Climate Change and Sustainability Education

Nasreen Majid looks at how mathematics can support teachers and pupils

Introduction

Mathematics is a beautiful subject that connects us to the natural and man-made world. It has the power to shape our understanding and thinking of Climate Change and Sustainability Education (CCSE). However, it is rarely seen as a subject that can support young people's problem framing of the environmental crisis of our times. Teachers work within the constraints of a busy curriculum and in a recent survey conducted by UCL's Centre for Climate Change and Sustainability Education (CCCSE) 77% of teachers from a total of 104 reported that they rarely incorporate CCSE in their mathematics teaching, (Greer et al., 2023). I argue that mathematical skills are crucial to shape and conceptualise an alternative future. Critical mathematics pedagogies (Barwell & Hauge, 2021) help us see how mathematical thinking can support teachers and young people to envisioning a socially just and sustainable future.

The article will present recent work developed for the CCCSE professional development programme; Teaching for Sustainable Futures (TSF). The overview and conceptualisation of the two modules, along with extracts from the modules, will be presented to illustrate the power maths holds in furthering our thinking of the complexities surrounding CCSE. At a time of rapid change and increasing complexity, the TSF materials aspire to model an 'alternative future' for mathematics pedagogies. Hence, the work asserts that CCSE forms a critical part of connecting mathematics with our sustainability consciousness (Gulzar, Eksili, Caylak, & Mir, 2023) to support our thinking and deeply linking us together as global citizens to 'reimagine our future, together'.

Framing the work/ Context

The TSF modules, The Potential of Primary Mathematics and living sustainably are designed to illustrate the potential primary mathematics holds in supporting both teachers and young people to better understand the complexities of the twin crisis of nature loss and the climate emergency. The modules support teachers to see the 'why' and 'how' of CCSE within the complexities of the National Curriculum; why should we have CCSE as an intrinsic strand in the curriculum and how can it be taught in a connected way? The main strand running through the modules is how mathematics can support us to 'awaken our sustainability consciousness' (Gulzar et al., 2023)

I will now share examples of the content in the two professional development modules developed for primary mathematics teachers.

Module 1: The Potential of Primary Mathematics

This module aims to empower teachers to develop knowledge and skills in understanding the potential for learning mathematics opens about climate change and sustainability. Using a range of approaches, the module supports thinking about how the mathematics taught in primary schools can be adapted to enable conversations about climate change and sustainability.

Fast Fashion

Fast Fashion is a good topic to start thinking about sustainability, where a range of mathematics can be embedded to inform debate. The practice of Fast Fashion has been heavily criticised for creating a culture of 'throw away' fashion. A range of resources, including a Stacy Dooley video clip from a BBC documentary are used to provoke thinking. Hence, using a mathematical

lens to critically examine the amount of water used to make one item of clothing (figure 1 illustrates resources needed to manufacture one pair of jeans) can facilitate mathematical thinking, reasoning and problem solving. Activities in class could consist of pupils bringing in their favourite items of clothing and calculating the amount of water used to produce them. They could further their thinking by examining how many times they will wear the item and how they will dispose of it when they grow out of the item. The class data can also be aggregated to look at the class average. This could then be used to think about one action the pupils can take to become more sustainable consumers of fashion.

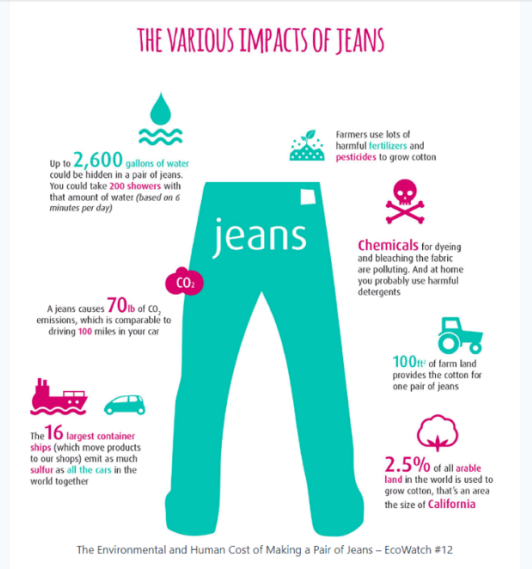

Figure 1 : The resources needed to make one pair of jeans. Source: https://de.daotaonec.edu.vn/environmental-impact-of-denim-fuief8t2/

Mathematics and Nature

The natural world is peppered with illustrations of mathematics and it's an excellent way to start conversations about biodiversity with pupils. This section of the module highlights how the natural world and mathematics are intrinsically linked. As busy teachers we may not make these connections automatically and hence there is a real opportunity to embed mathematical skills through connecting young people to the natural world. A mathematical lens can help us to build 'nudging behaviours' for our young people to connect with nature.

