DIGITALIZATION IN HIGHER FORESTRY EDUCATION –
TEACHING AND LEARNING REVISITED

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PREFACE I

You are reading the proceedings of the Annual Conference of the SILVA Network in 2021 organised by our colleagues from Tharandt, TUD Dresden University of Technology, Germany. It was the first digital meeting of the SILVA Network, done in such way, notwithstanding the great importance the SILVA Network attached to personal contacts between teachers and students during these Annual Conferences. The excursions into the forests as the traditional important means here, could not take place. Covid-19 forced the SILVA Network in that year to abandon both the excursion and the in-person Annual Conference. A digital meeting hosted by Tharandt was the consequence.

The meeting showed a large number of participants. These proceedings are the precipitates of quite a number of presentations. However, only five presentations were offered on paper to the editors for publication. A disappointing number. On the other hand, the editors and the SILVA Network Board estimated the content so important and newsworthy that a publication in the traditional way was pursued. The result is presented here and we wish you inspiring reading.

Our thanks go of course to the authors and to the reviewers Achim Dohrenbush, Gijs Elkhuizen and Gerhard Müller-Starck for reviewing and commenting on the contributions

The Editors
July 2023

PREFACE II
WELCOME BY THE HOST

SILVA Network Annual Conference 2021 was a special one. Instead of personal talks and participant discussions at the respective host university, TU Dresden had to offer a “digital equivalent” due to Covid-19 restrictions. Fortunately, most of us have nearly forgotten the unfavourable framework conditions at that time. However, it seems justified to remember the challenges we had to face in 2021. That is why in the following some parts of the original introduction are cited here:

“Then Covid-19 appeared on the stage as a kind of ‘game changer’. Within a few months, the pandemic rolled up our daily lives – and caused serious harm to societies. The pandemic also changed many of our habits. Amongst many others, it forced something like a landslide from traditional to online (or virtual) teaching and learning. Nearly all of us had to become familiar with online-platforms for teaching and learning, with open book exams, with voting tools and virtual breakout rooms, just to mention a few topics. I think it is fair to mention here that supporting staff both at many universities and universities of applied sciences did an excellent job in guiding us, especially ‘digital immigrants’ (…), and in handling these new challenges.”

Against that background, SILVA Network “Digital” Conference in 2021 offered the opportunity to share experiences in application of online teaching and learning in pandemic times. Amongst others, it provided examples both for transformation of single lectures and complete study programmes into digital curricula.

We are convinced that the described experiences of the contributing authors still have a high value for future discussions on excellent teaching and learning.

Norbert Weber
Spokesman of the Department of Forest Sciences, TUD Dresden University of Technology
President SILVA Network
Juli 2021, August 2023

PREFACE III

A warm welcome from the board of the ICA, the Association of European Life Science Universities to the participants of the 2019 annual conference of the SILVA Network. Thanks to Prof. Norbert Weber and his team for putting together this interesting programme. As you know, ICA is in the process of strengthening its position in Brussels. We plan to establish a secretariat there. We do this because we believe that ICA as the leading Life Science University Network with more than 50 member universities, needs a stronger voice in Europe and in particular in Brussels. This should be beneficial for all our Life Science Universities including the standing committees of ICA such as the SILVA Network.

The Silva Network covers an important topic: forestry and forest education. In the recent years, forests and therefore forest research and forest education have become a even more important role due to climate change. Forests are affected by climate but they also mitigate climate change effects by absorbing large amounts of carbon. Forests are the largest carbon storage pool on land and without forests, we would have a 30% higher CO_2 concentration in the atmosphere. Additionally, forest are increasingly important as renewable resource, for biodiversity as well for providing living space for animals.

The Silva Network Conference 2021 with the topic Digitalization in Higher Forestry education, clearly meets one of the requirements which we need today. Thus, the conference adds an important part to the mission of ICA and again congratulations for putting together this programme. I am looking forward to join one of the next SILVA Network meetings and hope to see you again soon.

Hubert Hasenauer
Vice President ICA
July 2021

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SUMMARY

P. SCHMIDT

This meeting was the first SILVA Network conference online, forced by the circumstances. Covid-19 determined the ongoings in the whole world and forced SILVA-Network to follow the general rules of no direct contact between persons but with a safe distance between persons, hence an online meeting. Moreover, COVID-19 determined the subject: Digitalization of the whole curricula as the only solution to continue education. More or less, the conference commented upon the actual situation. It is a pity but only five presentations were submitted to the editors to be published in the proceedings.

In his keynote "Digitalisation in higher forestry education – from wishful thinking to a normality with further wishes" CLAUS RAINER MICHALEK demonstrated that the forestry programme and related fields of study at the University of Natural Resources and Life Sciences, Vienna (BOKU) already used a number of successful digital teaching scenarios with a desirable sustainable effect, This development started already before the COVID-19 pandemic, but it was clearly reinforced by it. These include online lectures with recording, but also active learning, interaction and participation, as well as practical exercises and virtual field trips. It is shown that some of these transformations could have a lasting effect, such as flipped classroom or hybrid teaching. An outlook into future possibilities offered by immersive learning, virtual reality or augmented reality completes the picture. Despite this great potential of digital teaching, personal contact between teachers and students will continue to be important.

In the next paper "Application of modern information and communication technologies to create a virtual learning environment at the Ukrainian National Forestry University (UNFU)" YAROSLAV SOKOLOVSKYY and three colleagues describe a didactic model, developed by the authors, of Electronic Training Courses (ETCs) and the main approaches to their creation in the Moodle Learning Management System (LMS). This model has been applied during the development of ETCs for blended learning during the introduction of distance learning at UNFU. As a result of applying this model, the authors integrated 80-90% of ETC data into the Moodle LMS by using a package of cloud services "G Suite for Education" by Google.
In addition, an improved hybrid model is proposed that shows the relations of information and communication technologies with which the Virtual Learning Environment (VLE) was created at UNFU. This model improves the coordination of the use of human and material resources in the process of implementing distance learning at UNFU. The developed hybrid model, which is the basis of the VLE at UNFU, was successfully tested during the academic years 2015-2019 at the Department of Information Technologies of UNFU. This model ensured a successful

and rapid transition from face-to-face learning (traditional learning) to distance learning throughout the university at the beginning of the Covid-19 pandemic.
The Technical University of Munich (TUM), School of Life Sciences, was very active in developing the virtual laboratory "Wald Digital" already before the outbreak of the Covid-19 pandemic. According to MARTIN DÖLLERER and twelve colleagues, in their paper "'Wald Digital' - a virtual laboratory for studies in (not only) forest science", Wald Digital was developed in order to enable students in forest science and related fields to study digital twins of a real forest of about 1.5 ha, and its augmented reality. For this, three areas were selected, following these criteria: relevance for students´ education, possibility to incorporate up-to-date research results, and accessibility.

Detailed single tree data are obtained and enriched with third party information such as digital elevation and surface models, digital ortho photos, drone data, and terrestrial laser scanned (TLS) data. Corresponding data are consolidated to a spatio-temporal database that serves as input for models, which are integrated in "Wald Digital": Forest Growth Model, Climate Model, Survival Probability Model, and Disturbance Model. Further models can be included. Supported by a GIS database, students can investigate questions particularly related to forest growth dynamics and extreme biotic or abiotic impacts.

"Wald Digital" can be integrated in study courses of BSc and MSc curricula. Courses at TUM like Bachelorkolloquium, Controlling of Forest Enterprises or Forest Management Planning could benefit from it. In general, "Wald Digital" is open to any student and lecturer at TUM, both in reality with or without the help of augmented reality apps, and virtually: both at home and at the university campus in a computer room. With the evolvement of study programmes in the forest sector environments like "Wald Digital" could gain importance.

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. HARALD BUGMANN and three colleagues inform about direct consequences of this decision for ETH in the next paper "Lessons learned from the total virtualization of a forest curriculum in spring 2020". 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.

Authors review the experiences at ETH 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. They 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 the teaching staff to provide extensive individual feedback to the students, which proved to be a considerable burden on the staff. Even though such feedback strongly enhanced the learning experience of students, authors 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.

The conclusion of the authors is 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.

The leap in forced digitalization in higher education has led many to ponder the consequences over the long term. There is no fully going back to previous methods, because mindsets have changed. In this paper 'Shaping the forced change to online teaching towards a digital future: what are the disadvantages in forestry higher education?' FRANCESCO PIROTTI, TOMMASO ANFODILLO and PAOLA GATTO discuss the effects of the transition of forestry study programmes perceived by students to using more digital tools, and the pros and cons of some possible scenarios for the future. Experiences in two study programmes are analysed, one is the Bachelor programme Forestry and Environmental Technologies (TFA), the other the Master programme in Forestry and Environmental Sciences (SFA), taught at the University of Padua. Students were asked for their experiences and views regarding the novelty of didactic approaches and their opinion on the critical aspects and the future scenarios from the point of view of the learner. Results from the analysis of 248 answers show that technological solutions were on average considered well-performing, but that they were not enough to bridge the gap regarding social interaction and field visits. Various didactical approaches to online teaching are discussed critically.

In his concluding remarks, NORBERT WEBER, President of the SILVA Network, concluded that digitalization of teaching and learning comprises a lot of specific challenges for the involved groups of actors and individuals, i.e. students, lecturers, administrators, developers of software and hardware. Moreover he concluded that , digitalization in higher forestry education is here to stay, even if it cannot replace Haptic experiences and skills ("touch and feel. In a similar vein, universities also have to impart soft skills like communication and networking in direct contact with the students. It is in our responsibility to use digitalization wisely.

KEYNOTE: DIGITALISATION IN HIGHER FORESTRY EDUCATION – FROM WISHFUL THINKING TO A NORMALITY WITH FURTHER WISHES

CLAUS RAINER MICHALEK

Abstract
Using examples from the forestry programme and related fields of study at the University of Natural Resources and Life Sciences, Vienna (BOKU), it is demonstrated that there are a number of successful digital teaching scenarios with a desirable sustainable effect, not only since the COVID-19 pandemic, but reinforced by it. These include online lectures with recording, but also active learning, interaction and participation, as well as practical exercises and virtual field trips. It is shown that some of these transformations could have a lasting effect, such as flipped classroom or hybrid teaching. An outlook into future possibilities offered by immersive learning, virtual reality or augmented reality completes the picture. Despite this great potential of digital teaching, personal contact between teachers and students will continue to be important.

Keywords: digitalisation, higher education, forestry education, teaching, e-learning, blended learning

Introduction

The desire for digitalisation in forestry education has existed for a long time and there were already various approaches before the COVID-19 pandemic, but the pandemic was a real game changer. The fact that everything had to be shifted to online formats overnight, effectively made it a catalyst and a perfect excuse to do things differently or not at all. Teachers and students alike quickly recognised the advantages of solely online teaching, but also its limitations. Out of necessity, the adaptation of already existing but hitherto hardly accepted technologies such as videoconferencing or course recording took place in a very short time. It is to be hoped that they will become permanent features and thus a normality of forestry education, so that the way is open for new wishes, which will start the process all over again.

At this very special moment, a caesura as one might say, this keynote of the conference focuses on two aspects: firstly, the sudden challenges and the solutions that have emerged, and secondly, the transformations that have accompanied them and what might remain of them.

Sudden challenges that demanded quick solutions

Forestry is an important educational focus at the University of Natural Resources and Life Sciences, Vienna (BOKU), and is one of the founding degree programmes, however the COVID-19 pandemic hit it just as fast and hard as the other educational programmes offered. Therefore, forestry education cannot be addressed in isolation, but special consideration has been given to it when selecting examples.

After three semesters, in summer of 2021, some conditions have already become normal that seemed unthinkable before. For example, in a recent information session, one of the teachers stated in reference to the uncertainties of the coming winter term 2021 that the switch from face-to-face to online teaching would be easier than the other way around. This is a remarkable statement from teachers who until recently did almost only face-to-face teaching. A lot has changed in a relatively short time.

