Lessons Learned from the Total Virtualization of a Forest Curriculum in Spring 2020

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PRE-PRINT

from the Proceedings of the SILVA Network Annual Conference (digital)

Digitalization in Higher Forestry Education – Teaching and Learning Revisited

held at the Department of Forest Sciences,

Technische Universität Dresden

July 7th – 8th, 2021

This publication has been peer-reviewed.
Please cite as: Harald Bugmann, H., et al., 2023: Lessons learned from the total virtualization of a forest curriculum in spring 2020. In: Schmidt, P., Lewark, S. and Weber, N., (Eds.): Digitalization in higher forestry education – teaching and learning revisited. SILVA Publications 18, Dresden.
Pre-publication published online at https:ica-silva.eu/.

Silva NETWORK

SILVA Publications 18, 2023
Editors: P. Schmidt, S. Lewark, N. Weber

LESSONS LEARNED FROM THE TOTAL VIRTUALIZATION OF A FOREST CURRICULUM IN SPRING 2020

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Abstract

Switzerland entered a lockdown related to the Covid-19 pandemic on Friday, 13 March 2020, i.e. after merely four weeks of the spring semester, which starts early in Switzerland. ETH lecturers were mandated by the Rectorate that all teaching could be suspended in the following week, but that it had to be resumed fully and completely virtually starting on Monday, 23 March. No course was to be dropped or replaced by another course. This was a huge unplanned, comprehensive and systematic experiment that allowed us to evaluate the success of virtualizing all practicals and field trips, from the first year of the BSc to the capstone project in the last year of the MSc programme.

We review our experiences and reflect on the "lessons learned" from this exercise, pointing out aspects where virtualizing is neutral or even positive for student learning, as well as those elements where a clear deterioration of the learning experience took place, using four examples of different types of courses that were virtualized. We found that virtualizing field courses works better for advanced students who have some basic knowledge. On the one hand, students who are not familiar with basic concepts often misunderstood the instructions. This forced us to provide extensive individual feedback to the students, which was a considerable burden on the staff. Even though such feedback strongly enhanced the learning experience of students, we remained doubtful how successful this was. On the other hand, in more advanced courses most of the learning goals could be achieved in spite of the 100% virtualization.

We conclude that virtual teaching via settings such as a "flipped classroom" can be useful and advantageous also in non-Covid situations. Yet, with field courses this is more difficult than with lectures even if these are accompanied by (virtual) exercises, and in many instances "hands-on" experience under the direct guidance of scientific personnel (teaching assistants, lecturers) remains simply indispensable.

Keywords: Covid-19; Alternative teaching methods; Virtualization of field courses; ETH Zurich; Forest and Landscape Management.

Introduction

The spring semester starts early at Swiss universities, i.e. around the 20th of February. Thus, in 2020 the fourth week of the semester had elapsed in "presence mode" when on Friday 13 March a lockdown and virtualization of all teaching was decided at ETH Zurich. This came as a large surprise to most lecturers, the vast majority of whom had very limited if any experience with online teaching tools and approaches at that point in time.

The ETH lecturers were informed by the Rectorate that all teaching could be suspended in the following week (16-20 March), but we were mandated that it had to be resumed fully and completely virtually as of Monday, 23 March. No course was to be dropped or replaced by another course, and no credits were to be given to students "for free". Needless to say that this required a major effort on the side of lecturers and teaching assistants. This was a huge unplanned, comprehensive and systematic experiment that constituted a considerable challenge for all ETH lecturers. At the same time, however, it provided the opportunity to evaluate the success of virtualizing not only all classroom lectures, but particularly also all practicals and field trips, from the first year of the BSc to the capstone project in the last year of the MSc programme. The Environmental Science Programme at ETH consists of six semesters of BSc education, followed by a four-semester MSc education that includes a full semester of professional internship and one semester for the MSc thesis. The essential elements of the BSc and MSc programmes are outlined first, as essential background for understanding the four case studies that we will present and discuss (Figure 1).

