Latvian students' perceptions of experimental physics: insights from E-CLASS survey

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Abstract. Our ambition is to improve physics courses at the University of Latvia by transforming the lab works, to focus on practical skills and engage students in experiments. To assess Latvian students' perceptions of experimental physics and monitor changes during the transformation, we utilised the Colorado Learning Attitudes about Science Survey (E-CLASS) instrument with groups of bachelor and master students. Preliminary findings revealed the baseline of students' attitudes and demonstrate the diverse impact lab instructions can have on them. Characteristic differences for group scores emerged in individual survey questions, highlighting the importance of instructional design for achieving the intended learning goals.

Need for changes in laboratory course instruction

Practical laboratory is an integral component of university physics courses, where students not only learn procedures and practical skills relevant to research in physics but also acquire soft skills desired in any field, such as collaboration and critical thinking. Numerous studies demonstrate versatility of contemporary lab formats, and inquiry-based lab approaches are shown to be more effective than traditional guided labs for learning experimental physics [1,2]. This motivates us to transform the physics lab courses at the University of Latvia towards a more inquiry-based, student-centred, technology-supported, and practical skill-oriented approach.

Clear goals and reliable assessment instruments to monitor changes are essential for the lab transformation process. Firstly, we must assess the current state and distinguish some critical points, where changes in the lab format and content are needed. The Colorado Learning Attitudes about Science Survey (E-CLASS) for experimental physics has proven to be a useful tool for assessing student attitudes and measuring changes resulting from instructional interventions [3]. This instrument has been previously utilised in various regions, including North America [2,3], Asia [4], and Europe [5].

In this study, we establish a baseline of Latvian student attitudes on experimental physics and attempt tracking changes through pre- and post-tests to address the following research questions: How do attitudes towards experimental physics vary among students? Which attitudes are influenced most by our lab instruction? We administered the E-CLASS survey, utilizing its original version [3], as well as piloting its Latvian translation, to assess possible differences in responses between physics and non-physics bachelor and master level students. We will present preliminary findings, comparing pre- and post-test group scores from 103 respondents and examining questions with observed significant shifts in student attitudes after different lab courses, such as guided introductory physics lab or physics master-level research lab.

Differences in student perceptions revealed by the survey

The pre-test scores showed the baseline of student attitudes when they came to the physics lab. Physics students exhibited slightly higher scores (i.e., higher agreement with the responses from experts in experimental physics) than non-physics students. Master-level students showed higher scores than the first-year students. Overall, the proportion of answers in agreement with experts varied between 0.62-0.71 in the pre-tests (Fig. 1).

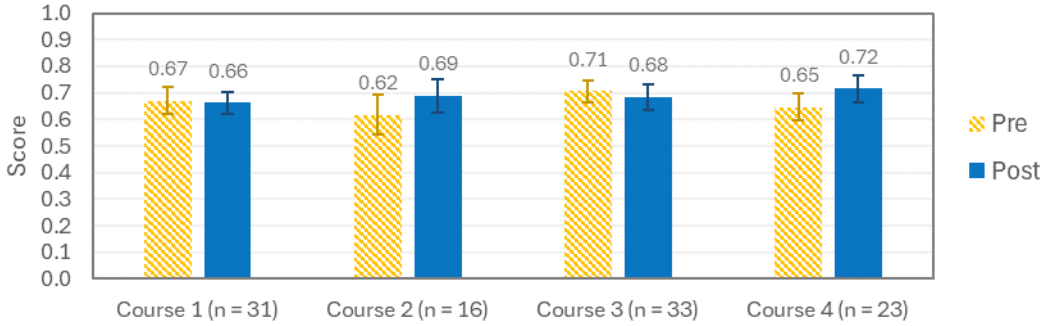

Fig. 1. Pre- and post-test scores in different lab courses for first-year students (Courses 1 and 2 for non-physics, Course 3 – for physics students) and master-level physics students (Course 4).

The post-test results showed that a lab course can have diverse effects on student views about experimental physics. For instance, overall scores increased after the research lab course for the master students. In contrast, after more traditional instruction in the first year, the post-test scores could exhibit positive, zero or negative shifts (Fig. 1). Significant shifts in post-test were observed in responses to different test items for different groups. Notably, students perceived differences between themselves and experts in some questions, while in others they were mistaken about what experienced physicists would say. This can be explained by variability in instructions as well as student interpretations of the questions, especially in the Latvian translation. The scores are discussed in line with the previously reported for other countries.

Conclusion

In conclusion, we utilized E-CLASS survey as an instrument for assessing student perceptions of experimental physics and monitoring changes caused by lab course instruction. Preliminary results highlight the need for targeted instructional interventions. By aligning objectives and tasks and establishing a lab transformation framework, we aim to enhance student engagement and learning outcomes in physics lab courses at the University of Latvia.

References

[1] N. G. Holmes, C. E. Wieman, Introductory physics labs: We can do better. *Physics Today* **71**(1) (2018) 38-45.

[2] B. R. Wilcox, H. J. Lewandowski, A summary of research-based assessment of students' beliefs about the nature of experimental physics, *American Journal of Physics* **86**(3) (2018) 212-219.

[3] B. R. Wilcox, H. J. Lewandowski, Students' epistemologies about experimental physics: Validating the Colorado Learning Attitudes about Science Survey for experimental physics, *Physical Review Physics Education Research* **12**(1) 2016 010123.

[4] W. Z. Shi, L. Ma, J. Wang, Effects of Inquiry-Based Teaching on Chinese University Students' Epistemologies about Experimental Physics and Learning Performance, *Journal of Baltic Science Education* **19**(2) (2020) 289-297.

[5] E. Teichmann, H. J. Lewandowski, M. Alemani, Investigating students' views of experimental physics in German laboratory classes, *Physical Review Physics Education Research* **18**(1) (2022) 010135.