FRIEDRICH-SCHILLER-UNIVERSITÄT JENA

Abbe School of Photonics | JENA
Friedrich-Schiller-Universität

Jena Online Symposium

for Digital Education in STEM 2022

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29 - 30 Nov'22

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Jena Online Symposium
for Digital Education in STEM 2022

Jena Online Symposium for Digital Education in STEM 2022

Contributions and Timeline

Organisation:

Dr. Christian Helgert
Chief Executive Officer ACP and ASP
Abbe Center of Photonics
Albert-Einstein-Straße 6
07745 Jena, Germany

Dr. Falko Sojka
Project team leader digiPHOTON
Abbe Center of Photonics
Albert-Einstein-Straße 6
07745 Jena, Germany

Jari Domke
Project team member digiPHOTON
Abbe Center of Photonics
Albert-Einstein-Straße 6
07745 Jena, Germany

Clara Henkel
Project team member digiPHOTON
Abbe Center of Photonics
Albert-Einstein-Straße 6
07745 Jena, Germany

Fabian Lukas
Project team member digiPHOTON
Abbe Center of Photonics
Albert-Einstein-Straße 6
07745 Jena, Germany

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Program committee:

Prof. Denis Barataud, University of Limoges

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Jena Online Symposium

for Digital Education in STEM 2022

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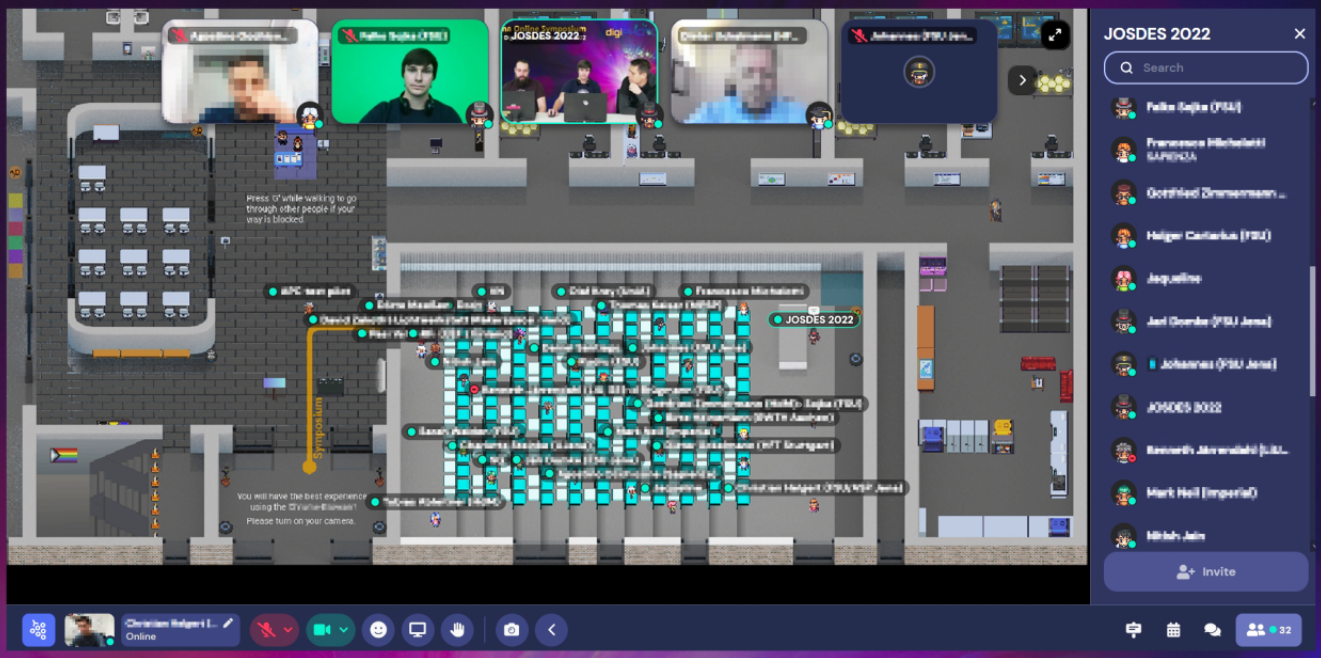


