



GÖTEBORGS UNIVERSITET

# **Teaching with Digital Mathematics Textbooks**

## **Activity Theoretical Studies of Data-Driven Technology in Classroom Practices**

**Marie Utterberg Modén**

Department of Applied Information Technology  
IT Faculty

Thesis for the Degree of Doctor of Philosophy in Applied Information Technology Towards Educational Science to be defended in public on Friday the 15<sup>th</sup> of October, 2021, at 13:00 in Torg Grön (4<sup>th</sup> floor), Patricia building, Department of Applied Information Technology, Forskningsgången 6, Göteborg. The discussion will also take place online.

Faculty opponent: Professor Diana Laurillard, UCL, Knowledge Lab, University College London.

ISBN: 978-91-8009-482-5 (PRINT)  
ISBN: 978-91-8009-483-2 (PDF)



# GÖTEBORGS UNIVERSITET

## Abstract

The introduction of digital textbooks, with data-driven functionalities, is a recent trend in mathematics education challenging established teaching practices. This new technology represents a key shift as student datasets make it possible to track the performance of all students, present data in real time, and allow teachers or the system itself to adjust the learning environment and presented tasks. Hence, the overall aim of this thesis is to explore and understand teachers concerns when digital mathematics textbooks are introduced in their teaching. The research is conducted in real classroom settings and activity theory has provided a lens to explore and understand teaching with digital textbooks by analysing its activity systems. The analysis is divided into three interrelated sub-activities: first, planning the teaching; second, teaching with data-driven decision support; and finally, teaching with adaptive tutoring functionality. Each of the three activities is discussed through the concepts of conflict of motives, congruence, and contradictions. This thesis reveals opportunities for development of teaching with digital textbooks by pointing out contradictions, which can act as a source of change and development for new ways of structuring and enacting the teaching activity. The studies show that planning teaching with a digital mathematics textbook with a high degree of flexibility puts more burden on teachers. They need additional competences and increased resources, particularly in terms of time for teaching. Teaching with data-driven dashboards and adaptive tutoring functionality builds on an individualized approach. This contradicts established teaching norms, building on the collective classroom activity, and where most activities are organized by a teacher to develop not only mathematics knowledge and abilities, but also more general skills. Furthermore, adaptive functionality challenges teachers' perceived control of the learning process and their accountability. On the other hand, the possibility of monitoring students' performance visualized on dashboards and support for adaptation to student needs showed to provide actionable knowledge in teaching, making individualization easier.

**Keywords:** digital textbooks, mathematics, education, artificial intelligence, intelligent tutoring systems, dashboards, activity theory