What were those sudden challenges? Most of them should be more than familiar to teachers at other universities from their own experience. First of all, the lectures had to be held online, which was fairly easy, assuming of course that a suitable videoconferencing solution was available. As an interesting side show, something that never really got off the ground was revived: the recording of lectures! But, it became more difficult not to lose the students at home, especially in large courses. So how could they be activated and how could interaction and participation take place? Here, too, the teachers relied on existing concepts and adapted them only slightly, such as the concept of flipped classroom, whereby the joint phase of applying what had previously been learned in self-study took place online instead of in the lecture hall. And then it became even more difficult: how can practical things like exercises be implemented remotely, or as virtual excursions? Great creativity was required to offer experiences similar to those in the forest or laboratory and to demand adequate substitute contributions. The important finale were the examinations, which had to fulfil all legal requirements. In summary, it can be stated that in addition to technical assistance, didactic interventions were especially necessary to find answers to these questions!

These didactic interventions on the part of the Division of E-Learning and Didactics comprised the following:

- Didactic course concepts had to be revised, often in the form of individual coaching of the teachers, with a special focus on the constructive alignment, i.e. the alignment of teaching and learning methods as well as forms of examination with the intended learning outcomes (Biggs, 1996).
- Numerous instructions and manuals for teachers were created or updated.
- A networking platform for teachers, the "BOKU E-Learning & Didactics Couch", was realised as a course in the learning management system, which is based on Moodle. In principle, this is an integrated performance support

system (Winslow and Caldwell, 1992) that is available around the clock and provides meaningful information at the moment it is needed.

- A special further training programme for student assistants was created to equip them with a good basis in didactic and technical skills.
- The e-multipliers programme was created as a mobile task force of the Division of E-Learning and Didactics. Like the tutors, they are student employees, but their training is even more extensive so that they can support the lecturers in the implementation of digital teaching concepts, in video production and post-editing, in the implementation of online examinations and in proctoring.
- The existing teacher training programme has been adapted and expanded and specialised training units for individual disciplines were developed.

Examples of successful teaching scenarios with a desirable lasting effect

In the following, a few courses, the didactic considerations regarding these and implementations are presented.

Online lectures with or without recording
The simple transformation of classic one-way lectures was primarily a technical challenge: the necessary hardware such as camera and headset were mostly available or could be obtained at short notice, the software in the form of the web-based open-source video conferencing solution BigBlueButton (BigBlueButton Developers, 2021) has already been integrated into the learning platform for several years; in addition, a campus license for the commercial solution Zoom (Zoom Video Communication, 2021) was acquired. Just delivering PowerPoint slides online with little interaction did not need much change in teaching. Nevertheless, it is positive that the number of lecture recordings has increased as a result. For more than ten years, BOKU has been providing full-service lecture recording for teachers. But it wasn't until the pandemic and videoconferencing it enforced, that it became more popular among teachers. What is interesting is that a change has taken place: It used to be offered by the institution, now either the teachers do it themselves or the students make unauthorized recordings, for example with the open source software OBS Studio (OBS Studio Contributors, 2021). There are still pitfalls, e.g. in relation to copyright, and Open Educational Resources are considered a solution to this.

Active learning, interaction and participation
To consolidate knowledge, students must be encouraged to apply what they have learned directly, preferably in practical contexts. Teachers need to provide space for reflection (Entner *et al.*, 2021). In synchronous environments, audience response systems are being used online in a way similar to how they have been applied in the auditorium in the past. Even easier than in the lecture hall, students can be divided into groups in breakout sessions so that they can discuss what they have learned. In

asynchronous settings, other methods were adopted, such as adding self-tests to the theory units or combining the revision questions with short videos.

Gamification elements, such as challenges, can offer additional potential, but have not yet been used much. For example, time-limited tasks may offer extra points and thus additional incentives to actively engage with the material. As an alternative to extra points, teachers have been awarding students virtual badges for special achievements for some time now, which are displayed directly in the learning platform for a certain period of time.

The flipped classroom method, which has also been practiced for many years and in which the content is no longer presented in class, but is prepared by the students at home and the time spent together is used for discussion, also received a digital transformation. For example, in the course “Dendrology” there is a voluntary introductory unit via video-conference. Students work through the content on their own using short videos of 10 minutes and then have to complete a quiz to unlock the next video. This is supplemented by online question and answer sessions every one or two weeks.

Practical exercises and virtual field trips

Practical exercises are probably the most difficult to do purely online. In the example "Forest Biometrics I", this is still relatively easy, because the lecture with exercises takes place on the computer with the statistical software R. The teacher's screen is shared and recorded in the video conference. Quizzes are used as homework, with the exercise information for the individual students randomly selected from a pool of questions and therefore different. However, the associated exercise took place quite conventionally in the teaching forest under safety precautions in both, 2020 and 2021.

Interactive courses are also not new, but have always involved a great deal of technical effort and time. With so-called authoring software, such as iSpring Suite or Storyline 360, interactive, complex quiz scenarios can be developed based on Microsoft PowerPoint slides (iSpring Solutions, 2022; Articulate, 2022; Microsoft, 2022). These can then be integrated into the Moodle learning management system with the help of the e-learning exchange format SCORM, which stands for Shareable Content Object Reference Model (Moodle Community, 2022). Such interactive slideshows are used, e.g., in the Master programme "Environmental Sciences – Soil, Water, Biodiversity (ENVEURO)". In the course "Soil and terroir in viticulture and oenology", students are guided step by step through the soil water balance test and receive immediate feedback and not just at the very end.

There are some good implementations of virtual excursions at BOKU, such as the course "Soil science and geology". The excursion lasts about as long as the face-to-face course. All participants take part at the same time, but access it from different locations. There is a common start and end via the video-conferencing platform Zoom, but in between the seven excursion sites can be visited at the students' own pace. Each site is presented in a short film of about 20 minutes. A course in the learning management system Moodle serves as the platform, which links to the video sessions, provides the clips and in which the discussions take place in the forums.

Another example comes from the field of agriculture, but can easily be transferred to forestry education. Whereas in the previous case the videos were provided by the teachers, in the course “Organic farming excursion” they are produced by the students themselves. Since a joint excursion was not possible, the students visited different farms on their own and documented their interviews with the farmers on video. On the one hand, the aim was to present as many agricultural enterprises as possible; on the other hand, it was a declared goal of the teachers to explore the potential of video documentation. For this purpose, an interview guide had to be prepared beforehand. Again, the videos were made available to the other students in an e-learning course.

Online examinations

Very early in the pandemic, the Dean of Studies issued regulations regarding electronic examinations so that they would be legally secure. However, in a few cases there were appeals and some exams had to be cancelled and repeated. Online exams are technically complex and there are some pitfalls to avoid. That's why the Division of E-Learning and Didactics also provided teachers with a manual at a very early stage. In addition, many hours of individual coaching were offered by this unit, especially in didactic matters. Teachers were informed by the Rectorate of some possibilities: Assignments, oral or written online exams, open-book tests, but also portfolios, posters, essays, learning diaries, forum and blog posts. In open-book exams, sometimes also called open-note exams, students can use books and notes, but time is the limiting factor. The questions are also set in such a way that students must not only reproduce the knowledge, but also apply it. Teachers are free to choose but must announce the method to the students in advance. The proctoring of students to prevent them from using unauthorized aids is done by specially trained staff, the e-multipliers, and not by proctoring software. The reasons for this were data protection concerns, technical immaturity of the products and the very high licensing costs.

Transformations with lasting impact

What will remain of these changes?

Students' expectations have certainly changed: it is almost taken for granted that for every course there is an accompanying e-learning course in the learning management system that at least provides the necessary materials. If possible, this should also offer all other amenities such as links to live streaming and recordings of past events. This expectation increases the pressure on lecturers. In general, however, most teachers are in favour of a good blend of face-to-face and online elements, to varying degrees.

According to a study by Berghoff *et al.* (2021) only 18 % of teachers in Germany would like to see a return to pure frontal teaching, but it has its justification and will remain. Furthermore, only 2 % prefer pure online teaching. The majority favours face-to-face enriched with online elements, blended learning (i.e. flipped classroom) and hybrid teaching.

And what happens next?
Flipped Classroom was not a new method, but will remain. It allows to use the valuable classroom time more meaningfully.

In the terms, when the vaccination rate will be already well advanced but not all students and or teachers can be back on campus yet, hybrid teaching could be a solution. It is a mixture of distance learning and on-campus activities. However, lecturers are quickly overburdened when they have to simultaneously teach in the lecture hall, broadcast the unit via video conference, solve technical problems and also answer questions from the audience on site and at a distance.

HyFlex is even a step up! All teaching units are offered in three formats: 1. as a face-to-face course, 2. synchronously online and 3. asynchronously online, e.g. as a recording. All three forms should be equivalent and students should be able to achieve the learning outcomes with them. This is didactically and technically very demanding!

Until now, online teaching has also been a grey area as it is not clearly regulated how the virtually delivered teaching performance is assessed as fulfilled. The old model, which counts pure attendance time in the lecture hall in the form of weekly hours, does not go far enough here.

What are still unresolved problems from the pre-pandemic period?

The pandemic did not accelerate the use and especially the production of Open Educational Resources. There are still a few loose ends to tie up and at least in Austria there are efforts on a national level. Teachers have been aware of the problem of copyright infringement for many years, but the step of creating their own materials, sharing them with others and using others to do so is still too large. The approach at BOKU is now to create the materials together with the teachers instead of taking away their materials. For this purpose, student assistants are provided by the university management supervised by the Division of E-Learning and Didactics.

In Austria, the University Act was reformed in 2021. The amendments improved for example, the legal situation for online examinations (Hochschulgesetz 2005 § 42b, Universitätsgesetz 2002 § 76a). The Web Accessibility Act (Web-Zugänglichkeits-Gesetz 2019), which in turn implements an EU directive (Directive 2016/2102), has been in force since 2019 but somewhat delayed by transition periods. This requires public bodies to make their websites, but also mobile applications, barrier-free and thus make them more accessible, especially for people with disabilities. In general, however, improvements in accessibility are beneficial to all users.

Another current topic is how students can be accompanied in their learning process in the best possible way, and a great hope is that the many student data can be evaluated, interpreted and the results made available to them. In addition to the positive aspects, this exciting topic of learning analytics naturally also brings with it some limitations such as data protection and security.

Students need personalised feedback for their learning success and want individual support and learning recommendations. A technical solution could be chatbots as a support system, i.e. a software that talks to students text-based and gives answers while behaving like a human being. The principle has been around for a very long time and depends heavily on the training of the software.

Are there any further wishes?
In order to make the digital learning experience even more intensive and effective, there are numerous approaches such as immersive learning, virtual reality or augmented reality, the latter is already being tested at BOKU in a course with the software Areeka Studio (Amlogy GmbH, 2022). Students move through the three-dimensional world by means of avatars that can be personalised by an uploaded photo or the shared video camera. Communication with others takes place via chat or microphone. The rooms are furnished differently for the respective intended use, as shown in Figure 1. For example, there is a large lecture hall, several smaller study rooms, a library, but also a student café or a chill-out room to listen to music together and have a virtual party. The first evaluations of this use of augmented reality with students are encouraging. In the next stage of expansion, virtual reality headsets will be used.

Figure 1: Students interacting with each other in a space created with Areeka Studio.

Conclusions

Even though the last few semesters have impressively demonstrated that large parts of university teaching can also be realized digitally, it has also become clear that face-to-face teaching continues to have great strengths and is therefore justified. It is anticipated that students and teaching staff alike will continue to seek personal contact, although the value of this jointly invested time will be better and more efficiently spent (Entner *et al.*, 2021; Berghoff *et al.* 2021). Although not all thinkable wishes could be fulfilled so far, we are much closer to a normality of digital teaching today than we were a few years ago.

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APPLICATION OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES TO CREATE A VIRTUAL LEARNING ENVIRONMENT AT THE UKRAINIAN NATIONAL FORESTRY UNIVERSITY

YAROSLAV SOKOLOVSKYY, VASYL LAVNYY, OLEKSANDR STOROZHUK, OLEKSIY SINKEVYCH

Abstract

This paper describes a didactic model, developed by the authors, of Electronic Training Courses (ETCs) and the main approaches to their creation in the Moodle Learning Management System (LMS). This model has been applied during the development of ETCs for blended learning during the introduction of distance learning at the Ukrainian National Forestry University (UNFU). As a result of applying this model, we integrated 80-90% of ETC data into the Moodle LMS by using a package of cloud services "G Suite for Education" by Google.

