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Astronomy Diagnostic Test Results Reflect Course Goals and Show Room for Improvement

by **Michael C. LoPresto**
Henry Ford Community College
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Abstract

The results of administering the Astronomy Diagnostic Test (ADT) to introductory astronomy students at Henry Ford Community College over three years have shown gains comparable with national averages. Results have also accurately corresponded to course goals, showing greater gains in topics covered in more detail, and lower gains in topics covered in less detail. Also evident in the results were topics for which improvement of instruction is needed. These factors and the ease with which the ADT can be administered constitute evidence of the usefulness of the ADT as an assessment instrument for introductory astronomy.

1. Introduction

The Astronomy Diagnostic Test (ADT) is an assessment instrument used to evaluate learning in undergraduate astronomy courses (see Hufnagel 2002 and http://solar.physics.montana.edu/aae/adt/ for more about the ADT and its development, and how to obtain a copy and guidelines for its use). The following is a report on the use of the ADT at Henry Ford Community College (HFCC) to assess the effectiveness of instruction in introductory astronomy over a three-year period.

Figure 1 shows the numbers of students scoring from 0 to 21 on the content questions on the ADT over three complete academic years of using it as a pretest (blue) and posttest (red) in ASTR 131–Descriptive Astronomy, a one-semester nonmathematical introductory course at HFCC.

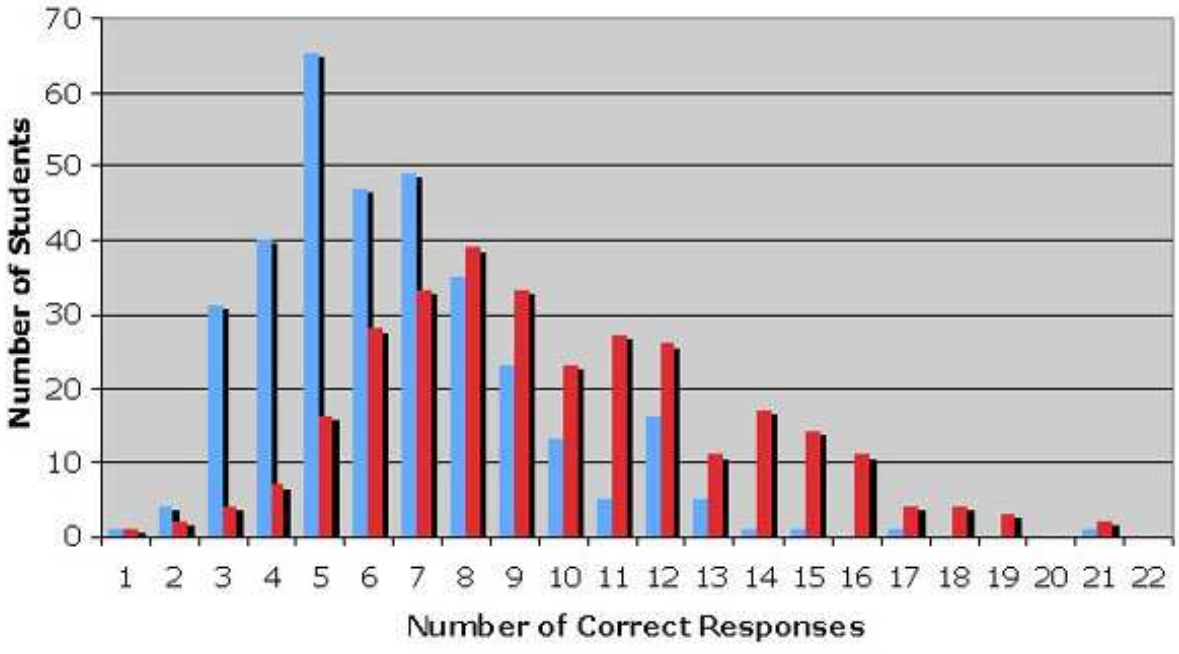

Figure 1. Numbers of students scoring from 0 to 21 on the ADT used as a pretest (blue) and a posttest (red)

2. Results

The pretest was administered in the first week of a one-semester introductory astronomy course, ASTR 131–Descriptive Astronomy. A total of 338 students, in 12 sections of approximately 30 students each, were enrolled in ASTR 131 during the fall and winter semesters from fall 2003 to winter 2006. All classes were taught by the same instructor. The posttest was administered to 305 students in the same sections during the last week of class. The average score on the pretest was 5.5 out of 21, 26.3% with a standard error of 0.15 or 0.7%. The average posttest score was 8.8, 41.7% with a standard error of 0.21 or 1%. These averages are both below the national averages of 32.4% (standard error 0.21%) and 47.3% (standard error 0.32%). The average score increased by 15.4%, similar to the national gain of 14.9% (Deming 2002). The errors were higher than in the national sample (the error in the posttest data was higher than on the pretest, as in the national sample).

The results for individual semesters or sections did not vary appreciably from the overall results. It is tempting to attribute scores on both the pretest and posttest being approximately 6% lower than national averages to the fact that the ADT is administered at two-year colleges, four-year colleges, and major universities, but data from the national survey show no significant differences in scores or gains at different types of institutions. One might expect smaller classes, like those at HFCC and other community colleges, to perform better, but class size does not seem to be a factor either (Deming 2002).

