TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
WAGENINGEN UNIVERSITY & RESEARCH
Universiteit Utrecht
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INVENTORY ALTERNATIVES FOR PRACTICAL EDUCATION

EWUU PROJECT 3

Author: Gregory Ashe

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Cover Page made with Canva

Rolled out	The alternative is currently available and being used at the university
Exploratory Phase	The use of the alternative is being explored and studied for future use
Pilot Phase	The alternative is being trialled in one or more courses

INVENTORY ALTERNATIVES FOR PRACTICAL EDUCATION

INTRODUCTION

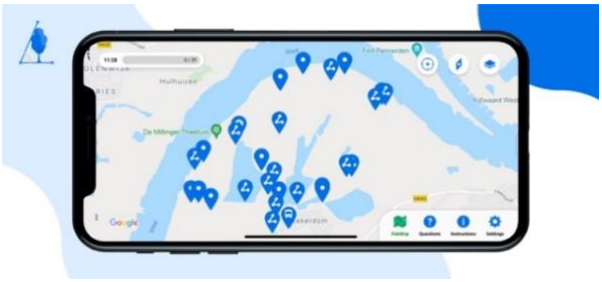
Although the worst part of the COVID-19 pandemic seems to be over, it has changed the world as we know it. People are thinking and behaving differently and long-term trends that were anticipated over the next few years have occurred in the space of mere weeks. The impact is profound in many spheres of society, particularly in the education sector. Educational institutions found new ways to provide quality education while maintaining social distancing and other health measures. One key approach has been the adoption of technologies that allow for remote learning, enabling students to access course materials and complete assignments from anywhere, at any time. However, while many courses can be taught in a virtual environment, practical skills-based courses such as practicals, fieldwork, and internships require hands-on experience that cannot be fully replicated in a remote setting. As a result, these courses have remained a challenge for institutions seeking to provide agile and flexible education.

To address this challenge, many institutions are investing in new ways to make practicals, fieldwork, and internships more agile so that students can continue to gain valuable experience while complying with public health guidelines. These efforts not only help solve short-term problems but also provide insight into the possibilities and limitations of such education in the future.

This plan is part of a series of yearly plans that will be implemented by the EWUU alliance with the aim of providing a comprehensive, future proof and adaptable educational experience that meets the needs of students in a rapidly changing world. This report will describe the current alternatives for practical education in the four members of the EWUU alliance encompassing Wageningen University, Utrecht University, Eindhoven University of Technology and Utrecht Medical Centre. This information will be collected through desk research and by interviews with both teachers and administrative education personnel.

CURRENT INVENTORY ALTERNATIVES

PEEK APP



Peek is an app developed by Wageningen University, aimed and created for educational professionals in order to guarantee the efficient organisation of field trips involving large number of students. By offering features like noting observations, taking measurements, answering questions and even reflecting on the activity, Peek enhances and stimulates the engagement of all participants, as well as giving users the chance to set up all-digital field trips, making it a trailblazing solution when it comes to distance learning. The global crisis ushered in by COVID-19 has accelerated the popularization of this program which has been massively adopted by numerous universities across Europe (PEEK, 2022).

Most teachers will agree that going through the ordeal of organising a field trip might present a number of challenges: First off, teachers are always outnumbered by large groups of students, and naturally to their own devices when it comes to all small arrangements, while simultaneously attempting to keep everyone engaged.

Back in 2019, The faculty of Geosciences of Utrecht University carried out an investigation under the project "Naar Buiten", reflecting on how digital teaching materials and mobile apps such as PEEK contribute to improving field education (Groothengel, et al., 2019) The report highlights the following positive aspects and the added value of PEEK:

- Increased student autonomy: PEEK successfully guides students to independently find their way through all excursion points, It also removed many practical tasks from the teacher.
- Participation during excursions improved: PEEK provides interactive teaching methods whereby students are encouraged to pose questions and discuss answers within the group.
- Straightforward feedback to students: Eliminating the need to print out materials, teachers have extra time in their hands to review all activities and consequently provide clear feedback digitally, meaning that it can be easily processed.
- Sharing's at the tip of your fingers: Outing-related info can be easily exported

Might be worth mentioning, that the report makes mention about how usage of PEEK may in some cases, disincentivize students from raising any potential concerns or questions directly with the tutor. However, it does result in the silver lining being that students are encouraged to first look for an answer themselves or to question their fellow classmates.

1. WUR: PEEK is integrated into 33 different courses.
2. UU: Five digital excursions for UU for the CHARM courses have been put together in UU.

LABBUDDY

This nifty e-learning tool was created to supplement traditional lab practical education by supporting students throughout the entire process; from their starting point prior to the actual lab work, as well as during the stage where all experiments are carried out by offering practical guidance. Labbuddy offers students the possibility of putting together a flow scheme of all experiments and answering interactive questions aimed at better understanding the theory behind the experiments. The program also provides an interactive lab manual with the ability to include videos, notes, pictures and even a booking tool in order to take advantage of lab equipment.

Labbuddy has shown to be a key solution to the increasing student numbers which have unfortunately proven to put a strain on the university facilities and staff, resulting in a limited amount of potential lab hours per student and therefore having a negative impact on the assessment of the experimental techniques.

