Final report for NV faculty: Student Active Exercises in electricity and magnetism (SAXEM)(FY1003)

Assoc. Prof. Raffaela Cabriolu[1] and Ass. Prof. Rolf Jonas Persson [1].

[1]Department of Physics, Trondheim, NTNU

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Scope of the project

The objective of this project was to enhance student learning in the Electricity and Magnetism course (FY1003) at the Physics Department through active exercises. Raffaela Cabriolu (RC) was responsible for the course, while Jonas Rolf Persson (JRP) organized the supporting work in the Laboratory and exercises of the FY1003 course.

Together, the P.I. revised and developed a new version of the exercises for the course during fall 2022, with the intention of implementing them in spring 2023. Funding was sought from the NV faculty to support the development of instructions and solutions for these exercises, which would be used by the Teaching Assistants (TAs). The project aimed to hire two students, who would write and validate the exercises and instructions for the TAs. A budget of 30,000 NKr was requested for this purpose.

This project aligns with the Physics Department's strategy for active teaching, which includes peer reviewing, discussions, and digital tools in the first-year physics courses.

The new version of the exercises was designed to encourage students to apply fundamental physical laws in group settings, fostering collaborative argumentation and problem-solving through a peer-reviewing approach. The exercises now also include reasoning using the fundamental concepts behind the equations, challenging students to critically evaluate their own understanding.

In practice, the exercises were divided into three main parts:

1. Group discussions to address misconceptions and promote peer reviewing.

2. Visualization of physics concepts using existing simulation applets.

3. Analytical problem-solving to develop mathematical skills.

The first part aimed to dismantle common misconceptions, promote peer discussions and enhance conceptual understanding. These conceptual exercises required group work and focused on perceiving real phenomena actively, rather than relying heavily on formulas.

The second part utilized interactive simulation tools to help students visualize mathematical concepts underlying real phenomena. This bridged the gap between mathematical and real-world descriptions established in the first part. The third part focused on problem-solving skills, requiring students to apply the mathematical language developed in the previous stages.

Results

The new version of the exercises underwent testing, and instructions and solutions were written by two bachelor students that were hired using the NV faculty funding. Both of those students had previously taken the course, and one of them had also worked as a teaching assistant for FY1003 in 2022. From a student perspective, the exercises were successfully validated. The hired students found the exercises more engaging than the previous version. They particularly appreciated the conceptual question part, which encouraged group work, and the visualization exercises. According to their feedback, the combination of group work, conceptual exercises, and analytical exercises significantly improved students' understanding.

The revised exercises, along with the solutions and instructions for the TAs, were implemented in the Spring 2023 offering of FY1003. The exercises received positive feedback from students, as highlighted in the course's reference group report. Students appreciated the compulsory activities for fostering social relations, collaborative learning, and a sense of unity, despite the large class size. The exercises were found immensely helpful for both conceptual and numerical understanding.

Continuity of the project

Based on the positive feedback from students, the new version of the exercises will be used again in Spring 2024. The project aligns with the principles of Fremtidens teknologistudier (FTS) principles III, IV, and IX [1], which the Physics Department at NTNU is currently implementing in the revision of its basic teaching courses. This novel version of the exercises combines conceptual, digital, and analytical approaches, leveraging NTNU's digital learning resources. It promotes a culture of cooperation among students and staff, rather than competition, and encourages interdisciplinary collaboration across different study courses. The simulations and exercises stimulate active follow-ups between students, teachers, and TAs. These follow-ups include additional training and regular TA meetings to discuss the didactic perspective.

Furthermore, the project is consistent with the vision expressed by the PIs in previous calls and activities aiming at integrating Interactive Computational Tools in designing novel teaching approaches.

[1] https://www.ntnu.no/fremtidensteknologistudier/prinsipper

Budget

30000 Noks was used in agreement with the original plan to hire two students. The details of the project are as follows: Prosjektnr 976814109 with k-sted 6200501.