In addition, an improved hybrid model is proposed that shows the relations of information and communication technologies with which the Virtual Learning Environment (VLE) was created at UNFU. This model improves the coordination of the use of human and material resources in the process of implementing distance learning at UNFU. The developed hybrid model, which is the basis of the VLE at UNFU, was successfully tested during the academic years 2015-2019 at the Department of Information Technologies of UNFU. This model ensured a successful and rapid transition from face-to-face learning (traditional learning) to distance learning throughout the university at the beginning of the Covid-19 pandemic.

Keywords: Distance Learning, Didactic model of ETCs, Electronic Training Courses, Moodle LMS.

Introduction

Electronic Training Courses (ETCs) belong to the main components of information and communication technologies. They use technologies providing an opportunity to implement the process of individual and group distance learning in educational institutions. These technologies should be used not only in distance learning as a specific form of learning, but also for the organization of the learning process in any other form of learning. The combination of traditional learning with distance learning technologies creates a new type of learning, namely, the "Blended Learning System" (Bonk and Graham, 2006). The Covid-19 pandemic, starting in 2020, has provoked the transition of programmes of educational institutions around the world from face-to-face to distance learning and further use of a mixed form of education as the quarantine measures will get relaxed.

The lack of standards in Ukraine regulating the creation of ETCs means that each educational institution is supposed to develop its own regulations and guidelines (Fedasyuk, 2013). As a result, educational communications between higher education institutions of Ukraine and the exchange of ETCs has become more complicated. Under these conditions, it is important to standardize ETCs within universities from the first stage of the distance learning implementation.

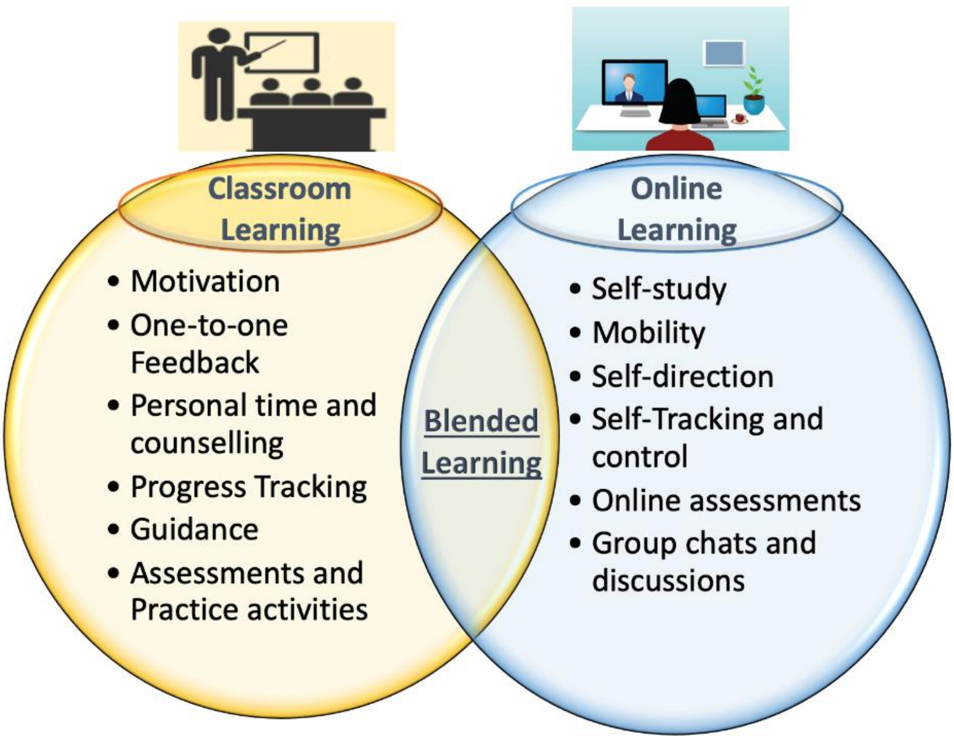


Figure 1. A new type of learning – the "Blended Learning System". (from Blended Learning, 2022).

ETCs have long been major components of modern information and communication technologies. Such ETCs allow teachers to use modern technologies in the implementation of the process of individual and group distance learning in higher education. It is clear that such technologies can be used to organize the learning process in any other form of learning and not only in distance learning. In turn, to create a "Blended Learning System" (Figure 1) it is necessary to combine traditional and distance learning technologies (Blended Learning, 2022). In 2010, the process of transition from traditional learning to blended learning was initiated at the Department of Information Technologies of the Ukrainian National Forestry University (UNFU). At the initial stage, three teachers of this department took part in this experiment. In

2012, the number of teachers who took part increased significantly. This was directly related to UNFU getting a subscription to the package of cloud services "Google Apps for Education" (currently "G Suite for Education") from Google Inc. In general, blended learning brings fundamental changes to the education system by combining digital technologies and active learning methods, which in turn significantly improves the entire learning process.

Approaches to the implementation of distance learning

The system of distance learning at UNFU at the beginning was implemented based on a hybrid service model that is shown in Figure 2. This model was chosen as a basis of the Virtual Learning Environment (VLE) of the Department of Information Technology.

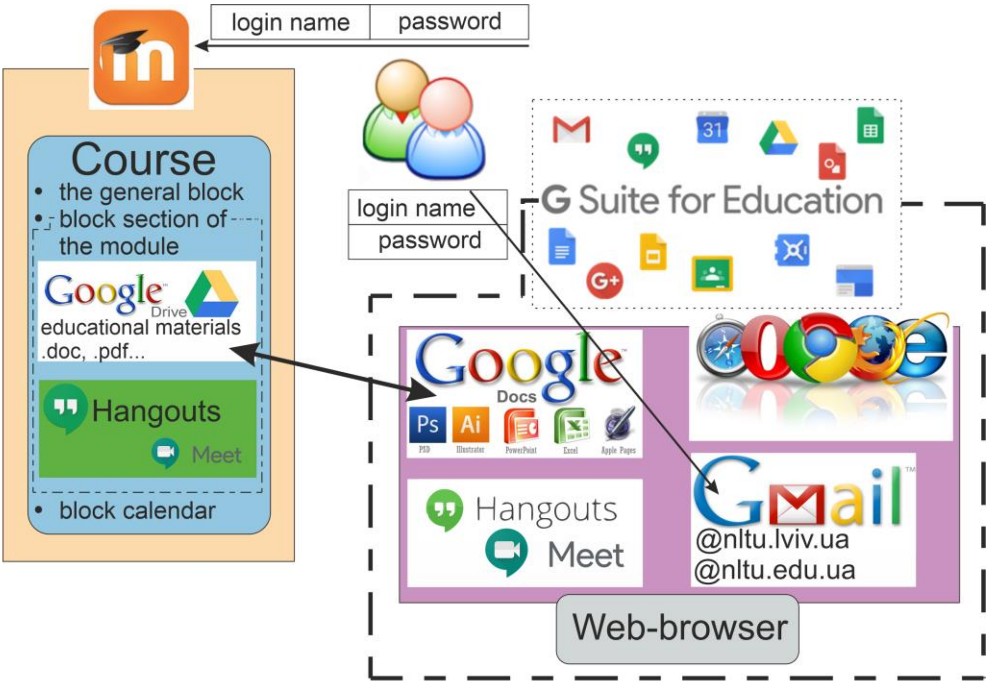


Figure 2. The initial version of hybrid model of communications in the cloud environment developed by the authors and tested at the Department of Information Technologies of UNFU (from Sokolovskyy et al., 2015a).

The proposed hybrid model allows us to use information technologies in the learning process in any form. To use Google Apps services, students and teachers get an e-mail address, which is both an account for all Google services and the VLE of UNFU. E-mail addresses for students are grouped, which makes it easier to communicate with them, for instance to send an e-mail to all students, to invite them for a meeting or to send educational material to all.

After completing the authorization procedure, the student gets access to the courses taught to him in the current semester. To support the standardization of ETCs, it was decided to make a structure of a typical course which includes:

- General block, which is formed from:
    - News;
    - Information about teachers;
    - Work programme of the course;
    - List of control questions;
    - Other.
- Module section block (a complete block of information that comprises a complex didactic goal) that contains:
    - The name of the module;
    - Information resources of the module;
    - Lecture materials;
    - Instructions for laboratory or practical works;
    - Other.
- Calendar block which displays events relating dates and times, including:
    - Course consultations;
    - Conducting tests;
    - Control measures;
    - Other.

The “Module Section Block” is a constituent part of an ETC. Educational materials in an ETC for the student are displayed as HTML (Hyper Text Markup Language) links; by default HTML links are displayed as underlined blue text. These HTML links open educational materials located on Google Drive. Google Drive provides a view of the educational materials without the need to install special software on laptops, mobile phones and other electronic devices used by students and teachers to work with the ETC.

In order to gain access to educational materials, a student must go through a two-stage authorization procedure. At the first stage, the student needs to enter a password, and at the second stage, the student needs to confirm his login in the form of a notification that comes to his phone from Google. This approach significantly increases content security. Since the content is accessed and stored using Google cloud services, it helps reduce the load on the server hosting Moodle. The Hangouts service allows us to conduct classes in video conference or webinar mode.

Didactic model of distance learning structure

The lack of standards in Ukraine regulating the creation of ETCs leads to the development of own regulations of each educational institution. As a result, cooperation between higher education institutions of Ukraine and the exchange of ETCs is complicated. In addition, the structure of a standard course, taking into account the requirements for information security and protection of intellectual property, structure and data format of ETCs, was synthesized by using a didactic model that is shown in Figure 3. With this model, 90% of an ETC is integrated into Moodle by using the G Suite for Education cloud service package, including Google Drive, Google Docs and Google Hangouts. To perform tests, it is necessary that the test questions must be stored in the question bank, which is an integral part of the ETC and is located on the server where the Moodle LMS is located.

To sum up: 90% of the educational material of the ETCs is hosted in Google cloud services, and 10% on the server where the Moodle LMS is hosted. This approach provides the possibility of data exchange between different platforms to support distance learning, such as Moodle, ATutor, ILIAS, Claroline, Dokeos and others. As mentioned earlier, another advantage is viewing of educational materials (including on smartphones) without special software. For example: Google Drive cloud service supports more than 40 popular file formats, including videos, images, Microsoft Office documents and PDF. It allows us to look at educational materials located on Google Drive directly in a web browser. It is worth noting that to use all the features, Google recommends using the Chrome web browser, but this is only a recommendation.

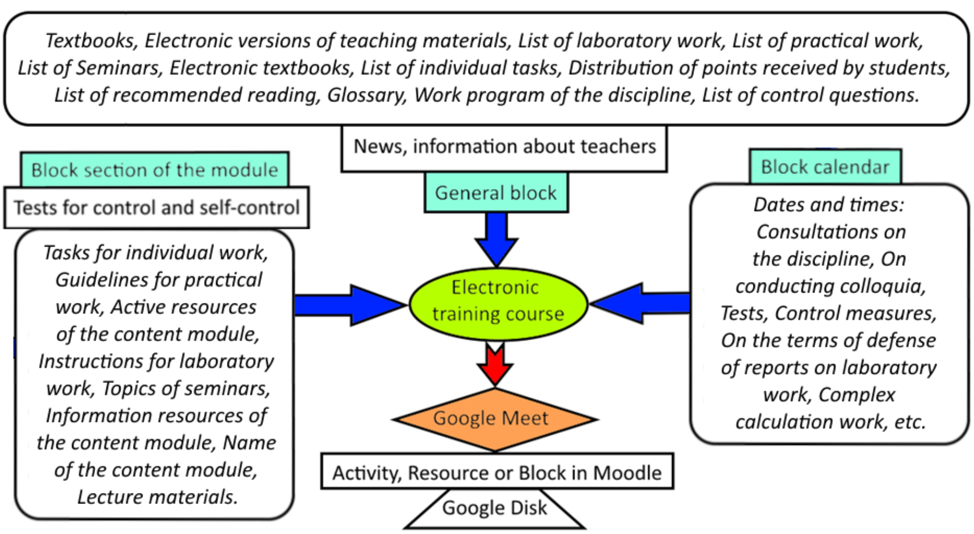


Figure 3. The didactic model of ETCs as developed by the authors and applied at the Department of Information Technologies of UNFU.

After getting a free subscription to the specialized cloud software package G Suite for Education by Google in 2012, UNFU got the opportunity to create shared access to content hosted on Google servers only for users of the @nltu.lviv.ua and @nltu.edu.ua domains. Mailboxes for students are issued for the period of study and have the domain @nltu.lviv.ua, and for teachers the domain is @nltu.edu.ua. Worth noting is that all mailboxes are hosted by Google.