In the BSc programme, the first four semesters are devoted to basic training in mathematics, chemistry, physics, and biology, with an emphasis on environmental systems. Here, students get a classroom-based introduction to soils (pedosphere), the water cycle (hydrosphere), and climate (atmosphere). Furthermore, electives can be chosen to prepare for one of the five specializations that are offered in the third year of the BSc, one of them being "Forests and Landscapes". These electives cover Botany, Dendrology, or Zoology, for example. Importantly, there are several slots where students get exposed to the subjects of the specializations. One of these opportunities is the "Integrated Practical on Forest Ecosystems" in the 4th semester (Figure 1, inset "IP ForEco"), which thus is important to alert students to the existence of the specialization "Forests and Landscapes".

Students choosing the specialization "Forests and Landscapes" in the third BSc year are exposed to introductory courses in this domain (e.g., Forest Ecology, Silviculture), and in the sixth semester, they have a large practical (two full days per week) named "Forests and Landscapes" that is dedicated to "hands-on" learning of methods and tools. Among others, part of this practical is devoted to forest mensuration, and there are also six full-day field trips to show to students the major forest site types of Switzerland along with their soils.

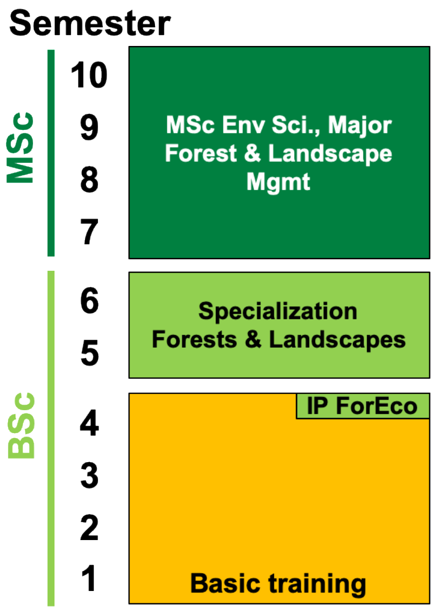


Figure 1: Structure of the Environmental Science Programme of ETH, Major in Forest and Landscape Management. The inset box "IP ForEco" stands for the so-called Integrated Practical on Forest Ecosystems, which represents a number of smaller, but important forest- and landscape related electives that start in the second semester already and serve to alert students to the different specializations that are available in the 3rd year of the BSc programme.

The MSc programme consists of two semesters of classroom and field teaching (excursions), and it ends with the capstone course "Interdisciplinary Project", where students work in groups (typically, 4-5 students per group) on a topic that was nominated by cantonal authorities as an open question for which the authorities are looking for an answer. Hence, this is a real-world learning and problem-solving setting, where interactions with stakeholders are essential. Stakeholders come in two groups in this regard: on the one hand the cantonal authorities themselves, on the other hand people "on the ground" like forest managers, forest owners, or farmers for whom the solution to the problem needs to be acceptable.

The four case studies

Integrated Practical "Forest Ecosystems", fourth semester BSc
In the normal setting, we would take students out into the forest to look at phenomena and conduct a first field sampling, followed by data analysis in the laboratorium. In the following, we only deal with one third of this practical as a case in point, dealing with the rejuvenation (regeneration) phase in the life cycle of a forest stand. The practical is open to a maximum of 25 students who then are split into five groups, each being coached by teaching assistant. Two half days are devoted to data collection in two different forest types (mixed deciduous stand in the immediate vicinity of Zurich, and uneven-aged conifer stand, about 30 km from Zurich, inaccessible by public

transportation). An essential component of this practical is the intensive coaching of the students who have hardly any forest experience, so as to demonstrate and explain concepts, methods and tools, and to watch and correct students as they apply them. How can this possibly work in a virtual setting?