Moreover, it has shown to propel students towards reaching their learning goals by reducing the cognitive load of all laboratory-related work, since the readily provided manual info prevents/limits many of the low level questions that would usually take up much of the tutor's time. This directly and effectively reduces the workload of lab assistants and educational professionals, who will find themselves with ample time to engage in scientific discussions with students. In addition the program also offers teachers the possibility of monitoring their students' progress and seeing how long students have taken to address specific questions, how often questions have been answered incorrectly, etc. (LabBuddy, 2021).

A good example of how Labbuddy has been taken advantage of:
A blueprint of the design principles for creating effective virtual experiment environments, was created by three course coordinators from the Food Chemistry chair group in Wageningen University. The main goal was the provision of a positive learning experience as well as the achievement of the learning outcomes. Consequently, several design approaches were tested and evaluated among the students of the MSc course Enzymology for Food and Biorefinery (FCH31306) These design principles showed to be extremely effective on the evaluated courses, however these have not yet been proven to function in other general courses and/or levels of education (Verstege, et al., 2021)

1. WUR: Labbuddy is used in a multitude of WUR courses for many different disciplines. Some examples include: Plant Biotechnology (GEN20806), Plant-Microbe Interactions (PHP30306), Enzymology for Food and Biorefinery (FCH31306), Applied cell biology (8LC00) and Capita Selecta Phytopathology (PHP50806) among others.

2. TU/e: At present Labbuddy is being used at five different courses at the Beta Faculty. This includes the Plants and micro-organisms (B-B1PLMI20), Rifampicineresistentie (B-B1PLMI20), Gallus staining (B-B2OBI07), Biologische eiwitten (FA-BA204) and Molecular Cell Research (B-B3MCR18). A sixth module is currently under development at the Faculty of Veterinary Medicine.
3. UU: Labbuddy is available for use at UU.

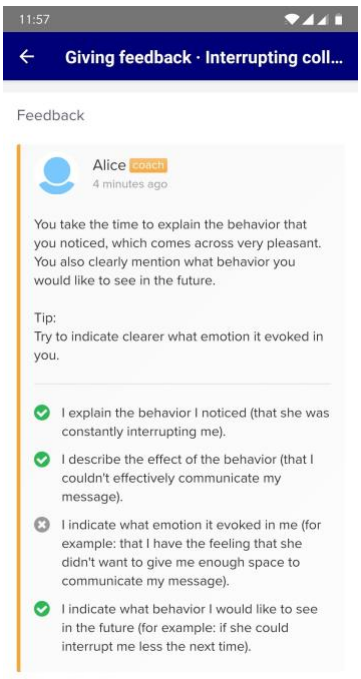
TRAINTOOL

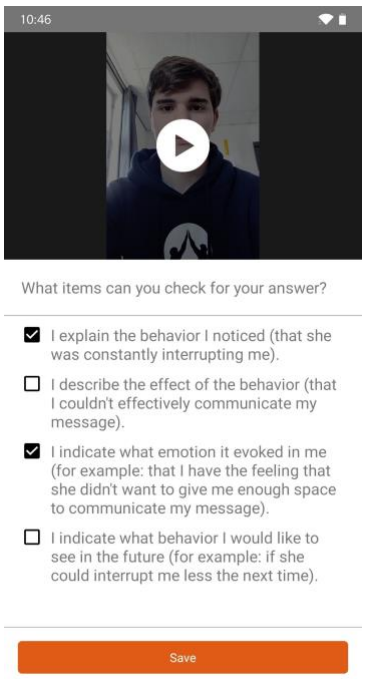
TrainTool, is an online video training tool focusing on the practice of "soft skills" such as presentation and communication skills. It has been widely used in a number of courses ranging from Psychology or Medical Sciences, pitching at Economics and Business, or interviewing at the Law and Spatial Sciences faculties. This program allows students to practise their communication skills by viewing underlying theories or examples, recording their speech, and even watching them back in private for self-practice. Might be worth mentioning that TrainTool has proven to be especially popular amongst online learners and has been used extensively to not only 'rehearse' prior to joining an online session but also do so within the so-called break-out rooms (4TU, 2022).

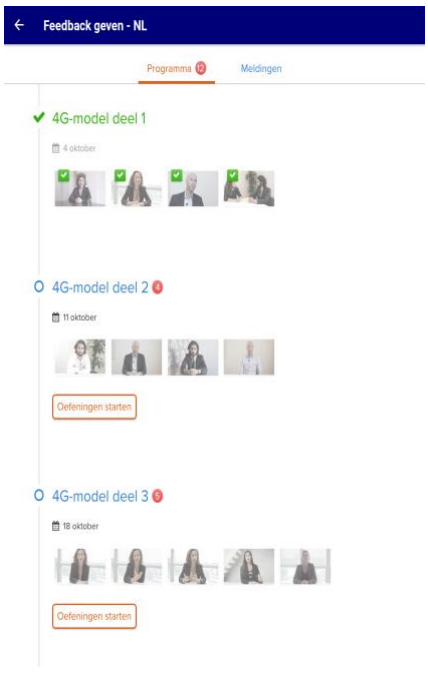
This tool has been in the pilot phase for two full academic years and has been evaluated by both teachers and students through focus group discussions, in-depth interviews, online surveys, and reflection reports. The retrieved data vehemently proves Traintool's effectiveness at training students in their communication skills through a well-structured and intuitive interface.