Figure 2 shows the percentage of correct responses to each individual question for the pretest (blue) and posttest (red), and gains or losses in the percent of correct responses (yellow).

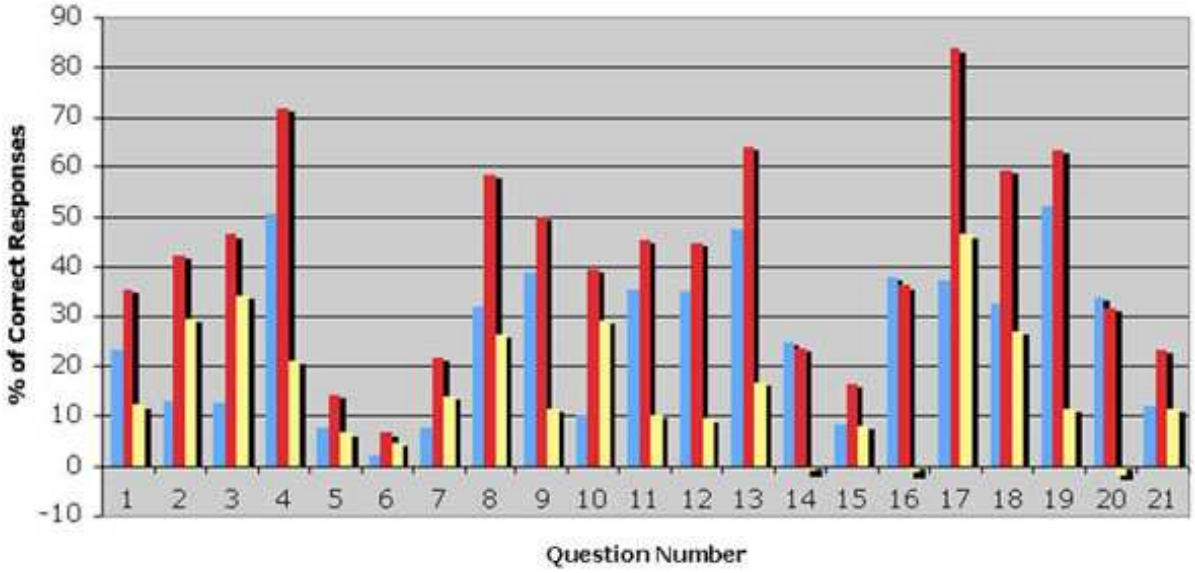

Figure 2. Percentage of correct responses to each question during pretest (blue) and the posttest (red), with gains (or losses) in yellow

3. Discussion

Larger gains that stand out are in Questions 2, 3, 8, 10, 17, and 18. Gains in Questions 2, 10, and 18, questions about lunar phases and daily and annual motion of the Sun, reflect well on the goals of the course. The course is taught in an active and collaborative format largely with lecture-tutorials (Adams & Slater 2000; Adams, Prather, & Slater 2005) with a major emphasis on the observable motions in the sky (LoPresto 2003, 2005). This also means that smaller gains on Questions 1, 9, and 19—also questions on observations of the motion of the Sun and the Moon—show room for improvement in achieving these goals.

Gains in Question 3, about the distance between Earth and the Moon relative to their sizes, are encouraging, because providing a sense of the size and scale of objects when compared with one another, and the distance between them, is also a major goal. Determining the temperatures of stars and energy production within them is an important theme in the course unit on light, the Sun, and stars, so the gains on Questions 8 and 17 are encouraging. It is interesting that despite star temperatures being covered in several activities and energy production being covered in lectures only, questions on both topics showed gains. Question 17 had the single highest number of correct posttest responses.

Small losses were seen in Questions 14, 16, and 20. Question 14, about how weight would change with changes in Earth's mass, showed no gain. Clearly, discussions on gravity as a force that varies with mass and distance did little to change student understanding of the topic. However, despite having a high number of correct pretest responses, Question 4, about falling objects of different mass, showed a moderate gain, which suggests some success with coverage of gravity. Taking more time in class doing lecture-tutorials and other activities often leaves little time for cosmology. This is a possible reason that there were no gains in Question 16, about the location of the center of the universe. Estimating angular measurements with the hand, thumb, and fingers is used in lectures several times but is only demonstrated and is not included in any hands-on activities. In addition, comparing the angular size of an object at different distances was not explicitly covered. Both of these facts may explain the lack of gains on Question 20.

Only comparatively moderate gains on Question 7 show that misconceptions about the seasons, first shown so poignantly in *A Private Universe* (1987), could be better addressed. That the lowest number of correct responses was for Question 6 makes it clear that the common myth about the reason for "weightlessness" in a spacecraft was not corrected. Although the cause of the seasons was covered extensively, the reasons for weightlessness were not.

4. Conclusion

Three years' worth of ADT results appear to show which topics have been more effectively taught and less effectively taught in introductory astronomy at HFCC. This is vital information that can be used to improve instruction. The results also reflect the course goals; subjects that are stressed show more gains than those that are not. Both of these results suggest that the ADT is a very useful assessment instrument. The ADT is readily available and can be implemented very easily. It can be given as both a short pretest and a posttest, and it can provide data on what students are (and are not) learning—data that constitute an essential starting point to making improvements in the teaching of introductory astronomy.

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