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Manjinder K. Jagdev and her student teachers reflect on their experiences of developing critical mathematics education and social justice themes in initial teacher education courses.

Critical mathematics education: student teachers' perspectives

For several years, I have been teaching the themes of inclusion, diversity, anti-racism, decolonial practice, critical mathematics education and social justice in BA Primary and PGCE Secondary courses. University sessions have included lectures and sessions about critical mathematics education. This draws on a wide range of reference materials and resources, including Ernest (2018) and The Teaching Mathematics for Social Justice Network (Wright, 2024).

Student teachers were encouraged to incorporate these themes into their classroom practice in placement schools. Some student teachers co-created sequences of lesson plans and activities, working collaboratively in groups. I invited my students to reflect on their experiences and some participated in follow-up interviews. The implications of this work on children, teachers in schools and the wider community are evident in their reflections below, which were prompted by the following questions:

1. How can you embed critical mathematics education in schools?
2. What are the implications, for children, you and school colleagues, with respect to teaching critical mathematics education in your classrooms?
3. Why is it important to include critical mathematics education in classrooms?
4. Do you have further questions about embedding critical mathematics education into your work in schools?

Drew

In February 2023, one of the PGCE mathematics student teachers, taught a Year 10 lesson about climate change using data and statistics based on the island of Tuvalu. The shores of this atoll are being eaten away by the rising sea level caused by climate change. The children watched a live video stream about Tuvalu created by the islanders (First Digital Nation, 2024). Following this, the children worked in groups on 'Climate Change Analysis' (a pack of activities) to apply their knowledge and skills on correlation, lines of best fit, percentages, interpreting graphs, area and temperatures to fossil fuel consumption. Students made comments about their observations of trends. At the end of the lesson, students provided illuminating feedback including:

> I wonder if the progressing extreme heat will affect our animals and even, human beings. Will this affect us in dangerous ways? For example, will we die from heat stroke, will the water sources dry up and the animals die of thirst? These are my wonders for this graph.

> ... the experience was like being in future employment—all coming together to work on a task

> ... learning this mathematics to challenge misleading/fake news

> I already knew climate change was a problem, but understanding the statistics behind it allows me to see the scale of the problem and how it will affect our lives in the future.

One student stated that often when working on their own, they get stuck and do not know what to do. They felt that this lesson was better because they could discuss their ideas: 'teamwork helps us work it out.' Students made links with other curriculum subjects like science and geography independently, without help from the teacher. They made positive statements about learning mathematics in context and the application of mathematics. Drew, the student teacher, reflected:

> Critical mathematics education was incorporated into a Year 10 scheme of work on analysing statistics. The students all came up with fascinating statistics on climate, which motivated them to want to understand the problem. The students collaborated in group projects and produced well-informed data driven discussions across the classroom. The sequence of lessons had many positive impacts:
>
> - Developing critical thinking skills by questioning assumptions, challenging narratives and engaging in meaningful discussions.
> - Promoting social justice and equity as students are informed and engaged in socially responsible mathematical practices.
> - Enhancing problem-solving skills by learning to approach problems in a critical and reflective manner, students become better problem-solvers and are better equipped to tackle complex issues in a variety of fields.
> - Increasing engagement and motivation because students see the relevance and importance of the subject matter to their lives and the world around them.
> - Fostering creativity and innovation by approaching problems from multiple perspectives.

Drew's school-based mentor commented that this was not the first time Drew had taught a lesson based on critical mathematics education, and that the children were arriving at subsequent lessons, more motivated, curious and enthusiastic about what they will be learning. Perhaps teaching lessons on critical mathematics education, social justice themes, inclusion and diversity, may be a solution to the decades of maths anxiety experienced by generations of learners.