Having said that, although TrainTool can contribute to the quality of teaching there's certainly room for improvement. First and foremost, one of the main issues to address is the fact TrainTool has failed to decrease the workload for both students and tutors, as reported in the two rounds of course evaluations, and should most definitely be one of the main issues to focus on, as advised by the teachers. On the other hand, opinions voiced by students also showcase the need for TrainTool to be more interactive and its lacking capabilities to create assignments (4TU, 2022). The full details of the report can be found at (Wageningen University, 2020).

1. WUR: This tool has been used and tested in five different MOS courses. This includes Intercultural Communication Skills (ELS-65400), Networking (ELS-66900), Negotiation Skills (ELS-65300), Management Skills (ELS-66300) and Dialogue Skills (ELS67500).
2. UU: TrainTool is used as part of it's career services programs. This includes the Assessment, Personal pitch and Networking programs.

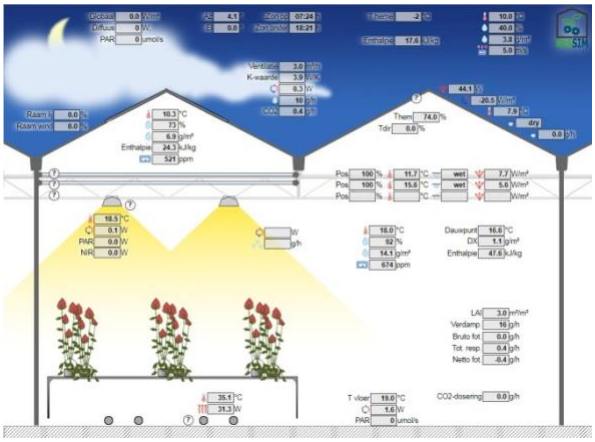






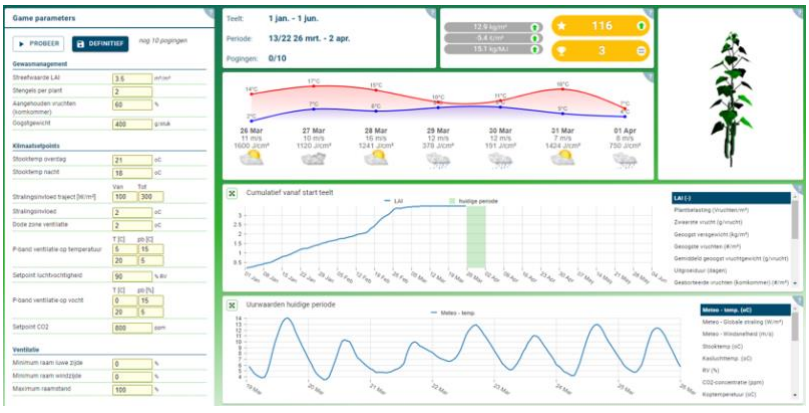
1. WAGENINGEN UNIVERSITY & RESEARCH

KASSIM



Consciously designed for educational purposes, Kassim is an online simulation tool that accurately mimics climate conditions present in greenhouses, aiming to provide proper insight into its numerous processes. Purposefully, built with the most up-to-date info on all recent developments concerning climate control strategy and greenhouse technology, Kassim directly analyses the effects of the outside weather and climate control on crop growth.
The model behind this new-fangled app is a greenhouse simulation model called KASPRO, developed by the Greenhouse Horticulture business unit of Wageningen University & Research. KASPRO is a dynamic model that has been further developed and validated on real-life practical data and is frequently used in practical research and expanded with relevant new developments. The model also contains a virtual climate computer whereby practical climate control can be reproduced. Kassim can be used for education at MBO, HBO and WO institutions within numerous fields such as climate control, energy, and greenhouse horticulture (Swinkles, 2021).

As of the summer of 2022, an updated version of KASSIM was rolled out to students. Using the same model as before the administrators created a game where players set a number of fixed parameters (e.g. the installations for climate control, screens, lighting, etc.) and can then experience hands-on the cultivation process step by step.



In each step, the player is given a maximum number of attempts to change and try out climate setpoints and crop management parameters. As they play the users receive assessments on the effects on crop production, energy consumption and cultivation indicators of their given actions.. Meanwhile, high-scores can be requested, which will conveniently include the player's preliminary score as well as their ranking together with the ones corresponding to the rest of the players from the class.
Upon reaching the end of the game, an overview and breakdown of all results will follow (score, settings and cultivation indicators) displaying those of the actual winner, and if desired, the results can be emailed to the player in a CSV file for their own personal analysis in Excel.

Kassim is currently being used at the WUR intensive summer program of Greenhouse horticulture. The program is also used in some of the 13 courses of the chair group of Horticulture and Product Physiology.

LabSim

As an extension of Labbuddy, LabSim also serves students, by furnishing them with a platform whereby they can design experiments aimed to answer certain research questions and receive the data, at a later stage, based on the design choices they made.

By processing the retrieved data, students are then able to provide answers thus preparing them for the actual lab classes and therefore ensuring their time spent at the laboratory is, in fact, efficient and effective. The panel of Food Technology agrees that this programme has allowed for the reduction of laboratory practical hours whilst simultaneously preventing the loss of quality in the courses, and has been indeed rather successful in tackling issues related to the increasing numbers of students previously mentioned within the LabBuddy section. LabSim can therefore prepare students for lab classes or even replace part of lab classes as seen during COVID-19. (Wageningen Univeristy, 2019)

Labsim is currently used at the BSc Food Technology and MSc Food Safety, Food Technology and Food Quality Management.

