Modelling climate change through Study and Research Paths

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Research topic

The upcoming research accounted for in this poster is related to CiviMatics, an Erasmus+ funded project involving Austria, Germany, Norway (NTNU), and Romania (see https://www.civimatics.eu). CiviMatics aims to combine approaches of mathematics education and political education by offering educational tools to enhance the competences of citizens, especially regarding the interaction with global issues facing our societies. A societal issue dealt with in this project is climate change, currently one of the most urgent problems requiring an initiative. At NTNU, the course MA3001 (see https://bit.ly/3DDy0df) has been designed for the sake of CiviMatics to conduct experiments with the modelling of climate change through so-called *Study and Research Paths* (SRPs; Chevallard, 2022). MA3001 will be taught in the spring 2022 as part of a master's programme for Grades 8–13, "Natural Science with Teacher Education". The accompanying research will be centred on the following questions: *What are the main constraints related to implementing SRPs? What is the student teachers' learning outcome? What are the successful points associated with conducting SRPs?*

Theoretical framework and methodology

The didactic design to be employed and the research to be conducted in MA3001 are rooted in the *Anthropological Theory of the Didactic* (ATD; Chevallard, 2022). Our conceptualization of modelling is based on the notions of *system* and *model* as explained by Strømskag and Chevallard (2021): A system $\mathcal{S}$ is any entity subject to laws of its own. Given a system $\mathcal{S}$, a system $\mathcal{S}'$ is said to be a model of $\mathcal{S}$ if, by studying $\mathcal{S}'$, one can answer certain questions Q about $\mathcal{S}$. In practice, given a question Q relating to $\mathcal{S}$ which one wants to answer, one tries to build up a model $\mathcal{S}'$ of $\mathcal{S}$ (or choose an existing one) whose study with respect to Q is easier, safer, quicker than by a "direct" study of $\mathcal{S}$.

The modelling activities to be conducted in MA3001 are based on the new didactic paradigm proposed by ATD, that of *questioning the world* (Chevallard, 2022). In this paradigm, the point is to create a didactic system $S(X; Y; Q)$ that inquiries into a question (or a set of questions) Q. A praxeological function that studying a question Q assumes is to lead to studying all sorts of works (including derived questions Q_i). How can we describe what happens in a didactic system S when a class X studies a question Q under the supervision of a teacher/teachers Y? The model provided by the ATD is the *reduced Herbartian schema* (Chevallard, 2022): $S(X; Y; Q) \rightarrow A^{\heartsuit}$. The heart hints at the fact that the answer A to Q will be "at the heart" of the didactic system, at least for some time.

The next step in building up a model of the inquiry is the introduction of the didactic *milieu*, M, which is the set of tools that the class gathers in order to carry out their inquiry into question Q. This results in the *semi-developed* Herbartian schema (Chevallard, 2022): $[S(X; Y; Q) \rightarrow M] \rightarrow A^{\heartsuit}$. Here, the

didactic system is seen to *create* (denoted by ➦) the milieu M and to *generate* (denoted by ➥) the answer $A^{\heartsuit}$ by drawing upon the milieu M. In the quest for an answer A to the question Q, three main components stick out: (1) The search in the literature (including Internet queries) for *existing answers* $A^{\diamondsuit}$ offered by other persons or institutions. (2) To draw upon the answers $A_i^{\diamondsuit}$, the didactic system has recourse to *works* W_j of various kinds, like theories, experiments, essays, etc. (3) To use these works, the student needs to study them. This involves studying a number of *questions* Q_w about the work under study. Hence, the milieu M takes on the following appearance: $M = \{A_1^{\diamondsuit}, A_2^{\diamondsuit}, \ldots, A_m^{\diamondsuit}, W_1, W_2, \ldots, W_n, Q_1, Q_2, \ldots, Q_p\}$. We will use the Herbartian schema as a tool to regulate and analyse inquiries.

An SRP in MA3001 will be organised as follows: The generating question Q of the SRP will be presented by the teacher who is supervising the SRP. Student teachers (hereafter 'students') work in teams to study and answer the question Q. The teams and the teacher meet regularly to review the teams' work on Q and to confirm, adjust or extend the SRP for a specific period. In addition, seminars will be arranged where the teams present preliminary progress reports and receive feedback from each other and from the teacher on the condition of the answer under construction.

This is the generating question Q_1 (with subquestions $Q_{1.1}$ and $Q_{1.2}$) that the students will be given:

Q_1. How is future climate change caused by long- and short-term pollutants modelled in the scientific literature?

> *$Q_{1.1}$. What assertions and simplifications are made in these models?*
>
> *$Q_{1.2}$. What knowledge seems indispensable to understand these models (focusing on mathematics, but also considering civic education, chemistry, biology, physics)?*

At present, the focus is on an a priori analysis of SRPs which involve inquiring into Q_1 and its subquestions. We will draw on the many SRPs reported on by the ATD research community (e.g., Barquero et al, 2018; Bartolomé et al., 2018). Data to answer the research questions for the follow-up research presented in the first section, will include observations of students' team work, students' reports from the SRPs, and questionnaires about the functioning of the didactic systems at work.

References

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