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Collaborative Research: Research and curriculum development in thermal physics

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ABSTRACT

Physics (13) This project is a continuation of an ongoing program of coordinated research and research-based curriculum development in thermal physics, primarily in the advanced-level undergraduate courses. Data are gathered using one-on-one student interviews, written pre- and post-test questions, and multiple-choice surveys. The research is then applied to the development of curricular materials intended to improve student understanding in a manner consistent with active-learning methods

previously shown to be effective in physics instruction. Prior support has resulted in the development of several interview protocols, diagnostic questions, and survey questions. Project staff have identified several specific conceptual difficulties in thermal physics, and have developed some preliminary curricular materials that have been pilot tested at the home institutions to address these difficulties. This project is adding to the existing data corpus and extending existing work and products to new topics in thermal physics. Existing materials and materials being developed during this project are being evaluated for their effectiveness at addressing student difficulties identified through research. Ancillary materials that integrate our curricular materials more fully into courses and provide instructors with background information and assessment questions are being developed. A set of supporting materials, including pre- and post-tests, homework exercises, and a brief instructors' guide with background on the content and our research findings as well as suggestions for implementation, are being prepared. Materials are applicable to courses taught from a classical thermodynamics and/or a statistical mechanics perspective. With its sharp focus on upper-division courses, this project is expanding the applicability of standard physics education research methods already widely used in introductory courses. Results from this aspect of the project are of great interest to the physics education research community and to instructors of advanced physics courses. The dissemination of both research results and of curricular materials in publications, in presentations at national and international meetings of physicists, physics educators and education researchers, and via pilot testing at participating institutions is contributing to the improvement of instruction in thermal physics nationally and internationally. There are additional interdisciplinary components to this work. One focus of both the research and the curricular materials is the connections between the physics and associated mathematics. In addition, results of the investigations in physics courses are being compared to the results from analogous courses in chemistry, engineering, and geological sciences. The aim is to compare the prevalence and persistence of specific difficulties or beliefs among these populations and to explore the extent to which the different discipline-specific approaches and instructional strategies affect student learning of thermodynamics.