Virtual Practicals (ViP)

Still in its pilot phase, Virtual Practicals allows students to brush up on their practical skills within a safe environment, by bringing into play a 3D virtual reality. This project is currently being trialled for its use in laboratory practical's in both Wageningen University & Research (WUR) and University of Groningen (RUG). An evaluation of the operational viability of (3D-)VR in practical education will be conducted as well as its scientific/educational and didactic functionality in education. If the evaluation gives positive results, then the program is expected to be made available to the public shortly after.

At the forefront of the entire project sits Harry Bitter who confidently expects all participating students to find themselves better prepared for lab practicals by posing specific questions and therefore working more effectively.
This will prove useful not only for students but also for practical supervisors as frequently asked questions will already provide answers to commonly made mistakes, and As a result, physical laboratories can be adequately taken advantage of, possibly allowing for even more ambitious learning objectives to be achieved within a shooter timeframe. (SURF, 2022).

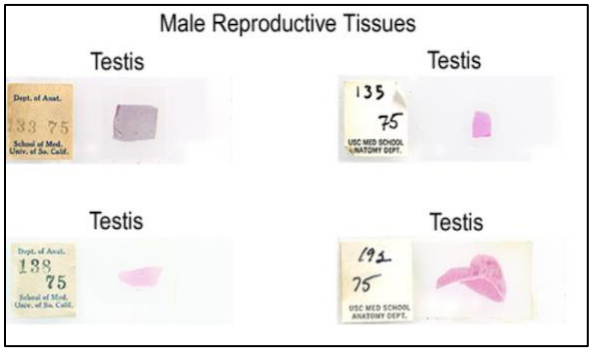
Virtual Microscope

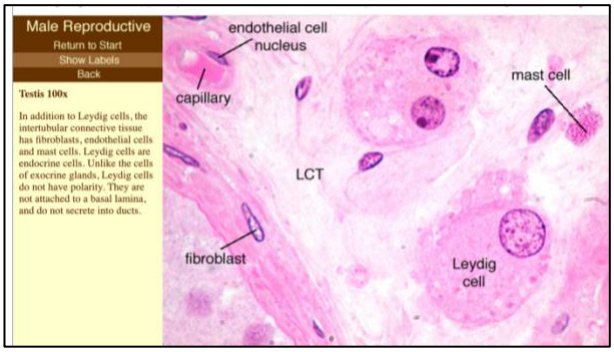
Recreates the look and feel of a microscope in an intuitive, browser-based interface. Histology is one of the core courses in the curriculum for medicine and it requires both an understanding of the cellular structure of organs and tissues and the ability to recognize tissues at the microscopic level. Traditionally, students have used microscopes to study specimens on glass slides. While extensive practice with the microscope is not essential in the modern health care setting, histology remains an image-intensive discipline. To understand the organization and function of tissues requires that students be able to interpret microscopic images. By presenting nested images at increasing magnification, *Virtual Microscope* provides a sense of scale and proportion that cannot be achieved in a standard histology text or atlas. Moreover, the text descriptions and labelled images offer flexibility (students can study at any computer) and opportunities

for small-group learning (several students can examine the images together), yet provide guidance for independent study. Each slide has a unique number which makes it easy for performing assignments and for facilitating group explanations by teachers (Anon., 2023).

This application prepares students before real life histology practical's and provides with a commentary and other resources to introduce laboratory sessions. It can also be used as an electronic atlas in a classroom. The program by itself however would be a poor substitute for real slides and real microscopes (Cloney, 2003).

This software program is currently used in four different courses Behavioural Endocrinology (HAP21806), Principles of Human Physiology (HAP10306), Integrated Human Physiology (HAP21303) and Brain, Hormones and Metabolism (HAP30806) since 2010 and it is used for more than 800 students a year. Currently WUR has a license for the program that amounts for 5 USD per computer. This license is indefinite meaning it is not an expensive alternative.





H5P

H5P's a nifty and free, open source content collaboration plugin software, compatible with several education management software's such as Brightspace, providing a wide range of functionalities related to academic content, and it's different types.

Despite the fact that H5P can be used for a multitude of different activities, its popularity went full tilt during the COVID-19 pandemic as it played a major role in the setting up and delivery of interactive online laboratory practical's.
When it comes to these, the content type defined as 'Branching Scenario' is considered to be a fundamental tool as it allows teachers to structure the steps of the experiment in a certain way so as to display a tree with multiple branches and endings. The choices are then made by the student which will consequently determine the content they will be granted access to, allowing them to take complete ownership of their projects by creating and designing the experiment in the lab. Another very useful feature are the interactive videos. This feature allows teachers to add multiple choice questions, pop up texts and other types of interactions to videos using only a web browser. This has shown to make videos more engaging and has been used for providing instructional videos of key laboratory techniques alongside the laboratory protocol ahead of the laboratory sessions..
During COVID-19 these content software was also widely used for creating virtual excursions by taking advantage of the 360 degree video functionality and the interactive videos. This functionality can also prove extremely useful for preparing the student before going to the field excursion. One of the main problems with this tool is that it's functionalities can only be accessed with a desktop computer and it's use has decreased significantly after some of the restrictions imposed by COVID-19 were removed.

