio-economic groups within the school. The research questions were:

1. Which teaching strategies are successful in helping students develop their ability to decipher the recognition and realisation rules of the mathematics classroom?
2. What impact do these strategies have on students' mathematical achievement and engagement, particularly for those from disadvantaged backgrounds?
3. What characteristics of PAR enable academic and teacher researchers to work collaboratively to bring about transformations in mathematics classroom practice?

A series of nine research group meetings were held at the school during the first year. At the first meeting, I provided Alba and Tiago with journals in which they were encouraged to reflect on their experiences and write a commentary on the development of their thinking and classroom practice over the course of the project. The initial meetings included jointly agreeing the research design and a focus on critical reflection on existing practice in relation to the research literature. The teacher researchers read and presented for discussion key research papers (identified by me) during these meetings. We decided that Alba and Tiago would work with two similar Year 7 (age 11-12) groups that they taught, making use of teaching materials that already existed within the department. This enabled them to focus on developing strategies to make their pedagogy more visible, alongside the progressive approaches to teaching mathematics already in use. Two 'plan-teach-evaluate' action research cycles were carried out in order to try out strategies devised during meetings. We jointly designed a survey to give students after the first cycle in order to evaluate the impact of these strategies. We also discussed and agreed the questions that were asked and the protocols that were adopted during semi-structured interviews conducted by Alba and Tiago after the second cycle with six disadvantaged students (identified on the basis that they qualified for the 'pupil premium grant').

The focus of the surveys and interviews was on assessing the impact of the strategies on students' success in, and engagement with mathematics, their dispositions towards learning, and their awareness of the pedagogical rationale employed by the teacher. We arranged for four of the lessons (two for each teacher) to be video-recorded and observed by either myself or the other teacher researcher. The observer created a time line of key events during the lesson so that these could be quickly located in the video recording during subsequent meetings. We carried out detailed evaluations of the strategies through reflective discussions during research group meetings. These discussions were prompted by watching back extracts from the video recordings and relating these to survey and interview responses and notes kept by Alba and Tiago in their reflective journals.

Data was collected through making audio-recordings of discussions held during research group meetings and audio-recordings of interviews conducted with the six students. These recordings were transcribed and fully anonymised, with pseudonyms being used throughout the data analysis for students and any third parties mentioned. During the thematic analysis, categories were assigned to extracts of text from the transcripts using a combination of deductive and inductive coding. Since the

project involves applying theory to pedagogical practice, an initial coding structure was derived from the theoretical framework. This structure was developed through a process of repeatedly reading the transcripts to allow familiarization with the data and to interrogate the relevance of the categories. Further amendments and additions were made during the coding process to increase the relevance of the categories to the data. The categories included in the coding structure fell into four broad groups: 1) students' understanding of recognition/realization rules; 2) students' recognition of educational disadvantage and relational equity; 3) teachers' pedagogical strategies; 4) students' dispositions towards learning. NVivo software was used to facilitate the comparison of extracts of text which had been assigned similar categories, and to explore 'commonalities', 'differences' and 'relationships' between these and other categories, enabling themes to emerge from the data (Gibson & Brown, 2009). These themes were then related back to the research questions and underlying theoretical framework in order to generate meaning (Kvale & Brinkmann, 2009).

Initial findings

The findings reported below are based on an initial analysis of the interview and survey data only, from the first year of the project. Further analysis is currently being undertaken of the data from the research group meetings, which will enable a fuller discussion of the research methodology and the collaborative and critical nature of the research design to be reported in due course.

It was noticeable from the responses to the surveys completed at the end of the first cycle that students often did not fully appreciate the intentions of the teacher in adopting progressive teaching pedagogies, resonating with Lubienski's (2004) conclusions described earlier in this paper. Many students misread the rationale behind teaching approaches aimed at enhancing mathematical learning, often perceiving them as being designed to enforce compliance. One example that illustrated this tendency was an open-ended problem given to students that involved calculating the area of different sections of a flag. There were several alternative methods that could have been used to solve this problem. There was 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 Alba and Tiago in their teaching practice prior to their involvement in the project. However, they developed strategies to use alongside the task that had not previously been a focus of their practice. In this case students were asked first to think about the problem on their own, discuss it in pairs, and then to explain their partner's thinking to the rest of the class (rather than explaining their own thinking). The completion of the task was followed by a whole class discussion prompted by teacher researchers asking: "Why do you think I asked you to present your partner's ideas rather than your own?" Students were encouraged to put forward suggestions which were then discussed with the teacher enabling her/him to help students appreciate how the teaching approach adopted was designed to facilitate deeper mathematical understanding. Prompting students to present their partner's ideas and the follow-up discussion of the pedagogical rationale represented a change in teachers' practice.

