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A National U.S. Study Assessing the Teaching and Learning of Introductory Astronomy

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Abstract

We present the results of a national U.S. study on the teaching and learning of astronomy taught in general education, non-science major, introductory astronomy courses (Astro 101). Nearly 4000 students enrolled in 69 sections of Astro 101 taught at 30 institutions around the United States, plus one in Ireland, completed (pre and post-instruction) the Light and Spectroscopy Concept Inventory (LSCI) from Fall 2006 to Fall 2007. The classes varied in size from very small (N<10) to large (N~180) and were from all types of institutions, including both 2-year and 4-year colleges and universities. Normalized gain scores for each class were calculated from the students' pre- and post-instruction results on the LSCI. To study how the instruction in different classrooms affected student learning, we developed and administered an Interactivity Assessment Instrument (IAI). This short survey, completed by instructors, allowed us to estimate the fraction of classroom time spent on learner-centered, active-engagement instruction such as Peer Instruction and collaborative tutorials.

Pre-instruction LSCI scores were clustered around ~25% (24±2%), independent of class size and institution type; however, the gains measured varied from about (-)0.07-0.50. These two results suggest that the differences in gain were due to instruction in the classroom, not the type of class or institution. Interactivity Assessment Scores (IAS's) ranged from 0%-50%, showing that our IAI was able to distinguishing between classes with higher and lower levels of interactivity. A comparison of class-averaged gain score to IAS showed that higher interactivity classes (IAS > 25%) were the only instructional environments capable of reaching the highest gains (<g> > 0.30). However, the range of gains seen for both groups of classes was quite wide, suggesting that the use of interactive learning strategies is not sufficient by itself to achieve high student gain.

We conducted additional analysis of how individual student characteristics affect student learning in these classes, and whether the demonstrated positive effect of interactive learning strategies on student learning differs based on these characteristics. The students completed a 15-question demographic survey, in addition to completing the 26-question Light and Spectroscopy Concept Inventory (LSCI) pre- and post-instruction.

A multivariate regression analysis was conducted to determine how ascribed characteristics (personal demographic and family characteristics), obtained characteristics (academic achievement and student major), and the use of interactive learning strategies predict student learning in these classes. The results show dramatic improvement in student learning with increased use of interactive learning strategies even after controlling for individual characteristics. In addition, we find that the positive effects of interactive learning strategies are the same for strong and weak students, men and women, across ethnicities, and regardless of primary language. The research strongly suggests all students benefit from interactive learning strategies.