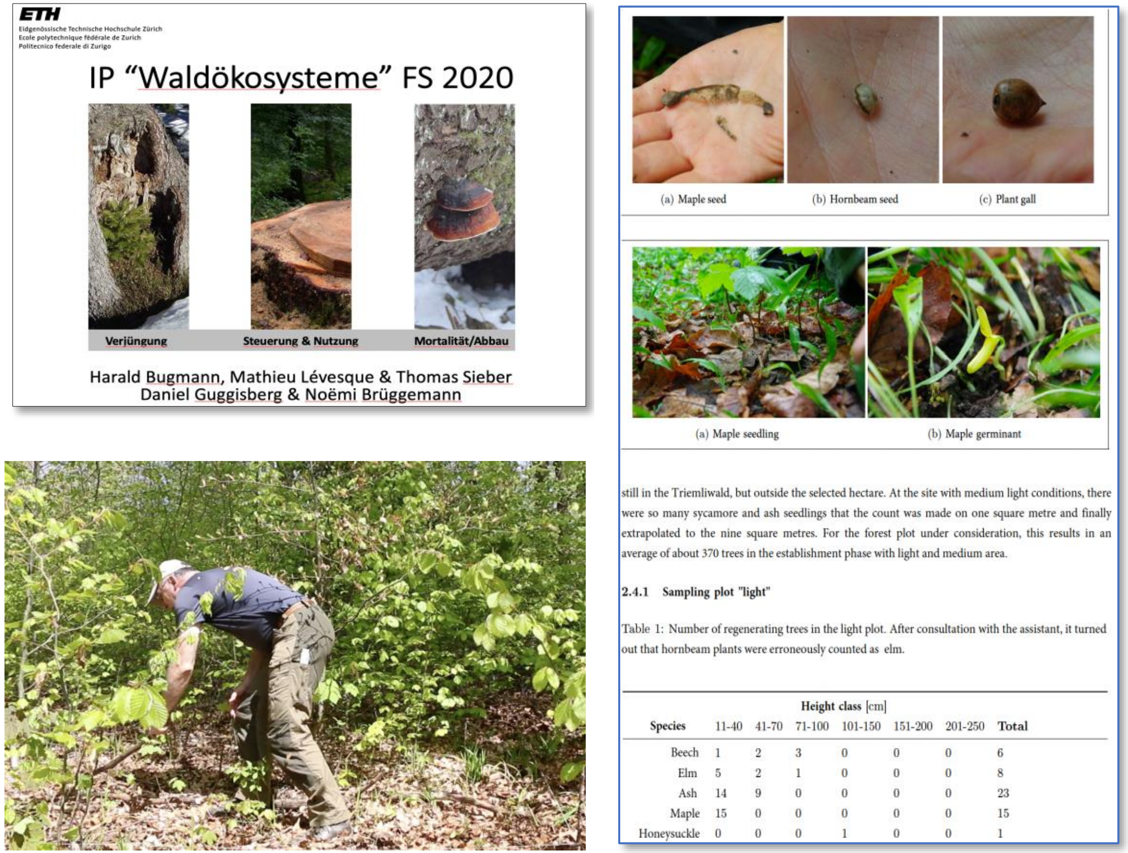
Within a very short time, we re-wrote and expanded the instruction manual that we are normally using, with the idea that this should be as self-explanatory as possible. For basically each and every step of the practical, we prepared videos that showed the students how and what they were supposed to measure (Figure 2) in a forest within walking distance of their house (travelling was forbidden at that time). This included a stand description, the search for tree seeds, germinants and seedlings, and the measurement of the height structure and species composition of the understorey layer (height 10 to 250 cm). Students were required to hand in a report detailing their findings and experience (Figure 2); please note that students were not allowed to work in groups, due to the strict Corona rules.

While many students grasped the essence of the task, many were struggling and thoroughly misunderstood the instructions, although we had offered a cell phone hotline for questions during the time the students were supposed to be out in the forest. Thus, we decided to provide extensive written feedback on the reports, and ultimately we felt that for those students who were facing difficulties, the majority of the learning experience was coming through our feedback, rather than through their primary experience when being out in the forest.

Practical in Forest mensuration, 6th semester BSc

Under normal circumstances, students would learn measuring techniques (e.g., diameter and height measurements, angle count method) during a half day in the forest, again coached in small groups by teaching assistants. In the afternoon, they would then present their data and use them for solving real-world questions related to the role of forests in the global carbon cycle. It is an essential component of this practical that students do things themselves, rather than just theoretically learning how these methods and tools are working.

In the Covid-19 setting, this was nearly impossible, as we were not allowed to hand out tools. Hence, this practical was virtualized in the true sense as we provided an extensive manual that explained not only the mathematical basis of the measurements (e.g., geometrical vs. trigonometrical methods for determining tree height), but also illustrated what these tools are looking like and how they are used, via a mixture of photographs, sketches (Figure 3) and links to online videos (not shown here). For the real-world problem solving, we provided last year’s data to the students, and this part of the practical took place “as usual”, albeit in front of the computer at home rather than in the classroom.