2. EINDHOVEN TECHNOLOGICAL UNIVERSITY

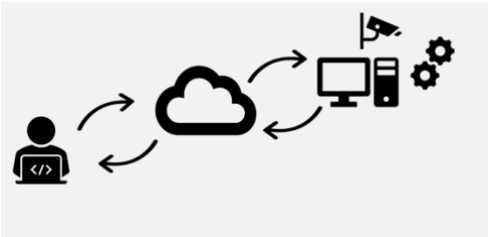
REMOTE LABS

Remote labs is a web-based software system that allows students to carry out engineering experiments by remotely controlling real test setups within the University labs from the comfort of their homes. Students can change parameters, measure signals and can view the whole setup live via the camera feed, all while operating it. This provides significant advantages over traditional simulation models, making for an engaging and tangible experience. Additionally, partaking in actual physical experiments renders the experience with realism by providing non-ideal characteristics, which are often absent in the 'ideal world' of simulation models.

In recent years the TU/e curriculum has been set to offer students as many laboratory practicals as possible, to ensure that the theory acquired in lectures can be properly applied and transferred onto real-world physical systems. However, the increasing number of students has only proven to be a hindrance to this goal's fulfilment as lab projects are often time demanding, directly and negatively affecting the academic calendar, and reducing the availability of both lab spaces and staff members.

As a consequence students wind up with limited time to focus on the experimental setups and are therefore tasked with structured assignments instead, preventing their exposure to the potential setbacks and challenges expected to be encountered that usually serve as valuable learning experiences, which has propelled the Remote Lab project forward, specifically tailored to resolve these difficulties by granting students access to a variety of physical systems remotely, 24/7. The system is fitted with a planning tool with which students can easily keep tabs on the equipment's availability and book time slots to avail of it. Moreover, the software also contains an interactive pedagogic system aiming to guide the student throughout the entire experimental process while providing the students with accurate answers to their preparation questions.

REMOTE LAB EXPERIMENT WITH WATER TANKS. PHOTO | BART VAN OVERBEEKE



This program was first integrated into the course Process Dynamics and Control in 2020, and tested as such with 47 chemistry students: The test setup consisted of three interconnected water tanks, and keeping the water levels within certain limits was the main goal of the entire assignment. In order to achieve this, the students were instructed to operate two pumps and open or close valves, while retrieving real-time information concerning the water levels via sensors. The concept of the remote lab has been in the making for many years as part of the TU/e STRATEGY 2030 and it will be primarily used for Bachelor courses. Interestingly, even though the program was envisioned prior to the global COVID crisis, the closure of the campus during the lockdowns has inevitably accelerated and expanded its system's implementation to further courses.

Remote Labs is currently deployed in its pilot phase for three different courses: Control systems (5ESD0), Systems (5ESB0) and Control systems (5ESD0). The use of the program will be evaluated for a duration of 36 months, upon completion the results will be disseminated through the TU/e internal communication channels. At the final stage of the project, a workshop will be organised, where people that have shown interest in the Remote Labs environment will receive all the instructions, details and software needed so they can start creating their own set-ups towards Remote Labs usage. Although this software is currently only used for control technology, it may be possible to integrate this program to some other applied sciences courses in the future due to the flexibility and scalability of the system (Meer, 2020).

ACOUSTIC VIRTUAL REALITY (AVR)

Sound and acoustics are vital aspects of numerous engineering applications, to say the very least. However, unlike other fields which rely primarily on visual tools, acoustics are mostly taught to students in a purely conceptual way, which has unfortunately given origin to more problems rather than solutions. It is commonplace to seeing students encountering difficulties in acoustic-related projects reflecting the glaring lack of required knowledge to satisfactorily handle or even understand key concepts carrying the most significance.

For instance, when conducting calculations intended to measure sound quantities students are thought to struggle to grasp the meaning or importance concealed behind these variabilities (BOOST TU/e, 2022). Deemed an emerging tool in the research community of building acoustics, Acoustic Virtual Reality (AVR) provides both visual and acoustic VR in 3D, and is currently being further developed as part of a new initiative by TU/e, striving to produce an AVR device intended to evaluate noise and sound in both indoor and outdoor spaces for educational purposes. Moreover, it will also serve as a learning tool for better understanding the meaning of sound in spaces and the consequences of material choice, room geometries, etc, making for an innovative project that promises to support students on their learning journey in all things acoustics, while considerably reducing the teacher's workload.

The project outcomes will consist of:

- A mobile AVR kit (laptop, VR headset, headphones).
- A tutorial for the use of the AVR kit for students and teachers.
- A procedure on rating the acoustic quality of spaces based on using the AVR tool.
- Course evaluations of using the AVR kit in CBL project work.

This is an ongoing project which will be applicable to all CBL projects that involve acoustics and the built environment. Upon completion of the project, an instructional video will be pulled up, touching on how to use the AVR kit, followed by a final conference paper analysing the role of AVR as an innovative education method. Lastly, as an internationally unique project, it is foreseen that it will raise a lot of interest from foreign universities (BOOST TU/e, 2022).