Jena Online Symposium

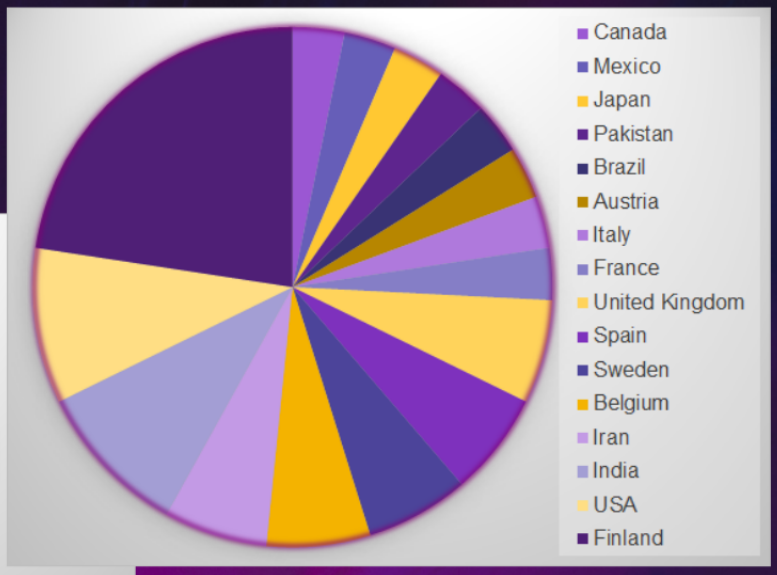
for Digital Education in STEM 2022

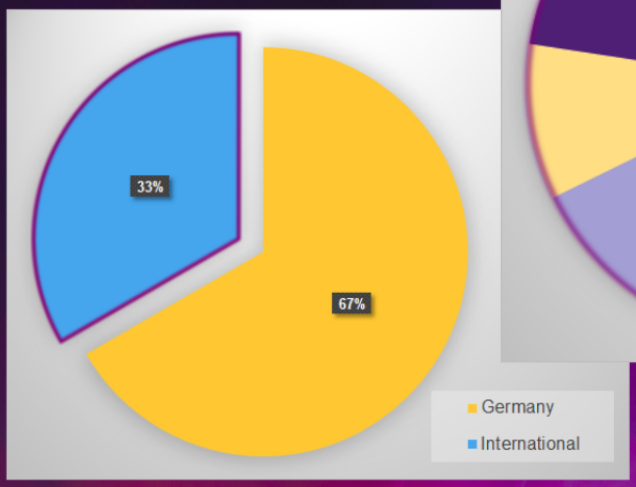
93 Registered participants

8 Keynotes

11 Contributions

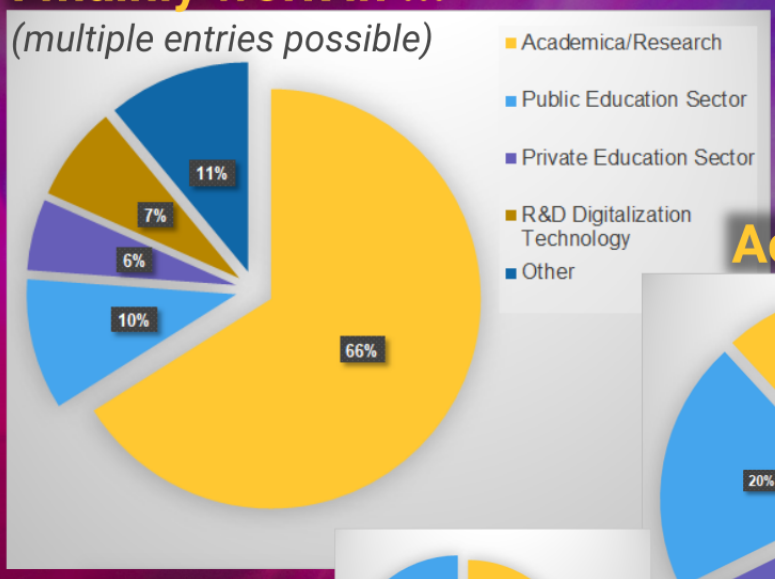
17 Nationalities





I mainly work in ...

(multiple entries possible)



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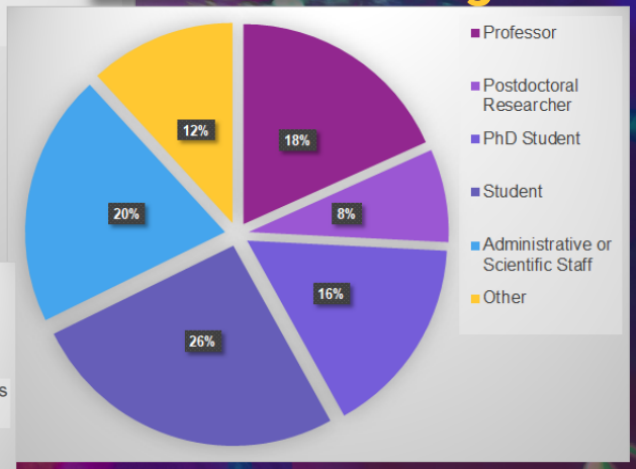
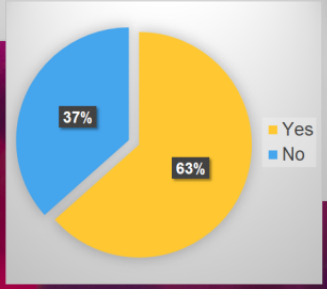
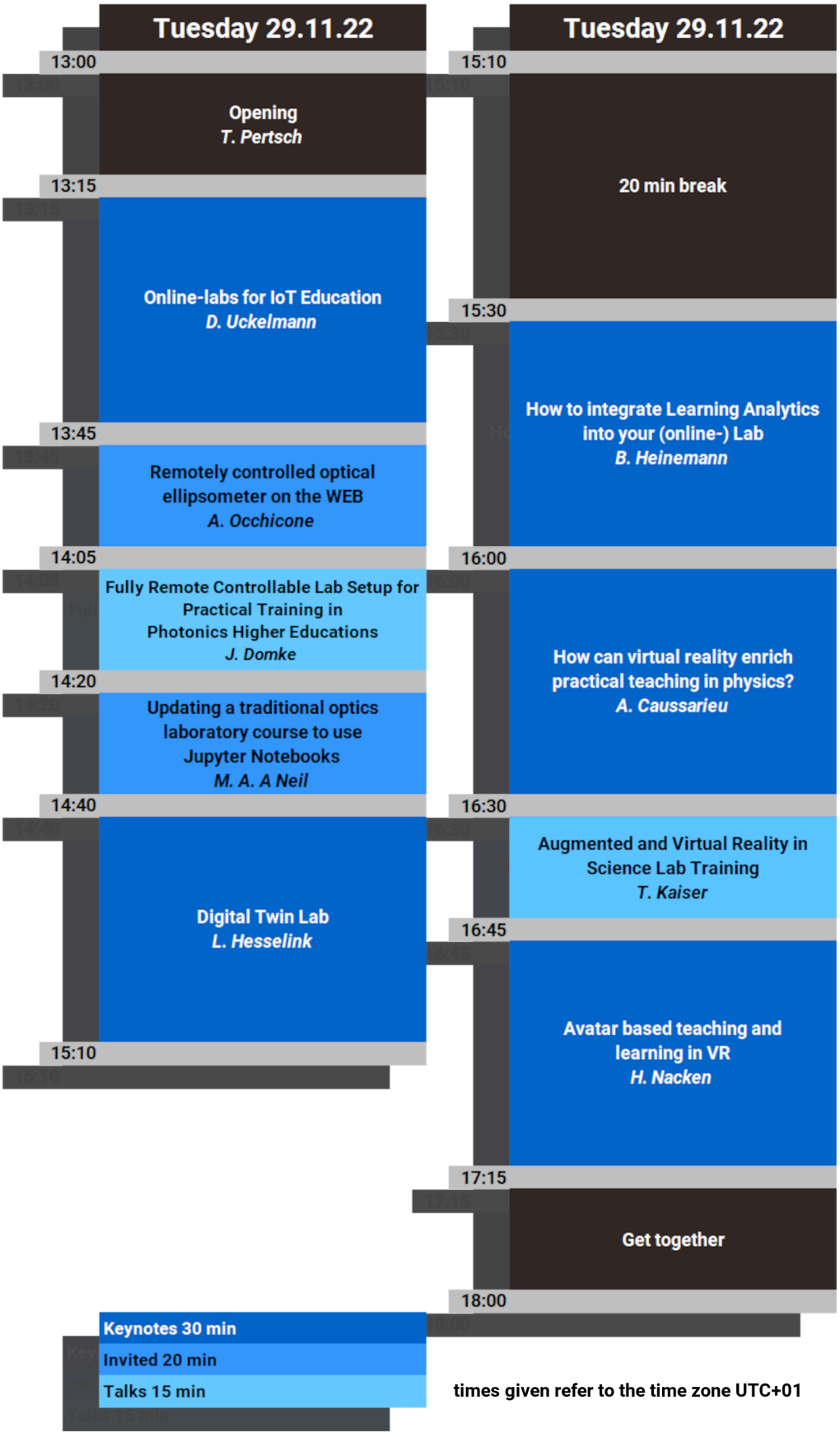


Teaching is part of my job.



