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# Technodiversity—An E-Learning Tool as an Additional Offer for the Master's Degree and In-Company Training

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**Abstract:** In November 2021, a project proposal submitted by the TU Dresden and in which seven other partner institutions are involved was approved in the ERASMUS+ program Action Type KA220-HED. The aim of the project is to develop an e-learning tool that can be used to teach forest technology at the Master's level. Project work develops along four main tasks: (1) Facts and methods (theoretical contents), (2) Scientific audiovisuals (descriptive contents), (3) E-learning platform (structure) and (4) Didactics (implementation). In this article, the advantages and disadvantages of e learning are discussed and the development of the course contents (facts and methods) is presented in detail.

**Keywords:** e-learning course; forest operations; ECTS; ERASMUS+



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## 1. Introduction

Forest technology is part of the curriculum at most forestry training centers. Compared to the basic disciplines (botany, soil science, chemistry, etc.), forest technology is an applied subject that deals with the technical implementation of forest goals under operational settings. A typical course offers a good description of forestry machines and equipment and of their use in forestry work, and it also covers ergonomics, work safety and accident prevention. It often includes the basics of forest road construction, logistics and other special topics, according to local conditions and perceived needs. In the previously usual sequence of diploma studies, the preliminary diploma was for the scientific basics, while applied subjects such as silviculture, business administration, politics, etc. were read in the last semesters before the diploma. The subjects of forest technology and work science are among the applied subjects and therefore usually only appeared relatively late in the curriculum.

As a result of the switch to bachelor's and master's degrees in the course of the Bologna process [1], a significant shift had to be made. The new didactic strategy required that the bachelor's degree should be designed in such a way that it would fully qualify students for the profession. Therefore, all essential instruction on forest technology had to be integrated into the bachelor's degree at an early stage. For the master's degree, however, the scientifically oriented, methodical approach remained, which could vary greatly depending on the individual Institutions. Unfortunately, in many places, the number of students enrolled in the master's courses was too small for yielding a critical mass of people who would opt for a teaching module with high technical content and the forest technology course would not be included in the teaching offer. Since there are no signs that this situation will improve in the future, a general lack of technical content can be predicted in the Master's programs. Therefore, statutory teaching in forest technology tends to be reduced to the simple basics and may become impoverished in its scientific content.

At the same time, the proportion of forest entrepreneurs offering technical services such as timber harvesting and forest regeneration is increasing across Europe. They too are looking for qualified training programs for their employees. Technology development is so rapid that knowledge becomes quickly obsolete and must be regularly updated. That problem is less severe with the basics of forestry technology, as taught in the bachelor's degree, but becomes urgent when it comes to applied subjects and methodological in-depth studies, as offered in the master's programs. However, that specific target group is often too busy for attending regular lectures at a university during the week, and is best reached through other teaching formats for which the Internet offers ideal conditions. This was the reason why eight research institutions across Europe have joined forces to create an e-learning offer for forest technology training at the Master's level. Institutions are as follows:

⇒ Dresden University of Technology, Germany; Jörn Erler is the project leader and guides the working group that is responsible for the course's theoretical contents (facts and methods); he gets administrational support from Christina Spirow at the European Project Center, Dresden.
⇒ Transylvania University, Romania; Stelian Borz coordinates the filming of audiovisual units and assembles them into scientific videos.
⇒ National Research Council, Italy; Raffaele Spinelli and Marco Simonetti build the e-learning platform to overcome technical barriers.
⇒ Poznań University of Life Sciences, Poland; Piotr Mederski transforms the tool into an e-learning system.
⇒ University of Natural Resources and Life Sciences, Austria; Karl Stampfer is responsible for the testing under mountain conditions.
⇒ Faculty of Forestry and Wood Technology University of Zagreb, Croatia; Andreja Đuka deals with the Mediterranean view and is responsible for communication.
⇒ FCBA Technological Institute, France; Nathalie Mionetto bridges to the practitioners as target group.
⇒ Swedish University of Agricultural Sciences, Sweden; Ola Lindroos and Mikael Lundbäck bring the Nordic focus on the fully mechanized methods.

