A story of incarceration motivates new conversations: Developing mathematics teaching for a future humanity

Nataly Chesky, John Lupinacci and Mark Wolfmeyer share a thematic unit they have devised to explore issues of social justice through mathematics education.

Sadly, in the United States, it is reported that on any given day 2.3 million people are locked up as part of a mass incarceration epidemic (Wagner & Sawyer, 2018). According to the National Association for the Advancement of Colored (sic) People (NAACP) (2018), while the United States make up approximately 5% of the world's population they imprison 21% of the world's prisoner population. The same report suggests that, "Though African Americans and Hispanics make up approximately 32% of the US population, they comprised 56% of all incarcerated people in 2015" (p.1). It is also reported that Black women are incarcerated at twice the rate of white women and in general Black people at five times the rate of those identified by authorities as white (NAACP, 2018). The Center (sic) for American Progress reported in 2016 on the overrepresentation of people with identified disabilities in the prison system and the Bureau of Justice Statistics reported that 1 in 5 prisoners have an identified serious mental illness (Glaze & James, 2016).

We would argue that in the US there is a war against marginalised communities that mirrors the patterns of mass incarcerations, with reports of police violence and killings of often unarmed non-violent civilians. A report produced by the Washington Post (2015), estimated that 25% of the people shot and killed by police in 2015 were people with mental health conditions.

How could such a culture of violence be accepted, rationalised, and justified in US society? As *EcoJustice* educators we ask this question wondering how it is that one group or individual might perceive the life of any other being as inferior. We see this as a key factor in understanding and confronting the systemic roots of such social injustices.

Our current research process is as follows: We gain access to mathematics teacher development spaces by meeting the challenge of content coverage. We support teacher professional development with a review of content and pedagogical content knowledge related to a specific content currently missing from programmes. Next, we design thematic units and share examples of thematic units related to the particular mathematics content. Our examples have been written within *EcoJustice* frameworks. Thus, our sharing leads to conversations about the values and beliefs that underpin mathematics education.

To give this process life in this article, we will now share the specifics of one such example unit titled, *A story of incarceration.* At present, we are using this in teacher education classrooms and professional development settings and studying the conversations taking place amongst both pre- and in-service mathematics teachers for their shifts in values and beliefs as to the purposes of mathematics teaching and learning. The statements come from the *Common Core State Standards for Mathematics (CCSSM)* and the *Next Generation Science Standards* (NGS).

In sharing this unit, we provide a list of materials and sources that allows the mathematical exploration of incarceration in all its forms. Initial findings indicate that such a unit indeed sparks conversation amongst mathematics educators. In these conversations, we, in turn, share how typical, seemingly apolitical, mathematics units on the same topics lend themselves to the political goal of human capital mathematics education, something of which many mathematics teachers are unaware. We are witnessing mathematics educators emerging with a newfound appreciation of the political nature to their work and the possibilities for shifting their practice. We also urge our teachers to think deeply about the covert ways that mathematical knowledge is used to understand a phenomenon such as incarceration. We ask how using mathematical operations; the choice of mathematical language or the design of mathematical models affects not only what we come to learn about the topic, but how we come to understand it. Mathematics becomes a powerful tool to raise awareness of eco-social injustices. Learners come to see themselves as powerful agents of change who can critique mathematical knowledge and become co-creators of new mathematical tools and models for the future.

In our classroom teaching, we share these and other

A story of incarceration, unit plan outine.

Established Goals (Standards):

1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
2. Recognise and represent proportional relationships between quantities.
3. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
4. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems.
5. The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.
6. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
7. The development of technology is a human activity and is the result of individual or collective needs and the ability to be creative.
8. Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

What essential questions will be considered?	What understandings are desired?
1. How do we compare rates and ratios? 2. What do the terms proportional and disproportional mean and how do we recognise these relationships? 3. How do incarceration rates and proportions differ across populations? 4. What do we know about human incarceration by studying the geometry and engineering of prisons? 5. How do we classify life on earth and what does this tell us about evolutionary relationships? 6. Which species among the classification are incarcerated and for what reason? 7. Is it possible to design an ethical incarceration?	1. Mathematical concepts of rates, ratio, proportion and disproportion illuminate our understanding of the real-world and augment our ability to solve problems. 2. Scientific concepts of biodiversity, taxonomy of species, and evolutionary relationships describe the variety of life on the planet and promote respect by humans for living things. 3. The engineering process applies scientific and mathematical concepts and is deeply intertwined with ethical considerations. 4. Ethical applications of science, engineering, and mathematics reveals that the mass incarceration of human and non-human animals may rest on unethical assumptions of domination and subordination. As well, such applications present steps towards eradicating these practices of incarceration.
What specific knowledge will learners acquire?	**What specific skills will learners acquire?**
1. Mathematical concepts of rate, ratio and proportion.	1a. How to compute rates and compare proportions. 1b. How to use a scale drawing to compute actual lengths and area. 1c. Apply the above to incarceration as i) computing rates of incarceration across sectors of the population; ii) identifying disproportionate groups that are incarcerated; and iii) studying prison floor plans and scaling to real life dimensions.

2. Scientific concepts of species taxonomy, biodiversity and evolutionary relationships.	2a. Identify the levels in the taxonomy of species. 2b. Distinguish species within the animal kingdom and the mammal class. 2c. Apply knowledge of evolutionary relationships and taxonomy to incarceration of animals existing in agribusiness, entertainment and experimental testing.
3. Ethics as a constraint on engineering design.	3a. Ethically analyse the existing design of incarceration. 3b. Debate the possibility of designing ethical incarceration systems, such as open prisons and humane zoos.

(Adapted from Wolfmeyer Lupinacci, & Chesky, 2017 p. 291)

thematic units that expand our teacher candidates' thinking on the political underpinnings of mathematics teaching and learning. After discussing this unit, we ask them to design a lesson, or a unit activity, to move mathematics teaching values from the implicit to explicit. Nataly asks student teachers for exemplar lesson plans that connect mathematics content to social and environmental issues. Her students have created lesson plans, linked to national standards, that also address socio-environmental issues, such as in one student's lesson for 8-9-year-olds, "Where do our fruit and vegetables come from – calculating your foodometer". Another student's lesson requires learners to map and mathematically model the electricity use of their school.

In Mark's classroom, after we read through the incarceration unit, students were asked to convert an apolitical mathematics lesson they have taught to a new version making political values explicit. Examples from his classroom include one the conversion of a lesson on area and perimeter to a lesson on political gerrymandering and another lesson on proportionality to a lesson on race, social class, and school districting.

In John's classroom, students learn about anthropocentrism, human as separate from and superior to all other beings, through developing mathematics lessons that illuminate the numbers of diverse species that comprise students' bodies, classrooms, and communities. These mathematics lessons are interdisciplinary and help students learn mathematical concepts while practicing their ability to recognise and value biodiversity.

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