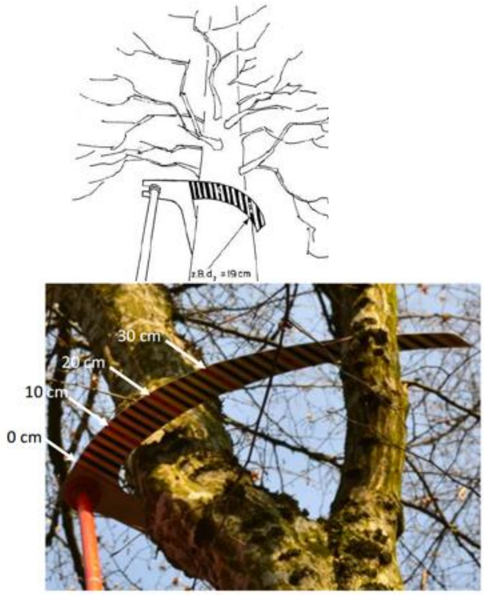
still in the Triemliwald, but outside the selected hectare. At the site with medium light conditions, there were so many sycamore and ash seedlings that the count was made on one square metre and finally extrapolated to the nine square metres. For the forest plot under consideration, this results in an average of about 370 trees in the establishment phase with light and medium area.

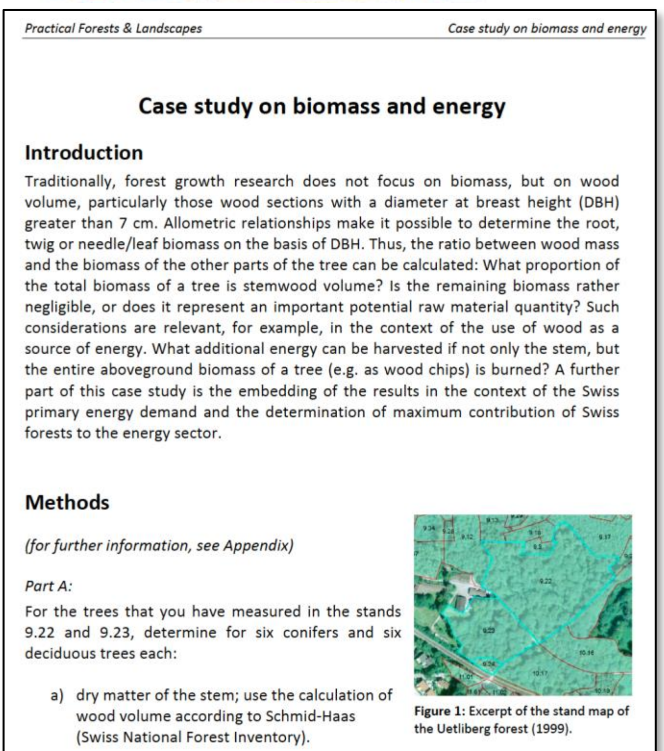
2.4.1 Sampling plot "light"

Table 1: Number of regenerating trees in the light plot. After consultation with the assistant, it turned out that hornbeam plants were erroneously counted as elm.

	Height class [cm]						
Species	11-40	41-70	71-100	101-150	151-200	201-250	**Total**
Beech	1	2	3	0	0	0	6
Elm	5	2	1	0	0	0	8
Ash	14	9	0	0	0	0	23
Maple	15	0	0	0	0	0	15
Honeysuckle	0	0	0	1	0	0	1

Figure 2: Student aids for the 4th semester practical "Forest Ecosystems". Left: Title page of the extensive instruction manual (top) and still of a video explaining to students what to do in the forest (bottom). Right: Excerpt of the report submitted by a student (translated from German to English) to document what (s)he had done. For further explanations, see text.





Practical Forests & Landscapes *Case study on biomass and energy*

Case study on biomass and energy

Introduction

Traditionally, forest growth research does not focus on biomass, but on wood volume, particularly those wood sections with a diameter at breast height (DBH) greater than 7 cm. Allometric relationships make it possible to determine the root, twig or needle/leaf biomass on the basis of DBH. Thus, the ratio between wood mass and the biomass of the other parts of the tree can be calculated: What proportion of the total biomass of a tree is stemwood volume? Is the remaining biomass rather negligible, or does it represent an important potential raw material quantity? Such considerations are relevant, for example, in the context of the use of wood as a source of energy. What additional energy can be harvested if not only the stem, but the entire aboveground biomass of a tree (e.g. as wood chips) is burned? A further part of this case study is the embedding of the results in the context of the Swiss primary energy demand and the determination of maximum contribution of Swiss forests to the energy sector.