## 2. Experiences with E-Learning in the Academic Environment

Initially, the term e-learning only meant that electronic aids were integrated into the teaching and learning process. Various concepts have emerged over the past 20 years or so, which for example are discussed and didactically evaluated in [2,3]. Findeisen et al. [4] emphasize that here not only a new way of imparting knowledge is used, but that the type of communication and the didactics are also shifting and diversifying. At this point it is useful to describe the difference between the classic face-to-face teaching approach, blended learning and e-learning in the narrower sense. In the classic teaching approach, the teacher first conveys content in face-to-face lessons, which the learner then has to repeat and learn. The opposite has proven to be advantageous with blended learning, where the learner first acquires the teaching content with the help of electronic media, and then can ask questions, conduct exercises etc. in the following face-to-face sessions, flipped classroom [5].

With e-learning in the narrower sense, there are no face-to-face phases; the entire teaching module is carried out remotely. Of course, there can be phases in which teachers and learners are connected, but that occurs exclusively via electronic media (e.g., in a video conference). Teaching modules are first created by the teacher and uploaded to the Internet, for the learner to download and use at a later time. In the strict implementation of the concept, regular two-way communication is categorically excluded; those who are looking for it must offer specific question times.

Köhler et al. [6] show that the European Council already recognized the potential of e-learning in its Lisbon Declaration of 2000. In 2011, the European Commission declared that individual learning through electronic means was a key policy issue. In [7], a spirit of optimism can be felt, which evidently prevailed among schools and universities at the

beginning of the century, building the expectation of a speedy introduction of those new teaching and learning opportunities. In a comparative experiment [8] showed that success in a final exam depended significantly on how often learners took part in a face-to-face event. She therefore recommended using e-learning components only as a supplement to conventional teaching (i.e., in blended learning). Riegg Cellini et al. [9] confirmed that students who carried out their studies in presence "on campus" performed significantly better than students who studied the same subjects online at a distance. Only in the case of "shorter technical certificates" was that difference not so sharp. Längin [10], on the other hand, was already able to prove in the early days of e-learning that the willingness of teachers and learners to try out e-learning methods increased significantly when external conditions made it difficult to practice classic teaching methods, and then the advantages of a spatially separate teaching with online formats obviously stood out. For forestry and even specifically for the area of forest ergonomics, he reported that blended learning proved itself in South Africa and was suitable for closing gaps in university education. Awan et al. [11] pointed out that e-learning offers have improved significantly in recent years and that use of the new didactic approach has increased as a result. They emphasized that students who could make their own experiences with e-learning modules overcame their prejudice and reached a better appreciation of the teaching formats. Giron-García et al. [12] addressed the question of whether the learning style of students who are confronted with e-learning offers changed, and whether that change had an impact on their motivation. Eventually, they could not find any clear trend and concluded that motivation to learn depends rather on the quality of the teaching modules, not their format.

The global COVID-19 pandemic has led to a significant acceleration in the adoption of digital exchange formats. Erdmann et al. [13] showed that not only has the diversity and professionalism of the e-learning offerings increased under that new pressure, but that teachers and students also reached a more differentiated view of electronic teaching forms. Egger and Witzel [14] assumed that the recent dramatic experience would lead to a permanent improvement in online formats, increasing their importance, especially in further education. This is quite revealing, especially if one considers that just before the pandemics the first of the two authors was committed to maintaining conventional teaching formats [15]. Cacault et al. [16] found limited confirmation to the common concern that students would no longer participate to face-to-face events if given the e-learning opportunity. In fact, they found that e-learning led to a further differentiation among the students, reducing the performance of low-ability students on average, while triggering positive effects in high-ability students. In particular, they reported that live-streaming options had less impact on live course attendance than expected, since they were only seized if that choice resulted in a clear reduction of expenses. Finally, Flake et al. [17] pointed out the potential that e-learning has for further education and training. With ISO 29993 [18] there are now standards that serve to ensure quality of e-learning.

## 3. Technodiversity as an E-Learning Tool for Forest Technology

The research partners, who all deal with questions of forest technology and six of whom work at universities and two at research institutes, developed a concept for a forest technology e-learning package with the following characteristics:

⇒ The e-learning package is primarily aimed at students in the forestry master's courses, but could also be usable by forest practitioners as a further training offer.
⇒ The possibility of digital knowledge transfer are fully developed in order to encompass all the variety and diversity of forestry challenges and solutions in Europe.
⇒ Teaching is based on a mix of basic verbal information, graphic visualization, short films and interactive sessions.
⇒ English language is chosen as the common language because it seems neither possible nor necessary to translate the entire course offer into all the official languages of the EU.

⇒ Access should be free of charge for everyone with standard software. Costs will only be incurred if a service is provided for which an administrative fee has to be levied (e.g., for issuing an official certificate or similar).