Graphical Timeline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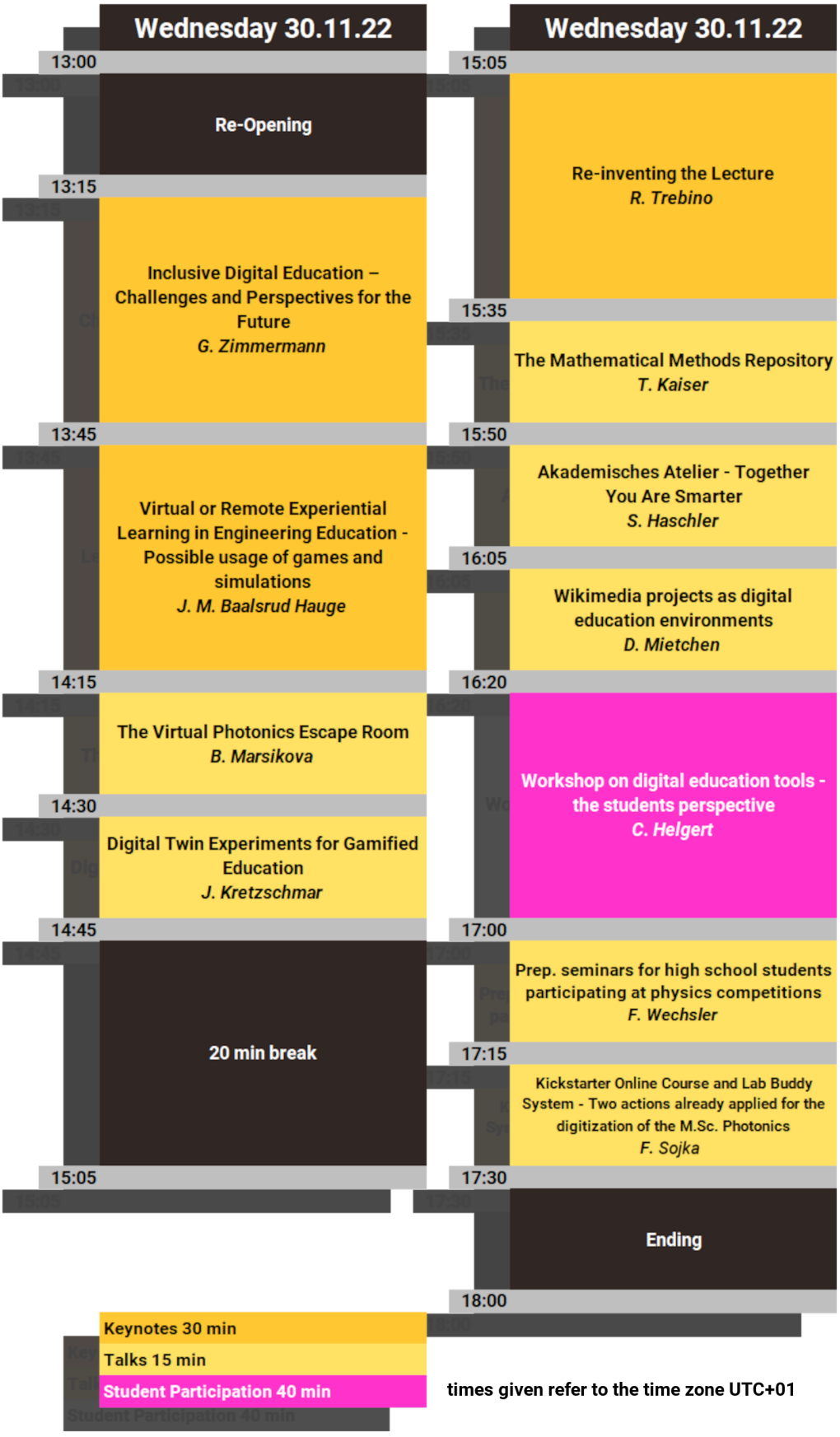
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Keynote

Date: **2022-11-29**

Time (UTC+01): **13:15:00 - 13:45:00**

Online-labs for IoT Education

D. Uckelmann [1]

[1] *Hochschule für Technik Stuttgart (GERMANY)*

The Internet of Things (IoT) bridges the virtual and real world. While the first focus of the IoT was mainly related to logistics and retail, we see a broader usage today in additional domains such as Smart Cities and Buildings, Smart Manufacturing, Smart Energy and Smart Education. The demand for highly skilled employees is growing and universities are expected to provide the necessary skills. While computer science education is providing the information technology skills, IoT skills require additional knowledge and experience related to sensors, actuators and domain-specific real world scenarios, such as provided in educational labs, which are typically used in physics, electronics, production engineering or logistics. However, quite a view of traditional real labs can be transformed into remote labs or substituted by virtual labs. The gaps between real labs and online labs are diminishing – just as the gaps between the real and virtual world in the IoT.

This key-note discusses firstly, how online-labs can enhance education on IoT-content and secondly, how IoT-technologies can be used for making labs remotely accessible to the students. The combination of both aspects leads to synergies and allows to integrate IoT-students into the IoT-lab development and corresponding research. Typical competencies required for the IoT address automatic identification, sensors, actuators, middleware, data visualisation, data analysis, data distribution and domain-specific knowledge – and most of these can be taught in lab-based scenarios. The work is based on the BMBF-funded project “Open Digital Lab for You” (DigiLab4U), which ended in July 2022, and further research related to the IoT. In DigiLab4U real laboratories were digitised and linked with virtual environments and serious games. DigiLab4U provides location-independent access to a digitised and networked learning and research environment. The technical, organizational and didactical concepts, benefits and hurdles of online-labs for IoT-education in DigiLab4U will be discussed.

Keywords: Internet of Things, Laboratories, Higher Education

Corresponding Author
Dieter Uckelmann: dieter.uckelmann@hft-stuttgart.de

Invited

Date: **2022-11-29**

Time (UTC+01): **13:45:00 - 14:05:00**

Remotely controlled optical ellipsometer on the WEB

A. Occhicone [1], F. Michelotti [1]

[1] *SAPIENZA University, Department of Basic and Applied Science for Engineering, Via A.Scarpa, 16 00161 Roma (ITALIA)*

We report on the design, fabrication and use for didactic purposes of an optical ellipsometer that can be controlled by any user via a custom WEB interface. The ellipsometer allows to perform basic experiments in optics, such as specular reflection, transmission, polarization, ellipsometry, diffraction and scattering. The experiments can be performed with 10 different samples: vacuum, a single air/glass interface, a thick cellulose membrane, a slit, a thin indium thin oxide (ITO) film deposited on glass, a portion of a compact disk used as a diffraction grating, an air/silicon interface, an air/ITO/silicon system, a solar cell, a gold coated prism.
The control firmware is based on the National Instruments Labview software used for laboratory equipment control, via its WEB server.
Any remote user can freely connect to the Remote-Lab website at the SAPIENZA University and:

- watch a video describing the main features of the ellipsometer
- review presentations describing in detail the modes of operation, the samples, the description of some exemplary experiments and the graphical user interface
- receive instructions on the remote PC system requirements and on the installation of the National Instruments runtime
- connect to the ellipsometer and begin performing the experiments
- download via ftp the experimental data that can be then analyzed remotely
- The ellipsometer is available at:
  https://remotelab.sbai.uniroma1.it/esperienze/ellipsometer.php

We shall report also on the future development of the system, in particular the improvement of the management of the WEB interface.

