Call for book chapter proposals:

Online Laboratories in Engineering and Technology Education - State of the Art and Trends for the Future

Edited volume to be published by Springer

Volume Editors:
Dominik May, University of Wuppertal, Germany, dommay@uni-wuppertal.de
Michael Auer, CTI Frankfurt, Germany, auer@cti-online.net;
Alexander Kist, University of Southern Queensland, Toowoomba, Australia, kist@usq.edu.au

Providing adequate laboratory experience that is convenient for both lecturers and students has long been a major challenge in science, engineering, and technology education. This challenge extends to both traditional laboratory courses, where classes are scheduled within specific timeframes and conducted on-site within academic institutions, and distance learning programs, which often lack significant laboratory-based courses. Moreover, many hands-on instructional laboratory settings fail to account for the diverse skill levels of students, and the allocated time for activities is often insufficient for all students to complete their tasks satisfactorily and gain the necessary experience to internalize complex processes. In some cases, students may wish to perform additional experiments beyond their assigned tasks, but universities often lack the resources to accommodate such additional experimentation. Additionally, the geographical location of laboratory facilities can make them inaccessible to students from other departments within the same institution. Paradoxically, much laboratory equipment remains idle for significant periods, despite its potential for use.

Additionally, recent years have revealed the challenges of offering distance or remotely accessible educational settings in science, engineering, and technology education, particularly when it comes to laboratory-based courses and learning experiences. In response, many academic institutions have attempted to adapt by either transitioning their laboratory classes into online laboratories or providing laboratory kits for at-home usage. Unlike online laboratories being one of several options for laboratory-based instruction, the COVID-19 pandemic made online laboratories the only viable option for many institutions to offer any form of laboratory activities. Drawing from existing research results, this unprecedented situation has acted as a catalyst for numerous new developments, approaches, and activities in this field.

In eight sections (see sections' calls for chapters), this book volume aims to present research findings that encompass both new experiences during the COVID-19 pandemic and long-term research efforts on online laboratories and virtual experimentation in educational contexts. It invites submissions from researchers and practitioners across all disciplines to explore current trends, critical challenges, and future opportunities for laboratory-based education in the context of online learning. Laboratories and experimentation span various disciplines, including engineering, environmental studies, and pharmacology, with related work in higher education research, online learning, computer science, user experience, learning experience labs, and virtual reality research, among others. The editors welcome a diverse range of disciplinary research activities in this field.

Call Details and Timeline (deadline extended):

This book project will follow a 2-step review process. Prospective authors are invited to submit a chapter proposal to one of the sections first, no later than November 15, 2023. On the basis of the 2-page proposal, the editorial team may invite the authors to submit a full manuscript or reject the submission. The chapter proposals should include a title, authors, affiliations, chapter abstract describing the content of the chapter (max. 2 pages), keywords, key references, and a 2-3 sentence describing how the chapter fits the theme of the respective section (see template for further details).

The proposed chapter should be a previously unpublished work. Upon acceptance of the chapter proposal, the full manuscript should be completed no later than February 29, 2024. Guidelines for preparing chapters will be sent to authors upon acceptance of the chapter proposal. Contributions will undergo a peer-review process where the authors identity will be concealed. Authors are expected to peer-review one or two chapters for other book sections (review-to-publish policy). Comments to authors will be returned by March 31, 2024. Finalized full chapter manuscripts are due no later than April 15, 2024.

- All manuscripts should be submitted online on https://www.conftool.net/online-laboratories/
- Authors are requested to choose one of the below-described sections for abstract submission
- Abstract submissions are strictly requested to use the abstract template and should not exceed 2 pages of length
- Abstract template: https://online-engineering.org/dl/online-labs/template_structured-abstract-onlinelabs.docx

We plan to publish this book in the second half of 2024 in Springer publishing house (Cham) in the book series *Lecture Notes in Networks and Systems*

• Call for Paper publication:	August 15, 2023
• Chapter manuscript proposals due (2-page abstract):	November 15, 2023
• Feedback and manuscript invitation (pending publisher decision):	November 30, 2023
• Full chapter manuscripts due:	February 29, 2024
• Notification of reviewers' feedback:	March 30, 2024
• Final chapter manuscript submission:	April 15, 2024
• Notification of final decision:	April 30, 2024
• Expected publication date:	Second half 2024

The edited volume will be sponsored by:

The International Association of Online Engineering (IAOE)

IAOE.