The e-learning course received the suggestive name Technodiversity. This name was deliberately chosen for creating a parallel to the concept of biodiversity and stress the importance of choosing among a diverse offer of techniques and technologies to match Europe's diverse operating conditions in terms of physical environment, economic conditions and social expectations. The project is planned to last 29 months and is funded by the European Union as part of ERASMUS+ Action Type KA220-HED. Work started in November 2021 and will continue until the end of March 2024.

### *3.1. Objectives*

The aim of the project is to show and explain the technological diversity in harvesting operations and to promote it through targeted training. For this purpose, four main components are being developed:

⇒ Facts and methods: tutorials about work techniques and an explicit method for their selection based on work conditions and operational goals. This component also includes a glossary on forest operations.
⇒ Scientific audiovisuals: Video clips illustrating all typical harvesting methods under regional forest situations.
⇒ Knowledge platform: An electronic platform to host, organize and allow easy access to the wide array of teaching materials offered by the course.
⇒ E-learning course: Implement the e-learning course in existing master programs at the participating universities and used for professional life-long learning.

### *3.2. Target Groups*

Four different target groups will be addressed:

1. Students on master's degree courses are the primary future learners. In three summer-schools the e-learning course will be tested and discussed among young specialists (PhD-students) and interested students on master's level under different environmental conditions (Poland, Croatia and Austria).
2. Forestry professionals are the second target group. They will be informed about the availability of the new course through articles in technical journals and posters/information points at sector fairs such as EUROFOREST in France in June 2023 and KWF fair in 2024.
3. Scientists will be specifically addressed in one open session organized at the FORMEC international forest engineering conference held in Italy in 2023. Here the subjects of education and harmonization of scientific methods and terminology will be discussed. The ultimate goal of that initiative is to get support from the scientific community and get the new e-learning course adopted by as many universities as possible, even if not project partners.
4. Deans and study coordinators, who are responsible for curricula planning at the partner universities will be informed with the projects' content. After familiarizing with the content of the e-learning course and the final test rules, they will get the opportunity to decide about the implementation of the e-learning course in their local curricula.

### *3.3. First Results: Facts and Methods*

The core content of the learning package is a coherent array of Power Point presentations. All project participants contributed their knowledge to the course according to the following development process:

⇒ When applying for the project, the rough framework was already defined and agreed by all applicants.

⇒ The first author of this article was responsible for the first draft of the presentations. In that first draft, the topics were placed in a logical order, a selection was made as to which scientific content was to be conveyed, and a first didactic suggestion was made.
⇒ The second Author then worked intensively on that first draft to improve content consistency, linguistic style and general readability, as well as relevance for the target groups.
⇒ After that, all other participants contributed their views, asked critical questions and suggested alternative texts. This step was particularly relevant in order to meet the requirement to actively involve all project participants in the result and to actually reflect the diversity in Europe.
⇒ During that step a number of questions were raised that could not be clarified in the written circular procedure. A multi-day workshop was then held for this purpose. For most questions, a common solution could be found. However, such topics on which no agreement could be reached among the project participants were shown in the presentations with all positions, so that learners will be able to form their own opinions.
⇒ Finally, the presentations were adapted to the status of the discussion and edited graphically and linguistically.

The presentations currently cover the following topics:

A. Basics of technodiversity
   1. Do we need diversity in forest techniques?
   2. Role of forest techniques in forestry
   3. Criteria for assessment
   4. Technique selection process (three steps model)
   5. Responsibility for the choice

B. Terminology and models
   1. Functions of timber harvesting
   2. Sub-functions of timber harvesting
   3. Harvesting equipment
   4. Steps and degrees of mechanization
   5. Functiograms
   6. Harvesting processes
   7. Process chaining

C. Economic assessment
   1. Economic criteria
   2. Engineering formula
   3. Performance of a subsystem
   4. Additional costs
   5. Total system costs

D. Ecological assessment
   1. Risks, side-effects and damage
   2. Damage on forest soils
   3. Repair and prevention
   4. Avoidance of soil damage
   5. Processes on trafficable areas

E. Social assessment
   1. Social criteria
   2. Societal compatibility
   3. Standard methods
   4. Safety and ergonomics
   5. Social suitability

F. Standard solutions for
   1. Northern Europe
   2. Atlantic broadleaf trees
   3. South-Western pine stands
   4. Mediterranean stands
   5. Alpine regions
   6. Eastern mixed stands

G. Path to the optimal solution
   1. Singular problem
   2. Selection of options
   3. Assessing options
   4. Extracting the best option
   5. Target-driven optimality.

