

## RECENT DISSERTATIONS

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*Teaching and learning through scientific practices in the laboratory in biology education: Exploring modelling through representation construction as scientific practice*

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### Abstract

The aim of this thesis is to explore the challenges and opportunities of teaching and learning through scientific practices in the laboratory in biology education, placing a main focus on exploring modelling through representation construction as a scientific practice. Traditionally, laboratory work often involves students simply following a cookbook approach to arrive at predefined results, which is not considered effective for developing students' conceptual understanding or knowledge about the nature of science. On the contrary, it contributes to the misleading idea that there is a single scientific method. The notion of scientific practices aims at working against this mistaken impression and the overemphasis on experimental exploration by directing attention towards other practices, such as argumentation and modelling. The focus in the thesis is on *practice* in the laboratory. In the thesis, I have investigated *practice* in two different ways. First, I have examined upper secondary biology teachers' *practices* as reported in a survey and group interview (Article I). Second, I have analysed undergraduate biology students' modelling *practices* through analysis of students' interactions and the role of different representations, such as their self-produced drawings and gestures in supporting their model-based reasoning (Article II and III).

The findings from the first article show that the major reported aim of laboratory work is to illustrate content knowledge and that teachers primarily implement teacher-directed laboratory work wherein the laboratory report plays an important role. Further, the findings demonstrate that teachers experience a tension between the aim of illustrating content knowledge and the aim of teaching through scientific practice. We show how concepts associated with scientific practices, such as hypotheses, were integrated into activities where the aim was not really to test the hypothesis. Article II and III are case studies focusing on undergraduate biology students' reasoning when constructing representations in a laboratory context. Our analysis showed that students' self-produced drawings supported their model-based reasoning as well as the development of conceptual understanding. Further, the findings clarify that gestures with different functions are important in students' inquiry. For instance, gestures representing molecules were important when the students were modelling molecular interactions. However, the findings also suggest that students' task framing could stand in the way of their reasoning. While most students seemed to frame the task as a modelling activity, one group framed it according to the conventions of a laboratory report. They remained loyal to the laboratory report genre, thereby placing a focus on the reporting of empirical results rather than reasoning through representations.

Together, these findings demonstrate the challenges and opportunities of teaching through scientific practices in the laboratory. One challenge is navigating the tension experienced between scientific practice and the goal of illustrating content knowledge through laboratory work. However, in this thesis I argue that when focusing on modelling through representation construction, the learning of scientific practices and conceptual knowledge go hand-in-hand, mutually supporting each other. The central point is that developing models and representations is a form of inquiry that is important in scientists' knowledge production in laboratories. However, the findings of this thesis point to the importance of the genre of the experimental report in both teachers and students' practice in the laboratory, and they suggest that the experimental report has become a standardised genre in the laboratory. I argue that the notion of scientific practices can open up space for new practices and new genres in the laboratory that are more in line with biology teachers' intentions to teach through laboratory work while, at the same time, authentically reflecting scientific practices.

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