It is recommended to give access rights to educational materials on Google Drive: only for users of the @nltu.lviv.ua and @nltu.edu.ua domains. This approach increases security, because when the link is opened by a third party (in case it becomes known illegally), the authentication system of Google services will ask to enter the e-mail name and password. Using Google Drive also reduces the server load because the content is accessed and stored using G Suite for Education cloud services.

Using the WORKSECTION project management service

In Figure 4 we can see a hybrid model that shows the relationships of information and communication technologies in the distance learning process. In this model, we use the project management system Worksection (https://worksection.com) for coordinating the use of human and material resources (Sokolovskyy et al., 2015b).

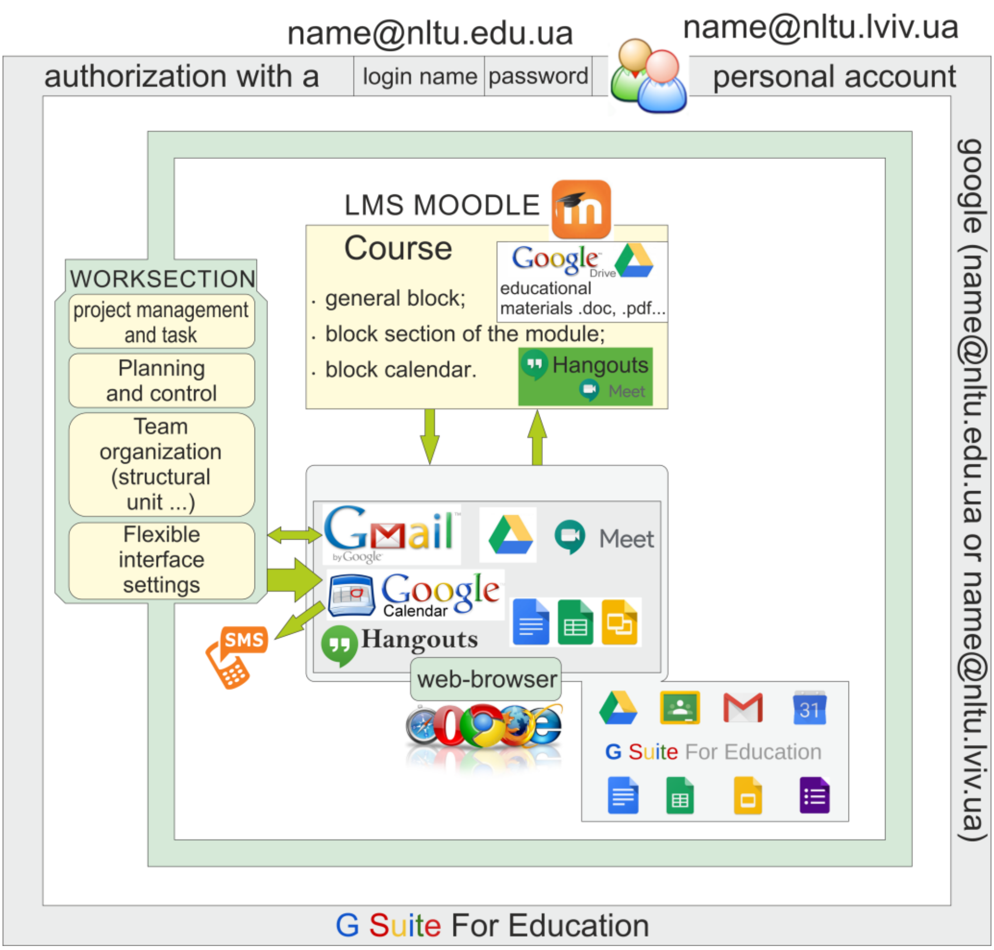


Figure 4. The improved hybrid model developed by the authors, which shows the relationships between information and communication technologies, which are the basis of the created VLE of UNFU.

The proposed hybrid model allows us to use information technologies in the learning process in any form of learning. The authors developed an initial (Figure 2) and this improved (Figure 4) hybrid model, which was successfully tested at the Department of Information Technologies of UNFU. In addition, this model was also tested at the Center for Distance Learning of UNFU and proposed for use during the implementation of distance learning in our university.

Employees of different structural units of the university work part-time, so they also used the Worksection project management service. This service provided fast communication between employees and clear structure of tasks to control all stages of their implementation. As part of the Worksection system, a mobile version for smartphones was developed, based on iOS (mobile operating system from Apple) and Android operation systems. In addition, the Worksection system has an adaptive design that allows us to use it with a regular browser on a smartphone or tablet. Another convenience of the system is duplication of all tasks by e-mail. After creating a task, the responsible employee assigned get an e-mail with a description and deadline for its completion. The list of tasks can be viewed both in the Worksection system itself and in personal e-mail.

At the Department of Information Technologies of UNFU, this system is used in the process of preparing for distance learning in various specialties and forms of education. In Worksection, the basis of any project is a task, which in turn can have subtasks (Moodle, 2022a). This is a step-by-step approach to the goal, because after setting new tasks, we can always analyze already completed ones. Worksection allows us to organize and manage resources in order to successfully achieve goals and complete project tasks. Also, project participants communicate through tasks. For example: A subject specific ETC is to be developed. In the Worksection, a project called "Item development" is created. Teachers who will develop the ETC from this subject are determined. Their accounts are connected to the created project in Worksection. Tasks are created in the project, their description, deadlines are entered, and responsible persons are appointed. All further communication between performers is provided by the Worksection system. In the same way we can create a project for writing a diploma thesis by a student. A student and his graduate supervisor are involved in such a project.

Features of creating curricula

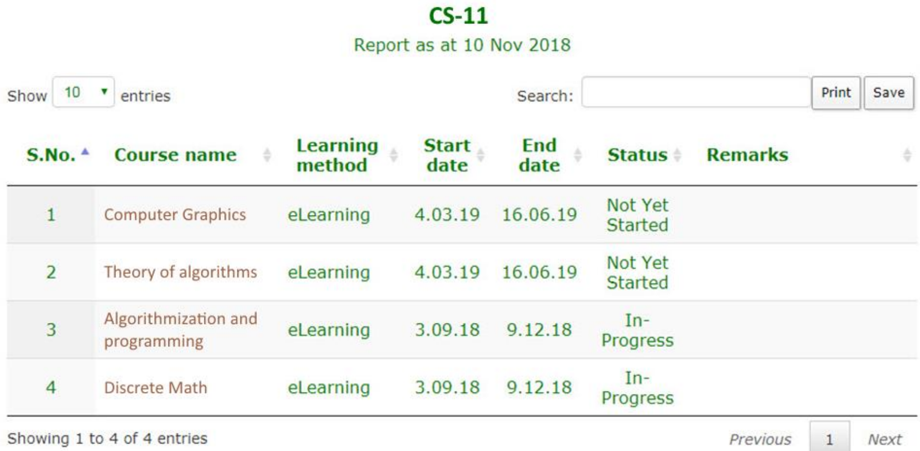
One of the main advantages of the Moodle LMS is the possibility to modify it for specific needs. As a rule, this is done with the help of special additions – plugins. These plugins help us change the design and extend the functionality of Moodle. Plugins are developed by members of the Moodle community.

In this project, we also proposed to use the plugins "Learning Plan" and "Subcourse" to create curricula in the VLE of UNFU. This environment is based on a hybrid model showing the integration of Moodle version 3 with the Google G Suite for Education and the Worksection cloud services package.

The "Learning plans" functionality has appeared in the basic configuration of the Moodle system since version 3.1. "Learning plans" allow us to create curriculum templates based on a system of competencies assigned to a group of students. The students see in their curriculum the related competencies and the progress in their study. Accordingly, each course should have a set of initial competencies.

Currently, the educational and professional programme lists the mandatory competencies of the graduate. Upon successful completion of the course, the student gets a single final grade that doesn`t reflect the percentage of successful study of individual competencies acquired as a result. The final grade for the course reflects the totality of competencies acquired by the student.

To create educational plans, it is advisable to use the module "Sub-course" (Moodle, 2022b). This module implements a very simple and useful functionality. With this module it is possible to add sub-courses to the course as included activities. The final grades that the student will get in the sub-courses will be reflected in the base course, called the target course. It allows us to divide courses into separate blocks or to create a more complex course structure. So, this module allows us to form the final tables of success and calculate the ratings of students in all courses of the curriculum. We also can use the "Learning plan" to create curricula. It is designed for Moodle versions 2 and 3. This plugin allows us to create the curriculum of an ETC and displays data on the terms and methods of studying each course, according to Figure 5. This module also allows us to form curricula for groups of students with a certain list of courses and the terms of their study.



CS-11

Report as at 10 Nov 2018

Show 10 entries Search: Print Save

S.No.	Course name	Learning method	Start date	End date	Status	Remarks
1	Computer Graphics	eLearning	4.03.19	16.06.19	Not Yet Started	
2	Theory of algorithms	eLearning	4.03.19	16.06.19	Not Yet Started	
3	Algorithmization and programming	eLearning	3.09.18	9.12.18	In-Progress	
4	Discrete Math	eLearning	3.09.18	9.12.18	In-Progress	

Showing 1 to 4 of 4 entries Previous 1 Next

Figure 5. Example of student's personal page of the "Learning plan" plugin.

Organization of individual student work

Specified in the work programme of the course, in traditional education the assumed ratio of the number of hours in classroom to individual work is about 1 to 1. This ratio is determined taking into account the specifics and the content of a particular course, its place and importance for the training of specialists. In total, we have the following possible types of independent and individual work of students:

- Practical and laboratory work;
- Research work;
- Internship at an enterprise.

The application of the proposed didactic model as shown in Figure 6 improves the teacher's control over the independent and individual work of students.

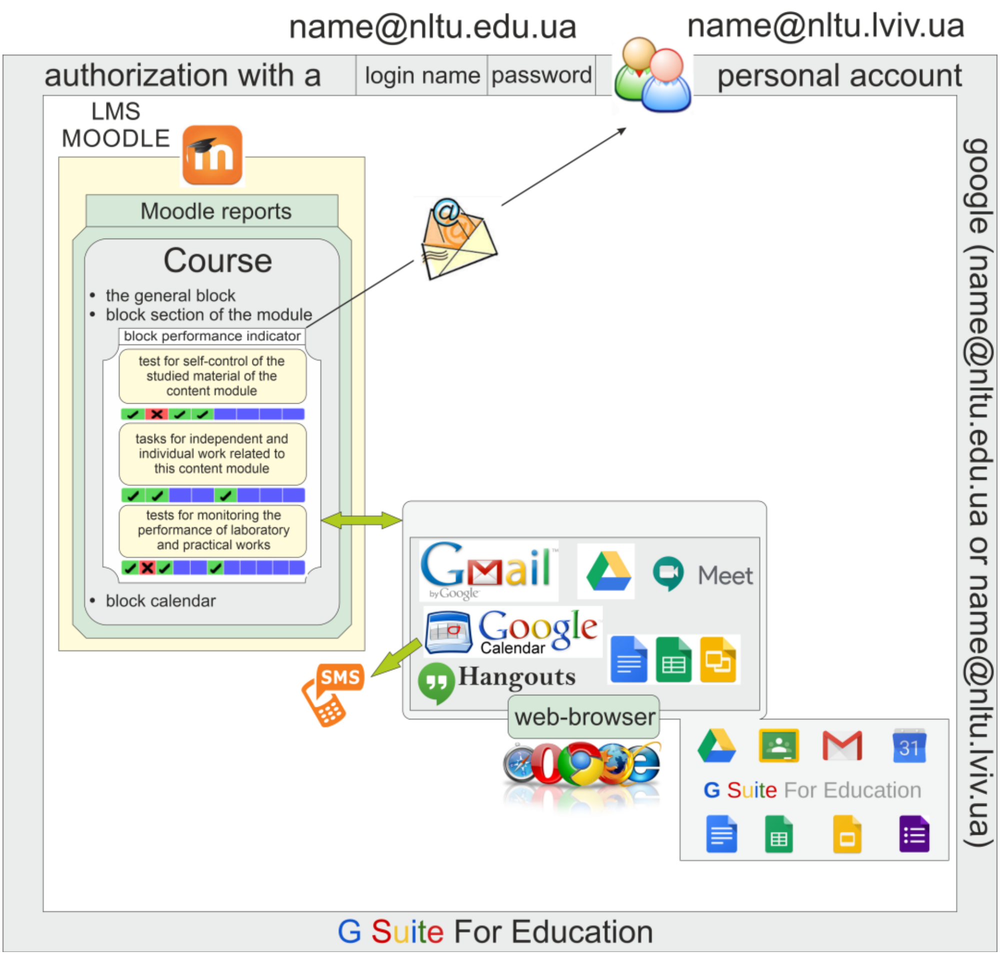


Figure 6. A didactic model that shows the relationships in the process of independent and individual work of students.

