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CLIMATE CHANGE IN MATHEMATICS CLASSROOMS

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An online survey was carried out to get a first impression of what teachers do in classrooms, and why, in relation to climate change and mathematics education. Barbosa's perspectives of mathematical modelling inspired the questionnaire: "modelling as vehicle", "modelling as content" and "modellings as critics". The survey response was mainly qualitative in nature. Although the questionnaire did not address modelling specifically, several of the teacher's answers to the open questions refer to modelling. In this paper, we analyze the answers in accordance to perspectives of mathematical modelling and to different modelling stages. The teachers express a great variety of ways to approach the topic, where many of these may be related to modelling.

INTRODUCTION

Climate change is a complex topic that involves expertise from a wide range of fields. The degree of mathematics applied in all aspects of the topic, indicates that a range of thematic areas could be relevant for mathematics classrooms. Climate change has received increased attention within mathematics education the last decade. It seems that critical, theoretical and normative perspectives dominate this part of the academic literature, and they are often accompanied by ideas linked to mathematical modelling. For example, Barwell and Suurtamm (2010) called for more visibility in the modelling of climate change, for instance through information on model assumptions. They further suggested that mathematics education has a responsibility in facilitating critical reflections on model assumptions and the role of mathematics in people's understanding of climate change. Barwell (2013) later theorized these ideas based on normative philosophies associated with critical citizenship. Assumptions in mathematical models were also a topic in Hansen's (2012) paper, where she reflected on an article in a local newspaper where future sea levels in her hometown were predicted as an effect of global warming. Her focus was on mathematical modelling as a classroom activity to prepare students for critical engagement. Hauge and Barwell (2015) examined how uncertainty is expressed in texts on global temperature change, which is also related to assumptions in mathematical modelling and critical citizenship.

While the above references exemplify the normative and theoretical approaches in the academic literature, we find limited literature on what teachers actually do related to climate change in classrooms, and why. To achieve insight into this, we carried out a scoping survey through an online questionnaire. In this paper, we study what the responses can tell us about how teachers connect the topic of climate change to mathematical modelling.

THEORETICAL FRAMEWORK

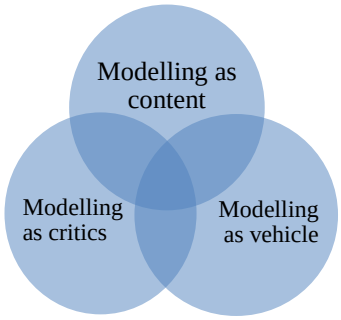

Figure 1 Visualization of overlaps between different educational perspectives on modelling, Hansen and Hana (2012).

Our teoretical framework is twofold. We analyze the responses according to Barbosa's (2006) educational perspectives on mathematical modelling: "modeling as vehicle", "modeling as content" and "modeling as critics" on modelling in education, building on Julie (2002). In the vehicle-perspective, modelling is understood as "a way to teach mathematical concepts", (Barbosa, 2006, p. 293), while in the "modelling as content" perspective, the main purpose of working with modelling in education will be to develop modelling competence. The perspective "modelling as critics" sees knowledge of modeling as an important educational background for citizens to be able to reflect on the role of mathematics in society, in particular the critical use of models. Barbosa (2006) identified these perspectives by investigating students' conversations in various learning-situations involving modelling. By performing similar experiments with student teachers, Hansen and Hana (2012) revealed the existence of possible overlaps between the perspectives, Figure 1. This last finding indicates that several positions and transitions between the areas in the figure could be an issue when discussing teaching and learning situations involving modelling. In analyzing our data below, we are mostly concerned with the three main categories and their overlaps.

To discuss to what extent the teachers' approaches to climate in the classroom may be considered as modelling approaches, we needed a general description of a modelling process. Different descriptions of general modelling processes are available, here we adopt a scheme suggested by Blomhøj (2003, p.67), which includes the stadiums a) Problem formulation b) System bounding c) Mathematizing the systematized problem d) Analyzing the mathematized model e) Interpretation and evaluation of model results f) Evaluation of the validity of the model. With these stages in mind, we found it possible to discuss the teachers' approaches to climate in the light of modelling.

METHOD

A questionnaire was developed to achieve insight into teachers' reasons for bringing the topic of climate change into classrooms, and how they use this topic to promote mathematical learning. Questions were formulated to gain knowledge on the teachers' aims, what types of tasks they gave, how they worked with the topic, if they had a multi-disciplinary approach, what tools they used (websites, data, ICT), age groups of pupils, time spent on climate change per year, and their experienced success and failures. We were also interested in how they used data, tables or charts, and what reasons they had for teaching climate change. Their reasoning could for instance be curricula, mathematical concepts, mathematical modelling, uncertainty in models and to gain insight into disagreements on climate change. There was a combination of closed and open questions. Another aim of this survey was to look for possible cooperation with teachers with respect to further research.

We posted the questionnaire in a Facebook group that discusses mathematic didactics, which counts a number of members above 5000. The survey was voluntary, and a prize (an iPad) was announced as an incentive to participate. The prompt on the Facebook group was a question "Do you teach

climate change in mathematics or other subjects?" The survey was intended for teachers who teach mathematics in primary and secondary schools. The questions were also intended for teachers who teach climate change in other school subjects than mathematics. The reason for this was the interdisciplinary nature of climate change.

