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Publications are listed according to the Intellectual Output (IO) aims and results obtained in

**IO1-IO2:**

**1. Enhancing laboratory teaching through digital tools – emerging examples from the UK and other European institutions (Conference Oral Presentation/University of Leeds)**

- **Authors:** Aysha Divan & Christopher Randall
- **Presented at** Technology-enhanced Learning in Laboratories Workshop (TELL) 2023\*
- This poster presents a brief overview of how digital tools were/are being used in European HEIs before, during and after the pandemic (IO1-IO2 Survey & analysis)

**IO3:**

**2. Digital labs as a complement to practical laboratory training for Bachelor and Master biomedicine students (Conference Proceedings Publication /Karolinska Institutet)**

- **Authors:** Louisa Cheung, Leena Strauss, Per Antonson, Sanna Soini, Matthew Kirkham and Rachel M Fisher
- **Presented at** Technology-enhanced Learning in Laboratories Workshop (TELL) 2023
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>
- **Direct download of the article:** [https://ceur-ws.org/Vol-3393/TELL23\\_paper\\_9410\\_1.pdf](https://ceur-ws.org/Vol-3393/TELL23_paper_9410_1.pdf)
- This paper examined the student perception of using digital laboratories in 13 courses within Biomedicine/Life Science at two different universities, University of Turku and Karolinska Institutet. Students' responses and comments were collected with survey questionnaires at the end of each course. Student feedback is important as it helps university teachers to gain insight on course design when incorporating digital laboratories in university courses. At present, however, digital laboratories could not support the teamwork and interactions between students that would take place in the real-life laboratory sessions. Since large amounts of data are collected in digital laboratory modules, learning analytics (LA) would help to identify the difficult concepts requiring additional support in other teaching and learning activities. While student feedback is always subjective, LA would provide valuable additional objective insight for an informed decision when choosing appropriate education tools for the future generation.

**3. Manuscript in preparation (Jenny Isaksson *et al.*, Åbo Akademi University)**

#### IO4:

#### 4. *International Online Team-based Learning in Higher Education of Biomedicine: Evaluation by Learning Analytics* (Conference Proceedings Publication/*Universities of Turku and Eastern Finland*)

- **Authors:** Laura Mairinoja, Sonsoles López-Pernas, Ramy Elmoazen, Einari A Niskanen, Tiina Kuningas, Anni Wärrri, Mohammed Saqr, Leena Strauss
- **Presented at** Technology-enhanced Learning in Laboratories Workshop (TELL) 2023
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>
- **Direct download of the article:** [https://ceur-ws.org/Vol-3393/TELL23\\_paper\\_1668\\_5.pdf](https://ceur-ws.org/Vol-3393/TELL23_paper_1668_5.pdf)
- In this work, learning analytics data were collected from Discord, which was the communication platform for students and teachers during the teamwork. The Community of Inquiry (CoI) framework was used as guidance, and indicators of CoI's social, cognitive, and teaching presences were used as a scheme for coding the interaction. To recognize the process of collaboration, the data were first analyzed by using process mining. Further, to understand the multidimensional property of collaboration, we developed a network analysis and visualized the results. In addition, a student survey was carried out. In line with the learning analytics data, the results of the survey pointed out the need of more in-depth instructions on how to carry out the team exercises, which belongs to the teaching presence category in the frame of CoI.

#### IO5:

#### 5. *Proceedings of the Technology-Enhanced Learning in Laboratories Workshop (TELL 2023) - CEUR Workshop Proceedings, Vol. 3393* <sup>\*)</sup> / *Universities of Eastern Finland and Bergen*

- **Editors:** R. Elmoazen, S. López-Pernas, K. Misiejuk, M. Khalil, B. Wasson, & M. Saqr (Eds.)
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>

#### 6. *Understanding Collaboration in Virtual Labs: A Learning Analytics Framework* (Master Thesis/*University of Bergen*)

- **Candidate:** Hanna Birkeland
- **Supervisors:** Mohammad Khalil, Barbara Wasson
- **Link to publication:** <https://bora.uib.no/bora-xmlui/handle/11250/3001938?locale-attribute=en>
- Thesis includes a literature review and a conceptual framework on learning analytics to support collaboration in virtual labs.

#### 7. *Learning Analytics in Collaborative Online Lab Environments: A Systematic Scoping Review* (Conference Poster/*University of Bergen*)

- **Authors:** Hanna Birkeland, Mohammad Khalil, Barbara Wasson.
- **Presented at** Learning Analytics & Knowledge (LAK) Conference 2022
- This poster presents a brief overview of a scoping review of the current research within the area of learning analytics and collaboration in online laboratory environments, including results on the used learning analytics methods.

