Physics Education Research on Inexpensive Active-Learning Lab Modules

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Abstract

Active learning strategies, including hands-on activities and lab work, have proved to be beneficial to student comprehension and success in physics classrooms. Only 47% of high school physics classes are taught by a teacher with a degree in physics. This project aims to design three modular, inexpensive, and demonstrative lab modules in introductory mechanics that are easy to implement and should enhance student knowledge in friction, conservation of energy, and torque, because students show weakness in these areas. Other WPI physics students tested the lab kits, and feedback on their efficacy was used to enhance the lab modules. In the future, another project will carry out these labs in a high school and suggest these lab modules to low-income schools.

Active Learning

Implementing active learning strategies, such as lab activities, in physics classrooms has been proven to increase conceptual gain (Figure 1) and decrease failure rates for introductory mechanics courses at all education levels. Yet, lab equipment remains costly for an institution, making it inaccessible to some schools. Because of the proven benefits of active learning, this project aims to make lab activities available to a wider variety of institutions. This was done by making the lab equipment as cost-effective as possible, making the labs easy for an instructor to implement without needing extensive training or experience, and making them as brief as possible, while remaining demonstrative.

Methodology

The project team used their own personal past experiences and results from the Mechanics Baseline Test to choose topics for the labs and design the modules. After the initial design process, the lab modules must go through a repeating process of testing with the target demographic, debriefing with the subjects, analyzing the data collected, and revising the set-ups and worksheets (Figure 2). This team did an initial trial run with undergraduate students, with the hope that a future project team will continue tests with high school students.

Results

The designed labs were put through preliminary tests with the Society of Physics Students (SPS) chapter at WPI. Each member gave general feedback on the lab module, wrote comments and suggestions on the worksheet, and ranked each of the following statements on the Likert scale:

1. The lab demonstrated physical concepts well.
2. The lab worksheet connected the physical concepts to equations well.
3. I feel that this lab will help students new to physics understand these concepts.
4. I feel that a lab similar to this style could be beneficial to students’ learning in other physical concepts.
5. I feel that this lab will encourage students to communicate with their classmates and/or their instructor(s).
6. I feel that the lab was clear, concise, and easy to follow.

Results from the survey for each lab module are shown in Figures 3, 4, 5.

Discussion

Due to time constraints, the authors were unable to test the labs with a target audience of high-school students. Working with the WPI chapter of SPS, the authors were still able to receive constructive criticism to revise each of the lab modules. Most comments were to clarify instructions and to add more conceptual questions to encourage student-to-student discussion. In a future project, these labs could be conducted in a high school and further developed.

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