Student's critical mathematic competencies in a climate change context.

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In this commentary paper, I will briefly highlight some findings related to empirical research carried out in lower secondary school, where students engaged in climate change in the mathematics classroom.

Introduction

Climate change is one of society biggest challenges and is both urgent and complex to deal with. The extent of mathematics involved to describe, predict and to communicate on the problem calls for the involvement of mathematics education (Barwell, 2013). The objectives of this research were to investigate how climate change in the mathematics classroom can develop a student's critical mathematics competencies. This objective has both a teacher perspective, e.g. how teachers can facilitate for such competencies, as well as a student perspective, e.g. identifying how student's critical mathematical competencies appear. While the first perspective has been the main issues in previous writings[1], the student perspective is the main issues of forthcoming research and writings. The focus of this study is on how to develop students' critical mathematics competencies, and how the competencies appear.

Theoretical framework

The theoretical foundation is mainly from critical mathematics education. Skovsmose (2014, p. 116) characterized critical mathematics education by concerns; "To address social exclusion and suppression, to work for social justice in whatever form possible, to try open new possibilities for students, and to address critical mathematics in all its forms and application". Other researchers such as Frankenstein (1983) and Gutstein (2006) has emphasized on critical consciousness, education for social changes, and social justice. However, also theoretical insights from post-normal science are relevant, and Funtowicz and Ravetz (2003, p. 1) refer to issues where "facts are uncertain, values in dispute, stakes high and decisions urgent" as a post-normal science. They argue that citizen must be involved in decision making along with the experts, in an extended peer community. Both critical mathematics education and post-normal science emphasis on the social and political aspects of society, how citizens can engage in a constructive critique of the existing, emphasis on uncertainty and complexity, and a perspective that science or mathematics are neither objective, certain, neutral or value-free.

The study

The data for the research was collected through a one and half year research partnership with three mathematics and natural science teachers and their 15-16-year-old students. The partnership was

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In "Wicked problem in school mathematics" (Steffensen, Herheim, & Rangnes, 2018), "Climate change controversies in the mathematics classroom" (Steffensen & Rangnes, 2019), "Wicked problems and critical judgment in school mathematics" (Steffensen, Herheim, & Rangnes, 2019b), and "The mathematical formatting of how climate change is perceived: teachers reflection and practice" (Steffensen, Herheim, & Rangnes, 2019a).

inspired by action research, and seven research partnership meetings with the teachers were audio recorded, and 42 classroom activities were both video and audio-recorded. In addition, students' and teachers' written material were collected. The research partnership meetings involved planning for lessons, reflection on the lessons, and meta-reflection on the topic of climate change and mathematics. The classroom activities included eight main lessons, were the teachers organized the students in groups. Not all teachers did all the activities. The analysis involved transcribing, coding and categorizing inspired by grounded theory methods as describes by Teppo (2015) by using NVIVO. The analysis included both research partnership meetings and lessons in the classroom.

Some findings from the study

The teachers

The findings from the teacher perspective showed that the teachers facilitated a wide range of different teaching activities: An introducing lesson were the students were invited to contribute with ideas, field-work with climate change parameters (such as temperature and CO_2 levels), group-work with the excursion-report, dialogue game with different claims on climate change, discussion based on graphs and numbers, poster-making, attending and contributing to an exhibition, and dialogues and debates concerning local climate change related issues. Important features of these group-activities were collaboration, reflections, dialogue, and communication. Furthermore, the teachers reflected in the research partnerships meetings on some of the challenges and opportunities experienced through the different classroom activities, and on teaching climate change in the mathematics classroom in general. For instance, the controversy of climate change appeared in some of the classroom activities where two of the teachers choose a different type of questions, graphs, and numbers to highlight different issues in climate change (see Steffensen et al., 2018). In addition, the mathematical formatting powers (a concept introduced by Skovsmose, 1994) of climate change were identified when the teachers facilitated students critical competencies, and in the teacher's reflection in the research partnership meetings (see Steffensen et al., 2019a). Also, how values can play a part in the teacher's facilitation, for instance, whether they should facilitate for students taking actions towards climate change, or whether to emphasize more on a factual approach (see Steffensen et al., 2019b).

The students

In a traditionally mathematically problem-solving task, students are often asked to provide a given and correct answer. In this study, where the students did empirical research, reflected, discussed, and took a stand on climate change issues, the aspect of providing a correct answer became less prevalent and prominent. Instead, the student's competencies were characterized by and appeared in several ways. One way was through inquiry-based dialogues such as those described by Alrø and Johnsen-Høines (2012). Another way was through critical reflections with their peers. A third characteristic of how the student's competencies appeared, was that their knowings (a concept defined by Skovsmose, 1994) were intertwined. For instance, common knowledge, mathematical or scientifically knowledge was intertwined in the student's arguments and utterances. Furthermore, ethical and personal views were a part of how the students discussed mathematical and scientifically based climate change issues.

Recently, students all over the world have engaged in climate change, doing "School strikes 4 Climate Action", and suing governments inactions against climate change (Wearden & Carrington, 2018). This engagement, and the student's concerns on complex problems such as climate change, could both be considered as an "outside school"-activity or included as a school activity which could support such engagement from students.

Concluding comments

The study has a focus on how to develop students' critical mathematics competencies, and how the competencies appear. From a teacher perspective, the study shows that when three teachers facilitated for such competencies, they facilitated a wide range of activities or lessons. These were organized in groups, and collaboration, communication, reflection, and dialogues were an important part of the student activities. Furthermore, some of the controversial aspects of climate change issues appeared when the teachers facilitated. The teachers' values came in play when reflecting and facilitating, and it the formatting powers of mathematics was identified in several contexts.

Preliminary results on the students' perspective showed that they critically engage in climate change issues and that the mathematics involved was intertwined with personal views and ethical stands on how to deal with climate change issues. When complex problems such as climate change are included in school mathematics, this involves opportunities and challenges for teachers and students to engage in "real-life" mathematics, and this empirical study displays some of these.

The findings from the teacher perspective indicate that the complexity and uncertainty of climate change, along with the controversial aspects of climate change issues, is challenging for the teachers. It could, therefore, be argued that pre-service and in-service teachers could experience how to deal with such problems in teacher education. To facilitate for students to reflect and take a stand on climate change issues that are complex, uncertain, and value-loaded, could enable them as critical citizens.

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