Keywords: Basics in Optics, Ellipsometry, Polarization, Reflection, Transmission, Diffraction, Scattering, Surface plasmon polaritons, Solar cells

Corresponding Author
Francesco Michelotti: francesco.michelotti@uniroma1.it

Talk

Date: **2022-11-29**

Time (UTC+01): **14:05:00 - 14:20:00**

Fully Remote Controllable Lab Setup for Practical Training in Photonics Higher Educations

J. Domke [1], C. Henkel [1], J. Kretzschmar [2], F. Lukas [1], F. Sojka [1], C. Helgert [1], T. Pertsch [2]

[1] *Abbe Center of Photonics, Friedrich Schiller University Jena (GERMANY)*
[2] *Institute of Applied Physics, Friedrich Schiller University Jena (GERMANY)*

Remote-controlled experiments have long been part of the everyday life of modern scientists, an experience we do not want to deprive our students of and even take it a step further. This digital transformation of the lab and practical training towards fully remote-controllable laboratories offers a wide range of advantages in future teaching of photonics. As main benefits study programs and courses can potentially be shared across institutions all around the globe or made accessible for off-site students. In the context of the international ”M.Sc. Photonics” degree course at the Friedrich Schiller University Jena (FSU), the two cooperating projects digiPHOTON and Lichtwerkstatt Jena strive to accomplish this.
digiPHOTON is a project funded by the German Academic Exchange Service (DAAD), in which we have taken on the task of making the content of this master’s degree course accessible to online students. The Lichtwerkstatt Jena is a BMBF-funded project with the goal of building up and establishing a photonics maker space at the FSU to facilitate innovation processes between research, industry, and open maker culture. In this contribution we want to show our fully remote controllable lab setup of a Michelson-Interferometer for higher education. It was implemented via XRTwinLab – an open-source framework to virtualize experimental setups and make them remotely accessible via extended reality (XR) technology. It consists of pre-built modules that are easy to adapt by teaching staff and research staff, even if no prior experience in software development exists. To ensure platform independence and offer access without specific devices, it is developed using open web technologies. Finally, to facilitate the use of remote labs as close as possible to real lab work, the framework supports immersive technologies, such as virtual (VR) and augmented reality (AR). Since optomechanical components frequently used in photonics laboratories are not motorized, we provide 3D-printable attachments. The attachments allow for the

addition of actuators and sensors that connect to a wireless network by use of microcontrollers. In the long run, the current GitHub repository used for development is intended as an open library for 3D-models and source code to integrate a broad variety of hardware or measurement devices used in photonics and other research fields. Right now, we have completed one fully remote-controllable experimental setup for a highereducational practical training. It is particularly important to us that a real experiment takes place, which confronts the students with all the challenges of a real environment, including systematic and statistical error sources like noise or other perturbations. We also believe that a real experiment conveys the learning content more convincingly than a simulation that by design only reflects pre-defined assumptions made by the developers. We will discuss the range of functions of our educational lab setup in the context of the possible learning experience in this contribution.

Keywords: Remote Experiment, Lab Course, Open Source, Photonics, Digital

Corresponding Author
Jari Domke: jari.domke@uni-jena.de

Invited

Date: **2022-11-29**

Time (UTC+01): **14:20:00 - 14:40:00**

Updating a traditional optics laboratory course to use Jupyter Notebooks

M. A. A Neil [1] and K. Weir [1]

[1] *Department of Physics, Blackett Laboratory, Imperial College, London (UNITED KINGDOM)*

The long standing Masters course in Optics and Photonics has always had significant element of laboratory training. This starts with a series of 15 three-hour experiments covering a wide range of fundamental topics that we have recently updated to deliver the experiment scripts as Jupyter notebooks. The notebooks provide a rich environment based on markdown that includes latex equations and figures to describe the background theory and experimental procedures. The integrated python interface is used for data acquisition, data analysis and experimental modelling where appropriate. Experiments vary in the amount of these elements they contain, but ensure that students develop each of these key skills through the course.

The Jupyter notebooks include detailed and extensive modelling to enhance student's understanding and provide wide ranging opportunities for them to apply advanced analysis and visualisation of data. In addition, the students produce a complete stand-alone laboratory record of their work by adding their own input to the provided Jupyter notebook scripts. Structuring the experimental script directs students where they should be focussing their activities and encourages them to complete the data analysis and interpretation before moving on to the next stage of the experiment.

One example of these experiments is an investigation of polarisation where students record observations of the transmission of various combinations of polarisers and wave plates. The integrated python code then leads them through presenting that data graphically in an appropriate way using the python matplotlib module and introduces them to tools that they can use to validate Malus's law through rigorous comparison between their results and the theory. By processing their data and any estimated experimental uncertainties with tools from the python numpy and scipy modules they carry out a much more sophisticated analysis of the significance of the errors and uncertainties in their data than they would have done before and therefore gain a better appreciation of the

value of their results and predictions. As they carry out the investigation they automatically create their laboratory record including any conclusions that they draw directly in the notebook.
The use of Jupyter notebooks in this way has a number of pedagogical advantages: it provides a unified way of presenting the 15 different experiments to the students; it gives a mechanism whereby theoretical predictions can be explored dynamically by students as they carry out the associated practical work; it demonstrates how computers can be used to acquire data from instrumentation; it teaches the analysis of acquired data and the appreciation of the significance of experimental uncertainties and errors; it exposes students to the theory alongside the experiment strengthening the links to the theoretical material that they are covering elsewhere in the course. By introducing these new scripts in these first short and prescriptive experiments prepares students well for later experimental elements when they will be working much more independently. Students enjoy this new approach to presenting the experiment scripts and find the direct incorporation of python elements very useful.

