Standardizations of Exams for Phscs 127 - Descriptive Astronomy

Karrie Beckstead

A senior thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Bachelor of Science

Eric G. Hintz, Advisor

Department of Physics and Astronomy

Brigham Young University

April 2017

ABSTRACT

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Karrie Beckstead
Department of Physics and Astronomy, BYU
Bachelor of Science

Many different teachers teach the Physics 127 (intro to astronomy) class at Brigham Young University (BYU). Each teacher has their own tests for their own students and these tests between teachers are so different from one another that there has arisen a need for some unity between them all. It was determined to create 10 multiple-choice questions that could be included in all of the tests some time in the future. To do this, research was done on what makes a good test question, then each teachers exams were analyzed for similarities and differences, and finally 10 questions were selected based on this research.

Keywords: Astronomy Education, Undergraduate Education, Descriptive Astronomy

ACKNOWLEDGMENTS

I would like to acknowledge my advisor, Professor Eric Hintz. He has been extremely helpful, patient, and kind. I would also like to thank the other professors in the astronomy department who helped me a great deal by letting me look at their exams and by giving me constructive feedback. It is also appropriate to thank the astronomy faculty who provided their exams to support this project; Professors J. Ward Moody, Denise Stephens, and Darin Ragozzine.

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Chapter 1

Introduction

1.1 Background

Being able to assess student learning is an incredibly important tool for a teacher. Reliable information can tell a teacher what concepts students struggle with, what approaches to certain topics is most effective, and can give a whole host of other information that can be valuable to a teacher. At universities it is common for one class to be taught by several different teachers with each teacher using their own unique exams to assess student learning. The exams between teachers can be extremely different and attempts are being made to unify them a little to make sure that the most important concepts are being taught and tested and to help students from different classes have similar class experiences. It can also provide proper testing to evaluate course outcomes.

The goal of this project was to begin the process of providing a set of common questions for the Phscs 127 - Descriptive Astronomy class at Brigham Young University. This first stage of the project focused on the night sky portion of the class. To unify the exams from different teachers, I helped create/assemble 10 multiple-choice questions that can be included in future exams between the teachers. To do this, I did research on what makes a good test question, then I examined

each teachers exam and looked for similarities and differences, and finally I created/assembled 10 questions based on this research.

1.2 What makes a good test question?

Before I could start writing the questions, I did quite a bit of research in to what makes a good test question. I discovered that a good test question tests concepts rather than vocabulary, does not test reading ability, tests common misconceptions, avoids biases towards any particular curriculum package, should only assess one concept at a time, and should be able to discriminate among populations that have received different levels of exposure (Slater 2015).

1.2.1 Tests Concept rather Than Vocabulary

Multiple-choice questions should not be used to test vocabulary. Other styles of questioning such as fill in the blank or matching are much better for testing vocabulary if one still wants to have that be part of the test. Multiple-choice questions should be used to test concepts.

1.2.2 Should not test Reading Ability

Some studies have shown that test questions should not require a reading ability beyond that of an eighth grade level (Slater 2015). The readability of a test questions can be assessed using the Flesch-Kincaid Grade Level Readability Formula. This formula first calculates the average number of words used per sentence. Then it calculates the average number of syllables per word. Finally you put the average sentence length (ASL) and the average number of syllable per word (ASW) into the equation: FKRA (Flesch-Kincaid Reading Age) = (.39 x ASL) + (ll.8 x ASW) 15.59

A score of 5.3 would be equal to a reading age of a fifth grader in his third month of school. The goal of a test question then is to have a score of 8 or less (Flesch 1948). It is not uncommon

for the score for questions in introductory science classes to be much higher.

1.2.3 Test Common Misconceptions

One of the most important parts of a test question is that it should use the distracter answers to test common misconceptions that students tend to have before taking an astronomy class. It is therefore important to know what some common misconceptions are. Fortunately, many studies have been conducted on this and here are some of the results pertaining to the night sky. Many students who have not taken an astronomy class believe that:

1. The stars do not move across the sky
2. The sun is higher in the sky during the northern hemisphere winter
3. Phases of the moon are caused by the earths shadow falling on the Moon
4. Think that the earths distance to the sun is responsible for the seasons

These are but a few of the known common misconceptions pertaining to the night sky that are prevalent among students, and these beliefs should be incorporated as distractors in test questions (Slater et al. 2015).

1.2.4 Avoid Biases Toward any particular Curriculum Package

Sometimes professors tend to spend a great deal of time teaching about things that they find to be the most interesting, while neglecting other equally important subjects. While it is understandable to talk a little more about subjects that one knows the most about, in a beginner astronomy course, these biases should be avoided, not only because we want the student to have a wider knowledge base, but because then the students from different classes taught by different teachers can still learn the same things.

1.2.5 Should only Assess one Concept

A test question should not assess more than one concept at a time. This helps keep the readability easy, but most importantly this allows the instructor to know exactly what concept his or her students are struggling on. Test questions not only assess how much a student has learned, but it also shows that instructor areas of his or her teaching that can be improved.

