

An idea for a conceptual replication across pairs of STEM subjects

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What problem is to be addressed?

Research on models in STEM education has established important distinctions between different types and functions of models—for example, models of vs. models for (Gouvea & Passmore, 2017), the communicative and epistemic roles of models (Coll & Lajium, 2011), and the emphasis on mathematization (Niss & Blum, 2020) and datafication (Weintrop et al., 2016). However, most studies remain confined to single-subject contexts. Chemistry emphasizes shifts between macro, micro (or sub-micro), and symbolic representations; biology often highlights qualitative and explanatory models, while physics and mathematics focus strongly on formalization and prediction.

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At the upper secondary level in Denmark, students encounter these different disciplinary model perspectives in parallel. In interdisciplinary projects, this can create challenges when students are asked to transfer or reconcile divergent notions of what a model is, what it is for, and how it should be evaluated. Yet these differences may also open productive opportunities if addressed didactically. Currently, few studies examine systematically how the concept of model plays out across subject boundaries.

How is it to be addressed?

The idea of the current proposed project is a conceptual replication (Aguilar, 2020; Cooper et al., 2024; Schoenfeld, 2018; Star, 2018, 2021) of research on the concept of model. Instead of reproducing a single-subject study verbatim, the replication will apply a shared modelling activity across three subject pairings: biology–chemistry, physics–chemistry, and biology–physics.

The central construct to be investigated—how students (and teachers) understand and use models—will remain constant, but the disciplinary framing is to vary systematically. This design would potentially make it possible to examine whether theoretical distinctions described in the literature manifest differently depending on the subject combination. For example, one might expect physics–chemistry activities to foreground mathematical formalism, biology–chemistry to emphasize representational transitions, and biology–physics to reveal tensions between qualitative and quantitative modelling approaches.

Methods will ideally combine analysis of student work, classroom observation, and interviews with students and teachers, thereby capturing both the enacted and perceived functions of models in these cross-disciplinary contexts.

What is to be replicated?

The study will conceptually replicate prior work on the educational functions of models, especially:

1. The distinction between models of and models for (Gouvea & Passmore, 2017).
2. The communicative, explanatory, and predictive functions of models (Coll & Lajium, 2011; Gilbert & Treagust, 2009).

The idea is that replication is to occur by applying the above theoretical distinctions not within a single subject, but across subject pairs, thereby testing the robustness and transferability of these constructs in a new educational context.

What might be the potential importance and significance?

Theoretically, this study would test whether widely cited distinctions in the model literature hold across disciplinary boundaries, and whether they can account for the ways students and teachers approach a common modelling activity in different subject pairings.

Practically, the study would provide insights into how students navigate divergent model practices across STEM subjects, and how teachers can scaffold these transitions. This could have direct implications for curriculum design and interdisciplinary teaching at the upper secondary level, where students frequently encounter models in different forms.

By identifying both sources of friction and productive overlaps, the study may potentially contribute to a more integrated understanding of the concept of modelling and inform strategies for leveraging cross-disciplinary synergies in STEM education.

Two potential research questions

We end with proposing two potential research questions for the study outlined:

1. How do students and teachers in different subject pairings (biology–physics, physics–chemistry, biology–chemistry) understand and enact the concept of model when engaging in a shared modelling activity?
2. In what ways do theoretical distinctions in the literature (e.g., models of vs. models for, formalization vs. representation, mathematization vs. datafication) manifest differently across subject pairs?

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