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Take-Home Experiments in Undergraduate Fluid Mechanics Education

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Hands-on take-home experiments, assigned as homework, are useful as supplements to traditional in-class demonstrations and laboratories. Students borrow the equipment from the department's equipment room, and perform the experiment either at home or in the student lounge or student shop work area. Advantages include: (1) easy implementation, especially for large classes, (2) low cost and easy duplication of multiple units, (3) no loss of lecture time since the take-home experiment is self-contained with all necessary instructions, and (4) negligible increase in student or teaching assistant work load since the experiment is assigned as a homework problem in place of a traditional pen and paper problem. As an example, a pump flow take-home experiment was developed, implemented, and assessed in our introductory junior-level fluid mechanics course at Penn State. The experimental apparatus consists of a bucket, tape measure, submersible aquarium pump, tubing, measuring cup, and extension cord. We put together twenty sets at a total cost of less than 20 dollars per set. Students connect the tube to the pump outlet, submerge the pump in water, and measure the volume flow rate produced at various outflow elevations. They record and plot volume flow rate as a function of outlet elevation, and compare with predictions based on the manufacturer's pump performance curve (head versus volume flow rate) and flow losses. The homework assignment includes an online pre-test and post-test to assess the change in students' understanding of the principles of pump performance. The results of the assessment support a significant learning gain following the completion of the take-home experiment.