# Conducting teaching experiments in Norway and Czechia using the didactical material developed within the initiative “Joint Czech-Norwegian initiative for the development of a modern mathematics education for engineers”

This report will give overview of the mathematics teaching sessions with the engineering students of UiT – The Arctic University of Norway located in the town of Bodø, and that with the international students at the Brno University of Technology.

The didactical material for these sessions was comprised of videos for the students to prepare with out-of-class, and tasks related to the topics covered in the videos. These tasks were meant for the in-class inquiry-based part of the flipped classroom sessions. Material for two different sessions was prepared, each covering three selected topics from linear algebra.

The first session was held with the Norwegian students at two different dates, the 20th and the 22nd of April 2021. Due to covid restrictions on teaming up physically with students for teaching activities, both these sessions were held digitally in Teams meetings. Before the sessions took place, the students had been told to prepare themselves with the videos. Statistics from the Learning Management System (LMS) we utilized for the teaching showed that all students had done this preparation.

We had divided the session into two different parts, where the first part was more theoretical introduction to the selected mathematical topics, and the second was more attuned towards applications of this theory. The utilization of digital meetings instead of physical meetings made it possible for us to invite the Czech member of the research team as an observer in the class. Four students were participating in the teaching sessions to the Bodø students.

After having introduced the topic of the day, the students were presented with the tasks associated with the teaching session. There were three different tasks, each related to the three different topics from the videos, and the students were told to choose one of these for their work in the session. The students were divided into two different groups, each group choosing a separate task, and gathered in separate breakout rooms to work on the tasks. Josef Rebenda was an observer in one of the groups, and Helge Fredriksen who was orchestrating most of the session, moved in and out of both rooms and guided the work of the students. An interesting aspect of working with mathematics is that the discourse consisting of the symbols can be easily understood across borders. That meant that even if the students talked Norwegian amongst themselves, their writing and use of verbal terms was well known from mathematical literature, making it possible for the Czech colleague to follow along with the solution process of the students.

Although there was a bit struggling to understand the tasks in the start for both student groups, needing a bit of consultancy from the teacher, both student groups worked quite successfully with the tasks. Below we show some examples of the students’ written material from these sessions.



Figure : Group 1 working with a system that has no solution, which emerged from linear combination of linearly independent vectors



Figure 2: Group 2 work on illustrating how three different lines relate geometrically to a graphical interpretations of various number of solutions to a system of linear equations

At the second round of teaching that was conducted physically at the Brno University of Technology on 18th of October 2021, there were two international students working with the same set of videos and tasks as the Norwegian students but limited to only the first session. We had a short introduction to the session when meeting the students, where we explained to them the concepts of inquiry-based teaching and flipped classroom, and that the videos were part of this scheme. Both students had prepared by watching the videos. Then, the students were asked to sit together and cooperate on the tasks. One of the students claimed she was not that good in English but would nevertheless try her best. They chose the task related to topic 1: Systems of equations. The students tried to cooperate in the beginning, but it very soon became apparent that the communication did not run fluid enough for the collaboration to work out. Thus, the teachers took the role of peers in the communication with the students. Helge Fredriksen sat down with one of them, while Josef Rebenda had a discussion over the topic with the other one on the whiteboard. The first student needed a bit guidance to keep going with the task, but after some guidance, she was able to solve the task. The discussion was directed towards the meaning of the matrix system to solve the problem of crossing lines. However, the student was not familiar with the Gauss-Jordan way of solving the system with the means of row operations, so a great deal of the time went into working on an operational level with the solution process. It might suggest that this student would have needed some more training on the procedural level before coming to the class.

To conclude, the two sessions with the Norwegian students on one occasion and the international students in Czechia at the other, showed a great variety of student perception of the idea of inquiry-based teaching. Most of the students adhered to the ideas of Flipped Classroom and seemed to have prepared well for the lessons. Also, their engagement with the tasks was high, even though the idea of inquiry-based working was a bit unknown territory for most of them. The idea of active learning seems to be a good one to follow up in further research, since it made the students reflect deeper on the mathematics together with the possibility of enhanced guidance of the lecturers.