VPI PHOTONICS

Practising with optical components and photonic systems is prohibitively expensive for students and not always possible. There are some existing software alternatives which tackle this issue by allowing the user to design optical communication systems as well as the emulation of photonic devices. VPIphotonics is a professional software program currently employed by companies in the field of optical communication and photonic systems. It emulates the operation of photonic devices, sub-systems, and systems up to the network applications. VPI photonics is currently employed by Postdoc and PhDs in their research and also delivers training courses on suitable modelling techniques and advanced software capabilities (Calabretta

& Matters-Kammerer, 2021) The end goal of this innovation project is to have this software integrated into all virtual optical lab module lectures, providing a better understanding about the technologies of optical interconnect networks. The idea is that it will complement lectures and practical's both in the class or remotely online. The fact that this tool can be accessed online means that the tool can also be used for carrying out dedicated assignments or exploited for research purposes such as final master projects or internships.

This program is specifically intended for the course Optical interconnection networks (5LAH0) from the BSc Electrical Engineering. It is expected to be rolled out in this course in the coming years. This is a unique project and one of the first advanced online virtual lab education tools for optical communication and photonics ever introduced at the EU level.

VOLTA – Virtual Optical Laboratory Assistant

As it was mentioned previously, gaining real-life practical experience in optical communication systems and photonic devices is prohibitive because of the space and costs associated with these devices. We have also seen how these problems can be tackled by the use of professional and commercial software programs such as VPI photonics.

The goal of this project is to develop a virtual optical lab emulator (VOLTA) based VPI that can be integrated to lectures, therefore providing a more in-depth understanding of the technologies in optical communication systems. The main idea is that each lecture will have a corresponding VOLTA module and this integration will allow students to use the program both in class or at home where they learn to design and analyse optical systems. They can also experience and practice the impact of changing components and settings on the system's operation and performance. The tool will also come with the ability to include dedicated assignments on optical systems as well as group projects (Boost, 2022)

The project outcomes will consist of:

- Set the VPI work frame and the cloud repository service for the students' online access and operation
- Develop the interactive teaching modules based on the professional software tool VPIphotonics.
- Develop the virtual laboratory exercises and assignments modules that can accurately reproduce the behaviour of the systems and components
- Develop the assessment modules
- Evaluate student feedback of VOLTA

This is a pilot project that will be initially intended for the course Optical fibre communication technology (5STA0). A timeframe of one semester will be used to develop the modules. The idea is that in the future VOLTA can be extended to other optical communication courses and the online micro master course on photonics. However, this extension will be decided after the completion and evaluation of the pilot project

COMSOL

COMSOL is a software program that enables engineers, scientists, and researchers to simulate and analyse complex physical systems using multiphysics modelling. It allows users to create virtual prototypes of devices, processes, and systems, and test their performance under a wide range of conditions. The program provides a user-friendly interface for defining geometries, setting up physical models, and solving systems of equations that describe the behaviour of the physical system being studied. It supports a wide range of physics, including structural mechanics, fluid dynamics, heat transfer, electromagnetics, and acoustics.

COMSOL is used in a variety of industries, including automotive, aerospace, biotechnology, and electronics, to design and optimize products, reduce costs, and improve efficiency. It is also widely used in academia and research institutions to explore new ideas and advance the frontiers of science and engineering.

This tool has been widely used for practical education in many different Universities across the world as it allows for doing virtual experiments without almost any prior software knowledge by the student. This allows students to better link theory with practice (van Schijndel & Schellen, 2022).

This program is currently used at the third year course Medical ultrasound (5XSD0) of the BSc Electrical Engineering. The possibility of expanding this software to other courses is being studied particularly in Biomedical Sensing Technology (5LSCO), Monitoring respiration and circulation (5LSB0), Advanced topics in Ultrasound imaging in the (bio)medical engineering (8VM70), Ultrasound in the (bio)medical engineering (8VM60), Cardiovascular fluid mechanics in the (bio)medical engineering (BVM00), Transport Physics in the (bio)medical engineering (8VB00).

VIRTUAL REALITY LABS

Virtual Reality is an evolution of computer-assisted instruction that facilitates efficient and safe environments for students, allowing them to dive into a three-dimensional world representing real-life scenarios. This program allows students to go through experiences, learn from applying deep knowledge in hands-on practical assignments and analyse data that otherwise could not have been possible due to risks for health, high costs in equipment and implantation, lack of time and alike. (Engeln & Gomez Puente, 2019).

VR was recently introduced as a pilot for the course Optical diagnostics, a master elective course within the MSc Applied Physics. The focus of this course is to learn the basic principles upon which optical measurement techniques such as emission spectroscopy, absorption spectroscopy, laser-induced fluorescence and Thomson scattering are performed. However, one of the biggest hurdles with working with lasers is the health risks associated with them, requiring extensive expertise and training. Creating a virtual reality lab has allowed the possibility of making experiments with lasers in a safe environment. In addition, the VR for this course recreates authentic scenarios from real life, with students responsible for their own learning as they first sketch and plan their own methods to implement in the VR lab. Moreover, students are able to integrate existing knowledge gained in lectures regarding measurements in the hands-on practical assignments in the VR-lab (Engeln & Gomez Puente, 2019)

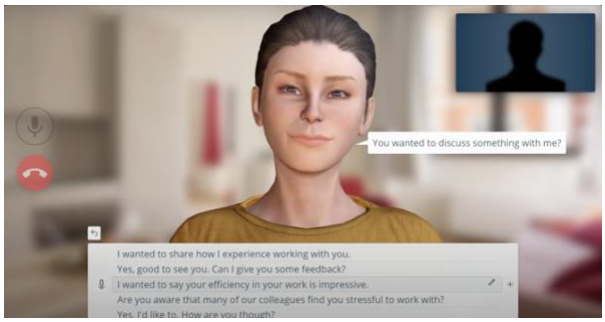
Student experiences the Virtual Laser Lab application and shows how he builds an arrangement to apply a variable time delay in an experiment with a pulsed laser. The computer screen shows what the student sees.