The application of the proposed didactic model is based on the block "Progress Bar" displayed on the main ETC page. This block displays a linear scale divided into rectangles. One rectangle corresponds to one task. If the task is completed on time, the rectangle turns green. A red rectangle signals to the student that the task deadline is over. If the student selects the rectangle with the mouse, he will get a description of the task. By clicking on the rectangle, the student will go to the task. The "Progress Bar" block contributes to knowledge about the progress in the study of the course. This block allows the teacher to quickly assess the course learning progress of an individual student.

In this block, teachers provide the student with a list of specific tasks for self-study, which are expected to be performed, according to the course work programme. The "Progress Bar" block is not available in the standard version of Moodle version 2.9, so it must be installed. This is important because the developers of this module have provided the possibility to view a list of students with a linear scale of their independent work progress.

One of the convenient functions in this module is that both group and individual messages can be sent by e-mail. To do this, we must select the checkbox of the relevant students and enter the text of the message before sending. By using this function, the teacher can review the maps of independent work, and have the opportunity to timely inform students about the planned deadlines. Moving the cursor, teacher or student can view additional information related to a specific task.

Conclusions

In this paper, the didactic model of the ETCs, as developed by the authors, and the main approaches to its creation in the Moodle LMS are described. This model used during the development of ETCs of blended learning and during the introduction of distance learning at UNFU. As a result of applying this model, we integrated 80-90% of ETC data into the Moodle LMS by using a package of cloud services “G Suite for Education”. This didactic model of ETCs was successfully tested at the Department of Information Technologies of UNFU.

The lack of standards in Ukraine regulating the creation of ETC means that each educational institution is supposed to develop its own regulations and guidelines. As a result, educational communications between higher education institutions of Ukraine and the exchange of ETCs has become more complicated. Under these conditions, it is important to standardize ETCs within universities from the first stage of the distance learning implementation.

In addition, a hybrid model of communications in a cloud environment, see Figure 2, has been developed. After testing and identifying its shortcomings, this model was improved. Figure 4 shows the improved hybrid model, which shows the relations between information and communication technologies that are the basis of the created

VLE of UNFU. This model improves the coordination of the use of personnel and material resources in the process of implementing distance learning at UNFU. This model ensured a successful and quick transition from face-to-face to distance learning across the university at the beginning of the Covid-19 pandemic.

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"WALD DIGITAL" - A VIRTUAL LABORATORY FOR STUDIES IN (NOT ONLY) FOREST SCIENCE

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Abstract
At the Technical University of Munich (TUM), School of Life Sciences, the virtual lab "Wald Digital" (Döllerer, 2021) was developed in order to enable students in forest science and related fields to study digital twins of a real forest of about 1.5 ha, and its augmented reality. Three areas were selected, following these criteria: relevance for student´s education, possibility to incorporate up-to-date research results, and accessibility.

Detailed single tree data are obtained and enriched with third party information such as digital elevation and surface models, digital ortho photos, drone data, and terrestrial laser scanned (TLS) data. Corresponding data are consolidated to a spatio-temporal database that serves as input for models, which are integrated in "Wald Digital": Forest Growth Model, Climate Model, Survival Probability Model, and Disturbance Model. Further models can be included. Supported by a GIS database, students can investigate questions particularly related to forest growth dynamics and extreme biotic or abiotic impacts.

"Wald Digital" can be integrated in study courses of BSc and MSc curricula. Courses at TUM like Bachelorkolloquium, Controlling of Forest Enterprises or Forest Management Planning could benefit from it. In general, "Wald Digital" is open to any student and lecturer at TUM, both in reality with or without the help of augmented reality apps, and virtually: both at home and at the university campus in a computer room. With the evolvement of study programmess in the forest sector environments like "Wald Digital" could gain importance.

Key words: "Wald Digital", forest plots, digital twins, virtual reality, forest curricula, life science, Technische Universität München, Germany.

Introduction

The most exciting lab for any forest scientist is, of course, the forest itself. Furthermore, forests are subject of the general interest of natural and environmental sciences, and of broad public attention with respect to ecological, economic and social benefits. “Wald Digital” is a virtual environment that manages digital twins of forest areas, which are relevant to education and research at the TUM School of Life Sciences in Weihenstephan.

“Wald Digital” allows the integration of third-party information such as digital elevation and surface models, digital ortho photos, stereo images, drone data, and terrestrial laser scanned (TLS) data. The resulting database can be integrated in a variety of investigations dealing for instance with forest dynamics in response to climate change and specific extreme events such as storm damage, drought, or biotic calamities. Such data are relevant for various educational purposes such as what-if-analyses and forecasting approaches. They may serve as criteria for forest management decisions, like tree species selection, rotation period optimisation etc. and can be utilized by forest enterprises, e.g. for risk assessment. Generally, the utilisation of augmented reality tools is expected to complete existing information via modelling, digital ortho photos, drone data, or terrestrial laser scan data.

“Wald Digital” allows to conduct what-if-analyses by the integration of simulation models like SILVA 2 (Pretzsch *et al*., 2002), iLand (Seidl *et al*., 2012) or BROOK90 (Federer *et al*. 2003). The implementation of innovative learning concepts via “serious gaming” like examination situations like in the Bachelorkolloquium can be simulated in the digital twin’s virtual landscape is also possible.

The target group of “Wald Digital” are the students in the field of forest sciences at the TUM School of Life Sciences. The major objective of “Wald Digital” is to assist in several study courses on both Bachelor and Master level, e. g. Bachelorkolloquium, Controlling of Forest Enterprises or Forest Management Planning.

“Wald Digital” should also serve as data pool and simulation environment for Bachelor’s or Master’s theses. Outstanding students could even extend “Wald Digital” as topic of their theses.

In general, “Wald Digital” is open not only to students of forest sciences, but also to other students and lecturers at TUM in the field of environmental sciences and beyond.

Material and methods

Experimental sites

Three sites ranging between 0.75 to 1.5 hectares were selected and tree attributes as well as supplemental data (e. g. micro habitats, soil layer) were assessed. These three “Wald Digital” sites are:

- The project site of the Kranzberg ROOF project (later referred to as “KROOF”, see Figure 1, left) which allowed to incorporate up-to-date research results.

- An area in the Kranzberger Forst (later referred to as “KRANZBERG”, see Figure 1, centre) because it is located in cycling-distance from the TUM campus in Freising Weihenstephan.
- An area in the “Stiftungswald” of the University of Munich (later referred to as “UNIWALD”, see Figure 1, right) because of its relevance for education as exams are held regularly in that forest.

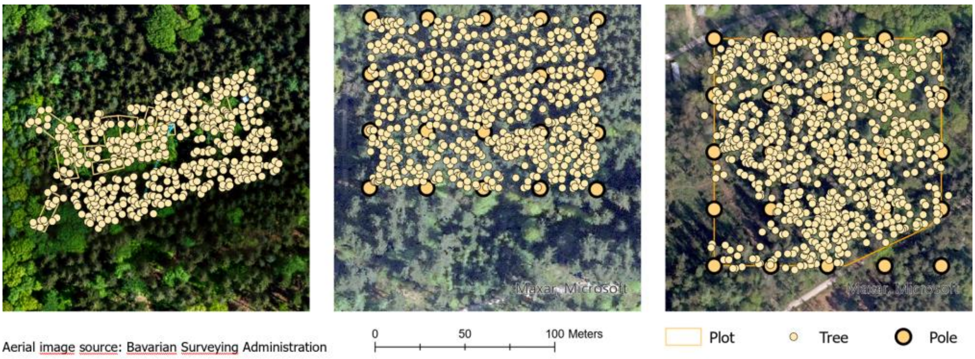

Figure 1: Position of trees, sub plots and staked out areas KROOF (left), KRANZBERG (centre), UNIWALD (right). For explanation see text.

Plot design and data acquisition

In all three areas, all trees with a diameter of at least 7 cm at breast height (dbh) were measured. In addition to dbh, tree species, position, height, crown length and special properties (e.g., trees with more than one stem) were assessed.

The KROOF area consists of twelve subplots, which are surrounded by fences. Poles (stakes) with a spacing of 31.60 m were installed in the other two areas. They form squares with an area of 1000 m² and help with orientation.

At the UNIWALD area, soil samples were taken in a 20 m by 20 m raster by means of a soil drill. In the KRANZBERG area, micro–habitats on trees such as lichens, mosses, bark damages, etc. were assessed The Chair of Forest Yield Science provided data about the development of tree dimensions from 1994 through 2020 for the KROOF area.

All measured data were enriched with third party information such as publicly available geo information (aerial photographs, digital terrain models, digital surface models), data from unmanned airborne vehicles (UAVs) and laser scanning data (airborne as well as terrestrial).

All available data was imported in a spatio-temporal data base and published to an online GIS environment (Esri, 2021).

The GIS and the associated data are coupled with simulation models. These enable for example the study of interactions between forest structure, forest dynamics, climate change and extreme events. The way how the visualisation systems communicate with the simulation models is derived from Döllerer (2008). It allows to couple basically any simulation model and handles communication as well as data transfer between the visualization software and the simulation model application.

Results

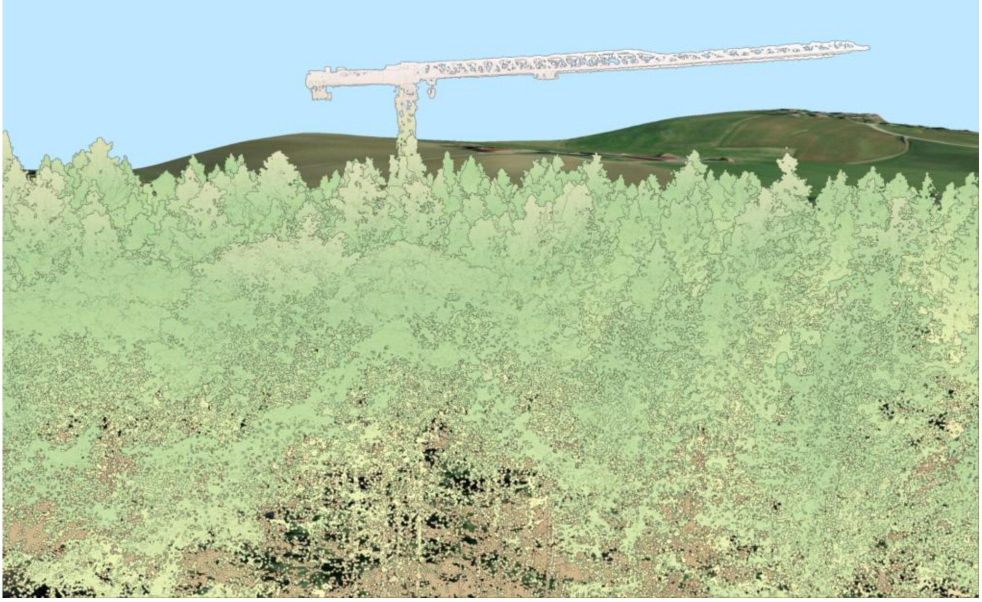

Figure 2: 3D GIS Visualisation of a LIDAR point cloud at the KROOF area.