Section 1 - Pedagogy in the context of Online Laboratories and Virtual Experimentation

The term "pedagogy" is interpreted differently worldwide, encompassing both broad educational philosophies and specific classroom teaching methods. This section delves into the theoretical foundations, practical applications, and empirical research related to teaching methods and instructional design, with a specific focus on online laboratories and virtual experimentation, known as "non-traditional labs." These labs utilize technology-driven approaches like remote labs, virtual reality, and simulations. However, pedagogical approaches have not fully adapted to these advancements, leading to a disconnect between instructional methods and real-world practices in academia and industry. This issue is particularly critical in the context of Industry 4.0 (and potentially 5.0), where future skills are essential.

The main objective of this section is to explore cutting-edge non-traditional pedagogical approaches customized for these unique laboratory settings. The goal is to move beyond conventional methods and embrace innovative strategies that push the boundaries of education in these environments.

Full consideration will be given, but not limited, to the following:

1. Case Studies and Applied Research: These studies showcase successful applications of innovative approaches to learning and teaching in instructional laboratories and practice classes.
2. Research Reviews: These reviews offer an overview of the latest research in the field, covering a wide range of topics and subfields.
3. Research-driven Frameworks: These frameworks assist educators in selecting suitable non-traditional methods for online laboratory and practical learning activities. They provide guidance based on empirical research and evidence.
4. Theoretical Studies: These studies delve into the underlying pedagogy of active and practical learning activities. They provide theoretical frameworks and insights into the effective design and implementation of such activities in online and digitalized laboratory settings.
5. Other Contributions: The inquiry welcomes any other theoretical, applied, or empirical studies that deepen our understanding of learning and teaching in the context of online laboratories and virtual experimentation.

Section editor: Claudius Terkowsky, TU Dortmund University, Germany

Section 2 - Remote (Controlled) Laboratories

Within the teaching and learning of science and engineering, practical laboratory work is undertaken to reinforce theory learnt and to demonstrate the ability to put “theory into practice”. Over the last twenty years, remote and virtual laboratories have gone from an interesting idea to mainstream adoption within teaching and learning to support remote learners by engaging with physical experiments through a suitable internet connection. Whilst many and varied laboratories have been developed and are in use today, as technology moves on then there are many more opportunities to enhance existing solutions and realise solutions that are yet to be imagined.

In this section, the remote laboratory as an educational resource to support current and future education needs will be considered. A broad range of perspectives, both technical and non-technical, are brought together to support and, importantly, enhance the student learning experience.

Full consideration will be given, but not limited, to the following:

1. Experiences in Remote Laboratory Establishment and Operation: This perspective includes insights into establishing and operating remote laboratories, with considerations for building online communities of developers and users.
2. Remote Laboratory Networks: This section focuses on providing dynamic support for remote laboratory networks and creating user-generated labs. It also addresses data security, information sharing considerations, and relevant guidelines for remote laboratories.
3. Diversity and Inclusion in Remote Laboratory Design and Operation: This perspective discusses the increasing attraction of Universal Design (UD) and Universal Design for Learning (UDL) principles and guidelines within remote environments. It also covers the adoption of appropriate technologies to bridge the digital divide for students in developing countries.
4. Innovative Use of Remote Labs within the Curriculum: Submissions may explore aspects of serious gaming for student engagement with remote laboratory environments. Additionally, the perspective could encompass "what if" scenarios supporting the investigation of science and engineering ideas using remote labs, such as electronic circuit design and computer software programming.
5. Future Trends: Submissions in this category may cover new and emerging education areas that can be supported through the adoption of remote laboratories. It can also include discussions on student-centered design of remote labs and democratized learning.

