

Multifunctional Teaching Studios for Virtual Classrooms during the Pandemic and Beyond

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Abstract: We will discuss the studios that we have built to livestream different learning activities for virtual classrooms. We will show how to optimize the experience for both students and instructors and bring back interactivity. © 2021 The Authors

In spring 2020, Chalmers University of Technology transitioned to distance learning because of government restrictions imposed on universities in response to the coronavirus pandemic. Recommendations to work from home combined with limited availability of virtual classroom facilities moved teaching largely to instructors' kitchens and basements. In that process, interactivity and connection with the students was lost to a substantial degree. It became soon clear that different facilities, at a reasonable cost, were necessary. In preparation for the fall term, we therefore took on the challenge to build distance-learning studios. The entire setup in our studios is designed in a way that optimizes the experience from the instructor's and the students' perspectives simultaneously.

By its very nature, optics education is characterized by a variety of activities, including theory instruction, problem solving, and experimental training, all demanding a high level of interaction between students and instructors. It was clear to us that livestreaming had to be part of our virtual classrooms. Successful livestreaming of educational activities requires a set of mutually conflicting technical features: high-quality video and audio streams, low bandwidth, and ultralow latency. High-quality video streams are necessary to visualize small details in experimental setups and mathematical notation. This requires the use of professional camcorders with Full HD (1920×1080 pixels) resolution. Students must be able to watch and interact with the livestreams from their homes, often with limited or shared bandwidth. The solution is to compress the video stream. However, if one does not want to compromise on video quality, video compression takes time and results in latency, which complicates interaction between students and instructors. We also found that the trade-off between quality, bandwidth, and latency depends strongly on lighting conditions.

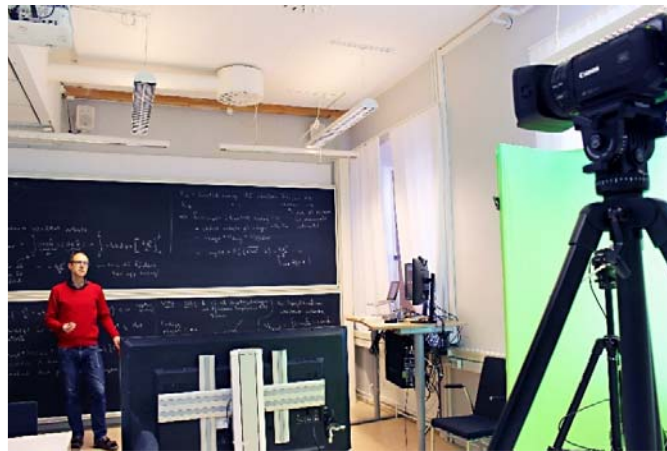


Fig. 1. Photograph of the teaching studio. Courtesy of Mia Halleröd Palmgren/Chalmers.

Incidentally, we noticed that these challenges are very similar to those experienced by e-sports professionals. Following advice on computer specifications from the community of live streamers, we built special-purpose computers in order to compress Full HD video with sub-second latency. Besides the video compression server, our studios (see Fig. 1) feature a number of different cameras (a high-end camcorder and two webcams), wireless microphones, and a suite of live-streaming software, e.g., Open Broadcaster Software (OBS) and Zoom. The

camcorder is used to image the screen with high resolution. One of the webcams is mounted on a monitor, which allows to talk with the students from a close-by perspective, and the second webcam is mounted on a tripod, so that it can be moved to show experiments and other demonstrations. A TV screen was added to permit the instructor to see the students and also easily read messages in the chat window of Zoom.



Fig. 2. The webcam in the front films a small conical pendulum; the image can be seen on the TV screen. Using the camera on the tripod, optics experiments can be shown and discussed live with students in a virtual classroom.

As with all new technology, some users may feel frightened by using it. Therefore, we spent a lot of effort to ensure that the studios can be used by instructors with different levels of digital aptitude, both for recording and for livestreaming. In its simplest form, interactive learning activities can simply be run over Zoom, where the instructor toggles between different video sources to switch between images of the blackboard, a close-up of the instructor, or a demonstration (see Fig. 2). The use of broadcasting software (OBS), however, opens up many more new possibilities, e.g., livestreaming to a streaming platform, combining different video signals in one screen—for example showing an experimental setup together with the instructor—or combining a slide show together with the blackboard to discuss a complex graph or figure. We configured OBS with predefined settings and scenes, so that instructors only have to start OBS and switch between scenes to make use of all these possibilities. While in the fall term only a few instructors used broadcasting software, during the spring term the vast majority had transitioned to using it to enhance the quality and interactivity of their classes.

A specific challenge in distance education we have experienced is that our students prefer to interact using the chat box of Zoom. This introduces an additional area of focus for the instructor. To solve this challenge, we use a large TV screen so that questions on the chat are visible from wherever the instructor is standing in the studio. This has brought back a lot of interactivity to our virtual classrooms. We also found out that the chat box has a number of advantages. Students can help each other with minor questions without interrupting the class. We also noticed that students who would not (dare to) speak up during an on-campus class now ask questions by directing their questions only to the instructor, effectively making them anonymous for the other students in the classroom.

Our studios have been adopted by the majority of faculty teaching in the fall and spring terms and are highly appreciated. Our students, who according to the student surveys find the quality of the learning activities in the distance-learning studios much better compared to the makeshift solutions that were used before, are very positive. This was also evidenced by the Golden Chalk award we received from the student association for our work. In general, we observe that adding livestreaming to the toolbox of virtual classrooms provides a number of opportunities: the students get a feeling of belonging to their class, we observe more active engagement, and it helps students who might otherwise postpone watching pre-recorded activities to follow the pace of the course. As a result of this feedback, it has now been decided that what was first considered to be a temporary solution during the pandemic will now become permanent infrastructure. Several other departments at Chalmers have visited our studios to implement similar virtual-classroom solutions. After the pandemic, we expect to continue using the studios for hybrid classrooms to enable students who cannot attend in person to engage with the class, e.g., because of illness or international students whose arrival is delayed because of visa issues.