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Introductory labs; what they don't, should, and can teach (and why)

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Introductory physics labs are widely used and expensive. They have a wide variety of potential learning goals, but these are seldom specified and less often measured if they are achieved. We cover three different research projects on introductory labs: 1) We have done cognitive task analyses of both experimental research in physics and instructional labs. The striking differences explain much of the unhappiness expressed by students with labs: 2) We have measured the effectiveness of two introductory physics lab courses specifically intended to teach the physics content covered in standard introductory courses on mechanics and E & M. As measured by course exams, the benefit is 0-2% for both. 3) We show how it is possible to use lab courses to teach students to correctly evaluate physical models with uncertain data. Such quantitative critical thinking is an important skill that is not learned in typical lab courses, but is well learned by our modified lab instruction.