Undergraduate laboratory without a manual

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Many researches have shown that interactive methods such as “Tutorials” [1], a group-learning concept-building activity, help students understand the fundamental concepts of physics more effectively than the traditional lecture and recitation. The traditional laboratory has also been considered less productive than teachers expect. Students often follow “cookbook”-style instructions with little attention paid to important physics. An interactive method must be effective in the laboratory as well.

In an undergraduate laboratory, we have introduced an experiment in which students decide what they do. The subject of the experiment is to understand how a simple model of a Stirling engine (see Figure) works. We provide the engine model together with PC-assisted data (pressure, temperature, volume etc.) acquisition. We only give instructions for the equipment, and students have to figure out what they want to do and what they should do for understanding the Stirling engine. 10 students, 3-4 in one group for each equipment, work totally for 20 hours in 4 days. At the beginning and end of each day, they share their ideas and results with other groups and discuss over 1 hour. Our method appears to get students more intellectually involved in the experiment than our previous thermodynamics experiment in a conventional style. It turned out that our method and purposes had been suggested as well in Ref. [2].


Experimental equipment (PC not shown).