#### 8. *The basic principles of temporal networks in education: The why, the what and the how of modeling a dynamic and relational learning process* (Conference Article/*University of Eastern Finland*)

- **Authors:** Mohamed Saqr, Sonsoles López-Pernas
- **Presented at** Netscilla 2022 "Networks and Learning Analytics: Addressing Educational Challenges" workshop
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>
- **Direct download of the article:** [https://ceur-ws.org/Vol-3258/article\\_4.pdf](https://ceur-ws.org/Vol-3258/article_4.pdf)

- This paper explains the basics of temporal networks, the different subtypes thereof, and the measures that can be taken, as well as examples from the few existing prior works.

**9. *Learning Analytics in Virtual Laboratories: A systematic Literature Review of Empirical Research* (Journal Paper/Universities of Eastern Finland and Bergen)**

- **Authors:** Ramy Elmoazen, Mohammed Saqr, Mohammad Khalil, Barbara Wasson
- **Published in** Smart Learning Environments Journal
- **Link to the review article:** [DOI 10.1186/s40561-023-00244-y](https://doi.org/10.1186/s40561-023-00244-y)
- This paper aimed to assess the use of learning analytics in virtual lab empirical publications. Total 21 articles study from 2015 to 2021 were reviewed. The finding of this study showed that learning analytics of the studies is mainly based on student log files and the reviewed articles used learning analytics to assess performance, activities, perception, and behavior. The studies are distributed over different fields, platforms, and methods.

**10. *Instant or distant: The tale of two interaction platforms and their influence on collaboration* (Conference Proceedings Publication/University of Eastern Finland)**

- **Authors:** Mohammed Saqr, Sonsoles López-Pernas
- **Presented at** European Conference of Technology Enhanced Learning (ECTEL) 2022
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>
- **Direct download of the article:** [https://doi.org/10.1007/978-3-031-16290-9\\_55](https://doi.org/10.1007/978-3-031-16290-9_55)
- This study compared two iterations of the same course where students had the same virtual collaborative activities. In the first iteration, the students had to use the typical discussion forums offered by the popular Moodle learning management system. In the second iteration, students had to use Discord, the popular gaming chat application. Students in the Discord group had higher indegree (i.e., more students received replies from different collaborators) compared to the Moodle network.

**11. *Tackling the Challenges with Data Access in Learning Analytics Research: A Case Study of Virtual Labs* (Conference Paper/University of Bergen)**

- **Authors:** Kamila Misiejuk, Mohammad Khalil, Barbara Wasson
- **Presented at** Technology-enhanced Learning in Laboratories Workshop (TELL) 2023
- **Link to publication:** <https://ceur-ws.org/Vol-3393/>
- **Direct download of the article:** [https://ceur-ws.org/Vol-3393/TELL23\\_paper\\_9675\\_6.pdf](https://ceur-ws.org/Vol-3393/TELL23_paper_9675_6.pdf)
- Data play a crucial role in learning analytics research. The analysis of student digital traces has the potential to not only provide new insights into authentic student learning but also to inform interventions and give students feedback on their performance. However, there are many challenges to implementing learning analytics, such as access to data and difficulties with aligning learning activities with appropriate data collection. This paper describes some of these obstacles encountered during a European project that focused on collaborative learning in virtual labs with help of learning analytics and presents recommendations for future learning analytics initiatives.

\*<sup>1</sup>) Table of Contents of **TELL 2023**, <https://sites.uef.fi/edtech/projects/tell2023/>

***Proceedings of the Technology-Enhanced Learning in Laboratories Workshop (TELL 2023) - CEUR Workshop Proceedings, Vol. 3393***

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**Summary:** There were 10 papers submitted for peer-review to this workshop. Out of these, 7 papers were accepted for this volume, 6 as regular papers and 1 as short paper.
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- [Supporting Microscopy Learning with Ocul-AR, a Virtual and Augmented Reality-Powered Mobile Application](#) 28-37  
Joanna W. Pylvänäinen, Laura Mairinoja, Tino Tuomisto, Junel Solis, Diana M. Toivola, Pasi Kankaanpää
- Enhancing laboratory teaching through digital tools – emerging examples from the UK and other European institutions Conference presentation (not published) by Aysha Divan, University of Leeds, UK
- [Virtual Laboratories for STEM in Nigerian Higher Education: The National Open University of Nigeria Learners' Perspective](#) 38-48  
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