The Fibonacci Sequence

Nature has inspired mathematicians across centuries. The iconic 'Fibonacci Sequence' can be found abundantly in nature. For example, when you look closely at the number of petals flowers have, many illustrate the Fibonacci Sequence (1,3,5,8 etc). The Fibonacci Sequence can be defined as a pattern that grows by the sum of the previous two numbers in the sequence. You can see this illustrated below (figure 2):

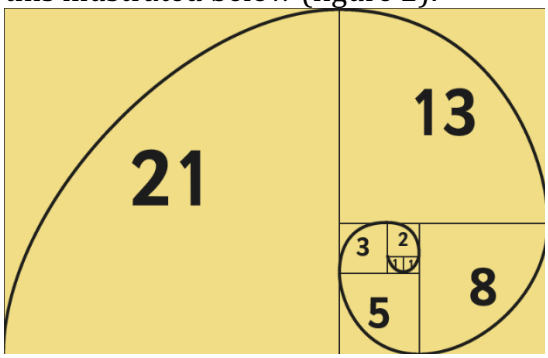

Figure 2: The 'Golden Ratio, illustrated through the Fibonacci sequence

The sequence can be shown visually as a spiral. This spiral is abundant in nature. Hence real opportunity to take pupils outdoors to 'hunt' for the Fibonacci sequence. The book Growing Patterns: Fibonacci Numbers in Nature by Sarah C. Campbell can be used as a starting point to think about mathematics in nature. Longer reads such as The Number Devil by Hans Magnus Enzenberger can also be used as stimulus to start conversations about mathematical patterns and the role they play in nature. Chapter six, for example, provides a detailed discussion on the Fibonacci Sequence. This book would particularly suit upper Key Stage 2 (Years 5 to 6).

The ideas in this section illustrate how teachers can inspire pupils to use their mathematical knowledge and skills to understand the natural environment. This section further examines how mathematics can facilitate a long-term project on biodiversity across the school's estate, incorporating both mathematical and scientific knowledge and understanding. This work also lends itself to working alongside materials available through the National Education Nature Park initiate, led by The Natural History Museum.

Mathematics for a fairer world

Mathematics can support young people to expand their horizons to understand how our actions influence the wider world. In a recent survey with 11-14 year olds, 56% of responses out 2429 pupils indicated that they would like to learn more about 'climate change and issues of fairness' (Walsh et al., 2024).

This section of the module helps teachers to think about how mathematics can be used to support primary pupils to start conversations about a more just world (Skovsmose, 2023). The ideas around climate justice are integral elements to think about our impact on the plant. Climate justice intersects with many aspects of our lives on a local, national and international level. E.G. The resource from Peter Menzel's Hungry Planet- What the World Eats- in Pictures provides lots of 'food for thought'! It illustrates a weekly shop from different parts of the world and we can explore this using a mathematics lens to look at what an average household consumes in a range of countries and hence the implications for sustainable living. Further ideas and thinking are explored with these materials in the published module.

Figure 3: Image 1:The Aymo family of Tingo, Ecuador, with a week's food that costs £19. Photograph: Peter Menzel /Barcroft Media image slide

Figure 4: Image 2: The Bainton family from Wiltshire in the UK, who spend around £160 on their weekly food. Photograph: Peter Menzel /Barcroft Media.

Module 2: Living sustainably

The second module provides further exemplification of how a powerful resource can support teachers to examine the climate crisis. The Overshoot data sets illustrate how much of the planet's natural resources are 'overconsumed' across a calendar year.