Section Editor: Ian Grout, University of Limerick, Ireland

Section 3 - Simulated and Virtualized Laboratories

Simulated and virtualized laboratories are cutting-edge teaching tools that leverage technology to provide hands-on learning experiences for students in various disciplines, particularly in science, engineering, and computers. These labs allow students to engage with virtual objects and conduct experiments without the need for physical materials, simulating real-world activities in a digital environment. Simulated laboratories utilize computer software and models to mimic real-world experiments, offering a safe and cost-effective learning alternative that closely resembles actual laboratory conditions. Taking the concept further, virtualized laboratories create an immersive learning environment using virtual reality (VR) or augmented reality (AR) technologies.

This section will explore successful developments and experiences that can assist STEM professors in enhancing their teaching and learning practices through these technological resources. There will be a particular emphasis on free and/or open-source solutions, which can benefit underserved communities and low-income countries, elevating the quality of their educational systems.

Full consideration will be given, but not limited, to the following:

1. Introduction to Virtualized and Simulated Laboratories: Submissions define the significance and evolution of virtualized and simulated laboratories.
2. Design and Development: This perspective explores principles and best practices for creating effective virtual labs, including user interface, interaction, and experience design. It also covers hardware and software requirements, accessibility and compatibility considerations for diverse learners, and scalability and maintenance of virtual laboratory platforms.
3. Integration into Educational Curricula and Assessment: Contributions discuss strategies for integrating virtual labs into various subjects and educational levels, aligning laboratory activities with learning objectives. It also explores approaches to assess student performance in virtual labs and evaluate their effectiveness.
4. Student Engagement and Performance: This perspective considers enhancing student engagement through interactive virtual laboratory experiences, incorporating gamification and

other motivational strategies. It also explores fostering collaboration and peer learning in virtual laboratory environments.
5. Future Trends and Innovations: This section also focuses on emerging technologies shaping the future of virtualized and simulated laboratories. It explores potential applications beyond science and engineering and predicts the evolution and impact of virtual labs in education.

Section Editor: Uriel Cukierman, National Technological University, Argentina

Section 4 - Augmented, Mixed, and Virtual Reality Laboratories

After a relatively slow digital transformation in higher education over the past decade, the global Covid-19 pandemic provided a much-needed boost. Online laboratories emerged as an urgent alternative to face-to-face labs, alongside various online conferencing tools. Consequently, there has been a remarkable surge in the integration of virtual, mixed, and augmented reality (VR/MR/AR) technologies in higher education. Those equipped with the necessary skills and resources have gained valuable experience in developing and utilizing immersive technologies for teaching and learning.

This section of the book concentrates on the use of immersive learning environments and shares experiences in this domain. It delves into empirical research findings, focusing on the application of augmented, mixed, and virtual laboratories and learning environments within the context of higher education.

Full consideration will be given, but not limited, to the following:

1. Overviews and Meta Studies: These meta studies offer comprehensive overviews of the latest scientific findings in the field, covering a wide range of topics and subtopics.
2. Experimental Studies and In-class Experiences: This section focuses on experimental studies and applied research exploring the effects of Virtual, Augmented, and Mixed Reality on students' learning experiences and performance within the classroom.
3. Theoretical Perspectives and Frameworks: This part presents research-driven frameworks to aid educators in selecting suitable non-traditional methods for online laboratory and practical learning activities. The guidance is based on empirical research and evidence.
4. Innovation and Future Applications: AR and VR technologies present new technical and pedagogical approaches for education. Some of these solutions are not widely used or are still in the user testing stage. However, discussions about future-oriented, out-of-the-box thinking concepts are crucial at this early stage.
5. Other Contributions: This section welcomes any other theoretical, applied, or empirical studies that contribute to a deeper understanding of learning and teaching in the context of virtual, augmented, and mixed reality learning environments.