RESULTS AND ANALYSIS

In general, the survey respondents gave quite informative feedback. Totally, we received 72 responds. Amongst these, there were a large majority of secondary school teachers (15.2% worked in primary school, 43.1% in lower secondary and 47.2% in upper secondary). About 78% reported that they spent more than two hours during a year on climate related topics, and about 20% spent more than 10 hours. The subject in which they taught climate change was dominated by natural sciences (77.3%), but around 45% of the respondents used it for teaching mathematics. The majority of the respondents informed that they applied data or figures from different sources, charts/graphs, tables, pictures, text from different media, internet, film and animations. A minority applied practical experiments, field trips, museums and contact with climate experts. Many organized discussions in class or oral activities in groups.

In the following, we present answers to some questions that may be categorized in accordance with Barbosa's (2006) three educational perspectives of modelling. One question was: "Rate your reasons for teaching climate as a topic." An answer we link to the metaphor "modelling as vehicle" is: "To learn about mathematical concepts". We interpret from the relatively low score (averagely 2.91 of maximum 5 points) that the teachers do not emphasize this reason much. An answer that may be associated with "modelling as content" is "To learn about mathematical modelling". This reason we considered a little more essential (an average of 2.95 points). Several of the answers may be linked to "modelling as critics", and some of these were considered as the most important reasons: "To learn about uncertainty in models" (3.26 points) and "To gain insight into the differences in the climate debate" (3.26), while "Because it's a political theme" (2.68) was at lower score.

Another key question was "If you used data, tables or charts, what was your emphasis in teaching?" Some of the respondents replied that they collect data (from internet or from experiments) on climate change to work with in classrooms. One may consider this as work with some kind of modelling, and the activities may be associated with the "modelling as content" metaphor. Temporarily, we interpret them to belong to Blomhøj's stage b) system bounding, although we do not have information on whether they used the data to calculate and analyze something mathematical (stages c) and d)) or to just interpret data (stage e). In the open questions, many respondents wrote that they interpreted graphs and charts, which corresponds to stage e).

Often the comments on the open questions indicated that the respondents emphasized *modelling as a vehicle*. The following quote shows one example: "Now I think that I could have used it more in teaching mathematical functions and models and motivate how we apply functions". In this quote, mathematical functions seems to be the aim, while mathematical modelling is a vehicle to motivate learning on functions. An example that can be classified in several ways is: "I would like the students to spend a lot of time on the topic, and to let them get insight in different climate models, and see how they match real measurement". The idea to spent time on different climate models could be interpreted as an aim to learn about modelling. However, the aim might be interpreted as *modelling*

as critics if the respondent had an expectation that the measured values would not match the modelled values. Another respondent writes that "It is a challenge that the students have strong opinion related to certain political issue that sometimes is an obstacle for critical thinking on different sources, especially media coverage". This quote indicates more clearly the aim of *modelling as critics*. Also, it is more strongly linked to critical thinking and mathematics in society than the previous quote.

DISCUSSION AND CONCLUSIONS

Our findings suggest that teachers have various aims of using climate change in mathematics classrooms. These can be linked to all of Barbosa's (2006) three educational perspectives of modelling. Although very briefly described, the responses indicate that there are overlapping areas between these three perspectives as described by Hansen and Hana (2012). It can also be concluded that collectively, teachers have ideas on how to use climate change in classrooms where all Blomhøj's stages can be recognized. The survey is only a scoping exercise. More research is needed to understand how and why teachers focus on mathematical modelling related to climate change. Several of the respondents called for ideas on how they could use climate change in classrooms, while some found the topic to complex or political for projects in schools.

References

Barbosa, J. C. (2006). Mathematical modeling in classroom: a socio-critical and discursive perspective. Zentralblatt Didaktik der Mathematik (ZDM)(38, 3), 293-301.

Barwell, R. (2013). The mathematical formatting of climate change: Critical mathematics education and post-normal science. Research in Mathematics Education, 15(1) 1-16.

Barwell, R., & Suurtamm, C. (2011). Climate change and mathematics education: Making the invisible visible. In M. Pytlak, T. Rowland & E. Swoboda (Eds.) Proceedings of the 7th Congress of the European Society for Research in Mathematics Education (pp. 1409-1419). Poland: European Society for Research in Mathematics Education.

Hansen, R. (2012): Hva sier egentlig prognosene? – kritisk kompetanse om modeller og miljø. In M. Johnsen-Høines & H. Alrø (Eds.) Læringssamtalen i matematikkfagets praksis – Bok I (pp. 185-194). Bergen: Caspar Forlag.

Hansen, R., & Hana, G. M. (2012). "But it is not possible to do this until …" – The sequencing of teaching mathematical modeling. In G. H. Gunnarsdottir, F. Hreinsdottir, G. Palsdottir, M. Hannula, M. Hannula-Sormunen, E. Jablonka, . . . K. Wæga (Eds.), Proceedings of NORMA 11 - The 6th Nordic Conference on Mathematics Education (Vol. 6, ss. 299-308). Reykjavik: University of Iceland Press.

Hauge, K.H., & Barwell, R. (2015). Uncertainty in texts about climate change: A critical mathematics education perspective. In Mukhopadhyay, S. & Greer, B. (Eds.) Proceedings of the Eighth International Mathematics Education and Society Conference, pp. 582-595. Portland, OR: Portland State University.

Blomhøj, M. (2003). Modellering som undervisningsform. In H. Alrø, M. Blomhøj, & O. Skovsmose (Eds.), *Kan det virkelig passe?* Copenhagen: L&R Uddannelse.

Julie, C. (2002). Making relevance in mathematics teacher education. In I. Vakalis, D. Hughes, Hallett, D. Quinney, & C. Kourouniotis (Eds.), *Proceedings of 2nd International Conference on the Teaching of Mathematics.* New York: Wiley.