GRASPING MEASUREMENT UNCERTAINTY: EVALUATING A PROJECT-BASED INTRODUCTORY PHYSICS LAB FOR MEDICAL PHYSICS STUDENT

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Proficiency in handling measurement uncertainty is a core competency in engineering and applied sciences, yet first-year students often struggle with its conceptual foundations. This contribution presents a project-oriented introductory physics and metrology lab developed for the Medical Physics undergraduate program at the Berlin University of Applied Sciences and Technology (BHT). Moving away from traditional "cookbook" experiments, the module emphasizes self-directed projects – such as 3D-printing-based component testing or the performance analysis of projectile launchers – where the practical application of the Guide to the Expression of Uncertainty in Measurement (GUM) [1] is central.

To evaluate student learning, the Physics Measurement Questionnaire (PMQ) [2] was administered in a pre-post-test design. The results indicate a significant conceptual shift from the error-focused "point paradigm" toward the scientifically grounded "set paradigm." While the observed learning gain is consistent with international literature on similar interventions [3, 4], the study identifies data comparison as the most persistent challenge for students. This contribution discusses the benefits of the project-based approach, shares qualitative student feedback, and outlines strategies for further optimizing the didactics of measurement in foundational physics labs for engineering students.

[1] ISO/IEC Guide 98-3:2008. Uncertainty of measurement Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)
[2] S. Allie, A. Buffler, B. Campbell, F. Lubben (1998). First-year physics students' perceptions of the quality of experimental measurements. International Journal of Science Education, 20(4), 447-459.
[3] T. S. Volkwyn, S. Allie, A. Buffler, F. Lubben (2008). Impact of a conventional introductory laboratory course on the understanding of measurement. Phys. Rev. ST Phys. Educ. Res. 4, 010108.
[4] B. Pollard, A. Werth, R. Hobbs, H. J. Lewandowski (2020). Impact of a course transformation on students' reasoning about measurement uncertainty. Phys. Rev. Phys. Educ. Res., 16(2), 020160.