Section Editor: Valerie Varney, TH Cologne, Germany

Section 5 – Commercial Online Laboratories

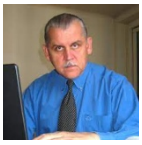
The International Association of Online Engineering (IAOE) is a non-profit organization with a mission to promote the broader development, distribution, and application of Online Engineering (OE) technologies. This vision has been realized through a strong collaboration between universities, industry, and research, evident in the IAOE main Conferences on Remote Engineering and Virtual Instrumentation spanning over 20 years. These conferences have thrived with creative contributions from universities and research institutions, resulting in well-developed commercial online laboratories. The collaboration between academic research and industry involves a bilateral transfer of competencies, leading to the implementation of remote labs that integrate creative educational solutions with commercially available online labs. This approach ensures the highest quality of education in science and engineering.

This book section serves as a dynamic and updated portal, showcasing what can be achieved and how we can adapt, integrate, develop, and optimize the efficiency of commercial online laboratory solutions from partners all around the world.

Full consideration will be given, but not limited, to the following:

1. Status-quo and Trends: This section presents modern solutions for commercial labs, along with insights into future developments and the implementation of Artificial Intelligence.
2. Academia-industry Collaborations and Partnerships: This part explores commercial online laboratories as a service for universities and industries, as well as "turnkey" laboratory solutions that can be easily installed.
3. Mixed Commercial Laboratories and Interconnectivity: This section focuses on supporting online laboratory networks across institutions and fostering the creation of cross-cutting laboratories. It also addresses data security, data sharing, and relevant standards.
4. Commercialization and Scalability: Approaches and experiences in monetizing online laboratories are discussed here. Additionally, advantages and barriers to scalability are examined, enabling educational institutions to accommodate a larger number of students without physical space or resource constraints.
5. Future Trends and Innovations: This perspective delves into the future of academia and industry collaboration in the context of online laboratories. It explores potential applications in fields beyond science and engineering and predicts future areas of development and collaboration.

Section Editors: Doru Ursutiu and Cornel Samoila, Transylvania University Brasov, Romania




Section 6 – Digital Twins and Virtual Instrumentation in Industry

In the constantly changing context of Industry 4.0, Digital Twins and Virtual Instrumentation are gaining significance. Both technologies model real processes, devices, and plants as virtual entities to optimize production processes. Digital Twins enable improved simulations, predictions, and control mechanisms, while Virtual Instrumentation adds flexibility, adaptability, and cost efficiency to measurement, control, and automation processes. These technologies are revolutionizing product design, development, operation, and maintenance. They are at the heart of digital transformation, reshaping our understanding and ability to control and optimize industrial processes. However, as these technologies are progressively integrated, they also present new challenges, such as implementation, interoperability, real-time capability, privacy, and data security issues.

This section invites contributions that explore current research, developments, and experiences with Digital Twins and Virtual Instrumentation in the industry.

Full consideration will be given, but not limited, to the following:

1. Applications: This section covers innovative applications of virtual Instrumentation, encompassing virtual commissioning of devices and plants, as well as interfaces and integration into existing systems.
2. Digital Twins: This part includes case studies on the implementation of Digital Twins in the industry, predictive maintenance through the use of digital twins, digital twin experience on the cloud in the context of Internet-of-Things, and as cyber-physical systems.
3. Security and Privacy: This perspective addresses data security and privacy considerations in Digital Twins and Virtual Instrumentation.
4. Virtualization: The focus is on applications of virtual and augmented reality in the context of virtual instrumentation.
5. Future Trends: This section explores the impact of digital twins and virtual instrumentation on the world of work and discusses other emerging trends in digital twins and virtual instrumentation.