Lebron

Following a mathematics session another PGCE mathematics student teacher reflected:

> I think, where possible, I will embed critical maths education in all areas… I'm teaching about salaries to Year 9…and will try to open a discussion about the two wages …a cleaner at £20k and a Software Engineer at £50k. I am also experiencing similar things inadvertently in other lessons too, and it's made me realise I wasn't prepared for some questions—for example, I started to teach lattice multiplication as a method of decimal multiplication and referred to it as Napier's bones. The first questions were 'why is it called that?', followed up by 'Who was Napier?'—to which I couldn't answer. What I should've done in the lesson is google after I set some independent work but I'm going to try to think about that in advance for next time. The implications for children is that if we don't raise these…then we have not done all we can to help prepare the students for the real world. It may be that they forget everything, but that doesn't matter. It is important to include critical maths and social justice themes for the reasons above, as well as for the wider impacts and cross-curricular connections that could be made by doing so. If we talk about Alan Turing in maths and history are doing a WW2 topic and do the same then we might start making more connections in the brain and the students may remember more of the content.

I observed Lebron teaching a Year 8 problem-solving lesson where the children worked in groups, discussing solutions and sharing methods. As a plenary to his lesson with a class of 13-year-olds, Lebron linked the problem-solving activities that the class had worked on, to Alan Turing's code breaking (Figure 1) and Katherine Johnson's mathematical calculations that sent the first Americans into space (Figure 2). Lebron's students responded to his questions about their cultural relevance, talking about Alan Turing's code breaking work on the Enigma Machine used in World War 2 and how Katherine Johnson's mathematical calculations enabled the successful return of a NASA astronaut to Earth. Lebron explained to the class how Alan Turing experienced homophobic injustices whilst African American women, including Katherine Johnson, faced racism and fought for desegregating higher education. He linked this to human suffering and fairness. A children's book (written by Margot Lee Shetterly) based on the movie 'Hidden Figures' tells the story of Katherine Johnson and the team of African American women who worked for NASA (Figure 3).

Five themes emerged from student teachers' critical reflections and online interviews:

1. wider benefits including cross-curricular links
2. using real-world contexts
3. learning and teaching
4. visionary, future-oriented and empowering
5. implications, questions and school staff responses.

One of the student teachers, Cherry, reflected on embedding critical mathematics education into their lesson planning:

> Critical thinking skills—fosters creativity... can help them be engaged with a mathematics lesson (helpful for those who find mathematics stressful)

This relates to maths anxiety (Boaler, 2015) and how lessons can be made more engaging using a critical mathematics lens when teaching. Considering practical mathematics topics a student teacher, Acacia, reflected:

> Also, they are able to explore the different ways that maths can be used to help find a solution to the problems and embeds the fact that mathematics is used in everyday life even if we are not always aware of it.

Acacia identifies the potential to make cross-curricular links and connects to wider benefits. Two student teachers, Willow and Laurel, considered their own primary school experiences as children:

> I found it very interesting and feel I would've benefitted from this approach if it had been used in my mathematics lessons during my own primary school experience. I think the implications for children would be that it makes mathematics more engaging and purposeful. For myself, it would help me teach mathematics in a more interesting way and it would help me to create more hands-on mathematic lessons. (Willow)

Figure 1. Alan Turing (*https://en.wikipedia.org/wiki/File:Alan_Turing_(1912-1954)_in_1936_at_Princeton_University_(cropped).jpg*)

Figure 2. Katherine Johnson (*https://en.wikipedia.org/wiki/File:Katherine_Johnson_at_NASA,_in_1966.jpg*)

> I thought Year 4s could have really benefited from learning like problems going on in the world because I know especially from when I was younger in primary school and like growing up, people would talk about things that would be on the news and I wouldn't understand like what was going on just because it's so hush hush sometimes. I also think you could even link it further with PSHE (Personal, Social, Health and Economic education) lessons. I think when children understand more about the wider world it helps them understand and become more open to other people and cultures. They could think more about how it affects them and how they affect different world/environment issues/conditions. (Laurel)

In the above reflection, Laurel makes cross-curricular links between teaching critical mathematics education and PSHE. Several student teachers commented on teaching about the world:

> Sometimes I think children are often sheltered from what goes on in the wider world but I think it could be helpful if children could link it to their maths lessons in order to help them understand it more. ... I wanted to search for a video, so I found one on YouTube to do with, like teaching kids about climate change... the children had more questions from that. So, it was like... you're going to have to give me time to research this before I can answer your questions. ...[I made] cards and like answers.... Would have an idea first and then I could go into it to sort of guide the learning a bit. If children have no idea. (Laurel)