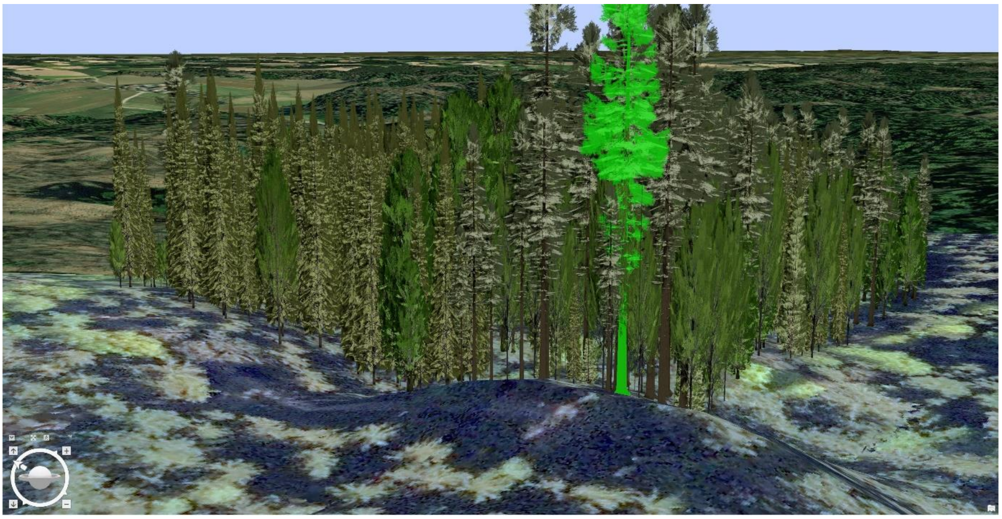

Figure 3: 3D GIS Visualisation of the KRANZBERG plot (Douglas Fir at the front selected, Navigation Tools bottom left).

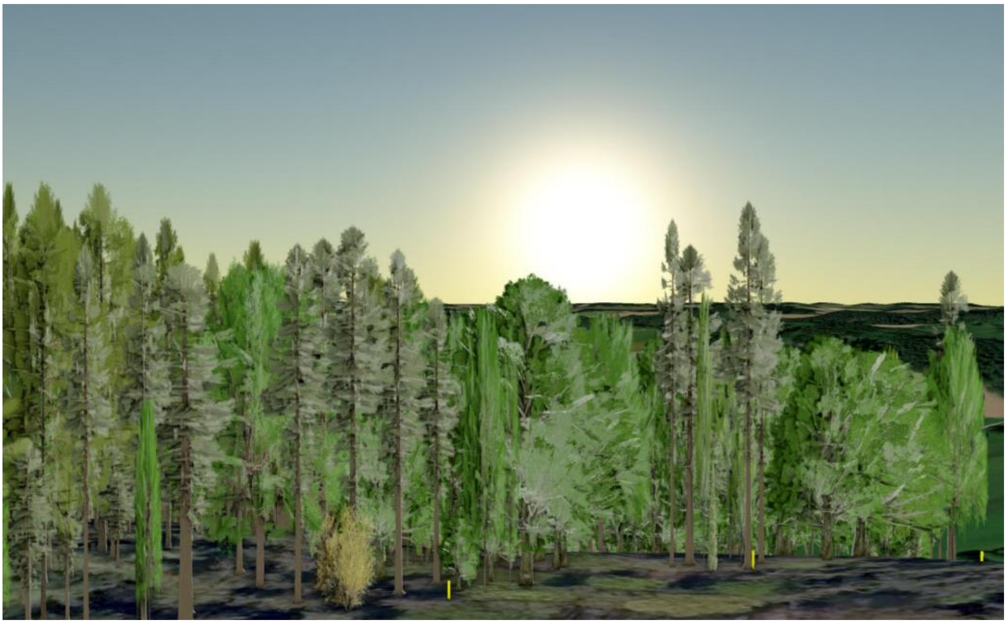

Figure 4: GIS Visualization of the UNIWALD plot at sunset.

Close to reality visualisation using computer game technology

So called game engines are used in the production process of computer games that allow the creation of the game environment interactively and intuitively. Modern computer games are able to visualize their game world in a very realistic way. A game engine was used to realize the graphically most sophisticated version of "Wald Digital". We decided to use the Unreal Engine 4.27 by EPIC games (Epic Games, 2021). 3D models of different tree species were bought from the EPIC games store, distributed in the virtual landscape and scaled to the correct height. Two forest landscapes – the KROOF area and the UNIWALD area – were created by a group of talented students in the frame of a Bachelor project study.

To ease placement and scaling of the individual trees, a GIS layer was imported (see Figure 5) to visualise position, species and height of each tree. Three examples are presented in Figures 6, 7 and 8. Figure 9 proves that the virtual pictures approach the real sceneries pretty well.

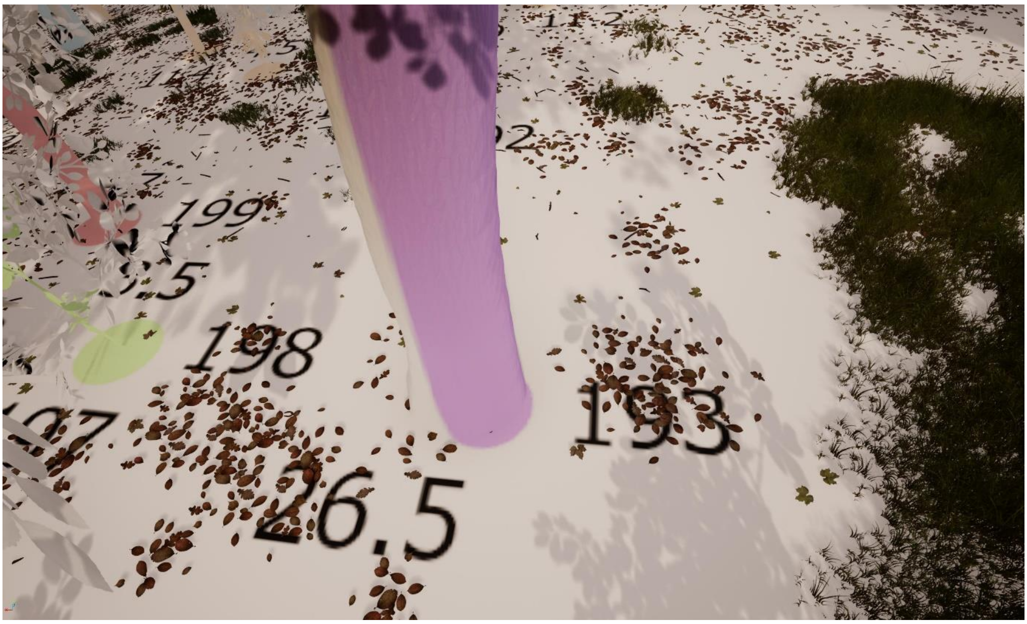

Figure 5: Imported GIS layer in the Game Engine Editor: The numbers indicate tree number (193) and height (26.5), the dot indicates position and species (purple: Oak).

Figure 6: Visualisation of the KROOF area.

Figure 7: Visualisation of the UNIWALD area.

Figure 8: Visualisation of a measurement facility at the KROOF area.

Figure 9: Photograph of the scene shown in Figure 8.

Integration of "Wald Digital" into curricula

"Wald Digital" is currently available as an early prototype. Simulation of forest growth dynamics with SILVA is already available.
There are numerous possibilities for integration of "Wald Digital" into current study programmes:

- Basic GIS courses (e. g.: Introduction to GIS);
- Forest management courses;
- Environmental management courses;
- Climate change courses;
- And many more.

Demonstrations have shown that environments like this are appreciated by both teaching staff and students. Advertisements of "Wald Digital" are currently ongoing, so are enhancements of the system.

Concluding remarks

Even with standardized three-dimensional tree models, it is possible to create notably realistic forest landscapes. Querying and selecting objects must be added by programming code. By identifying individual trees in the terrestrial laser scanning point clouds and converting them to wire frames, every tree could be modelled as it grew in reality. The search for methods to automatically create such wire frame models is at the moment subject to basic research.

Unlike e.g. Marteloscopes or visualisation-only approaches (Chandler *et al.*, 2022), "Wald Digital" allows both free navigation through the scene and flexible interaction with objects as well as the invocation of external applications that modify the scenery. All trees have to be placed and scaled manually in the two existing game environments. Although GIS data assist the process, this is a considerable workload: The UNIWALD area consists of 845 trees and there are 479 trees at the KROOF area. Virtual Reality (VR) visualisation is directly supported by the game engine, VR displays are available. The third forest landscape at the KRANZBERG area is under development. An approach to add program code that creates the trees automatically is tested.

Study programmes evolve and environments like "Wald Digital" most likely will gain importance. As an example, the module "forest simulation" (Waldsimulation) will be a compulsory module in the German master programme "Forst- und Holzwissenschaft" at TUM. As the KROOF area and the KRANZBERG area are located in a publicly owned forest in cycling distance from the University campus, participants of this module could benefit from "Wald Digital" being integrated.

Acknowledgements

We are indebted to the Chair of Forest Yield Science for providing us with tree data from the KROOF area and Martin Jacobs for scanning the UNIWALD area and the KRANZBERG area with his TLS.
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LESSONS LEARNED FROM THE TOTAL VIRTUALIZATION OF A FOREST CURRICULUM IN SPRING 2020

HARALD BUGMANN, DANIEL GUGGISBERG, MOHAMMED IBRAHIM, FLORIAN KNAUS

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.

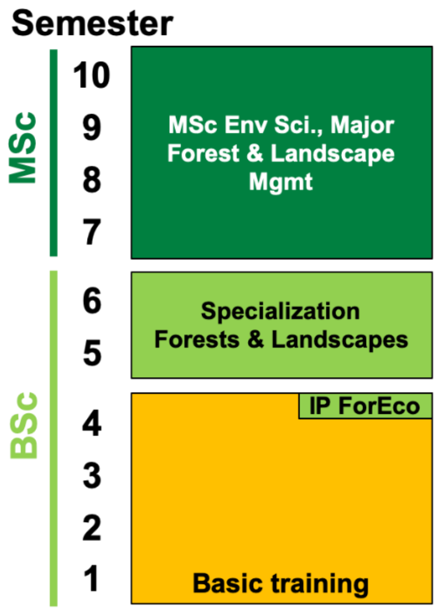


Figure 1: Structure of the Environmental Science Programme of ETH, Major in Forest and Landscape Management. The inset box "IP ForEco" stands for the so-called Integrated Practical on Forest Ecosystems, which represents a number of smaller, but important forest- and landscape related electives that start 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?

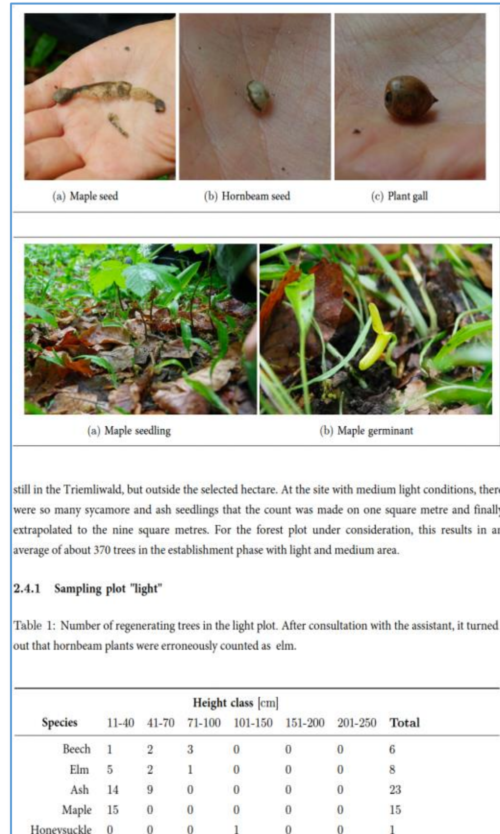
Within a very short time, we re-wrote and expanded the instruction manual that we are normally using, with the idea that this should be as self-explanatory as possible. For basically each and every step of the practical, we prepared videos that showed the students how and what they were supposed to measure (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.