1.2.6 Discriminate among Populations that have Received Different Levels of Exposure

Test questions should be difficult enough that someone with no astronomy knowledge cannot guess a large majority of the answers and get them right. Because of this it is important to test ones questions on a control group of people who have not taken astronomy before and those who have. If those who have not taken an astronomy class before can still guess a large majority of the questions right then the questions are not discriminating enough, but if those who have taken astronomy cannot answer the questions right then the questions are too discriminating.

Chapter 2

Methods and Procedures

The goal of this project was to create 10 standard multiple-choice questions about the night sky that could be incorporated into the future tests of all of the teachers. That way classes taught by different teachers would have at least 10 questions that were commonly taught and tested between them. For this project, I first gathered midterms from different teachers and looked at their similarities and differences. Then I created a list of 10 questions/concepts that all of the teachers like to test on, and finally I created/assembled the test questions and edited them based on teacher feedback.

2.1 Gathering and analysis of midterms

My first step was to gather midterms from all of the astronomy teachers that taught the beginner astronomy course. This covered material generally tested on the first midterm of the semester which covers the night sky. Unfortunately, I was only able to get midterms from 4 out of the 7 teachers who generally teach the descriptive astronomy class, but I felt that this was still a good amount of midterms to determine commonly taught concepts.

By examining these midterms, I found 8 major concepts that each teacher made sure to include in their night sky tests. These concepts are synchronous rotation, phases of the moon, solar

vs. sidereal time, precession/seasons, Keplerian motion, the Heliocentric model, eclipses, and the motion of the celestial sphere.

Looking at the questions from each midterm that pertained to these subjects, I choose several questions from each midterm that I thought did the best job of testing a students understanding, based on the before mentioned criteria, and put them together to create the 10 standard test questions pertaining to the night sky. After doing this, I sent the questions back to the professors and asked them for their feedback.

One professor said that he did not teach some of the terminology to his students so they would fail some of the questions because of that. Another professor did not like how some of the questions where phrased and gave some great ideas of how they could be improved. I unfortunately was unable to get feedback from any of the other teachers.

2.2 Selected Test Questions

Based on the research that I have done I have created 10 standard test questions on the night sky that would make an excellent addition to future Physics 127 exams on the night sky. Each question is prefaced with the concept that is being tested (answers are: c,c,a,f,c,c,d,b,b,b).

Concept tested: Synchronous rotation

1. If you lived on the far side of the Moon, which of the following statements about what you can and cannot see would be true?

    A. You could never see the Sun from that location

    B. You could never see the Earth from that location

    C. The stars visible from that location would be very different from the stars visible from Earth at that time of year

    D. Earth would set about 14 days after rising

E. The Earth would rise and set once a year

Concept tested: Phases of the moon

2. Which Moon Phase could be high in the sky at sunrise?

   A. New Moon

   B. Half Moon

   C. Third-quarter Moon

   D. Full Moon

   E. There is no such phase

Concept tested: Solar vs. Sidereal Time

3. Sidereal time is the more fundamental time, since it is a measure of the true rotation rate of the Earth. Why then do we govern our lives by solar time rather than sidereal time?

   A. We wish to remain in time with the suns illumination on Earth, with the Sun highest in the sky at noon every day

   B. We cannot divide the day into 24 equal hours of sidereal time

   C. In sidereal time, the Sun would reach the meridian early or late, sometimes by as much as 17 minutes at certain times of the year

   D. Different clocks tick at different rates depending on latitude in sidereal time

Concept tested: Precession/seasons

4. If the tilt of the Earths axis were 0 degrees instead of 23.5 degrees then

   A. There would be no seasons

   B. The sun would always rise due east and set due west as seen in Provo

C. The celestial equator and the ecliptic would be the same

D. There would be no precession

E. All of the above are true

Concept tested: Heliocentric vs. Geocentric model

5. Why did Ptolemy need to add epicycles and deferents to his geocentric model of the solar system..

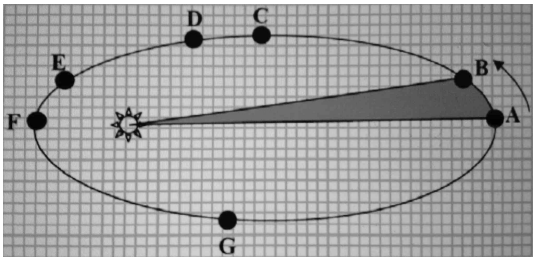
   A. To account for stars rising and setting at different locations on the horizon Motion of the planets; planets move in ellipses

   B. To account for the elliptical orbits of the planets

   C. To account for the retrograde motion of the planets

   D. To account for the Sun's path being along the ecliptic and not the celestial equator

   Concept tested: Keplerian motion



6. In the drawing above, the motion of a planet traveling around a star is shown. We have shaded in a triangular area that was swept out during the motion of the planet while moving from position A to position B. Which two other planet positions would sweep out another triangular area for the motion of the planet that would obey Keplers Second Law?

