Creating Opportunities for Astronomy Majors to Collaborate in Introductory Courses

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Abstract

The University of Maryland courses ASTR120 and ASTR121 form a two-semester introduction to astrophysics required for the Astronomy major. Here we report on successes and challenges of transforming the courses to be more student-centered, drawing on existing research-based strategies and creating a new lab curriculum that teaches skills relevant for professional astronomers. We aim to provide equitable learning opportunities for all potential Astronomy majors, by creating space for them to collaborate and reason about the content during class. We are adopting and building on materials that have been developed for Astronomy non-majors (including Peer Instruction questions and Lecture-Tutorials). We are also using two-stage exams, where the second stage allows students to collaborate outside of class, in order to reduce stereotype threat and better align our assessments with other changes to the course. This effort is supported in part by a grant from the University of Maryland TLC Elevate Fellows program.

Come See Our Talk:

“Teaching the Skills of Professional Astronomy through Collaborative Introductory Labs”

Session: FK (Astronomy Education Research)
Location: Stamp Student Union - Benjamin Banneker A
Time: Wednesday, July 29th, 9:10-9:20 am

Description of ASTR120/121

We are in the process of transforming ASTR120 and ASTR121, a required two-semester sequence for Astronomy majors. These are the only two courses in the undergraduate astronomy sequence and span a range of topics including planets, stars, galaxies, and cosmology, along with underlying physics such as the behavior of light and the influence of gravity. ASTR120 is offered in a single fall section, with typical enrollment of 40-50 students; ASTR121 is divided into 2 spring sections, with typical enrollment of 35-40 students total. Each course consists of two 75-minute lectures and a 50-minute discussion section per week and ASTR121 also includes 2-2 hour lab weekly. This spring ASTR121 had 2 LAs running lab 1 and 1 TA for discussion and grading (all undergraduates), with everyone, plus the instructor, committed to 2 office hours per week. In addition, free tutoring sessions were available for students throughout each week, run by astronomy major volunteers.

Report on Successes in ASTR120 (Fall 2014) and ASTR 121 (Spring 2015)

Retest Improvement

With our new retest policy, after finishing each in-class exam, students are given a take-home copy that they can re-do for partial credit, though it is graded much more strictly than the initial exam. The retest may help students overcome anxiety and reduce the cognitive burden of stereotype threat. We now see evidence of this: on the first retest, several initially low-scoring students greatly improved their scores, with the highest score overall being from the student who originally had the fifth-lowest score.

Transformation Components

• Make the ASTR121 lab more relevant, collaborative, and engaging
• Implement a “faded scaffolding” [1] approach to lab reports
• Teach practical and relevant astronomy skills
• Encourage collaboration in the form of lab partners and peer reviews
• Improve assessments
• Base assessments on learning outcomes*
• Provide students with opportunities to re-do their exams for partial credit
• Make discussion a fully collaborative activity
• Adapt “Lecture-Tutorials for Introductory Astronomy” [2] for use in discussion section (recitation)
• Provide time devoted to group collaboration on homework*
• Transform the lecture strategy
  • Focus on 2–3 learning outcomes per lecture*
  • Include related out-of-class activities
• Reduce lecture time for more interactive group learning in class *

* indicates changes that have yet to be completed

Future Plans

We are encouraged by the successes we have had in this course transformation project so far, and hope to sustain these positive changes as new LAs, TAs and instructors become involved in teaching this course in the future. While we have started to incorporate more formative assessments and research-based materials, e.g., Peer Instruction questions and Lecture-Tutorials, into the lecture and discussion sections of both ASTR120 and ASTR121, the majority of our efforts so far have been focused on the lab component of ASTR121. In the coming year, we plan to focus our efforts on the lab as a whole, including defining clear learning goals for every topic, writing new discussion activities, planning more interactive-learning class activities, and creating even more cohesion between the lab and the rest of the course.

Lab Materials

The materials designed for the ASTR121 lab are now available at http://ter.uv/9jns, which is accessible through the QR Code to the right.

References


Grades for Each Section of Lab Reports

<table>
<thead>
<tr>
<th>Grade for Section</th>
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<tr>
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| Group Work |

A major component of the reform focused on student collaboration. Using an adapted version of Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) [1], students showed a 30% increase in agreement with the statement, “Working in a group is an important part of doing astronomy experiments” between the start and end of the course. Also, students found group work to be important to their grade, rating it on average 4.2 on a scale of 1 to 5, with 5 being the most important to earning a good grade. This opinion is reflected in mid-semester course evaluations, in which 27% of students listed working in groups as the thing they like best about the class, making comments such as “working in pairs does relieve some of the anxiety (associated with the work).”

Independent and Critical Thinking

There was also a 10% increase in expert-like opinions on “thinking about the purpose of instructions in the lab guide” and “overcoming difficulties without an instructors help”, reflecting our attempt to make lab activities less “cookbook-like” and give students an opportunity to work independently. Students visibly benefited from and enjoyed this aspect of the lab, with one student writing in their mid-semester evaluation, “I like the amount of freedom we have to try different methods of solving the problem that we encounter in the lab.”

Adapted E-CLASS Results

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<th>Importance of Earning a Good Grade</th>
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Key for E-CLASS Statements

1. Considering sources of systemic error 2. Understanding that classifications are based on broad generalizations. 3. Understanding that classifications are based on broad generalizations. 4. Using computers for planning and analyzing data. 5. Understanding that classifications are based on broad generalizations. 6. Understanding that classifications are based on broad generalizations. 7. Using computers for planning and analyzing data. 8. Making predictions to see if results are reliable. 9. Making predictions to see if results are reliable. 10. Thinking about the purpose of instructions. 11. Overcoming difficulties without an instructor. 12. Systematically working with solutions to problems. 13. Communicating scientific results to peers. 14. Reading scientific journal articles. 15. Working in a group. 16. Making conclusions on data using scientific reasoning. 17. Reporting results with the correct formatting. 18. Comparing previously known results.

Change in fraction of class with

Important Item                          | Importance of Earning a Good Grade |
----------------------------------------|-----------------------------------|
1. Considering sources of systemic error | Important                         |
2. Understanding that classifications are based on broad generalizations. | Important                         |
3. Understanding that classifications are based on broad generalizations. | Important                         |
4. Using computers for planning and analyzing data. | Important                         |
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13. Reading scientific journal articles. | Important                         |
14. Working in a group. | Important                         |
15. Making conclusions on data using scientific reasoning. | Important                         |
16. Reporting results with the correct formatting. | Important                         |
17. Comparing previously known results. | Important                         |

Overall importance is determined through a rubric created for this class.

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