# EVALUATION OF ACTIVE LEARNING MATERIALS FOR ENGINEERING STUDENTS IN FLUID DYNAMICS: PROGRESS AND DIFFICULTIES ADDRESSING MISCONCEPTIONS

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Students in engineering sciences engage intensively with physics content in several foundational courses. Fluid dynamics in particular is a complex subject that requires strong groundwork in mechanics and mathematics. It also presents significant challenges for students. To address these challenges, we have been investigating students' specific conceptual difficulties in fluid mechanics since 2023. Using regular short quizzes during the semester as well as broad conceptual diagnostic tests at the start and end of each semester we could observe misconceptions and faulty reasoning patterns.

Based on the results, activating learning materials were developed to enhance the traditional teaching format in 2024 and 2025. In this new format, the traditional lecture was kept as is but the small-group sessions were changed. Usually students discuss calculation-heavy homework with tutors in these sessions without going into the why and how of the calculations. In the new format, between 5 and 8 out of 13 sessions were replaced with active learning materials where students work in groups of four to reason and think together about the fundamental concepts of fluid mechanic.

In this study, we present quantitative and qualitative data on the effectiveness of the intervention. Pre- and post-test questions on three core concepts of fluid dynamics (hydrostatic pressure, the continuity principle, and the Bernoulli equation) were analyzed in order to draw conclusions about students' misconceptions and how to better address them. On the one hand, the results demonstrate successes in terms of reducing misconceptions and improving test scores in hydrodynamics. Post-intervention items in hydrostatic showed a 29% increase in correct answers compared to the no-intervention population while average scores on the pre-intervention items were practically the same for both cohorts. Also, students who attended the intervention session on hydrostatics showed 15% to 25% reduced likelihood to demonstrate specific misconceptions in hydrostatics compared to students in the same year that did not attend the intervention. On the other hand, we report on certain difficulties that proved to be persistent. Students confronted with a specific scenario (narrowed pipe) in which the continuity principle needs to be applied correctly to yield the correct answer during the intervention, still showed comparable misconceptions (and incorrect answer scores) in the post-intervention quiz item when confronted with a slightly different scenario (height difference in pipe). These findings imply a complex, granular and subject specific view of misconceptions in fluid mechanics that prompted further revisions to the teaching materials for the summer semester of 2026.