Section Editor: Reinhard Langmann, Reinhard Langmann, Edunet World Association, Blomberg, Germany (Emeritus)

Section 7 – International and Cross-institutional Collaboration in Online Laboratories

Online laboratories have a history of over 30 years, with the concept of remote laboratories proposed as early as 1991. The widespread availability of the Internet in the mid-nineties led to the emergence of online laboratories and facilitated global collaborations in various fields of experimentation. Over the past three decades, collaborative networks worldwide have formed, addressing challenges related to STEM Education, inclusion, diversity, accessibility, and sustainability in the context of rapidly changing technology. In the last two decades, educators' roles have undergone a significant transformation, and there is a growing global concern for sustainable education. Collaborative networks around online laboratories aim to make knowledge and educational tools equally accessible to all, bridging the gap between low-income countries and more developed communities.

The section's focus is to showcase international and cross-institutional collaborations in the realm of online laboratories and highlight their outcomes at various levels. These collaborations demonstrate how sharing ideas and resources can enhance educational opportunities and promote development in low-income and remote regions.

Full consideration will be given, but are not limited, to the following:

1. Accessibility and Inclusion: This section emphasizes the relevance of ensuring that online labs are accessible to students from diverse backgrounds and geographical locations. International collaboration should focus on creating opportunities for learners worldwide, including those from low-income countries and remote regions.
2. Quality and Standardization: Maintaining high standards of educational content and experiential learning in online labs is at the heart of this perspective. International collaboration should strive for uniformity in quality across different institutions and ensure that the learning outcomes are consistent.
3. Technological Infrastructure: Contributions discuss establishing robust technological infrastructure to support seamless online laboratory experiences. This includes reliable internet connectivity, user-friendly interfaces, and compatibility with various devices.
4. Cultural Sensitivity and Adaptability: This perspective pays attention to the important aspect of being sensitive to cultural differences and adapting the online laboratory content to cater to diverse audiences. International collaboration should consider local contexts and preferences while designing educational materials.

5. Knowledge Exchange and Resource Sharing: Contributions discuss facilitating the exchange of knowledge and best practices among collaborating institutions. International collaboration should promote the sharing of resources, experiences, and expertise to enrich the online laboratory offerings and optimize educational outcomes.

Section Editors: Gustavo Alves and Arcelina Marques,
Polytechnic of Porto, Portugal


Section 8 – Lessons Learned for Online Laboratory Instruction in the time COVID

Online laboratories have gained significant prominence in secondary and higher education teaching practices. Originally intended to complement traditional labs, their role was put to the test during the recent COVID pandemic when teaching was abruptly shifted to virtual platforms. As we transition into a post-pandemic phase or the "new normality," it becomes essential to reflect on how Engineering and Technology education was handled and the challenges that were overcome.

This section specifically focuses on sharing theoretical and empirical studies that shed light on the lessons learned from online laboratory instruction during the COVID era. It goes beyond mere descriptions and includes the assessment of learning achievements through quantitative, qualitative, or combined methods. The goal is to identify best practices and effective strategies that emerged during this transformative period.

Full consideration will be given, but not limited, to the following:

1. Theoretical Studies: These pieces lay out the foundation for applied research in the respective context, including the impact of different socioeconomic, political, and geographical environments.
2. Empirical Studies: This includes best-practice examples, projects, and applied research of learning outcomes. Empirical studies also may include the students' point of view about which learning experiences have been more enriching, ways to assess students' learning according to the pedagogical approach, or strategies to potentiate the students' work with empirical evidence of the results.
3. Practical Experiences: This section explores the way classes were carried out during the COVID pandemic, the resources and activities used, and their learning outcomes. It also examines the support provided between different educational institutions, even from different countries.
4. Curricular Implications: Contributions focus on strategies to potentiate the students' work with empirical evidence of the results as well as learning situations, tasks, and assessment which allow students to develop scientific, technical, personal, and social competencies.
5. Look into the Future: This section presents future-oriented work on how this field may develop in the near to middle-term future.

Section Editor: María Isabel Pozzo, National Scientific and
Technical Research Council, Argentina