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Evaluating digital experimental tasks for physics laboratory courses

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Motivation & goals

- Lab concepts usually follow the approach of task-based learning
  - **Good experimental tasks are the main learning opportunity** in lab courses
  - **New developed tasks need to be evaluated** & re-designed based on the findings
- Already two evaluation approaches exist:
  - **Evaluation of a lab course in its entirety**, e.g., its teaching quality (PraQ, [1])
  - **Assessment of students' acquisition of specific competencies**

    e.g., for experimental skills [2,3], the acquisition of expert-like views on experimental physics (E-CLASS, [4]) the improvement of conceptual understanding [5], or critical thinking (PLIC, [6])
- **But: typical lab courses consist of multiple tasks & development of competencies takes place on a larger time scale than the execution of single tasks**

→ Both approaches are unsuitable for evaluating single experimental tasks

→ Need for a new instrument focusing on the experimental task

Development of the evaluation questionnaire

- Development followed two guiding questions:
  - **To what extent are the developed experimental tasks from students' point of view suitable for university education?**
  - **How do students experience working on the experimental task?**
- Discursive development and structuring of items within our project group based on literature (e.g., [9,10]) and own experiences/interests
- Communicative validation with 2-3 students in each language (mostly native speakers)

→ Questionnaire available in four languages: English, German, Finnish & Croatian

Overview of the questionnaire

Aspects	# Items	Scale	Example items
Personal information	8 + 1 open	nominal & 5-point scale	➢ What is your major field of study? ➢ In general, where would you put doing lab experiments on the scale from interesting to boring?
Efficacy/ perceived learning gains	7	5-point scale strongly disagree – strongly agree	*After completing the task…* ➢ … I could explain the physical concepts in this task to someone else. ➢ … I feel like I learned something new.
Adequacy of the task	13	5-point scale strongly disagree – strongly agree & nominal	➢ The task instructions were easy to understand. ➢ This experimental task was too easy/adquately challenging/too difficult for my level of study.
Students' experience during the task	12	5-point scale strongly disagree – strongly agree	➢ During this task, I felt frustrated. ➢ I had opportunities to make my own decisions about the experiment.
Experimental activities in focus	15	no – somewhat - yes	*In this task I had to…* ➢ … formulate my own hypothesis. ➢ … collect reliable data.
Use of digital technology in the task	7 +1 open	5-point scale strongly disagree – strongly agree	➢ Digital technologies made this task interesting. ➢ The effort to learn how to use digital technologies in this task was worthwhile.
Final questions	1 +3 open		➢ What did you like about the task? And why? ➢ What would you change in this task? And why?

The Erasmus+ project DigiPhysLab

- Cooperation between the Universities of Jyväskylä (FI), Göttingen (DE) & Zagreb (HR), co-funded by the Erasmus+ program of the European Union (03/21-02/23)
- Main objectives/intellectual outputs [7]
  - **Development of a framework for designing experimental tasks** [8]
  - **Production of 15 competence-centered, digital physics lab tasks for on-campus & distance learning** (instructions for students and instructors)
    - Standalone experimental tasks (independent from a specific lab concept)
    - Data collection with smartphone & digital data analysis
    - Main target group: physics major & teacher students in the study entry phase
  - **Pilot and evaluation of the tasks** with students in our faculties using the presented questionnaire and accompanying interviews

