

Table of Contents

Preface	5
<i>1 Scientific Contributions on Online Labs</i>	
1.1 General Topics and Organizational Issues	
<i>Valentin Kammerlohr and David Paradice</i>	
Fundamental Organizational Aspects of Shared Lab-Networks: Trust, Business- and Maturity-Model Considerations in DigiLab4U	19
<i>Giovanni Esposito, Davide Reverberi, Giovanni Romagnoli and Riccardo Ghinzelli</i>	
Research Data Management for Laboratory Services: the DigiLab4U Use Case of Dataverse	35
<i>Jens Doveren, Birte Heinemann and Ulrik Schroeder</i>	
Towards Guidelines for Data Protection and Privacy in Learning Analytics Implementation	45
<i>Jannicke Baalsrud Hauge and David Romero</i>	
Remote, Virtual and Physical Labs in Engineering Education: What is the Best for What?	53
1.2 Technical Topics	
<i>Erfan Abbasi Zadeh Bebbahani, Hadi Adineh, Dieter Uckelmann and Marc Philipp Jensen</i>	
Digitalization of an Indoor-Positioning Lab Using a Mobile Robot and IIoT Integration	67
<i>Eva Ngo, Tobias Ableitner, Sebastian Koch, Gottfried Zimmermann</i>	
Virtualization of a Smart Home Lab: Design, Implementation and Evaluation	79

<i>Hadi Adineh, Andreas Jaekel and Dieter Uckelmann</i>	
Enabling Remote Laboratories with LabMS – Fundamental Considerations and Proof of Concept	99
<i>Ratnadeep Rajendra Kharade, Hadi Adineh and Dieter Uckelmann</i>	
Comparing Service-Oriented System Management Solutions in Remote and Virtual Laboratory Environments	113
<i>Birte Heinemann, Matthias Ehlenz and Ulrik Schroeder</i>	
Enhancing Serious Game-Based Teaching and Learning through Learning Analytics	127
<i>Matthias Ehlenz, Birte Heinemann and Ulrik Schroeder</i>	
Information Sources and their Potential for Multimodal Learning Analytics in Laboratory-based Learning	139
1.3 Didactical Considerations	
<i>Massimo Bertolini and Mattia Neroni</i>	
Online Labs in Engineering Education: the Experience of SimuLOPS Lab	155
<i>Peter Treffinger, Michael Canz and Jens Glembin</i>	
Opportunities and Shortcomings of Model-based Online Laboratories in Mechanical Engineering – Findings from a Guided Laboratory Study	165
<i>Benedikt Reuter, Gottfried Zimmermann, Tobias Ableitner and Sebastian Koch</i>	
OpenAPETutorial – A Problem-Based Learning Unit for the Personalization of Smart Home Applications	181
<i>Davide Reverberi, Matteo Galli, Davide Mezzogori and Giovanni Romagnoli</i>	
Didactical Concepts and Evaluation of a Supply Chain Management Serious Game	201

<i>Table of Contents</i>	11
<i>Martin Burghardt, Nils Höhner, David Schepkowski and Peter Ferdinand</i> Development of Hybrid Lab-based Learning Environments with a Design-based Research Approach	211
<i>Karsten Henke, Johannes Nau and Detlef Streitferdt</i> Hybrid Take-Home Labs Empower Future STEM Education	225
<i>Martin Burghardt</i> Design, Implementation, and Evaluation of Self-Directed Learning in Digital and Hybrid Lab-based Environments	235
<i>Anke Pfeiffer, Birte Heinemann, Jens Doveren and Ulrik Schroeder</i> Implementing Learning Analytics-based Feedback in Online Laboratories—using the Example of a Remote Laboratory	245
<i>2 Educational Chapters (Didactical Considerations)</i>	
<i>Yasmin Hayat, Tobias Ableitner, Gottfried Zimmermann, Sebastian Koch</i> Universal Design & Personalization for Smart Homes – Concepts	265
<i>Benedikt Reuter, Gottfried Zimmermann, Tobias Ableitner and Sebastian Koch</i> Universal Design & Personalization for Smart Homes – Implementation	289
<i>Majsa Ammouriova, Juliana Castaneda, Rafael David Tordecilla and Angel A. Juan</i> Heuristics to Solve a Team Orienteering Problem	307
<i>Jannicke Baalsrud Hauge and Wajid Khilji</i> Smart Production Logistics Concepts	327
<i>Jan Seedorf, Kazim Mazhar, Florian Schwabe and Irman Omerovic</i> Applied Cryptography in the Internet-ofThings	361

<i>Matas Führer, Roland Heinrich, Abdelwadoud Mabrouk, Tobias Christian Piller, Abdelmajid Khelil and Kubilay Yildiz</i>	
Online-MQTT: Online Lab for Basic and Advanced Features of the MQTT Protocol	375
<i>Dieter Uckelmann and Anke Pfeiffer</i>	
Understanding the Impact of Measuring and Choosing RFID-Transponders for Applications in Logistics	389
<i>Jannicke Baalsrud-Hauge, Anindya Chowdhury, Prabahan Basu, Sundus Fatima, Jakob Baalsrud-Hauge and Artem Schurig</i>	
Data-Driven Warehouse Logistics Concepts	407
<i>Giovanni Romagnoli, Dieter Uckelmann, Davide Reverberi and Maria Ustenko</i>	
Applied RFID in Logistics Testing RFID Technology for its Application in the Fast-Moving Consumer Goods and Apparel Industries	425
 <i>3 Interactive Demos</i>	
<i>Michael Klein, Andrej Itrich and Thomas Eppler</i>	
Interactive Demonstration showing a Remote Lab using the Fischertechnik learning Factory 4.0	463
<i>Paul Press</i>	
A Rationale to Form a Community to Develop Free Online Simulations that improve Access to Higher Education Science and Engineering Courses for Students in Low-Income Countries	471
<i>Johannes Kretzschmar, Clara Henkel, Falko Sojka, Jari Domke, Thomas Kaiser, Christian Helgert and Thomas Pertsch</i>	
XR Twin Lab: an Open-Source Toolbox for XR Remote Access to Experimental Setups in Photonics based on Web Technologies	479

<i>Table of Contents</i>	13
<i>Hans-Georg Reimer, Felix Gers and Steffen Prowe</i>	
Is Game-based Learning as a Computer Game a Benefit for Teaching?	485
<i>Jean-Vincent Loddo and Rushed Kanawati</i>	
Mariotel: A Virtual Remote Computer Science Lab	491