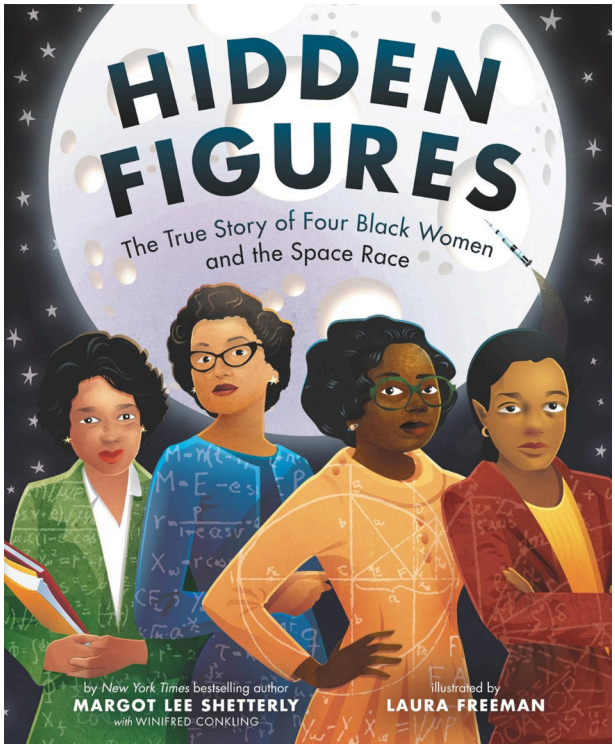


Figure 3. A children's book (written by Margot Lee Shetterly) based on the movie 'Hidden Figures' that tells the story of Katherine Johnson and the team of African American women who worked for NASA.

> I think embedding critical mathematics education into schools is something that can really inspire children and support them in protecting the world around them. It is definitely an area of mathematics I would include when I become qualified teacher and during placements as it sets the learning into context. I really liked the idea of bringing in environmental issues into mathematics. (Karo)

> Incorporating work from discrete teaching into questions to give them a real-world context... On the whole, it would be beneficial and improve their understanding of these real-world situations. However, they can be sensitive topics so should be handled delicately and respectfully. (Damson)

> By incorporating mathematics with global events... the children learn more about the world they are living in and the impact of what our actions have on the planet. (Acacia)

> Using real-life problems as a hook into a topic... teaches them about real world issues (Cherry)

Like the students in Drew's lesson and as described by Abtahi et al. (2020), the student teachers highlighted teaching a vision and using a future-oriented approach to empower themselves, their learners and family members:

> The children in our classes are more likely to make a difference to these issues if they're educated about them and if we give them ideas about how they can help. (Damson)

> It is about their future and what they can do now to help save it... Address a wide range of ethical situations. (Cherry)

> Can further encourage the children to take what they have learnt in the classroom and apply it to their home life and teach their parents. (Acacia)

Student teachers commented on the implications for their own practice, questions and school staff responses:

> I think if more teachers work together to share their knowledge, to share their resources, especially with things like this... I think it'd be really helpful. So, I think teachers working together would be beneficial. ...I brought up global warming so they let me do the whole geography part and I just said it'd be nice to bring in some actual problems like climate change and the school were all for it. They were saying here is some of the stuff we've got because they had files on things to help me research... and some of the staff were... it's really brave that you're going into this...because as a student teacher, you probably wouldn't delve into things like that... It was really positive... So, there were (two primary) classes and...because the teachers were just like, ... but we don't have the knowledge to, like sort of go into this. And I just thought this is an opportunity. We'll just do it. We'll see where it goes. (Laurel)

The Year 2 Primary undergraduate student teachers have worked in groups to create lesson ideas and plans based on critical mathematics education for their teaching in placement schools. Examples include the following, which I have grouped into similar themes:

- Saving sea turtles (plastic pollution); landfill pollution; plastic consumption; pollution in the oceans and seas; litter in the ocean; litter picking; recycling; water pollution
- Food miles; food poverty; rate of inflation for food; sharing food and resources; chocolate and fair trade; food waste; healthy diets
- Air quality; Australian forest fires; Turkish and Syrian Earthquake crisis; carbon emissions; carbon footprints
- Cost of living crisis; fair trade and sustainability; budgeting
- Biodiversity; endangered animals; creating a butterfly garden; dog rescue
- Other: Fast fashion; homelessness.

