OPEN ACCESS

University of BRISTOL

Brown, J., Coles, A. T., Hayward, R., Helliwell, T., Lustig-Bruce, D., Owen, E., & Salt, A. (2021). Mathematics teaching and global challenges: Part 1. *Mathematics Teaching*, *276*, 5-8. https://www.atm.org.uk/mathematics-teaching-journal-archive/176131

Peer reviewed version

Link to publication record in Explore Bristol Research

PDF-document

This is the author accepted manuscript (AAM). The final published version (version of record) is available online via Association of Teachers of Mathematics at https://www.atm.org.uk/mathematics-teaching-journal-archive/176131 . Please refer to any applicable terms of use of the publisher.

University of Bristol - Explore Bristol Research

General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available: http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/

Mathematics Teaching and Global Challenges: Part One

Julian Brown, Alf Coles, Rhiannon Hayward, Tracy Helliwell, Dan Lustig-Bruce, Elly Owen, Amelia Salt

We are a group of mathematics teachers and university tutors, who spent the academic year 2019-20 working together in the context of the Postgraduate Certificate of Education (PGCE) course at the University of Bristol, a one-year, initial teacher education course. We live and teach in a world experiencing challenges and issues on a global scale (poverty, climate change, extremism, inequality, etc) and it is hard not to think about the role of teaching and learning mathematics in the context of creating a better or fairer society. We look to provoke and support one another to develop classroom cultures that foster values such as collaboration and respect but we also hold that mathematics is far from a 'neutral' subject and has a role in a range of global issues, including how these are communicated. It became increasingly apparent, as 2020 unfolded, how mathematics is used by politicians, policy makers, think tanks, academics, journalists and others to influence behaviour and thinking.

This is one of two articles where we reflect on mathematics tasks that were designed, researched or adapted, during the PGCE year 2019-20, in response to the prompt to consider how our teaching connects with values and global issues. We offer brief descriptions of the tasks, along with reflections on how we *have* used (Part One) or can *imagine* using (Part Two) the tasks in the classroom. We hope these articles will act as a prompt for further discussion in the journal about how we might teach mathematics, as if the planet matters (Coles, et al., 2013). The task sections are written individually by a teacher and the three tutors reflect together across the different offerings at the end of this Part.

Before getting to the tasks themselves, we address a worry we know can be raised, namely, how do we find time to deal with global challenges and issues, when the curriculum itself is so full? Here are some responses from the teachers whose writing follows:

It may feel at the time that it would be worth spending the time on a larger amount of "textbook" questions, however bringing in a real life, relevant context can give pupils an opportunity to see how the maths they are learning fits in to the bigger picture, which gives opportunity for pupils who struggle to see the point of mathematics learnt in the classroom a chance to see how worthwhile their knowledge truly is. It also allows an opportunity to build extra mathematical skills without directly paying attention to them - such as mathematical reasoning, comparisons and interpreting data.

To a teacher feeling that they would love to ... but didn't have the time, I would say the teaching certainly can take longer, and you do run the risk of the children not actually taking away the methods in the same way that they would if they were just taught some skills and given exercises to use them. However, the children I taught really enjoyed learning this way, which was something they were not used to in mathematics. Teaching in a way that shows mathematics has real-life utility is essential for some students, and though you may spend longer on a particular unit, you may also

find yourself rewarded with higher engagement in other units. I also believe that though some of them did not learn the mathematical concepts in ways that I would have liked, they did learn a significant amount about a global issue, and this has value too.

How many trees? - Elly Owen

Related content: tessellation, box packing

“How many trees could fit in this room?", I ask my year 7 (age 11-12) class. A flurry of questions from students followed: "What type of tree?"; "Can I measure the room?"; "How big is the tree?". Most pressingly, students wondered “why?". I gave no further clarity, other than suggesting they might wish to draw a diagram, and that I expected an answer and justification from every student. When I opened up the room for ideas, I noticed enthusiasm to share from a lot of students, predominantly girls, who would usually keep quiet. They offered creative suggestions, describing different varieties of trees, how they could chop them up or use seeds or saplings, which led to a debate on what constitutes a tree. Tessellation often occurs in nature, for example honeycomb or cobs of corn, but is also a feature of intensive crop farming (Darvas, 2007, p216). Some students considered trees in a park, and how far away from they are from one another, others crammed their hypothetical trees together. These students did not consider, or did not value, the lifetime of the tree or the development of this classroom ecosystem. When asked how the trees would get oxygen or nutrients if sat side by side and stacked as high as the ceiling, a student readily responded that wouldn't matter and they'd happily kill the trees as long as they'd “won". Other students identified that the head teacher would be left with rotting trees having destroyed her classroom. This invited discussion on sustainability: Short term profit (getting as many trees in the room as possible) would be unsustainable, and undesirable. A tree brings many things to an environment: shade; shelter; birds; bugs; fungi; food. Some students considered these additions as beneficial, others saw them as non-essential or even parasitic, I envisaged continuing this conversation, perhaps considering “how many people could fit in this room?"[1] and how this may differ from “how many people could live in this room?". Offering not only an insight into students' perceptions of tessellation, this question offered insight into how they view their environment.