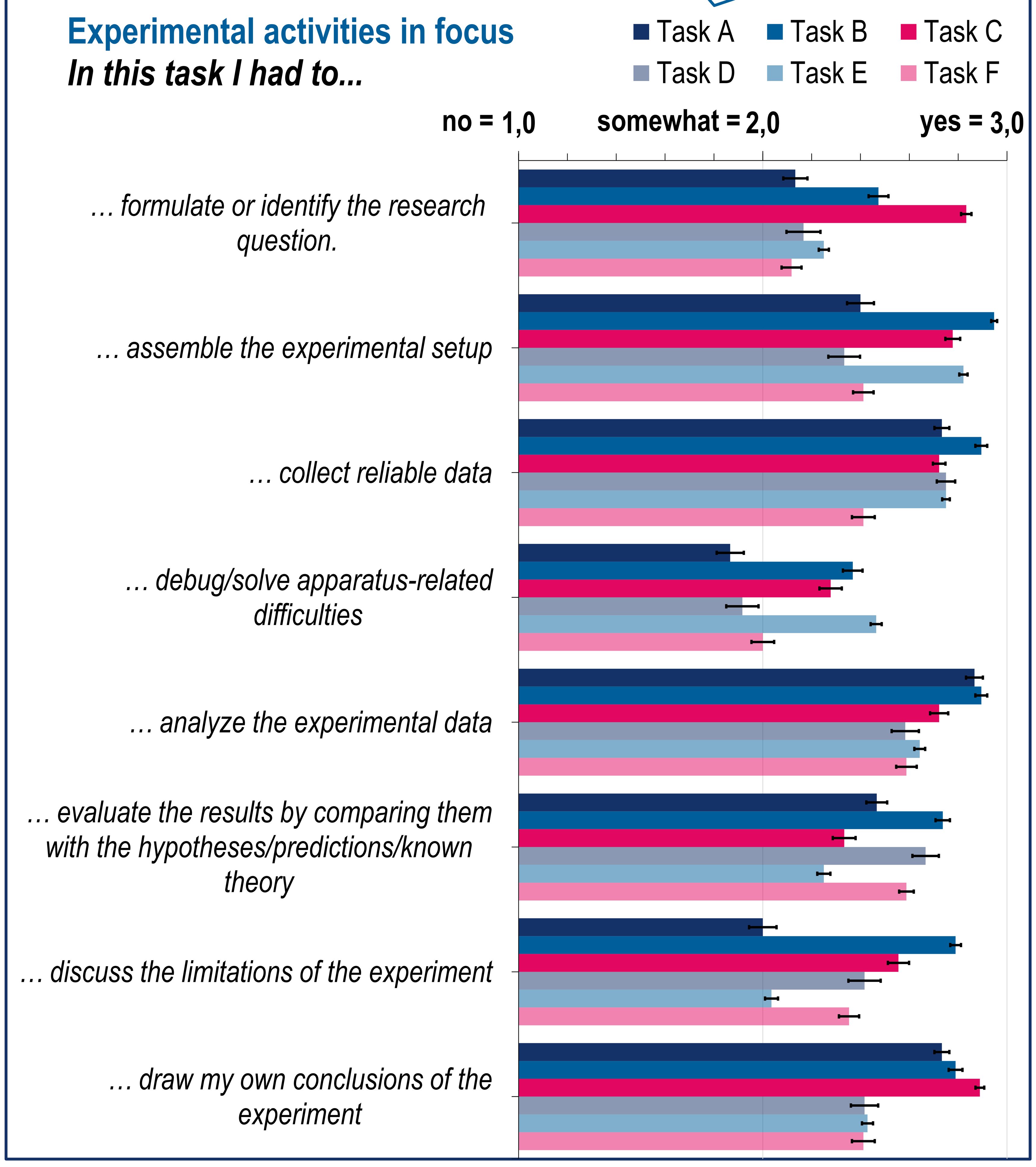
→ Dissemination of all materials as OER on our project website

https://www.jyu.fi/digiphyslab

Example data

Task	A	B	C	D	E	F
N participants	15	19	18	13	28	17

For more information about the tasks please visit poster DD 27.1!



Outlook

- Questionnaire allows evaluation of experimental tasks within the DigiPhysLab-project and beyond to improve tasks and lab course concepts
- Further statistic and expert validation of the instrument is needed

Literature

[1] Rehfeldt, D. (2017). *Erfassung der Lehrqualität naturwissenschaftlicher Experimentalpraktika*. Berlin, Logos.

[2] Schreiber, N. (2012). *Diagnostik experimenteller Kompetenz*. Berlin, Logos.

[3] Bauer, A. (2023). *Experimentelle Kompetenz Physikstudierender*. Thesis, Universität Paderborn. https://doi.org/10.17619/UNIPB/1-1652

[4] Zwickl., B. M., Hirokawa, T., Finkelstein, N., & Lewandowski, H. J. (2014). Epistemology and expectations survey about experimental physics. *PHYS REV SPEC TOP-PH.,* **10**, 010120.

[5] Holmes, N. G., Olsen, J., Thomas, J. L., & Wieman, C. E. (2017). Value added or misattributed? A multi-institution study on the educational benefit of labs for reinforcing physics content. *Phys. Rev. Phys. Educ. Res.*, **13**(1), 010129.

[6] Walsh, C., Quinn, K. N., Wieman, C., & Holmes, N. G. (2019). Quantifying critical thinking. *Phys. Rev. Phys. Educ. Res.*, **15**, 010135.

[7] Lahme, S. Z., Klein, P., Lehtinen, A., Müller, A., Pirinen, P., Susac, A., & Tomrlin, B. (2022). DigiPhysLab: Digital Physics Laboratory Work for Distance Learning. *PhyDid B,* 383-390.

[8] Lahme, S. Z., Pirinen, P., Roncevic, L., Lehtinen, A., Susac, A., Müller, A., & Klein, P. (2023). A framework for designing experimental tasks in contemporary physics lab courses. Preprint on arXiv, submitted to the proceedings of GIREP conference Ljubljana 2022. http://dx.doi.org/10.48550/arXiv.2302.14464

[9] Pekrun, R., Vogl, E., Muis, K. R., & Sinatra, G. M. (2017). Measuring emotions during epistemic activities: The Epistemically-Related Emotion Scales. *Cogn. Emot.*, **31**(6), 1268-1276.

[10] Trình-Bá, T. (2016) *Development of a course on integrating ICT into inquiry-based science education.* Thesis, Vrije Universiteit Amsterdam. https://research.vu.nl/en/publications/9a4434c0-9e95-4b8e-b150-4b230b546578