   A. C to D

B. E to F

C. F to G

Concept tested: Eclipses

7. What 2 conditions must be met in order for a annular solar eclipse to occur

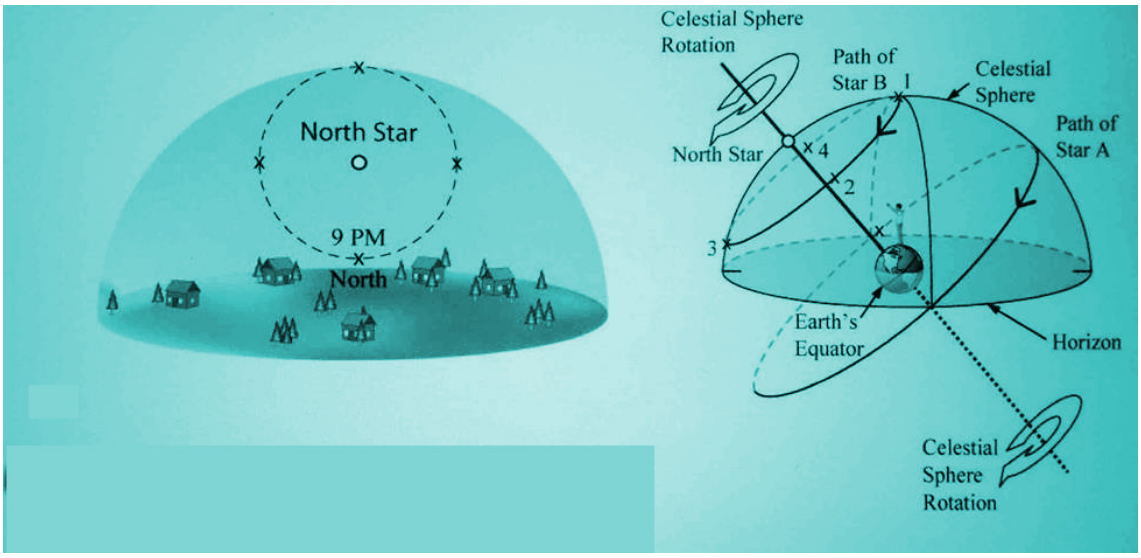
   A. The Moon must be full and be nearer the earth

   B. The Moon must be full and be farther from the earth

   C. The Moon must be new and be nearer the earth

   D. The Moon must be new and be farther from the earth

Concept tested: Celestial Motion



For the next 2 question, use the two figures provided above, which show the motion of Stars A and B in the sky. Note that Star A reaches its maximum height above the horizon at 3:00 am, which is not the same time that Star B reaches its maximum height as shown in the figure.

8. At what time will Star B be located at position 3?

    A. 11:00 pm

    B. 9:00 pm

    C. 11:00 am

    D. 9:00 am

9. In what time would you see star A high in the southern part of the sky?

    A. 3:00 am

    B. 9:00 am

    C. 3:00 pm

    D. 9:00 pm

10. During the winter in the northern hemisphere the sun is:

    A. Higher in the sky then it is during summer

    B. Lower in the sky then it is during summer

    C. The same height in the sky as it is in the summer

    D. It will have moved toward the north

Chapter 3

Conclusions

3.1 Night Sky Questions

There is a need for some uniformity between the exams from different teachers for the same Phscs 127 class. I attempted to create some uniformity by creating 10 multiple-choice questions that test general concepts from the 127 class. To do this I first did research on what makes a great test question. I found that a great multiple-choice question is one that tests concepts rather than vocabulary, does not test reading ability, tests common misconceptions, avoids biases towards any particular curriculum package, should only assess one concept at a time, and should be able to discriminate among populations that have received different levels of exposure.

After finding what makes a good test question, I then gathered 4 exams from 4 different teachers and studied them to identify any similarities and differences. Using this knowledge, I then created 10 multiple-choice questions about the night sky. These are the beginning of an assessment tool that allows comparison between the various instructors.

3.2 Future Work

The questions selected need to be tested on a control group to verify that they can discriminate between people who have never taken a college astronomy course and those who have. Using a pre-test/post-test structure these questions can also be used to examine learning gains and provide comparison between the sections. It would be best if we could get these questions done before the beginning of the fall semester so they could be tested on students before and after they have taken the 127 class. After all of this is done, then we will see if we can get these sets of standard questions for each midterm, and get them incorporated into the all of the tests given by the 127 teachers. Overall there is a great deal more work and research to do, but the final product will be worth it.

Also these questions only cover the night sky portion of the class. Questions for the remaining three sections; 1) Solar System, 2) Stars, and 3) Galaxies and the Universe, still need to be examined. For future research, someone needs to gather midterms 2 and 3 from the professors who teach 127, find the major concepts that all of the teachers test on, generate 10 multiple-choice questions based on these concepts, and test them on a control group.

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