Extinction - Amelia Salt

Related content: Fractions; finding fractions of an amount; comparing fractions

The Global Challenge resource I created explores fractions in connection with the extinction of animals. I gathered statistics, mainly from WWF, and formed questions comparing the current population of certain species in the world their relative historic populations. Due to time restrictions around the pandemic, the resource took shape of a PowerPoint slide with four to five questions for pupils to answer whilst working together. Examples of these questions include:

[1] A different question in the age of social distancing.

- There are only ½ of Asian Elephants in the world as there were around 150 years ago. There are currently estimated 50,000 elephants in the world. How many were there 150 years ago?
- In 1902 there were 31/44 of the amount of Mountain Gorillas now. Luckily, there are now 880 Mountain Gorillas. How many were there in 1902?

The task also involved a class discussion at the end to analyse these statistics and answers together.

I wanted to choose a challenge that was meaningful and required little or no prior knowledge to make sure no pupil was disadvantaged, whilst also creating something pupils would be interested in. No prerequisites were required for the students to work with endangered species. There were pictures of each animal too, so pupils could learn about the animals along the way.

The Year 7 class I used this resource with, was a high set for the school. They engaged with the task and took interest in looking at the different animals. They answered the questions quite quickly and then we moved on to a class discussion, which seemed valuable. Not only did the pupils get a chance to practise reasoning, it was also an opportunity for me to observe how pupils reason. For example, I asked the class whether they thought there were a lot of Asian Elephants left (after working out there were 100,000 elephants 150 years ago). Some pupils used comparisons to the previous number of elephants and said there were not many left. Some pupils, on the other hand, compared the number of elephants left to how many would fit into a given area (e.g. could 50,000 elephants fit into Bristol?). Going from there, they reasoned that 50,000 elephants were still a considerable number. Most of the class wanted to contribute to this group discussion. We also discussed what we as individuals can do to help protect animals. The next day, I carried on this style of question as part of the starter of the lesson and sensed they enjoyed it.

I originally hoped that this task would take the form of worksheets or a booklet. If I were to do it again, I would definitely have formed it in the shape of a booklet with basic facts about the animals, such as their habitat and life span. A booklet would also offer the opportunity for information retrieval, rather than just being given information within the question. Furthermore, it would give the pupils something to take home and potentially take their research further if they were interested.

Deforestation - Dan Lustig-Bruce

Related content: Area of triangles, squares, rectangles, parallelograms and trapezia; area of compound shapes; conversion of units of length; conversion of units of area; map scales

In February 2020 I begun to teach a low prior attainment Year 8 group how to find the area of parallelograms, trapezia, and complex shapes with respect to deforestation. Deforestation is intrinsically linked to climate change, an issue close to the hearts of many of the worlds young people. Greta Thunberg was also to speak in Bristol later that month,

increasing interest among young Bristolians. Deforestation readily lent itself to the topic, as areas that undergo deforestation rarely do so in a consistent shape. By splitting areas up into shapes students are comfortable with, they can much more readily find the area as a sum of smaller shapes.

Students were first taught the equations used to find the area of quadrilaterals and where they came from. Attention was paid to the conversion between units of area. They were then given an opportunity to utilise these equations to find the area of basic shapes, as well as some compound ones, and were then asked for a variety of conversions of these areas. Once students understood these methods, they were given an aerial view of their school grounds and asked to use what they had learnt to find the area, with the closest receiving a prize. When the students had produced a variety of answers, we explored how these answers had been achieved; what made an answer more accurate? What hindered accuracy? When discussions had concluded, the class was split into groups of four. Each group was assigned an area where mass deforestation had occurred (Brazil, Indonesia, Congo etc). They were given aerial shots of these areas before and after deforestation had happened. Their task was to find the area that had been cut down, and how many 'areas of the school' that this represented.

Figure 2: Arial view of an area that has undergone deforestation, with a scale.

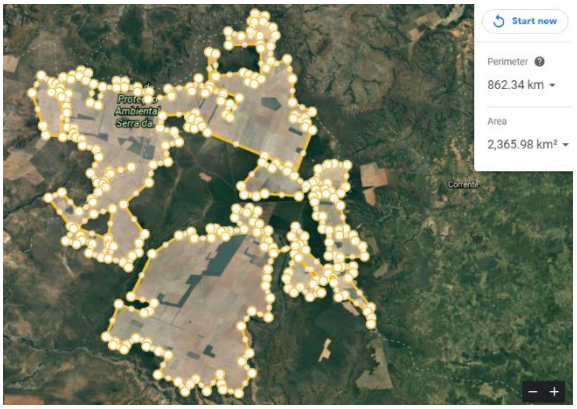

Figure 2: The 'correct' area to be found. Questions should be asked of the class as to why this is not entirely accurate.