In the survey administered at the end of the lesson, students were asked the following question: "Why do you think the teacher asked you to explain your partner's thinking and not your own?" The responses of some students suggested they had correctly interpreted the teacher's intentions, for example "So that we understand other's point [of] view", "So you can share everyone's methods", "Because it

helps you to understand different opinions on the maths problems and different paths to the answer", "Because you can get two different perspective[s] and it may help you finalise your idea". However, a majority of responses suggested most students misinterpreted the strategy as simply an implicit way of enforcing listening, for example "To make sure you listen", "To see if you're listening to your friend."

The strategy described above was aimed at making pedagogies visible that would otherwise remain implicit (and often not at all transparent) to learners. The intentions of the teacher thus become an explicit focus for discussion and consideration by learners. Another strategy employed during the second cycle was to scribe students' responses to questions verbatim, that is to write down exactly what they said regardless of whether they were correct or incorrect. This was followed up with a discussion with students around the rationale for doing so, in this case to draw out ambiguity in language used by students and to enable students to identify errors and misconceptions for themselves.

It appeared, from interview responses at the end of the second cycle, that disadvantaged students were developing a greater awareness of some (but not all) of the primary reasons for teachers' pedagogical choices. Four of the six students interviewed, Marcus, Sophia, Mary and Keira (all pseudonyms), appeared to recognise the primary purpose of identifying and addressing errors and misconceptions when they were asked why they thought the teacher wrote down exactly what students said:

> To maybe see like where we go … because it's better if you say it out than keep it in because the teacher could help you and try and improve from wrong to right. (Marcus, interview)
>
> Cos then you can compare the correct and incorrect answers together and see, like, where you went wrong, and how you, you know, changed the answer to get the correct one. (Sophia, interview)
>
> It was nice to like write down it, and then look at our mistakes. … Because of, then we can, like, fix the mistakes. … But usually people will like … if we make a mistake, and then they just change it. They just tell you it's this, but they don't tell you why … and then next time they do the same mistake. (Mary, interview)
>
> It will be showing us that you think we've gone wrong a little bit. 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. (Keira, interview)

However, Ennis demonstrated only a partial appreciation of the primary purpose, identifying a reason that might be valid in a different situation, whilst Neal was not able to articulate a valid purpose:

> So other people can know how to do it. And so everyone could like … everyone can understand from it, and see what they've done wrong, if they've got it wrong, and see what they've done correct, if they've got it correct. (Ennis, interview)
>
> Maybe they never got it right, but then someone worked out the same way but still got it right. And then you will show the person who did it how … they should do it correctly. (Neal, interview)

There was a similar pattern for other strategies that Alba and Tiago tried out for making pedagogy more visible, with most students recognising at least one purpose identified as primary by the teachers during research group meetings. However, students also articulated other purposes, some considered potentially valid in other situations but not primary for these strategies, and others considered invalid.

Conclusion

From an initial analysis of the data from the early stages of the research project, it appears that developing strategies for making teachers' pedagogical rationale more visible to learners has the potential to increase students' appreciation of the intentions of the teacher, although some misinterpretation is likely to persist. This offers the promise of eliciting more appropriate responses from a wider range of students, including those from poorer backgrounds, when less-structured teaching approaches are employed. This in turn suggests ways of developing classroom practice that can begin to address issues of inequity in mathematics classrooms without the need to abandon progressive pedagogies. It offers a positive way forward for teachers who are committed towards closing the gap in achievement between advantaged and disadvantaged students and who also believe that adopting collaborative and problem-solving teaching approaches promotes greater mathematical understanding. It highlights the need for further research to explore, refine and disseminate strategies, that can be adopted alongside progressive pedagogies, to help all students recognise the intentions of the teacher and hence to respond appropriately and achieve greater success in mathematics.

References

ACME. (2011). *Mathematical needs: Summary*. London: Advisory Committee on Mathematics Education.