Methods

(for further information, see Appendix)

Part A:

For the trees that you have measured in the stands 9.22 and 9.23, determine for six conifers and six deciduous trees each:

a) dry matter of the stem; use the calculation of wood volume according to Schmid-Haas (Swiss National Forest Inventory).

Figure 1: Excerpt of the stand map of the Uetliberg forest (1999).

Figure 3: Virtualization of a practical on forest mensuration in the context of the large 6th semester practical “Forests and Landscapes”. Above: Excerpt of the theoretical instructions regarding the use of the 7 m calliper (“Finnenkluppe”). Under: Instruction manual (translated from German) for the use of forest mensuration data (the data from the previous year’s practical were made available to the students) to solve practical questions based on forest inventory data.

We received rather positive informal feedback from the students on the setup of this virtualized course. However, later in the semester when we were again allowed to go out into the field with the students, they were quite happy to finally get a hand on these tools and be able to use them. In essence, the theoretical part of the practical could be conveyed by self-guided learning and online classroom exercises. However, the hands-on part could not be substituted at all.

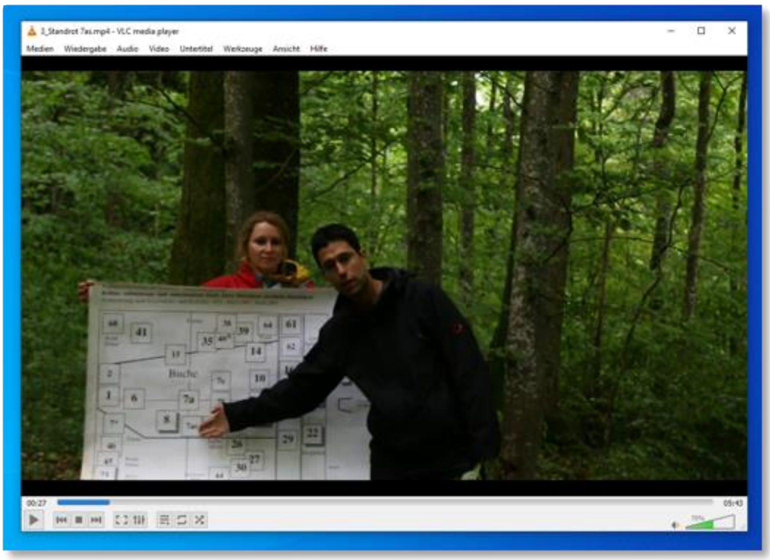


Figure 4: Examples of the virtualization of the six full days of site classification excursions in the context of the 6th semester practical "Forests and Landscapes". Left: frame from a video explaining a site type and its location in the ecogram. Right: Frame from a video where the soil scientist is explaining the details of the soil profile of that site.

Excursions on site classification, sixth semester BSc

Before the Covid-19 lockdown, this part of the practical consisted of a series of six full-day excursions to get acquainted with the major forest site types of Switzerland (from the colline to the subalpine elevational zone), integrating plants and soils. It includes plant identification exercises, the hands-on assessment of soil profiles as well as a site mapping exercise. As a rule, on each excursion day two to three types are visited, yielding an overview of about 15 site types.

In the spring semester 2020, this was substituted (Figure 4) by

- an online “live” introduction for each excursion day, to explain the important aspects of that excursion;
- reading assignments based on a comprehensive excursion guide that existed already and had been developed over the previous years for student use;
- multiple videos for each site type that were filmed specifically by the lecturers and teaching assistants, comprising a general introduction, an overview of the site in the ecogram and the plant species that are typical for this site (indicator species concept), and – last but not least – an assessment of the soil profile; (iv) students had to solve a quiz on each site type; and (v) students did an ‘independent field exercise’ themselves, by going out into a forest adjacent to their home, describing which site types they found, and writing and submitting a report on this trip; on this latter part, every student received comprehensive written feedback.

