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Improving Education and Public Outreach Through Astronomy Education Research

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Following in the footsteps of physics education research, the relatively new field of astronomy education research is already making dramatic improvements to the teaching and learning of astronomy. Whereas physics education research has focused predominantly on the introductory physics course, astronomy education is working on developing instruments and models to understand widely ranging domains that span K-12, undergraduate majors and non-majors, and even into the realms of public outreach. As one example, the repeated call for a more student-centered approach to teaching due to the ineffectiveness of lecture has been gaining prominence in the astronomy teaching community. At the beginning of a large-enrollment introductory astronomy survey course, we administered 68-multiple choice items as a pretest to 81 students. At the end of each lecture we administered the specific items related to that particular day's lecture a second time as a posttest. The pretest was 30% correct and the test, when given after lecture alone showed 52% correct. These results illustrate that instructor-centered strategies are largely ineffective at promoting meaningful conceptual gains. Alternatively, when using curriculum materials created from a basis of astronomy education research, we find that the posttest average score grows beyond 70%. Each 15-minute *Lecture-Tutorial* poses a carefully crafted sequence of conceptually challenging, Socratic-dialogue driven questions, along with graphs and data tables, all designed to encourage students to reason critically about difficult concepts in astronomy. A significant effort was focused on carefully evaluating changes in students' conceptual understanding and attitudes toward learning astronomy. The quantitative and qualitative results strongly suggest that the *Lecture-Tutorials* help students make significant conceptual gains.