Distance teaching: An opportunity to improve the teaching at the university?

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***Abstract*—The teaching in undergraduate courses in physics at Lund University and LTH has mostly followed the same format over the past decades: teacher-led lectures, problem-solving exercises, where the students work on alone or in groups, and laboratory exercises, followed by a written exam. During the COVID-19 pandemic, many teachers were forced to adapt other teaching methods more suitable for online teaching. This article will discuss the experience from online teaching at a first-year course at the Bachelor's Physics program at Lund University, and how this can be used to improve the on-campus teaching in the future.**

***Index Terms*—distance teaching, project-based courses, active learning, flipped-classroom**

I. Introduction

THE Covid-19 pandemic led to a hurried adaptation of a large number of courses at Lund University and LTH to distance teaching. Due to the sudden shift, some parts of the distance teaching worked better than others. However, one positive aspect is that it forced many teachers to test new approaches to teaching and learning. Now that the university is moving back to more traditional on-campus teaching, it is time to evaluate the lessons learned from online teaching and how it can be applied to improve teaching at the university.

With proper structure, distance teaching can work just as well for both teachers and students as on-campus teaching [1]. The main challenge in distance teaching is less contact between student and teacher, as well as fewer natural interactions between students in the courses. Online courses therefore need to take a different approach to teaching the same subject, to compensate for this. This article will outline the strategies taken in the FYSA14 course at the Department of Physics.

II. Course Design

The course "FYSA14 – Introduction to University Physics, with Thermodynamics, Climate and Experimental Methodology", 7.5 hp, is a part of the Bachelor's program in Physics at the science faculty at Lund University. It is given to first-year students during the first semester of the program. As the name suggests, the FYSA14 course contains three main parts. The aim of the course is to introduce the basic concepts of thermodynamics, and the relationship with the Earth's climate. In addition, the students should also get training in basic experimental methodology.

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The course was given for the first time during period 4, Spring semester 2020. The course was adapted for online teaching during the first semester and has been given online three times since then.

III. Adaptations to Online Teaching

The FYSA14 course contains many different elements. The thermodynamics and climate teaching consists of lectures and problem-solving exercises, while the students get training in experimental methodology through traditional laboratory exercises related to thermodynamics, as well as a project-based experimental seminar. This section will outline the adaptations to online teaching employed in the course during this time.

A. Online lectures

A challenge that exists in all lectures is the natural difficulty of the students to keep up active listening during long lectures. This problem is even more pronounced in online lectures, due to less contact between student and lecturer and more distractions for students watching lectures from home. Pedagogic research advocates active learning as a more effective way to learn science subjects compared to traditional lectures [2,3]. The lecture does however have benefits in distributing information to many students at once in large courses [4]. Using frequent questions, group discussions and relevant examples, active learning can be incorporated during lectures [4,5].

There are two common approaches to online lectures: pre-recorded videos or online lectures where the students watch the lecture live. The advantage of pre-recorded videos is that the students can pause and rewind if they miss something, and re-watch the videos if they did not understand the theory. This makes it easier for students who fall behind in the course to take in all lecture material at their own pace. On the other hand, in pre-recorded lectures the students lose the ability to ask questions from the teachers, which is very important and highly encouraged during normal lectures. This may be even more important during online teaching, since students might need more teacher guidance due to less in-person interactions [1].

In FYSA14, a mix of short (10-20 min) pre-recorded video lectures and live-lectures were used. The first semester of the course relied heavily on pre-recorded lectures, and interactions with the teacher was scheduled during open question sessions online. In the course evaluations the pre-recorded videos were much appreciated but more live-lectures were also requested. In later semesters the video lectures were maintained, but more live-lectures were added to further teacher-student interactions and give more opportunities for questions. Active

discussions were encouraged through questions and breakout rooms during the live-lectures. Many students appreciated having access to both the pre-recorded videos and live-lectures during the course. In the future, the pre-recorded videos can continue to be a complement to lectures during on-campus teaching.

There has been much interest in recent years in the "flipped-classroom" approach to teaching, where students read up on facts outside of class and have active participation in the classroom through projects or discussions [6-8]. One possible approach in the future could be to use the pre-recorded videos for an active flipped-classroom approach [9], where studying the videos is a pre-requisite for interactive seminars.

B. *Problem-solving seminars*

In a traditional "exercise session" the students work individually or in groups with problem-solving and ask a teacher for help when they need it. This format has not worked well with online teaching for FYSA14. The open structure of the online question sessions resulted in low attendance and little to no engagement from the students. Instead, problem-solving seminars were introduced, where the teacher focused on presenting and discussing practical problem-solving related to the lecture theory. This encouraged students to show up at the sessions, and active discussions around pre-defined problems could be achieved in smaller student groups. Allowing anonymous requests for problem-solving in the chat also made many more students engage in asking open questions.

The traditional exercise sessions work much better on campus than online. However, an active structured seminar with group discussions around advanced problem solving could be a good complement to the traditional individual exercises, as a way to encourage students to actively discuss the problems with each other rather than with the teacher.

C. *Laboratory exercises*

The experimental methodology experience achieved through laboratory exercises is difficult to replicate via distance teaching. In FYSA14, students were allowed to perform shorter experiments on campus in smaller lab groups, combined with more theoretical data analysis done outside of the lab time. This is a format that worked well for online teaching with restrictions, but having the full exercise on-site is preferable for laboratory exercises. However, in courses where there is a shortage of lab space and time, a solution like this could still be implemented where part of the data analysis is performed outside of scheduled lab

D. *Experimental seminar*

The experimental seminar is a group project, where the students come up with their own project idea, perform the experiments and hold an oral presentation of their project. It involves one full week of independent work, and is run as a semi-independent part of the course led by a separate team of teachers. During distance teaching, the on-site experimental seminar was replaced with experiments performed at home with borrowed equipment, with online support from the teacher team. Instead of oral presentations, the students recorded a video demonstrating their project design and results, as well as watching and giving feedback to other students' videos.

The seminar has been highly appreciated in each course semester. The work-from-home-approach led to less teacher-student interactions, but also more independence in the student work. The video presentations were also appreciated as a form of examination that the students seemed to enjoy, although some students felt video editing took too much time away from the project itself. Nevertheless, it was a successful adaptation that could be kept for future project-based courses.

IV. Outlook

In summary, the many of the different teaching methods adapted during online teaching can be continued after going back to on-campus teaching. Pre-recorded video lectures could be used either as a support and complement to traditional lectures, or as a basis for a flipped-classroom approach to lectures. Independent projects can be successfully based on work at home, and many students find video-presentations more exciting than oral presentations in front of a group. The discussion of how to best integrate our experiences in distance teaching into campus teaching is a very interesting problem for teachers at this time.

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