The university is planning to introduce new pilot programs using VR soon and to report results and finding into an academic journal in 2022.

3. Utrecht University

Dialogue Trainer

Effective communication has always been a discipline that could only be learned through face-to-face education. However, recently developed technology such as the Dialogue Trainer app makes it possible to do this online. Dialogue Trainer is an online simulator where students can practice their conversation skills with a virtual character. This character reacts with both text and emotion based on the dialogue choices. An example of this can be a bad news conversation in a medical or veterinary consultation. At the end of a conversation, the student will get a score based on the choices made during the exchange. The student can also receive feedback from the lecturer who can explain the effects of each choice. Dialogue Trainer can prepare students for face-to-face education, it also lets them work on communication skills that would in many cases be hard to train for in real-life (TU/e, 2022).



DialogueTrainer is currently used in several courses of Pharmacy, Psychology, Medicine and Veterinary Medicine.

PleitVrij

A virtual environment that gives students the possibility to practice and argue in a virtual courtroom. This courtroom is based on a video of the oldest courtroom in The Netherlands which has been photographed 360 degrees with a layer in which the audience and judges have been filmed. This allows the student to look around with his Oculus Rift S-glasses where on one side you see the judges and on the other side the audience giving the participant an experience which is very close to reality. The other students (audience) can watch the pleader on a big screen and provide feedback. The video can also be rewatched to contribute to an optimal learning experience. This program was made possible by a grant from the Stimuleringsregeling Open and Online Education and it is financed by the Utrechts Stimuleringsfonds Onderwijs and the universities of Utrecht and Groningen (University Utrecht, 2022).

At the moment this program is in its pilot phase in the Faculty of Law of UU, but Interest has also been shown from other disciplines where communication skills play a major role (SURF, 2021).

Obstetric Simulators

Teaching clinical skills in veterinary sciences such as obstetrical procedures or reproductive examinations is not short of challenges. First, the gap between textbook pictures and working with live tissue is enormous. Another problem is that a teacher cannot control what a student is palpating in a live examination. Although testing skills in live animals remains necessary, good preparation is essential to overcome animal welfare issues. Using live animals for practical education also presents the challenge of high costs, leading to a large student-to-animal ratio making it more difficult for students to gain sufficient experience (Jonker, 2022)

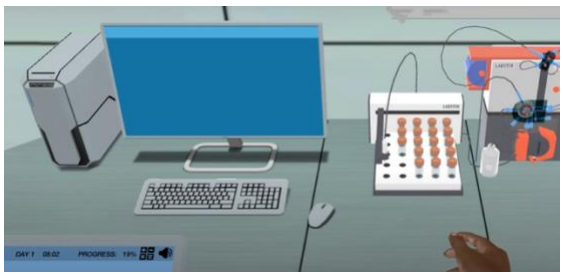
This problem has been overcome by the utilization of simulators and/or models/mannequins such as the obstetrical Holstein Dystocia Simulator, used in the current reproductive course of BSc Veterinary Medicine at UU. This simulator enables the recognition of the posture of the calf and the correction of an abnormal posture; it also allows an assisted vaginal delivery by traction. The use of these mannequins allows for better preparation and training for students before they carry out procedures on live animals. This safe learning environment with mannequins has shown increased confidence and a better ability to recognize reproductive organs by the student. Again, it should be emphasized that models are used in training before real living animals; hence, this technique is complementary and not a complete replacement for training in living animals (Jonker, 2022)

Labster

An online tool that provides a large collection of virtual laboratory simulations. This program creates a virtual and interactive lab simulation where students can conduct experiments showing them what would happen in real life while also underlying the theory behind each procedure. The program has around 200 different labs to choose from with varying levels going from beginner to more advanced ones covering many different disciplines ranging from Biology, chemistry, engineering, genetics, etc.

Labster is ideal for preparing students for real lab experiments while also explaining some of the theories behind the experiments. The virtual lab also creates a safe environment for students where it doesn't matter if they make a mistake. Teachers can monitor the progress of their students via a dashboard function (Educate-it, 2020)

Utrecht university has a license for this program and it can be used by any employee.