Andersson, A., & Valero, P. (2016). Negotiating critical pedagogical discourses: Stories of contexts, mathematics, and agency. In P. Ernest, & B. Sriraman (Eds.), *Critical mathematics education: Theory, praxis, and reality* (pp. 199–226). Charlotte, NC: Information Age.

Barrett, B. (2017). Bernstein in the urban classroom: A case study. *British Journal of Sociology of Education, 38*(8), 1258–1272.

Bernstein, B. (2000). *Pedagogy, symbolic control and identity: Theory, research, critique*. Lanham: Rowman & Littlefield.

Boaler, J. (2008). Promoting 'relational equity' and high mathematics achievement through an innovative mixed-ability approach. *British Educational Research Journal, 34*(2), 167–194.

Boaler, J., Altendorf, L., & Kent, G. (2011). Mathematics and science inequalities in the United Kingdom: When elitism, sexism and culture collide. *Oxford Review of Education, 37*(4), 457–484.

Bourne, J. (2004). Framing talk: Towards a 'radical visible pedagogy'. In J. Muller, B. Davies, & A. Morais (Eds.), *Reading Bernstein, researching Bernstein* (pp. 91–122). London: Routledge.

Brydon-Miller, M., & Maguire, P. (2009). Participatory action research: Contributions to the development of practitioner inquiry in education. *Educational Action Research, 16*(1), 79–93.

DFE. (2013). *Mathematics programmes of study: Key stage 3*. London: Department for Education.

Foster, C. (2013). Resisting reductionism in mathematics pedagogy. *The Curriculum Journal, 24*(4), 565–585.

Geiger, V., Muir, T., & Lamb, J. (2016). Video-stimulated recall as a catalyst for teacher professional learning. *Journal of Mathematics Teacher Education, 19*(5), 457–475.

Gibson, W. J., & Brown, A. (2009). *Working with qualitative data*. London: Sage.

Hatton, N., & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and teacher education, 11*(1), 33–49.

Hodgen, J., Foster, C., Marks, R., & Brown, M. (2018). *Evidence for review of mathematics teaching: Improving mathematics in key stages 2 and 3*. London: Education Endowment Fund.

Jaworski, B. (2006). Theory and practice in mathematics teaching development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education, 9*(2), 187–211.

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

Kemmis, S. (2009). Action research as a practice-based practice. *Educational Action Research, 17*(3), 463–474.

Kvale, S., & Brinkmann, S. (2009). *InterViews: Learning the craft of qualitative research interviewing*. London: Sage Publications.

Liu, K. (2015). Critical reflection as a framework for transformative learning in teacher education. *Educational review, 67*(2), 135–157.

Lubienski, S. (2004). Decoding mathematics instruction: A critical examination of an invisible pedagogy. In J. Muller, B. Davies, & A. Morais (Eds.), *Reading Bernstein, researching Bernstein* (pp. 91–122). London: Routledge.

Morais, A., & Neves, I. (2017). The quest for high-level knowledge in schools: Revisiting the concepts of classification and framing. *British Journal of Sociology of Education*, *39*(3), 1–19.

Myhill, D. (2015). A self-improving system. *Research Intelligence*, 126, 20–21.

Nardi, E., & Steward, S. (2003). Is mathematics T.I.R.E.D.? A profile of quiet disaffection in the secondary mathematics classroom. *British Educational Research Journal, 29*(3), 345–367.

NCETM. (2008). *Mathematics matters: Final report*. London: National Centre for Excellence in Teaching Mathematics.

OFSTED. (2012). *Mathematics: Made to measure*. Manchester: The Office for Standards in Education, Children's Services and Skills.

Robutti, O., Cusi, A., Clark-Wilson, A., Jaworski, B., Chapman, O., Esteley, C., . . . Joubert, M. (2016). ICME international survey on teachers working and learning through collaboration: June 2016. *ZDM Mathematics Education, 48*(5), 651–690.

Skovsmose, O. (2011). *An invitation to critical mathematics education*. Rotterdam: Sense Publishers.

Williams, J., & Choudhury, S. (2016). Mathematics capital in the educational field: Beyond Bourdieu. *Research in Mathematics Education, 18*(1), 3–21.

Wright, P. (2017). Critical relationships between teachers and learners of school mathematics. *Pedagogy, Culture and Society, 25*(4), 515–530.