Climate change and road tolls …in the mathematics classroom

Climate change is a global, urgent and complex issue that impact society, such as transportation.

Steffensen, Lisa. Western Norway University of Applied Sciences lste@hvl.no

Research focus: This research concerns Norwegian students' argumentation, asked by their teachers to discuss and suggest a model of payment distribution for a road project. The focus is on students' argumentation when designing a model for road tolls.

Research context: Norway aims for zero emissions for cars in 2025. Incentives (e.g. road toll) are introduced for Electric Vehicles (EVs). The share of EVs (new sale) in Bergen for 2017 was 50% (internationally, about 1%). The incentives cause public debate: it is questioned if this is appropriate as a means for a sustainable world.

Theoretical framework

Critical Mathematics Education (CME): Mathematics is crucial in describing, predicting and communicating climate change, and calls for mathematics education to be involved (Barwell, 2018). Skovsmose (1994) described CME in terms of concerns of critical citizenship, identifying the role − and formatting power − of mathematics in society.

Socio-critical perspective in modelling aims to develop a critical understanding of the society in a social and political context (Stillman, Kaiser, Blum and Brown, 2013).

Prescriptive modelling aims to design, prescribe, and structure society (Niss, 2015). Road tolls are used as a tool for obtaining citizens' behaviour (e.g. rush hour rates, a free pass to EVs), and is based in prescriptive mathematical models which influence on citizens choice of cars, and how they commute

The empirical data was collected in four 10th grade classes, over one year, and involved 42 lessons. This research concern the lesson "Dialogue & Debate" (highlighted in red), students discussed in groups and in a plenary debate. The data consist of video- and audio-recordings, students and teachers written materials, and field notes. The data was transcribed, thematically coded and categorized using NVivo.

Themes (chronological)	Who and What:
1. Start-up	All four classes Invite students to contribute with ideas
2. Excursion & Report	All four classes Measure climate relevant data (CO2 etc.)
3. Dialogue game	One class (Kim's) Discuss and reflect on claims
4. Discussions	One class (Kim's) Discuss and reflect on graphs/facts
5. Make posters	Two classes (Max's) Make posters for an energy-exhibition
6. Energy-exhibition	All four classes Present posters and quiz
7. Dialogue & Debate	Three classes (Kim's and Max's) Discuss claims in groups & plenary panel-debate

Preliminary findings suggest that students' argumentations involved critical reflections on five categories; Economical, technological, traffic-related, environmental, and ethical. Their argumentation concerned the economic impact on a family and on society, different technology (fossil-based transportation and EVs), impacts of CO2-emissions, traffic flow and traffic security, and ethical concerns for the present and future generations.

The students suggested different models of road tolls, discussed intentions and implications, as well as critiquing them. Mathematics was a part of their discussions when using tables, graphs, and numbers to inform discussions, and as a part of their argumentation.

Important keyword for students' argumentation: Engagement, Complexity (initiated by themselves), Inquiry-based dialogues (Alrø and Johnsen-Høines, 2012).

So what: Mathematics education can enable students awareness and understanding of prescriptive mathematical modelling in society, and by that, students can be(come) critical citizens on real-life problems.

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Western Norway University of Applied Sciences