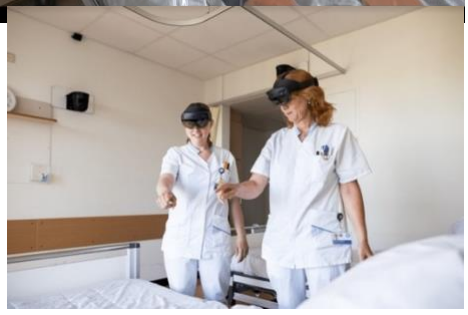
4. Utrecht Medical Center

PathXL

Software that makes it possible to examine microscopic slides online. These coupes are scanned and posted by teachers and made available to the student via a URL. Once the link is accessed the student can zoom, rotate, change depth, take measurements and even see slides in different colours. The tool also offers an e-learning tool where the viewer is guided through a microscopic preparation and is asked carefully directed questions to provide insights about some of the observations.
PathXL can be a great aid for preparing students for practicals at home, making their time at the lab much more efficient. The application also makes it possible to completely replace lab practicals which can be made entirely by digital means. Therefore, teachers are no longer limited to practical rooms with all the accompanying problems, such as the limited amount of expensive equipment and rare and fragile physical slides. Also, another positive aspect of the app is that the teacher can access a library of digital slides from other faculties.
PathXL also facilitates teaching and explanation. Uploaded slides are always available, kept forever and can be examined with the whole class facilitating feedback and plenary discussions. In addition, students can more easily cooperate with each other by working on the same slides.
(Educate-it, 2022)

PathXL is being used in two courses from the BSc Biomedical Sciences and is in pilot stage. A report will be presented upon completion.

HoloLearn



An interactive mixed-reality game environment, where nurses can practice movement-centred care with virtual patients. Physical inactivity during a hospital stay is a major cause of medical complications and delayed recovery. This game allows practising these key skills for nursing and physiotherapy students (Univeristy Utrecht, 2022)

The game starts by putting on the HoloLens goggles and walking to a random hospital room where a virtual patient is lying on a bed. The objective consists in trying to achieve the best possible exercises and energy score for the patient based on the different patient health records and unique personalities. A total of 7 scenarios have been developed with the aim of allowing nurses to experience how movement-oriented care can be integrated into their daily activities, even when the issues of the day are pressing upon them (Dutch Game Awards, 2022)

This game has been developed by HoloMoves BV together with the chair group of Physiotherapy Science of UMC.

DISCUSSION

The collection of inventory alternatives in this report reveals that the tools used by the four partner universities vary significantly. This is primarily because each university has its unique area of specialization. For instance, Wageningen University specializes in the agricultural and environmental sciences, as well as the life sciences. Consequently, it is no surprise that the alternatives used by this university are mostly geared towards complementing laboratory practicals and field excursions. In contrast, Eindhoven University of Technology has a focus on engineering and technology. Therefore, the alternatives used by this university have a stronger emphasis on emulating and simulating the operation of various technological components which are not always possible in real life due to their prohibitive costs or because of safety concerns. Utrecht University, on the other hand, has several faculties covering a wide range of disciplines, including science, veterinary medicine, humanities, social sciences, law, and economics. Many of the described alternatives are shared with Wageningen for the hard sciences. But because it has a lot of social sciences and humanities courses you also see greater availability of alternatives preparing students for soft skills such as communication, argumentation and debate. Finally, Utrecht Medical Centre has alternatives focused on medicine, which is expected given its area of expertise. Overall, the report shows that the programs and tools used in universities are tailored to their areas of specialization. This highlights the importance of considering the unique needs of a particular discipline when choosing inventory alternatives to be used in a university setting.

However, with so many different alternatives available, it can be difficult for course coordinators to determine which ones are the most effective and appropriate for their particular course or subject area. To address this issue, there needs to be a stronger effort towards evaluating these different alternatives from both the perspective of teachers and students. Teachers can provide valuable feedback on the ease of use and effectiveness of different tools, as well as any challenges they may have faced when implementing them in the classroom. Students, on the other hand, can provide insights into the level of engagement, motivation, and overall learning outcomes associated with each alternative. By gathering this information, course coordinators can make more informed decisions about which alternatives to include in their courses in the future. It can also help identify any areas where improvements or adjustments may be needed to optimize the effectiveness of the alternatives. In order to facilitate this evaluation process, it may be necessary to provide training and resources for university admin personnel on how to effectively use and evaluate different alternatives. Additionally, there may need to be a system in place for collecting and analysing feedback from both teachers and students, to ensure that their perspectives are taken into account when making decisions about which alternatives to include in future courses.

The need for more experimentation and innovation in practical education is another essential aspect to improving the effectiveness of teaching methods and learning outcomes. Course coordinators and teachers should take the initiative to pilot the use of different new alternatives. This process should include testing, feedback, and analysis of the results. Experimentation can take many forms, such as small-scale pilots or larger trials across multiple courses or even institutions. Through experimentation, teachers and coordinators can identify what works and what doesn't, enabling them to make informed decisions on these novel alternatives. By exploring new alternatives, teachers and coordinators may discover new ways of presenting material, engaging students, and assessing learning outcomes. It can also be an opportunity to collaborate with other educators and institutions, share experiences and knowledge, and develop new best practices. However, experimentation also requires a certain level of flexibility and openness to change. Educators must be willing to try new things, adapt to different teaching methods and be open to feedback from students. Additionally, the availability of resources and support from institutions is crucial to enable experimentation.

Hosting events and conferences that allow different companies to showcase their practical education alternatives is also a very important step for the promotion of innovation in practical education. By attending these events, educators can learn about new and innovative teaching methods and tools that they can use to enhance their courses. They can also network with other educators and industry professionals to learn about best practices and potential collaborations. In addition, these events can help to promote industry and academic collaborations, as companies can use these events as a platform to showcase their products and services and connect with potential partners or customers in the educational sector. This can lead to new research and development opportunities, as well as collaborations on curriculum development and practical education initiatives.

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