Keywords: Optics, Photonics, Jupiter notebook

Corresponding Author
Mark Neil: mark.neil@imperial.ac.uk

Keynote

Date: **2022-11-29**

Time (UTC+01): **14:40:00 - 15:10:00**

Digital Twin Lab

L. Hesselink [1]

[1] *Stanford University School of Engineering, California (UNITED STATES OF AMERICA)*

”As a digital twin, the experiments on the iLabs platform are exact replicas of physical experiments and can be continuously updated. The digital twin contains all sensor readings and images of the experimental setup. Any experiment can be recorded, uploaded and widely shared!
The idea behind iLabs is simple, yet powerful: experiments have a finite number of states. Thus, they can be recorded in their entirety. The resulting data is displayed on this platform - with all details from the physical lab, but easily scalable to as many users as desired.
iLabs originated at Stanford University in the 1990s as the world’s first remote laboratory platform. This new platform brings the concept of digital twins to scientific experimentation and educational laboratories.
If you have any questions about our platform, please reach out to us at bert@kaos.stanford.edu. We are happy to talk about the ongoing development of iLabs and we welcome contributors.” [https://www.ilabs.education/]

Keywords: Scalable Laboratory, Digital, Photonics, Digital Twin, iLabs

Corresponding Author
Lambertus Hesselink: hesselink@ee.stanford.edu

Keynote

Date: **2022-11-29**

Time (UTC+01): **15:30:00 - 16:00:00**

How to integrate Learning Analytics into your (online-) Lab

B. Heinemann [1] et al.

[1] *RWTH Aachen University (GERMANY)*

Learning analytics are tempting - what teacher doesn't wish to gain insights about their learners, improve teaching efficiently and be able to show colorful statistics about learning processes? This keynote will present lessons learned from different projects and provide guidelines and checklists.

This symposium covers online/virtual laboratories, hybrid laboratories, different technologies, and teaching methods. And so this presentation will give an insight into various labs, settings, and projects, for example, a project in which we investigated how to digitize engineering labs and tested different levels of digitization against each other. The question of whether all students will be able to use location-independent labs in the future and optimize their learning process via learning analytics will be examined, and - how do we get meaningful learning data from the labs in the first place?

Not only are laboratories exciting data sources, but different teaching methods, such as serious games and gamification, can give us insight into the learning process and how we motivate and stimulate learners with this variety of teaching styles. Moreover, using technologies such as virtual reality almost demands that we collect and evaluate the learning data. This talk will address what we do with all the data and how we get from data to information.

Keywords: Lab-based learning, Multimodal Learning Analytics, Learning Technologies Research, Virtual Reality

Corresponding Author
Birte Heinemann: heinemann@informatik.rwth-aachen.de

Keynote

Date: **2022-11-29**

Time (UTC+01): **16:00:00 - 16:30:00**

How can virtual reality enrich practical teaching in physics?

A. Caussarieu [1], J. Bribet [2], J. -C. Delagnes [1], L. Dutertre [2], B. Fabre [2], L. Lescieux [2], R. Mrabet [2], E. Cormier [1]

[1] *Univ. de Bordeaux (FRANCE)*
[2] *Alphanov Univ. (FRANCE)*

While we recognize that virtual laboratories will never replace real physics lab in providing authentic learning experiences, they provide legitimate learning opportunities.
In this presentation, we will provide an overview of the various pedagogical goals that may be achieved through physics practicals. It will allow us to identify those for which virtual reality may be a useful alternative.
We will show how instructional design can be used to enhance the effectiveness of virtual reality in physics teaching by discussing several instructional scenarios. And we will discuss the first findings that can be obtained from comparisons of students in the immersive photonics lab and in a real optical lab.

Keywords: Virtual Laboratories, Instructional Design, Virtual Reality

Corresponding Author
Aude Caussarieu: aude@caussarieu.fr

Talk

Date: **2022-11-29**

Time (UTC+01): **16:30:00 - 16:45:00**

Augmented and Virtual Reality in Science Lab Training

T. Kaiser [1], J. Kretzschmar [2], R. Geiss [1], T. Pertsch [1,2,3], A. Tünnermann [1,3,4]

[1] *Max Planck School of Photonics, Friedrich Schiller University Jena (GERMANY)*
[2] *Lichtwerkstatt Jena, Friedrich Schiller University Jena (GERMANY)*
[3] *Abbe Center of Photonics, Friedrich Schiller University Jena (GERMANY)*
[4] *Fraunhofer Institute for Applied Optics and Precision Engineering (GERMANY)*

Successful experiments in scientific laboratories require a specialized sets of skills. The equipment, that students learn to handle, is often sensitive, expensive, dangerous, complicated or a mixture of all of those attributes. In general, lab equipment has limited accessibility. This makes the training process complicated from the organizational and didactic point of view. Learning methodologies are very limited in a classical hands-on setting, although the genre is typically regarded as most worth pursuing in science education. This is due to the fact, that lab trainings address the highest levels in the learning taxonomy and thus promise to promote the deepest understanding.

How can we bridge the gap between a promising outcome and the very limited possibilities of realization? Augmented and Virtual Reality devices are now available on the consumer market for affordable prices. Regarding smartphones and tablets, a situation where one could rely on bring-your-own-device approaches seems feasible. We thus looked to bridge the gap between classical hands-on experiments and theoretical treatment using this immersive technology to create two hybrid settings for lab training.

The first setting makes use of tablets for augmentation. It is intended for use in an undergraduate laboratory experiment at a university. It's didactic design, however, is in no way limited to this. We have created a real labwork setup in the field of physical optics consisting of a light source, filters, apertures, lenses, beamsplitters, camera and so on. It's intention is to provide the possibility to discover the resolution limit of a microscope and related physics. The standard procedure would be to provide written instructions and background information together with measurement tasks on a couple of pages. After having prepared

with this written manual, students are quickly briefed about the handling by an instructor on site and then perform the experiment, concluded by a written report. We have noticed that the gap between preparation with a manual and working with the real setup can be quite large. Thus we have created a learning app using augmentation in two possible modes. In preparation mode, students can literally project the real lab setup onto their kitchen desk and explore the functionality of the components in a virtual way. Vice versa, the app provides additional physical background augmented on the real setup in ”lab companion mode” when the actual experiment is taken.

The second setting emulates a clean room environment. When qualifying future microstructure technology specialists, this is an extremely important aspect of training. However, due to the enormous cost of the machinery, training hours are expensive. We have thus aimed for a solution similar to a flight simulator for pilots which gives the first-time real-world user the certitude of many training hours. Our Virtual Cleanroom runs on a standard Oculus Quest VR headset. We have taken particular care to realistically mimic every step of handling a combined scanning electron microscopy / focused ion beam device starting by venting the sample chamber and loading a sample. A realistic model was created to emulate the special image acquis

Keywords: Augmented Reality, Virtual Reality, Digital Laboratories

Corresponding Author
Thomas Kaiser: thomas.kaiser.1@uni-jena.de

Keynote

Date: **2022-11-29**

Time (UTC+01): **16:45:00 - 17:15:00**

Avatar based teaching and learning in VR

H. Nacken [1]

[1] *RWTH Aachen University (GERMANY)*

The open source software MyScore for avatar-based teaching and learning aims to give students and lecturers the possibility to collaborate and interact with each other in 3D VR scenarios, independent of their real location. Students and lecturers are represented by avatars and can communicate with each other in the various VR scenarios, with a 360-degree neuro and audio function guaranteeing a realistic perception. Collaboration among participants is enabled in the VR scenarios through browser-based functionalities; everything they can accomplish in the real world via web browser is also available to them in VR. In addition, there are separate VR scenarios in which haptic processes, such as the use of laboratory experiments or, for example, the construction of mobile flood protection walls, can also be realized. The existing 3D scenarios range from simple conference rooms for communication to role-play scenarios for the development of communication skills and virtualized laboratory rooms. They are available to users as Open Educational Resources for immediate application. The software was developed as an open source solution within the framework of the DAAD project MyScore at RWTH Aachen University; all scenarios are provided as Open Educational Resources in the sense of UNESCO under a CC BY 4.0 license. The software was developed from scratch, tested and is now part of the curriculum of two courses at RWTH Aachen University.