I feel this task was well received by the class. The idea that we were looking at something there was real interest in, meant that students who can be apathetic towards mathematics, began to lead their groups in achieving accuracy. There were some issues in the implementation of this task. Firstly, areas and conversions picked were perhaps too challenging, as numerically many students struggled. It was also clear that this class needed some further explanation of how to use scales on maps, as this was something students found difficult. When running this task again, I will be certain to make sure these scales print off in a fashion that does not impede learning. In the above print out the '100.04km' line printed to be 9.3cm rather than the 10cm that was planned, which confused students further. However, once these issues had been resolved, students seemed to tackle the problem with interest as well as understanding.

Rainfall - Rhiannon Hayward

Related content: Bar charts; representing data; comparing data; misleading data

My task focuses on drawing bar charts from published data. My example being rainfall per month, as given by the Met Office (Met Office, 2020). Students were shown, from the website, how the data is recorded. This was followed by a short discussion about how it is difficult to compare results when given data in a list form. After the example of drawing one year's data set into a bar chart, students were given the task to draw another year and compare results. Students were able to pick out a few different results, such as the month with the most rain. Whenever a contribution was given, another would try and 'beat' it by finding a higher result. Additionally, if a student made a different insight, say the total rainfall of a given year, other students would follow along and contribute their result. As the students were drawing a variety of graphs, I used a Data Handling checklist (Basic Skills Cymru, 2009) to ensure they created complete charts. This covered the data handling topic being taught at the time.

Following on from this, I had planned for students to review the topic by exploring the Met Office Data Website. I designed a task where students would investigate the data for patterns and create a report, using the bars and charts taught throughout the topic. For example, rainfall versus sunlight hours in 2018. To support their findings students would need to answer why they chose the bars/charts they did. To conclude students would present their findings. I had in mind this could be done as a pair, or even set as a homework task.

I was drawn to this focus as it is a global challenge to record, store and compare, data such as rainfall. In hindsight, I would add on a section where I show how data can be misconstrued. This would include how data is shown in the media and how we choose to portray the data can affect the conclusion of the results. Naturally, I could have chosen to use data from Covid-19 at the time, however I knew the class well enough to know it would distract them. With more mature or older classes, I would definitely consider using Covid-19 data and contrasting media portrayals to show the significance of data analysis. I believe this is becoming an increasingly important skill to teach young people, due to the media pitfalls of data representation.

Reflections – Julian Brown, Alf Coles, Tracy Helliwell

We are struck by how, in each task, the authors paid attention to relating a topic to students' locality. Elly challenged students to think about the number of trees in the classroom; Amelia asked whether 50,000 elephants could fit into Bristol; Dan used a unit of area of the school site, and Rhiannon was taking rainfall data from the UK. We wonder if there is something significant here about helping global challenges or issues become imaginable and perhaps, as a result, engaging for students.

Linking global and local is hard and complex work. It is easy to become overwhelmed by the scale of global challenges and to consider that nothing done by an individual will make any

difference. It is challenging to even conceptualise how local and global fit together. One typical image might be of the local as the parts that fit together to make the global. We might see our own actions (e.g., of carbon emission, or of political activism) as contributing to a sum total of emissions, or of political will. Another image might be of the global as a constraining force, which limits the range of possible actions at the local level (e.g., capitalism or centralised schooling structures). We have been thinking about other possible images that could help us consider how the local and global interact and intersect. The tasks in this article all use the local to help conceptualise more global phenomena and make sense of scale. There is a sense of using the local to imagine some kind of middle scale that helps us, perhaps, gain some grasp of numbers or quantities that might otherwise be incomprehensible. Dan's use of the area of the school, for instance, allows a reference point at some middle point (between us and the world), that might allow us to get a feel for the scale of change happening across the globe.

We are conscious of the potential to provoke anxiety, anger and helplessness, through addressing issues in mathematics lessons that can seem insurmountable. It is no doubt easier and safer to stick to the kind of pseudo-real-life contexts found in most text-books. And while we also recognise the potential for students to experience "climate-change fatigue" (as a Geography colleague put it to us recently) we believe relating mathematics to global challenges is part of what it means to prepare students to become active citizens. This will bring with it the need to allow space for students to express emotions and we recognise the risk that entails and the need for personal work, as teachers, on the capacity to listen. We have found it useful to think of our current times not as a "crisis", or something that we (or our students) need to "solve" or "overcome". Rather, what we appear to be slowly recognising in the West, is something known for a long time in other parts of the world, namely that life is precarious. We need, perhaps, to find ways of approaching the teaching and learning of mathematics without the promises and stabilities we once thought we had, and, therefore, with a renewed sense of our vulnerability to others, human and non-human alike.

References

Basic Skills Cymru (2009). *How to ... Teach Data Handling Across the Curriculum.* Cardiff: Welsh Assembly Government.

Coles, A., Barwell, R., Cotton, T., Winter, J. & Brown, L. (Eds.) (2013). *Teaching Secondary Mathematics as if the Planet Matters*. Routledge: London & New York

Darvas, G. (2007). *Symmetry: Cultural-historical and ontological aspects of science-arts relations; the natural and man-made world in an interdisciplinary approach*. Basel: Springer Science & Business Media.

Met Office, (2020). *Precipitation amount for the UK*. Available at: https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Rainfall/date/UK.txt