We found that watching an explanation in the forest can be replaced by watching a video at home. However, seeing, touching and inspecting plants in reality, and particularly having soil material in one’s hand cannot be replaced by seeing these materials in a video. Even more unfortunate, we found that the “do-it-yourself” mapping exercise largely failed because students did not have sufficient background knowledge and could not be coached and corrected while they were executing the task.

Interdisciplinary Project, end of MSc

As mentioned above, this course is problem-based at the interface between science and practice, where students work in small groups. Each group has a coach (teaching assistant), one or several experts (ETH lecturers) in the background, and at least one or two stakeholders with whom intensive interactions take place throughout the project. All this leads to a substantial investment of time (5 credit points ≈ 150 hours of student work, thereof two weeks as a block course in the respective canton (Figure 5). Under regular conditions, this course is characterized by intensive, informal, often spontaneous interactions among the student groups, between students and their respective coach, with the experts who are present for a substantial part of the block course, and of course also with the regional stakeholders.

The Covid-19 pandemic lockdown made all of this obsolete. However, we maintained the structure of the course, while all interactions were conducted via online tools (e.g., Zoom software), including interim presentations as well as the final joint presentation in front of all students, coaches, experts, and stakeholders. The student groups were allowed to do individual field days e.g. for data collection in the forest or for surveys of tourism etc. (as far as tourists were to be found in this particular setting at all).

Surprisingly, this completely artificial setup turned out to work quite well. Obviously, there were fewer interactions among all the parties except for those that were planned and set up online by the students (and sometimes the coaches). However, the overall success of the project work was remarkable. We think that this is due to the fact that at the very end of their BSc/MSc curriculum the students have advanced knowledge of concepts, theories, and field methods, and thus are skilled enough so they can work rather independently and also know when to seek help, rather than to simply get lost (cf. the contrast with the situation in the fourth semester practical "Forest Ecosystems").

Figure 5: The regular setup of the Interdisciplinary Project, the capstone course in the MSc curriculum (here in Klosters, canton of Grisons, in 2019). In contrast to this situation, no spontaneous interactions could take place in the lockdown semester (2020) among students, coaches and experts. All interactions had to be replaced by formal meetings over a dedicated software (e.g., Zoom).

Discussion

It is not a new insight that virtual teaching technologies such as "flipped classrooms" can be useful, highly effective and overall advantageous for a range of settings, also beyond the Covid-10 pandemic. This mostly relates to classroom teaching, however. Therefore, we were much less worried about the replacement of our classroom teaching by online methods, than about the need to do practicals, excursions, and project work exclusively online.

From our experiences (as explained in the four examples presented above, but also in other courses of the Forest and Landscape Management curriculum not reviewed here), we draw a number of conclusions:

- First, the virtualization success of "hands-on" courses such as practicals, full-day field trips and project-related work is directly coupled to the amount of pre-existing knowledge and skills that the students have. Our success was most limited when students had hardly any forest-related basis upon which they could build (4th semester BSc), and this gradually improved with their experience within the curriculum, albeit with variations related to the specific subject (cf. forest mensuration vs. site types, both in the 6th semester). Thus, in case a prioritization is needed, it is clearly more vital to offer "hands-on" teaching to the less experienced students.
- Second, there are distinct advantages of virtual teaching also in the setting of field-related courses. For example, virtualization allows for the repeated work through the materials by the students. This is not possible in a field setting, and if a student hasn't understood something, often (s)he does not dare to ask the question that the explanation be repeated (e.g. in front of a soil profile in the forest), so this is a lost learning opportunity. Furthermore, students who have to miss a class (due to illness or other reasons) can easily be catered for in a virtualized setting, whereas in the case of presence teaching, they require a significant extra effort with regard to substitute assignments, to which we are obliged. Lastly, virtual tools such as conference software can replace some (but not all) of the stakeholder meetings in the Interdisciplinary Project. This avoids the need to travel for each and every meeting, which has benefits for all the involved persons as well as for the environment.
- Third, in spite of all the virtues of virtualization tools and software, the direct exposure to phenomena, methods, and tools in the forest cannot be completely replaced, no matter what the level of experience of the students is. Thus, in many instances "hands-on" experience under the direct guidance of scientific personnel (teaching assistants, lecturers) remains indispensable. However, advanced virtualization tools have allowed us at ETH to manage successfully the lockdown situation in spring 2020, and to offer acceptable learning opportunities to students at all levels of the curriculum.