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The Role of Physics Education Research in Undergraduate Education

Physics Education Research (PER) has emerged over the past 20 years as an effort by physicists to systematically investigate the learning and teaching of physics, directed toward increasing the effectiveness of instruction. Although PER can only inform not determine the selection of specific objectives for physics instruction, it can serve these objectives through basic research into students reasoning, development of new curricular materials and instructional methods, and careful assessment of student learning. The ISU Physics Education Research Group is investigating students reasoning in thermodynamics, finding persistent confusion regarding process-dependent quantities such as heat and work to a degree previously unreported. For instance, most introductory students seem to believe that net heat absorbed and net work done in a cyclic process must be zero. Curricular materials designed to address these and other learning difficulties are being developed and tested. Initial phases of a parallel investigation into the relationship of representational mode (verbal, mathematical, diagrammatic, etc.) to student learning have identified severe and widespread conceptual difficulties with vectors. We also continue development of a Workbook for Introductory Physics comprising curricular materials designed for fully interactive lectures in large-enrollment classes. Methodologies involved in assessing these materials raise general questions regarding sample-selection bias and measurement of learning gain in PER. Methods developed to address these and related problems in physics education have implications and impact behind the confines of departments of physics and astronomy.