Additionally, student teachers have made links to the mathematics national curriculum (England). For example, on the topic of recycling, these include bar graph interpretation, data collection, percentages, averages (mean, median and mode), trends, graphs and pie-charts, fractions, 2D and 3D shapes, plastic packaging waste and co-creation of activities with learners to increase recycling. This group of student teachers provided further details about their activities, and these included litter picking for half an hour each week at school or nearby for a half term or a longer period. They collected data about the volume of litter collected and sorted it to find out what proportion could be recycled. They surveyed the number of bins available and petitioned for more bins to reduce littering.

Concluding remarks

Teaching critical mathematics education gives opportunities for student teachers (and their learners) to work together collaboratively and creatively, to meet the challenges of climate, racial and social justice issues that affect us all, regardless of our diverse backgrounds and geographies.

In the current curriculum review in England, there is an opportunity to include social justice and diversity themes. A truly socially just, inclusive and updated curriculum needs to be genuine and authentic in having a vision to make the world a better place, not only for economic and individual gain but for communities that schools serve and the wider world. Learners need to be prepared to tackle real-life contexts such as climate change and sustainability through the mathematics curriculum.

The curriculum needs to provide rich opportunities to engage and motivate learners to tackle misleading data and statistics, by developing critical literacy. The work of Teach the

Future (2019) should support modernising the curriculum and identifying possibilities for climate education. In addition, there are glimpses of hope in the 2024 ACME Mathematical Futures report: A new approach to mathematical and data education.

Critical mathematics education is needed to challenge inequalities in society and the world—this includes teaching about social justice issues in mathematics to develop critical thinking skills. Curriculum content needs to provide real-life problem-solving contexts in relation to climate change and racial, gender, and class inequalities. Then, perhaps, more mathematics teachers will stay in our profession.

References

Abtahi, Y., Hauge, K., Hauge, L., Steffensen, L. & Barwell, R. (2020). *Teaching about issues of climate change in mathematics classrooms: Empowerment of critical citizenship*. AERA Conference. Toronto (August 2020)

ACME (2024). *A new approach to mathematical and data education* `https://royalsociety.org/-/media/policy/projects/maths-futures/mathematical-and-data-education-policy-report.pdf`

Boaler, J. (2015). *Fluency Without Fear: Research Evidence on the Best Ways to Learn Math Facts.* `https://www.youcubed.org/evidence/fluency-without-fear/`

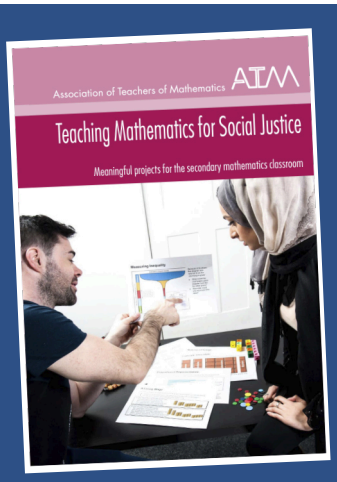
Ernest, P. (2018). The Philosophy of Mathematics Education: An Overview, in Ernest, P. (ed.) *The Philosophy of Mathematics Education Today*. ICME-13 Monographs. https://doi.org/10.1007/978-3-319-77760-3_2

Teach the Future (2019) `www.teachthefuture.uk/tracked-changes-project`

The First Digital Nation (2024). *Save Tuvalu,* `https://www.tuvalu.tv/about`

Wright, P. (2024). *The Teaching Mathematics for Social Justice Network,* `mathsocialjustice.org`

Manjinder Jagdev is a teacher educator who has been teaching the themes of inclusion, diversity, anti-racism, decolonial practice, critical mathematics education and social justice for several years.



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