It is planned to give the talk directly in a MyScore scenario. Participants can participate directly either via VR headset (immersive version) or with a Windows PC solution (non-immersive version). Information can be found at the end of the project homepage https://vredu.lfi.rwth-aachen.de/.

Keywords: VR, Open Source Software, Avatar Based Teaching and Learning, OER Scenarios

Corresponding Author
Heribert Nacken: nacken@lfi.rwth-aachen.de

Keynote

Date: **2022-11-30**

Time (UTC+01): **13:15:00 - 13:45:00**

Inclusive Digital Education – Challenges and Perspectives for the Future

G. Zimmermann [1], T. Ableiter [1]

[1] *Competence Center for Digital Accessibility, Stuttgart Media University (GERMANY)*

Digital Teaching imposes challenges for an inclusive teaching approach in Higher Education. In this presentation, we will talk about general aspects and our experiences in virtual/remote labs, digitally enhanced teaching and online learning. This includes thoughts about immersive environments (AR/VR) in learning contexts, and future perspectives.

Keywords: Higher Education, Virtual/Remote Labs, Digitally Enhanced Teaching, Immersive Environments

Corresponding Author
Gottfried Zimmermann: zimmermanng@hdm-stuttgart.de

Keynote

Date: **2022-11-30**

Time (UTC+01): **13:45:00 - 14:15:00**

Virtual or Remote Experiential Learning in Engineering Education - Possible usage of games and simulations

J. M. Baalsrud Hauge [1,2]

[1] *Bremer Institut für Produktion und Logistik an der Universität Bremen (BIBA) (GERMANY),*
[2] *KTH-Royal Institute of Technology (SWEDEN)*

Experiential work (practical labs, simulations, games) plays a vital role in engineering education. The rationale is that such ways of learning will ensure that the students have become acquainted with the right practical and scientific engineering competencies when leaving university. Labs, simulations and serious games are costly, age fast, require specific staff, and are often used with low utilization if used for a single institution. This talk discusses recent experiences when games, simulation or virtual labs are used in a virtual setting. It also presents shortages and pitfalls in the implementation and operations of the transfer process of such tools from an on-site to an online environment.

Keywords: Serious Games, Virtual Labs, Simulation, Online Environment, Experiential Work

Corresponding Author
Jannicke Baalsrud Hauge: jmbh@kth.se

Talk

Date: **2022-11-30**

Time (UTC+01): **14:15:00 - 14:30:00**

The Virtual Photonics Escape Room

B. Marsikova [1], A. -K. Grimm [2]

[1] *Max Planck School of Photonics, Friedrich Schiller University Jena (GERMANY)*
[2] *Fraunhofer IOF, Jena (GERMANY)*

The Max Planck School of Photonics, a Joint Graduate Program of German Universities and Research Institutions, constantly searches for new Marketing and Digital Teaching strategies to increase the visibility of the field and reach out to potential PhD candidates. For the application phase of 2022 we released the Virtual Photonics Escape Room, as a social outreach activity for interested students all over the world.

Digital Escape Room games became a popular activity for digital socializing during the pandemic. Their concept is similar to the in-person or board game version, where a group of players has to collaborate to solve a series of puzzles to reach the final goal, such as escaping a danger, saving a person or solving a crime, in a given time limit. In the digital version, the game is hosted on a website and the players communicate via a video conferencing platform of their choice. The design and implementation were done by Tim Heitmann and Uwe Malow from D.Escape – Digitale Escape Rooms a Business Gamification Agency.

The game itself has not only a photonics-related story but the puzzles themselves are based on the research topics of the institutions in the MPSP network. Our Escape Room was developed in close collaboration between the agency and the MPSP coordinators to translate the scientific questions into riddles that are feasible for this game environment. In the story, the players get into the role of students visiting one of the labs when they learn that Dr. Dark wants to destroy the Nobel Prize ceremony, because he was not awarded a prize himself. The goal is to find a secret code to re-align his “superlaser”, which is focused on the ceremony site in time. To achieve this, the players travel virtually to all eight MPSP locations, where parts of the code are hidden in puzzles in the research labs. The answers are, for example, found in microscope images or specially prepared molecules. It is however not necessary to be an expert in any of the fields to solve the puzzles, ensuring that the game is suitable for outreach. For

every mentioned research topic, we provide additional information about the scientific background, offering the potential applicants an opportunity to learn more about the specific research. By forgoing the feature of a time limit, we enable the players to freely read these materials without losing their game time. To create an immersive experience, the game starts and ends with videos of Dr. Dark and the student characters who try to stop him. Additionally, the players are guided by a character of Dr. Dark's PhD student, implemented in the form of explanatory voiceovers for the puzzles and a "Hint" button.

This project was funded by the Community Prize of the initiative "Research in Germany" of the German Federal Ministry of Education and Research (BMBF). The research materials that served as an inspiration for the puzzles were kindly provided by the PhD candidates and Fellows of the MPSP network. The Virtual Photonics Escape Room – The Cruel Plan of Dr. Dark is available at https://mpsp-escape-game.de/.

Keywords: digital escape room, outreach, photonics

Corresponding Author

Barbora Marsikova: barbora.marsikova@uni-jena.de

Talk

Date: **2022-11-30**

Time (UTC+01): **14:30:00 - 14:45:00**

Digital Twin Experiments for Gamified Education

J. Kretzschmar [1], S. Ritter [1,2], F. Eilenberger [1,3], T. Pertsch [1]

[1] *Institute of Applied Physics, Friedrich Schiller University Jena (GERMANY)*
[2] *Max Planck School of Photonics, Friedrich Schiller University Jena (GERMANY)*
[3] *Fraunhofer IOF, Jena, Germany*

Quantum is considered a key technology for the future of communication and computing. Accordingly, it is crucial to focus the training and communication not only on university but also at lower educational levels. We introduce a contemporary way to explore and learn about quantum experiments due to the implementation of an augmented interactive gamification layer. We show our method, possibilities, and the used technology within a demonstrator application based on a basic quantum experiment: the Hanbury-Brown-Twiss-Interferometer.