(a) Maple seed (b) Hornbeam seed (c) Plant gall

(a) Maple seedling (b) Maple germinant

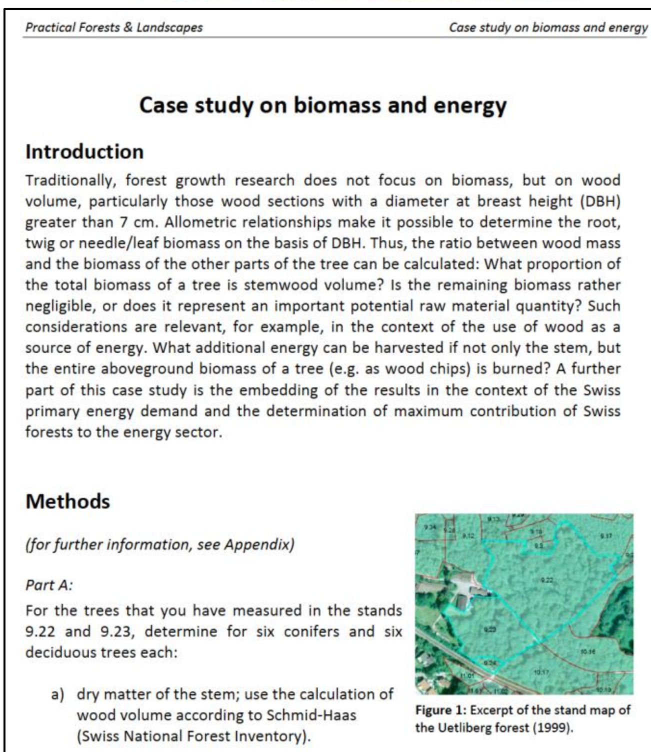
still in the Triemliwald, but outside the selected hectare. At the site with medium light conditions, there were so many sycamore and ash seedlings that the count was made on one square metre and finally extrapolated to the nine square metres. For the forest plot under consideration, this results in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

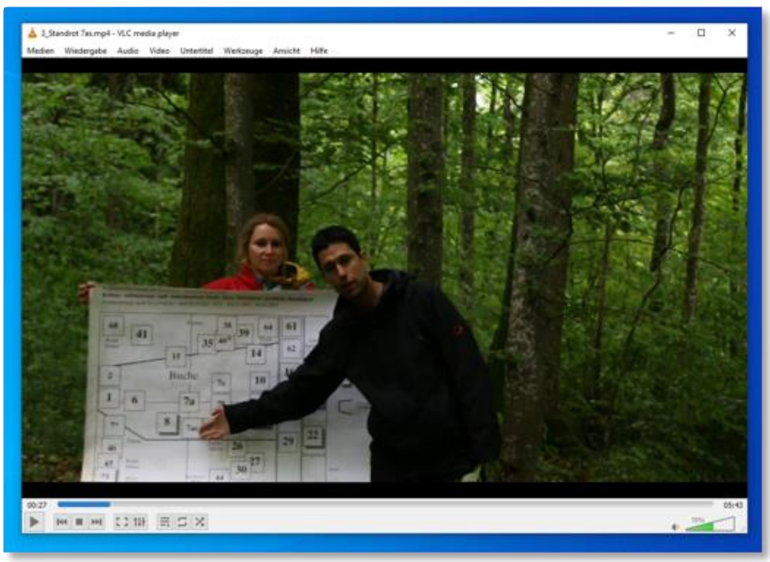


Figure 4: Examples of the virtualization of the six full days of site classification excursions in the context of the 6th semester practical “Forests and Landscapes”. Left: frame from a video explaining a site type and its location in the ecogram. Right: Frame from a video where the soil scientist is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

SHAPING THE FORCED CHANGE TO ONLINE TEACHING TOWARDS A DIGITAL FUTURE: WHAT ARE THE DISADVANTAGES IN FORESTRY HIGHER EDUCATION?

FRANCESCO PIROTTI, TOMMASO ANFODILLO, PAOLA GATTO

Abstract
The leap in forced digitalization in higher education has led many to ponder the consequences over the long term. There is no fully going back to previous methods, because mindsets have changed. In this note we discuss the effects of the transition of forestry study programmes perceived by students to using more digital tools, and the pros and cons of some possible scenarios for the future. Experiences in two study programmes are analysed, one is the Bachelor programme Forestry and Environmental Technologies (TFA), the other the Master programme in Forestry and Environmental Sciences (SFA), taught at the University of Padua. Students were asked for their experiences and views regarding the novelty of didactic approaches and their opinion on the critical aspects and the future scenarios from the point of view of the learner. Results from the analysis of 248 answers show that technological solutions were on average considered well-performing, but that they were not enough to bridge the gap regarding social interaction and field visits. Various didactical approaches to online teaching are discussed critically.

Keywords: teaching remotely; online learning; digital lecturing.

Introduction

The COVID-19 pandemic impacted higher education, among other things. The first and foremost thought by teachers and learners was the following: “is it possible to lecture efficiently with online tools?” and “what are the main problems in this transition?”. Colleagues across the world started collaborating by sharing ideas and experiences from countries that were first to suffer from the pandemic and, hence, first testing solutions. One example that can be representative of the situation when teaching went completely online, were hard-skill courses teaching software-based topics. For example, geographic information systems courses for the Master programme of Forestry and Environmental Sciences (Science Forestali e Ambientali - SFA) at the University of Padova (UdP) had a smooth transition to online teaching for two trivial reasons: they are courses from a digital dominated discipline – thus already requiring students to use the computer – and University of Padova had invested in several tools for online interaction (i.e. Zoom©licence), which had already been tested, and the networking infrastructure had been improved to support the increase in internet network traffic. Topics requiring field visits and hands-on experience in the forest were another story, as the physical presence of teachers and learners on the site is of utmost importance.

The jump of all courses to full online mode meant that the network traffic increased dramatically. Digitalization in this context refers to the use of digital interfaces, i.e. hardware and software, to extend or substitute experiences in the classroom or in the forest. Regarding online lectures during the pandemic students and lecturers had to learn to use several digital tools, i.e. online meeting software, portals for registering students' participation, video publishing and also editing in some cases. On top of software tools, also new devices had to be used, e.g. earphones, microphones and video cameras for lecturing. Also, the time spent in front of a computer screen increased significantly for both students and teachers. The former had to follow video-lectures, the latter had to prepare the video-lectures and both had to resort to remote teaching/learning. Devices are an important asset for students as learning tools. When some years ago notebooks were affordable by only a few, computer rooms gave all students the chance to use software. Now there is a shifting towards the "bring your own device" (BYOD) principle, with universities often financially supporting students needing to buy a notebook. The pandemic pushed further the necessity of students to have their own digital interface for learning. Recently UPd is testing the feasibility of giving each student access to a virtual machine profiled with software that is required for each course. This solution would allow students to access high-performing computers from low-cost devices, provided that they have a good internet connection.

Now that the pandemic seems to be over, some considerations can be made over the solutions used and which ones could have been improved. In this paper, we survey, report and discuss the students' perspective regarding technical solutions but also the impact of online teaching on learning to use different hard and soft-skills.

Materials and methods

Students from the forestry programmes were interviewed in a survey by phone after an invitation and their agreement via e-mail. This resulted in 248 survey participants. The questions were the following:

- What programme are you registered for?
  - What year did you begin?
  - Are you a working student?
  - What distance from the campus is your residence?
  - walking/bicycling distance;
  - same municipality;
  - same province;
  - same region;
  - >400 km distance.

- Hardware and software used for teaching: how was the experience with the sudden acceleration of their use? This question had the following sub-questions to which a score ranging between -2 to 2 could be chosen, with -2 = very bad, 0 = no insurmountable problem, 2 = very good, no problem found.
  - Was the internet connection from home was sufficient?
  - Online meeting software (ZOOM) - did you feel comfortable using it during the lessons?
  - Your device (PC, laptop, notebook, tablet, other) was sufficient or did you feel the need for a more performing device?
  - Has the portal for teaching (Moodle) been sufficient for the required activities?
- Do you think the practical exercises in the forest and the educational visits can be validly replaced with virtual exercises? For example with videos or movies?
  - -2 = absolutely not;
  - -1 = no, I don't think so;
  - 0 = neutral / indifferent / I don't know;
  - 1 = yes, enough;
  - 2 = absolutely yes.
- Which of the following elements do you think has undergone a change for the better or for the worse? This question had the following sub-questions to which a range between -2 to 2 could be chosen, with -2 = much worse; -1 = worsened slightly; 0 = remained the same; 1 = improved; 2 = much improved.
  - Interaction with teachers;
  - Exam procedures;
  - Field exercises / educational outings;
  - Relationship with other students;
  - Ease of following the lessons;
  - Administrative operations (e.g. enrolment in study programme, courses).
- How has distance learning influenced the effectiveness of learning in the various disciplinary fields according to your experience? If you did not follow the subject answer not applicable. This question had the following sub-questions to which a range between -2 to 2 could be chosen, with -2 = much worse; -1 = worsened slightly; 0 = remained the same; 1 = improved; 2 = much improved.
  - Forestry and silviculture;
  - Geomatics and/ GIS;
  - Economics and policy of forest resources;
  - Watershed management and hydrology;
  - Livestock chains and mountain agriculture.

- If recordings of the lessons are available online even after the lessons, how much can it lead the student not to participate in the original lesson on ZOOM? Scores from 1 to 10.
  - = no, I follow the lessons carefully;
  - 10 = yes, the availability of the video actually discouraged me from attending the lesson.
- How long do you think the recorded lessons should remain available to the student?
  - = 1 week;
  - = 2 weeks;
  - = 1 month;
  - = 3 months;
  - = 6 months;
  - = longer than 6 months.

Results

A total of 248 students answered the phone interviews. Of these, 116 were from the Master of forestry programme and 132 from the Bachelor of forestry programme providing quite a balanced set of data (see Figure 1). Eleven percent (11%) of these students are working students, which means that they register at the university with a special status allowing them to take less exams and still be in the course schedule, similar to part-time studying.

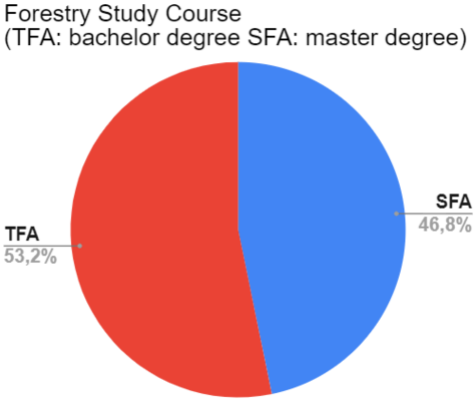


Figure 1: Students enrolled in the Bachelor programme (TFA) and the Master programme (SFA).

The Master programme is a two-years programme and the Bachelor programme is planned for three years. Table 1 shows the proportion of students who were interviewed according to study programmes and years. Also in this case the participation percentage was balanced between the years. The term “FC” in the table and in the plot means that the student is “*fuori corso*” meaning that she/he is over-time with respect to the planned university career, and is thus delaying graduation till after the expected number of years that it should take (three years for Bachelor programme and two years for the Master programme).

The following sections show and discuss the results of the survey. The actual data has been plotted as box-plots for analysis. Three aspects of the perceived differences between the pre-pandemic situation and pandemic lock-downs will be presented. The first aspect is technical and relates the way in which hardware and software have been used during the sudden change to online teaching and learning. The second part is related to programme contents, the missed field visits and the relationship between students, lecturers and administrators during online-only interaction. The last part deals with methods and tools considered positive and to be kept, looking backwards at the moment that the pandemic situation is over; e.g. how much “online” should the future lectures be.

Hardware and software used for teaching: how was the reaction to the sudden acceleration of their use?

This first set of questions is related to the technical aspects of shifting completely to an online system in a short time. Table 1 below reports the scores grouped by degree and year.

Table 1: Average and standard deviation of answers from scores from -2 to 2 of the four questions regarding technical aspects. N=number of answers.

Study programme	**Internet connection**	**Hardware/software**	**Devices**	**Web portal**	N
SFA - FC	1.0(2.0)	1.0(2.0)	1.0(2.0)	1.0(2.0)	4
SFA - I°	0.7(1.2)	1.2(0.8)	0.9(1.1)	1.1(0.8)	39
SFA - II°	0.6(1.1)	1.2(0.8)	1.0(1.1)	1.0(1.0)	73
TFA – FC	-0.4(1.3)	1.1(0.7)	0.2(1.4)	0.7(0.8)	11
TFA - I°	0.8(1.1)	1.2(0.8)	1.2(1.3)	1.3(0.9)	40
TFA - II°	0.6(1.0)	0.9(0.9)	0.7(1.0)	0.7(1.1)	31
TFA - III°	0.5(1.1)	1.0(1.0)	0.9(1.2)	0.9(1.1)	50

The first question regarded an obviously limiting factor of online teaching: was the internet connection in students' homes good enough? Italy is not well known for its internet network as a ranking by the Worldwide Broadband Speed League in 2020 (IlSole24Ore) showed that Italy is among the last European countries in terms of internet connection speed, with 23 Mb/s, where the average is 55 Mb/s. Nevertheless, the responses by students were overwhelmingly positive, with most answers (above 75%) being positive for all course degrees and years. A notable exception were the 11 students of the Bachelor programme that were outside the planned programme years (FC), which were well below the rest. This seems to indicate that students who have difficulties with keeping pace with the course schedule in general also have difficulties following the lectures, being them online or in presence as before the pandemic.