Parallel to the Power Point teaching modules, a glossary is being created, in which terms are defined and explained using various examples. That is necessary due to different ways in which the same term is used and the different terms used to define the same thing by different professionals and in different countries. When creating the project glossary, existing glossaries already published and used in English-speaking countries are being taken into account. Here, too, the same principle applies: standardization and consensus if possible, but presentation of differences and diversity if necessary. The project participants do not want to add to the confusion with one more glossary, but rather make an attempt at consolidation in the hope that it will help clarify the terminology.

## 4. Instead of Conclusions

In summary, the following statements can currently be made about e-learning for-mats in the strict sense:

⇒ In training, they are not so much suitable for imparting basic knowledge, but for deepening existing knowledge and for further training.
⇒ Above all, they are offered by teachers and accepted by learners when the ad-vantages of the digital format become clearly recognizable for both sides.
⇒ The didactics of digital media must differ from the didactics in the lecture hall and must make full use of the possibilities offered by dedicated software.
⇒ The offers must be easily accessible; their costs must be significantly lower than those that a face-to-face event would incur.

The success of technology training is often dependent on psychological impact. Field trips are best suited for that effect, but they are usually limited to the region in which the training takes place and are therefore are not an option for a European project such as Technodiversity. Therefore, our project tries to obtain the same effect through the use of short instructional videos. That expectation is supported by the experience that e-learning is primarily perceived and accepted by the target group as advantageous if the special possibilities of digital communication are also used [4]. One might think that there are enough videos on the Internet that deal with forest technology topics. Some of them are also extremely valuable, especially if they deal specifically with working processes and provide tips for the practitioner. However, they are usually too specific for training at master's level and can hardly be used in teaching, simply because of the time it takes to look at them. At the other extreme are the many videos of forestry machines in use, in which the focus is apparently on 'showing particularly impressive situations', often reinforced by emotional music, so that psychological impact becomes the main goal and technical content is only secondary. Between these two categories are commercial videos, offered by equipment manufacturers and primarily aimed at attracting customers: although rich in technical information, those videos are weakened by a strong commercial overtone that is all, but impartial. All those categories can hardly be defined as ideal for use in scientific training at master's level.

For that reason, the project work plan included the production of short videos of around 5 min, in which machines and sub-processes are shown, explained and evaluated in a targeted manner. Those videos, which are offered in different categories (machining principles, technical features, machine in action, effects, risks and side effects...), are based on a uniform script style developed by Stelian Alexandru Borz (Brasov, Romania) in collaboration with Mikael Lundbäck (Umeå, Sweden). According to that plan, each project partner will shoot a few clips, which will be then edited and equipped with English texts in Romania according to a uniform pattern. In this way, a complete range of explanatory videos will be made available for describing all the sub-processes in the lectures, for a total of more than 100 short films, all featuring the same consistent style and format.

With 38 teaching modules (Power Point), a glossary and probably more than 100 videos and other audiovisual offers it is no longer possible to set up a linear educational path that every learner must complete. Such a wealth of training materials will be integrated in a platform on which learners will develop their own path, according to capacity and needs. Such a platform is being created by Raffaele Spinelli and Marco Simonetti from National Research Council (CNR), Italy. To that purpose, they are using the proven learning software MOODLE in connection with 5hp and LUMI, so that all materials mentioned above can be integrated in a way that is logical, user-friendly and didactically appealing.

An e-learning tool must not only provide information, but also organize the learning process towards a final exam. Such process will match the formal requirements for a master level course and conform with the European standards and examination regulations. That way a student in Padua, like her fellow student in Vilnius, can choose this course and have it recognized as an equivalent exam achievement.

On the one hand, the project requires quality control in which the study ability and the level of performance are ensured. For this purpose, summer schools are being organized within the scope of the project, for all target groups. Furthermore, the success of the new e-learning tool requires recognition by colleagues from other forest faculties not involved in the project. Piotr Mederski from Poznan, Poland, is responsible for quality assurance and market launch. The further steps mentioned above will occupy the project team in the coming months. The end of the project is set for March 2024. In order to reflect the diversity and also get to know other opinions, the project team decided to involve other partners as well. Although their later arrival excludes them from accessing to the project financing, they are included in most exchanges so that they can actively contribute to the development process. If you are interested in this, please contact us at the following e-mail address: joern.erler1@tu-dresden.de.

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