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**Session:** Poster Session IV  
**Presentation Number:** 209.12  
**Title:** "Is Entropy conserved?" Student Understanding of Entropy in Introductory Physics  
**Presentation Start:** 1/10/2007 9:20:00 AM  
**Presentation End:** 1/10/2007 4:00:00 PM  
**Category:** 02. Research Techniques in Physics Education  
**Authors:** **Warren M. Christensen**<sup>1</sup>, D. E. Meltzer<sup>2</sup>  
*<sup>1</sup>Iowa State University, <sup>2</sup>University of Washington.*

As part of our continuing investigation into student learning of thermal physics in an introductory calculus-based course, we are probing student ideas regarding entropy and the second law of thermodynamics. We will present free-response and multiple-choice data collected both pre- and post-instruction from the previous five semesters. These data suggest that many key concepts are challenging for students. For example, as many as 75% of students, both before and after instruction, incorrectly claim that the total entropy of a system plus its surroundings must stay the same during a spontaneous process. Many of these students base their claim by asserting some sort of conservation principle for entropy. Early indications are that use of modified instruction with research-based materials may have yielded significant learning gains with some of these concepts. However, many student ideas remain resistant to change despite the modified instruction.

\*Supported in part by NSF DUE-9981140, PHY-0406724, and PHY-0604703