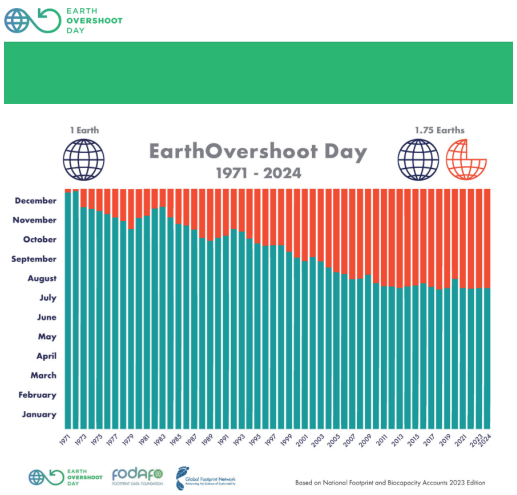

Figure 5: Overshoot data sets. Taken from: [Earth Overshoot Day home - #MoveTheDate (footprintnetwork.org)]

Figure 5 illustrates the planet's 'Overshoot Day'. This data set can be used in an innovative way to start conversations about our consumption habits. The graph represents the point in time, each year, when human consumption of the earth's ecological resources exceeds the capacity for the earth to replenish those resources. The graph offers a starting point to illustrate how humans have consistently overused the Earth's natural resources since 1971. Questions such as: What does the graph show about our consumption habits? How could the graph be used in class to start discussion about our consumption? Have a look at the statistics of 2020. Why were they different? Can we use the lessons from 2020 to help us look at our consumption habits? The graph provides an example of how data can be used impactfully to awaken our sustainability consciousness.

However, this graph also poses the question of whether every single country in the world is responsible for this collective consumption. Hence, it is important to deeply examine the data behind the overall 'Overshoot Graph' to gain further insights. This type of reasoning can support us to consider the notions of equity and highlight the exacerbation of inequality across nations. E.g. those countries affected most by the climate crisis are contributing least to the warming temperatures.

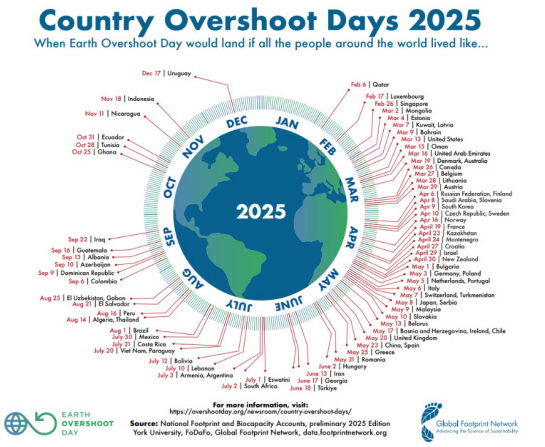

Figure 6: Country level overshoot data sets. [Earth Overshoot Day home - #MoveTheDate (footprintnetwork.org)]

Figure 6 provides further insight into how the complexity of consumption can be explored to think about sustainability and our own consumption habits. E.G. the Overshoot Data for the UK can be used to look at when the UK overshoots and compare this with other comparable nations.

The first country to overshoot is Qatar, it would be interesting to explore this further by looking at the country level data (available on the website) to understand why this happens. Is it simply through overconsumption or are there other factors involved such as the location of the country, the natural resources available within the nation and hence the resource implication to sustain the national population. Detailed calculations can be done about food consumption per capita and compared. The site has a dedicated section to food consumption, food waste, this could be explored with appropriate data sets and conclusions drawn, using mathematical thinking. Info graphics such as figure 7 show measurable ways that individuals

can #movethedate of the world overshooting their natural resources through their food consumption.

Figure 7 showing an infographic of measurable ways we can take action to reduce food waste and #movethe date

Further exploration of this data set can be done by looking more closely at the country level data sets to make comparisons? Are all 195 nations and territories of the world represented here? What does this tell us about the world's consumption habits? Will the impact on the environment in Benin and Qatar be different to that of the UK? Why? The analytical examination of these data sets enables the development of reasoning and problem-solving skills, hence supporting the principles driving mathematical thinking, reasoning and problem solving.

Concluding remarks

The article has set out the role mathematics can play is developing deeper understanding of the twin crisis of nature loss and the climate emergency. It is hoped that the mathematics TSF modules inspires teachers of primary mathematics to visualise the explicit connections mathematics holds in supporting young people to navigate the complexities of the climate crisis in a connected way to give them the tools to foster a sense of hope and sustainable habits.

I would encourage you to explore the modules in your own time. The materials can be accessed at the CCCSE site are free to all. Alongside mathematics, you will also find modules for Primary English, Geography and History. If you join our mailing list, all updates will be shared with you on a regular basis. Please do write to share your thoughts on the modules and if you have any further questions.

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