Keywords: Photonics, Augmented Reality, Learning Apps

Corresponding Author
Johannes Kretzschmar: johannes.kretzschmar@uni-jena.de

Keynote

Date: **2022-11-30**

Time (UTC+01): **15:05:00 - 15:35:00**

Re-inventing the Lecture

R. Trebino [1]

[1] *Georgia Institute of Technology, Atlanta (UNITED STATES OF AMERICA)*

The class lecture hasn't changed in 5000 years, continuing to comprise a pitifully dull talking head blathering before a bleak wall with chalk in hand. Having completely sat out the ongoing spectacular technological revolution, it remains, not only limited by inadequate teacher knowledge, but also by his poor oratorical skills. Even at its best, the talking head is generally considered the universal symbol of boredom. Worse, presenting a lecture is exhausting. Worse still, lecture preparation is extremely time-consuming, and lecture notes are not amenable to being shared. So, as with books before Gutenberg, the task of preparing lectures must currently be performed independently, and hence massively redundantly, by every teacher in the world. Lecture preparation absorbs tens of billions of human-hours and over a trillion euros annually.

So, it's time to re-invent the class lecture. If lectures were actually exciting, students would pay attention, not because they fear low grades, but because they'd want to. Alas, a talking head cannot effectively convey this excitement. Teenagers easily remember minute details of popular movies seen years earlier but often can't recall key ideas from math class the previous day.
As a result, I've created visually exciting, elegant, high-tech multimedia Power Point lectures, packed with colorful gifs, animations, images, and diagrams. Then, during the pandemic, I carefully wrote entertaining scripts for them and narrated and meticulously audio-edited them, yielding near-professional videos of entire Modern Physics and Optics courses (https://frog.gatech.edu/talks.html).
While still works-in-progress, they're already vastly superior to live lectures. As downloadable movies, they can be watched anytime and many times, greatly reducing student anxiety. Also, they can easily be shared with the world (which I am already doing, https://frog.gatech.edu/talks.html), solving the redundant-effort problem.
They also immediately solve one pesky problem: the ubiquitous exponential decay of college class attendance over the semester. In my Optics course, for example, because they could do so anytime, all the students reported watching

100 percent of the lectures. Also, grades were spectacular, mostly A's for the first time in a course of mine.
Now, of course, we can't expect teachers to have all the skills or time to create such lectures, especially an entire course of them. But we don't need to. We only need one. Or, better, one team of teachers.
Perhaps the Gates or similar foundation would provide grants of, say, $200,000 per team per course. Creation of, for example, 50 high-school and 200 college courses, each at two different levels, would cost $100M, a fraction of the approx. $1B spent reducing class size in a previous failed attempt to improve student performance.
Implementation of this approach would do for lectures what Gutenberg did for books. Of course, for lectures, we already have the mass-dissemination method (the internet); what we lack is lectures worth mass-disseminating.
The result would be a free permanent resource for the entire world. With it, teachers could then spend their newly available time themselves learning and working more directly with the students. Or they could simply work shorter, less exhausting days at a higher hourly wage.
As the entire world acquires internet access, such lectures could bring quality education to even the poorest schools worldwide. Indeed, Power Point can sub-title narrated lectures into 60 languages. Finally, in countries hostile to the education of girls, girls could self-educate by privately watching such lectures.
In conclusion, I believe this transformation is long overdue, and the resulting better-educated world will enjoy benefits currently unimagined.

Keywords: Multimedia Research, Higher Education, Joint Resources

Corresponding Author
Rick Trebino: rick.trebino@physics.gatech.edu

Talk

Date: **2022-11-30**

Time (UTC+01): **15:35:00 - 15:50:00**

The Mathematical Methods Repository

T. Kaiser [1]

[1] *Max Planck School of Photonics, Friedrich Schiller University Jena (GERMANY)*

The acquisition of skills in Mathematical Methods is a crucial point for successfully managing the first study phase in natural sciences. Without them, concepts of the field cannot be fully understood. It is, however, cumbersome for many students to study this subject, since its content seems to be detached from the field they actually want to study and it is not immediately clear to them, wherefore the trained methods are needed. The starting level of students is also very inhomgeneous, making it different for teaching staff to address the individual needs in classical full-analog learning scenarios. In later semesters, when more depth and knowledge in the specific subject is reached by the students, a frequent wish is to look back at the mathematical methodology once learned ”with new eyes”. It is just in these moments, that higher levels of the learning taxonomy can actually be reached. Here, mathematical methods and subject-specific content are synthesized into a deeper understanding of the field.

The repository is a digital home for all learning content related to Mathematical Methods - from simple introductory content to very specific topics of later semesters. It’s content can be anything from learning videos, assignments, short quizzes to topical discussion forums where students of different semesters can effectively interact and learn from each other. The repository can be used in different learning scnarios from on-site to self-paced learning. The use of an LMS offers the unique possibility to individually trace the learning progress via learning analytics and manage learning paths through the entity of topics. Since the repository is a single place for gathering the entity of topics, advanced learning paths for later semesters can be created which target to modules placed side-by-side with basic content. This allows the students to easily go back and jump to lower-level content to refresh the basics.

Keywords: Learning Analytics, inter-semester teaching

Corresponding Author
Thomas Kaiser: thomas.kaiser.1@uni-jena.de

Talk

Date: **2022-11-30**

Time (UTC+01): **15:50:00 - 16:05:00**

Akademisches Atelier - Together You Are Smarter

S. Haschler [1], A. Suarez [2], S. Floerchinger [3]

[1] *Academic Staff for Implementation of "Akademisches Atelier" project, Friedrich Schiller University Jena (GERMANY)*
[2] *Academic Staff for Digital Teaching and Learning Lab, Heidelberg School of Education (GERMANY)*
[3] *Researcher and Professor for Quantum Field Theory, Friedrich Schiller University Jena (GERMANY)*

With the "Akademisches Atelier", a workshop for the creation of digital teaching and learning content, mainly by and for students of physics and other STEM subjects, is to be set up, from which other students and teachers at schools can also benefit. The digital content should be provided in addition to the normal offers of the university, for example in the form of supplementary courses for special research-related topics, but also didactically specially prepared materials, for example for student teachers. At the same time, the Academic Studio serves as a technological playground and development platform. This allows students and lecturers to try out the latest technologies, learn how to use them and develop them further. An important aspect is the active role that students should play in the "Akademisches Atelier". They should help to process the teaching and learning materials digitally, bring in suggestions for improvement, or work in the development team - this is how they gain valuable experience for their future tasks, for example in science, business or in the school service.