The second question was more related in general to hardware and software, therefore to the programmes that were used for lectures, and the typical software used by students like spreadsheets, word processors, statistical software. In this case the answers were more positive than the previous ones, with all groups saying on average that no problems were encountered.

The third question was specific about the device used by the student, and how well it performed for lectures and homework. Devices can be home desktop PCs or laptops, or even tablets in some cases. Here the answers were similar to the ones related to the internet connection, with most of the groups responding positively except the FC of the Bachelor programme. Again this supports the hypothesis that these students have a general difficulty that has manifold aspects and should be addressed.

The fourth question, related to the online web portals of the university, had overall positive answers for all groups, without exceptions. To conclude, it seems that from a technical point of view the shift to online lecturing did not pose problems to the students except in specific cases that can be related to more personal difficulties of the students than a general one.

Impact of online lectures on practical work and social interactions

The second set of questions is related to the practical aspects inherent to forestry study programmes, e.g. field trips, visits to forests. This is, of course, a sensible factor as the hands-on learning in the field is a very important skill provided to future foresters. Table 2 below summarizes average and dispersion

Table 2: Average and standard deviation of answers from scores from -2 to 2 of the four questions regarding interaction and networking aspects.

Study programme - year	**Interaction with lecturers**	**Exam procedures**	**Field work**	**Student networking**	**Lecture online attendance**	**Administrative tasks**
SFA - FC	-0.8(1.0)	0.5(1.9)	-1.5(0.6)	-1.2(1.0)	0.5(1.9)	-0.7(1.2)
SFA - I°	-1.1(0.9)	-0.4(1.0)	-1.5(0.8)	-1.7(0.6)	0.7(1.3)	0.2(0.9)
SFA - II°	-0.8(1.0)	0.1(1.1)	-1.7(0.5)	-1.4(0.8)	0.7(1.4)	0.2(0.9)
TFA - FC	0.1(1.1)	0.1(1.4)	-1.5(0.7)	-1.6(0.7)	0.4(1.6)	0.0(0.8)
TFA - I°	-0.7(1.0)	0.1(1.0)	-1.1(1.0)	-1.0(1.0)	0.0(1.5)	0.2(1.1)
TFA - II°	-1.0(0.9)	-0.3(1.0)	-1.4(0.8)	-1.3(0.8)	0.2(1.5)	0.2(0.8)
TFA - III°	-0.9(0.9)	-0.3(1.1)	-1.7(0.7)	-1.4(0.8)	0.5(1.2)	0.0(0.9)

Students expressed their dissatisfaction with having virtual learning methods instead of field visits. This might depend on the technology used, which is not ready for a fully virtual environment, but is also probably related to the students requiring to touch and feel what it is like to survey/visit a forest.

The interaction of students with the lecturers was seen as less than ideal, with students expressing a negative opinion on the change after the shift to online-only interaction. On the contrary, online examinations showed quite a neutral stand of students, with an overall median of zero (neutral) and a interquartile range between -1 and +1. Also averages for the different groups show results around this value. Slight variations probably depend on the specific topic and lecturers.

The other two questions regarded interaction with the teachers during field trips and interaction with fellow students. Field trips during the pandemic period had a very negative response as can be expected, as some teachers managed to record some video-lectures in the field, but it was far from the real experience. The interaction with fellow students was negatively affected. A different scenario was provided by the question related to how easy it was to follow the online lectures, which had overall positive results. This reflects the first part of the results, were hardware and software and internet connection were overall perceived by students as working well. Nevertheless, it must be noted that most, but not all students, gave positive feedback regarding the online lectures, with a large variability also towards the lower scores. Last but not least the interaction between students and administration was perceived as mostly neutral, without problems or improvements between the pre-pandemic and the pandemic periods. This seems reasonable as basically all results of tasks given had already to be presented online.

Lectures are aggregated in five categories. Students were asked if lecturing got worse or improved thanks to online lectures for respective category. The scores ranged from -2 to 2 with -2 = much worse; -1 = worsened slightly; 0 = remained the same; 1 = improved; 2 = much improved. The courses considered are listed in the methods section (question 8). Results show an overall average of -0.1 and a standard deviation of 1.1. The difference between the five groups was tested with a Wilcoxon non-parametric test for group differences, finding no significant differences except between geomatics and mountain agriculture, respectively the highest and lowest scores. This is likely due to the digital component of the geomatics course, where geographic information systems (GIS) courses not requiring field visits concern a large part of lectures and is thus not perceived as having lowered the quality with respect to more practical courses. Surprisingly though, no significant differences were found between other groups and overall the course quality was perceived as not having changed significantly (around zero score). Also the distribution around the mean is limited to basically a slight improvement or a slight decline of quality.

Online versus recorded lectures: what do students prefer?

The opinion on how helpful were the online lectures and the recordings of the lectures is of importance if students can access both and do it. There is a clear preference of recorded lectures, as can be seen in Table 3.

Both were considered extremely helpful by students, with a slight preference towards having the recorded lectures over having the online lecture. This can also be seen by the answer to the following question: “having to choose between having online lecturing only – but no recording of the video-lecture – and having a recorded lecture – but no possibility of online lecture – which do you prefer?” The students predominantly prefer the latter as can be seen in Figure 2.

Table 3: Question “how helpful were the recorded lectures” (columns) and “how helpful were the online lectures” (rows); values from 0 to 10 respectively 0=useless, 10=extremely helpful. Absolute numbers reported.

	0	1	2	3	4	5	6	7	8	9	10
0	1						1		1		1
1											1
2				1					1	1	1
3				1		1	1	2	1	3	5
4								1	2	2	2
5								1	6		7
6							2	2	9	3	6
7						1	2	5	4	2	10
8						1			5	6	28
9								1	2	6	10
10					1			2	1	2	93

It is interesting to note that not all students prefer recorded lectures over online lectures, when having only one choice. It can be interpreted as the need for interaction by students – even if somewhat virtual – with a lecturer, is considered an important asset by some. This does not mean that the other students don’t find that important, but not as important as accessing the recorded lecture independently. Further discussion on providing recorded lectures to students after the pandemic is debated

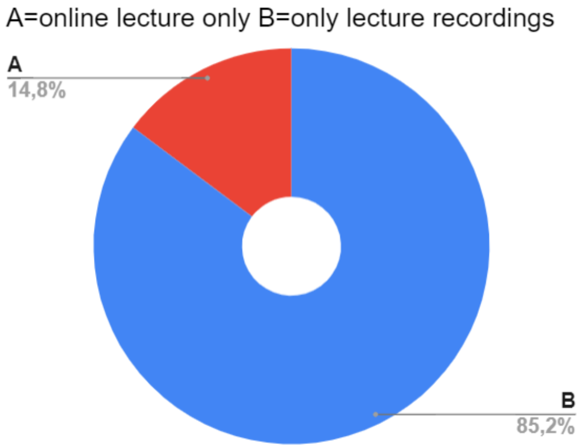


Figure 2: Students prefer online lectures only (A) or prefer recorded lectures (B). See text.

among students and lecturers. It is undoubtedly a factor that some students are less likely to go to lectures physically if a full lecture is video-recorded and available, due to easier access. Figure 3 also shows that the tendency of the student is to wish access to the recorded material without time limitation. If all courses allow this, the study programme risks to become fully virtual.

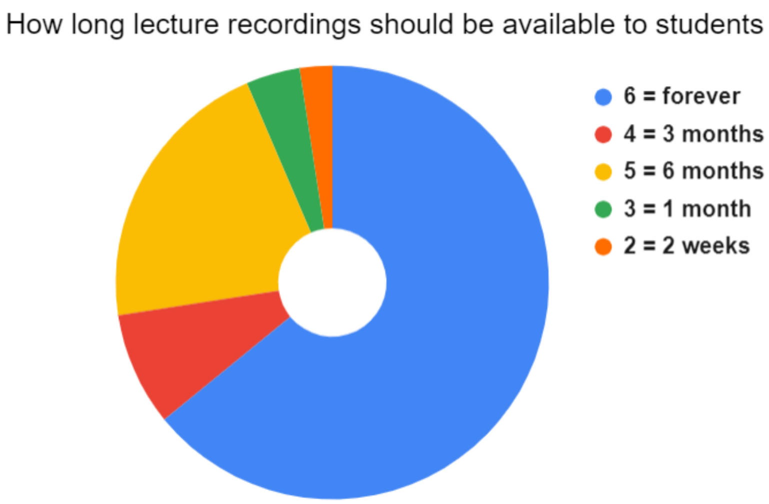


Figure 3: The amount of time that recorded lectures should be available to students, according to students. Forever?

Students will stay at home for many reasons. Distance from the campus implies commuting, which in turn means economic and personal effort. Some students also have a full-time or part-time occupation, and in this case self-pacing the lectures without a strict schedule due to the physical attendance is very important. On a personal level physical presence is a key factor to being with other students and creating the necessary social networking making university life so important. This latter point is strongly highlighted by rectors of classical universities when asked about the increase of interest towards online virtual universities. Creating a network is one of the main objectives of a university, which strives to enhance personal growth of the students not only regarding knowledge, but also soft skills like communication and interaction with peers.

Conclusions

Recalling the title, the problems in online education are not easily detected. The students' opinions in the survey showed that from a technical point of view, the forestry study programmes have the ability to go "online" without students perceiving problems related to hardware, software and other tools such as communication programmes. When it comes to practical skills, particularly to be gained by field work and the relationship and networking with fellow students and lecturers, the online-only solution is decreasing the quality of the students' experience. It must be considered that university life is not only learning hard-skills, but also building competences in soft-skills, communication, networking and other things that are very different in the virtual world. Maybe, someday virtual reality will bridge the gap between field experience and real experience, but we are still quite far from that point. The results from the survey may suggest that the future might keep some of the online activities limited to some aspects such as hard-skills in using software, but that campus life is a holistic experience providing many aspects to be considered.

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CONCLUDING REMARKS

NORBERT WEBER

Although an important element of SILVA Annual Conferences was missing in 2021, *as this event took place in virtual space without personal interaction, the topic and* the format were mirroring reality in Covid-19 times.

Elements of digitalization in teaching can be traced for several decades. Just to mention two examples: In the 1990s, Chris Brack at the Australian National University provided panorama videos of forests for his students to make them familiar with forests in the Australian outback, as presented at a conference of the IUFRO education group in Freiburg (Brack, 2004). More recently, the introduction of marteloscopes in European universities enabled students to explore selected forest plots on the basis of comprehensive databases independently. However, caused by the pandemic, "a huge unplanned, comprehensive and systematic experiment" (Bugmann *et al*., this volume) in teaching happened at many universities in Europe and other parts of the World. Covid-19 was boosting *both breadth and depth* of digitalization in teaching. It was inevitable for all members of the universities to deal with e.g. online meeting software, portals for managing student participation and examination, software for video publishing or editing. Large-scale digitalization of *teaching* followed digitalization of *research* in forestry and related sciences.

As the contributions in this volume are displaying, digitalization of teaching and learning comprises a lot of specific challenges for the involved groups of actors and individuals, i.e. students, lecturers, administrators, developers of software and hardware. In principle, technical solutions are available on all levels of teaching, from single courses to complete learning management systems and curriculum development on university level. Innovation is still going on, especially in the field of digital twins (Döllerer *et al*., this vol.) and immersive landscapes and soundscapes.

Of course, the "forced transformation" to digital teaching and learning caused a lot of challenges. While these were smaller with regard to hard-skill training courses (teaching software, e.g. GIS courses), it was practical placements, excursions or project work where both lecturers and students often were not pleased with the alternative, i.e. digital solutions. Haptic experiences and skills ("touch and feel") cannot be replaced. In a similar vein, universities also have to impart soft skills like communication and networking in direct contact with the students. In the words of Pirotti *et al*. (this volume): "Campus life as a holistic experience is a must."

Anyway, digitalization in higher forestry education is here to stay. It is in our responsibility to use it wisely.

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