Keywords: Digital Learning, Self-paced Learning, Blended Learning, Learning Management System, STEAM, STEM, Magisterium, Moodle, Innovation

Corresponding Author
Stefan Floerchinger: stefan.floerchinger@uni-jena.de

Talk

Date: **2022-11-30**

Time (UTC+01): **16:05:00 - 16:20:00**

Wikimedia projects as digital education environments

D. Mietchen [1,2,3,4]

[1] *Ronin Institute for Independent Scholarship, Montclair, New Jersey (UNITED STATES OF AMERICA),*
[2] *Institute for Globally Distributed Open Research and Education (IGDORE),*
[3] *Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin (GERMANY),*
[4] *FIZ Karlsruhe - Leibniz Institute for Information Infrastructure, Berlin (GERMANY)*

The ecosystem of websites around Wikipedia facilitates a multitude of educational activities, some of which this talk will sketch out. First, the Wikimedia projects contain collaboratively curated information about a large number of topics (including but not limited to digital and STEM education) and in multiple languages, thereby facilitating introductory education. Second, they provide pointers to additional information available elsewhere, thereby facilitating knowledge discovery and deeper engagement. Third, their content and the underlying software are entirely openly licensed, allowing for independent reuse and adaptation in lots of different ways, both within and outside the Wikimedia ecosystem. Fourth, Wikimedia projects are continuously being updated, in part by reusing or adapting openly licensed materials from other sources, in part by creating new materials, including infographics or data visualizations, textbooks, quizzes or games. Fifth, Wikimedia projects are open for participation, which provides a range of avenues for integration with educational activities. Sixth, Wikimedia projects are sustained by global communities of content contributors, software developers, community organizers, donors and others, which provides multiple paths for prospective contributors to get engaged. Seventh, they are web native and accessible via mobile and desktop devices as well as offline, so they can already be reached from many educational settings, and incorporation into additional ones (e.g. augmented or virtual reality) is not hampered by legal barriers or technological silos. Eighth, activities around this digital ecosystem can be meaningfully combined with other activities like citizen science projects or photography, both on- and offline. Ninth, a good number of examples of activities involving Wikimedia projects and primary, secondary or tertiary education have been publicly documented, and various groups within the ecosystem focus on its educational aspects. Tenth, Wikimedia projects are increasingly integrated

with professional workflows in areas ranging from cultural heritage to journalism, software development, knowledge graphs, disaster management and pedagogy, thereby facilitating educational endeavours across various levels of expertise, especially in open science contexts. Besides highlighting examples for the above, the talk will also outline potential avenues for interactions between the Wikimedia ecosystem and other activities in digital and STEM education spaces.

Keywords: collaboration, open education, cross-disciplinary education, multilingual education, Wikipedia, Wikidata, Wikimedia Commons

Corresponding Author
Daniel Mietchen: daniel.mietchen@ronininstitute.org

Talk

Date: **2022-11-30**

Time (UTC+01): **17:00:00 - 17:15:00**

Preparation seminars for high school students participating at physics competitions

F. Wechsler [1,2]

[1] *Orpheus e.V., Jena (GERMANY)*
[2] *Leibniz Institute of Photonic Technology, Jena (GERMANY)*

We present the idea behind and the design of a series of regular seminars meant to support students in their preparation for physics competitions. Emphasis is placed on the effect the COVID-19 pandemic had on the seminars.

The Orpheus e.V. is a registered association which organizes seminars for gifted high-school students as preparation for physics competitions in Germany. Orpheus e.V. has been founded by former members of the German selection for the International Physics Olympiad (IPhO) which is organized by the Leibniz Institute for Science and Mathematics Education (IPN).

Usually, the preparation seminars are organized as on-site events at varying locations in Germany. Many of the students are not familiar with each other and for most of them it is the first occasion to participate at an event where students from diverse backgrounds and different parts of Germany meet. With the COVID-19 restrictions the concept had to change to an online format.

We will discuss the challenges and present the solutions to overcome the difficulties connected to our specific situation. However, we also conclude that online seminars can not fully replace the conventional on-site events as the social interaction is changed drastically.

Keywords: physics competitions, education, high-school students

Corresponding Author
Felix Wechsler: felix.wechsler@orpheus-verein.de

Talk

Date: **2022-11-30**

Time (UTC+01): **17:15:00 - 17:30:00**

Kickstarter Online Course and Lab Buddy System - Two actions already applied for the digitization of the Master of Photonics course

F. Sojka [1], F. Lukas [1], J. Domke [1], C. Henkel [1], J. Kretzschmar [2], C. Helgert [1], T. Pertsch [2]

[1] *Abbe Center of Photonics, Friedrich Schiller University Jena (GERMANY)*
[2] *Institute of Applied Physics, Friedrich Schiller University Jena (GERMANY)*

digiPHOTON is a project funded by the German Academic Exchange Service (DAAD). In this project, we have taken on the task of making the content of the ”M.Sc. Photonics” program accessible to online students. This master’s course is mainly attended by international students, who normally resettle to Jena in good time before the studies begin, but recently the number of reasons preventing this at least temporarily is rising. By digitalizing the course, we gave students the opportunity to start their studies in time despite travel difficulties or restrictions.

The first thing our students were exposed to after their application was our Kickstarter Moodle course. Moodle is an open-source learning platform designed for distance education and other online learning formats. Our course consists of a collection of hints and advices for a successful start into studying in Jena with a special focus on local characteristics and online study options. Furthermore, we present an overview on necessary prerequisites in mathematics for a successful start to the M.Sc. Photonics studies. They are formulated in such a way that they serve as keywords for engaging in self-study. We also added self-test questions for the new students to easier evaluate their individual state of knowledge on their own. As additional preparation material for highly motivated students, we provide a collection of video tutorials for useful soft skills, such as coding in Python or typesetting with LaTeX.

Since these online students are participants who are only temporarily prevented from attending in person due to external influences, we are interested in flexible and sustainable solutions during the semester. A particular challenge for us was practical content and laboratory experiments. Together with the Open Photonics Makerspace Lichtwerkstatt Jena, one of the approaches was implemented and carried out last winter semester 21/22. Our Lab Buddy system is a

multi-camera conference system that enables a team of two onsite students and one online student to work together in the lab. The system essentially consists of a zoom meeting equipped with a number of cameras (PiCams), which enable various perspectives on the experimental setup, and a hands-free device which enables audio interaction regardless of the number of people. Each individual PiCam automatically connects itself as a participant to the Zoom meeting. In this way, the Lab Buddy system can be used very flexibly with a variable number of cameras, adapted to the respective experiments. This quite simple solution offers a wide scope for possible applications and is therefore adaptable to nearly all practical fields of study.
We have already applied our Kickstarter Moodle course and Lab Buddy system and we will take a detailed look at the feedback from our students in this contribution.

Keywords: Online Students, International, Preparation, Digital, Learner Centered Approach, Moodle, Hybrid Lectures, Lab Course

Corresponding Author
Falko Sojka: falko.sojka@uni-jena.de