The Department of Physics and Astronomy offers the AST2010 Descriptive Astronomy course as an online course. The course provides an elementary foundation in modern astronomy. It covers a wide range of topics going from planetary astronomy, stellar evolution, galaxies, cosmology, the Big Bang as well as basic physics concepts required for the study of astronomy. The course is based on the textbook Pathways to Astronomy by Stephan E. Schneider and Thomas T. Arny and a web site created by Prof. C. Pruneau. Given it is an online course, evaluations of student’s learning is carried out through exams and weekly quizzes administered online through the Blackboard web portal. The class’s website is [http://rhig.physics.wayne.edu/AST2010](http://rhig.physics.wayne.edu/AST2010) As of winter 2009, approximately 700 questions, covering 80 units were available and loaded in Blackboard for the for auto generation of exams and quizzes given to students. Auto generation means just a list of questions randomly chosen from a larger bank. In order to minimize plagiarism, and to properly challenge the students, one needs tests to be generated based on a large number of questions. Each student may be presented with unique exams, and quizzes, i.e. no student receive the exam same test. To accomplish this, one needs a very large and varied bank of questions. While the existing bank of 700 questions available during winter 2009 constitutes already provides for a reasonable degree of randomness and uniqueness, there are in effect too few questions to properly challenge the students and produce individualized tests. I was then charged to create a bank of new questions covering all units of the textbook. My goal was simple; I was to write an average of 20 questions per unit for all 84 units. I received assistance from undergrads, professors, various texts, on-line sources, and previous classes; modern astrophysics and stellar evolution to help me towards my goal (see acknowledgements section). The questions and answers I created were reviewed by Dr. Elizabeth Atems, and then loaded into Blackboard using the software Respondus.

In this report, I describe in Section 1 the type of questions I have created and discuss the limitations, advantages and disadvantages these questions. The questions were created in part to guide the students and enhance their reading skills as described in Section 2. Section 3 provides exemplars of the various types of questions created and added to the Blackboard bank.

1 - Variety of Questions

I created questions of different types and difficulty levels. These include multiple choice, fill in the blank, true or false, matching, and combinations. The following are examples of the variety of questions with names I have given them.

- Multiple choice true or false is a question with that has three true and false statements in one. This type of question has a high difficulty level. The advantage to this question is that instead of a single true and false statement; a binomial distribution with a 50% probability for guessing each question, the student now has a 17 % probability of guessing the correct answer. This question also adds more quiz material on each quiz because its three questions in one.
I. The oxygen we breathe is O$_3$
II. The bending of light from the sun is greater away from the horizon
III. Near the horizon, the sun's shape is distorted
   A. Only I is false
   B. Only II is false
   C. Only III is false
   D. Only I and II are false
   E. All are false
   F. All are true

- **Multiple choice calculation questions** are the most common type of questions in the bank. These types of questions are most useful for quantitative questions. This is important because the quiz taker has to read the question and interpret and understand the mathematical language.

(Example)
If you have 200g of substance X, and X has a half life of 2 years, after 6 years, how much is left?
   A. 100g
   B. 50g
   C. 25g
   D. 12.5g
   E. None of the above

- **Fill in the blank vocabulary** is a tricky type of question because the Blackboard web portal is case sensitive. It's important not to the student not to use capitals, dashes, etc, i.e. light-year. This is one of the least used questions in the bank.

(Example)
A period around year 1700 C.E. where the number of sun spots was low for about 70 years is known as

- **Multiple choice fill in the blank** is a multiple choice question with a fill in the blank and an answer bank. The advantage of these types of questions is that they avoid the problems of regular fill in the blank questions. These questions also are most useful for vocabulary questions.

(Example)
A ______ telescope would be most suitable for observing from the ground.
   A. Radio
   B. Ultraviolet
   C. X-ray
   D. Infrared
   E. Gamma-ray

- **Multiple choice fill in the blanks** is a type of question with two fill in the blank questions in one. These types of questions are useful for showing relationships between terms as well as comparing them.

(Example)
Silicate material is found in ______, and organic compounds are found in ______.
   A. Carbonaceous chondrites, Chondrules
   B. Chondritic meteorites, Carbonaceous chondrites
   C. Carbonaceous chondrites, Chondritic meteorites
   D. Chondritic meteorites, Chondrules
• **Fill in the blank numerical** questions were used the least for obvious reasons. The student must know to use commas as in 3,000,000 compared to 3000000 as well as the significant figures. To avoid problems such as round off errors, it is easier to have an answer bank for the student to pick from.

(Example)
Convert the speed of light, \( c = 3 \times 10^8 \, \text{(m/s)} \) to (km/hr)
Ans. _________(km/hr)

• **True or false** questions were the easiest questions to come up with. The statements should be general because there always seems to be exceptions to specific statements.

(Example)
True or false
Most of the exo-planets discovered are comparable to the mass of Earth.

• **Matching**

(Example)
Below are the components found in the atmosphere of Venus, match each with the best description provided.

_**D**_. 1. Argon
   a. nonexistent

_**B**_. 2. Carbon Dioxide
   b. the most abundant gaseous component found

_**E**_. 3. Nitrogen
   c. makes up the majority of the clouds

_**C**_. 4. Sulfuric Acid
   d. remains of the period formation, primordial

_**A**_. 5. Water
   e. 2\text{nd} most abundant atmospheric component

• **From the figure** questions include tables, graphs, diagrams, and charts. Before, figures were never used for this class’s online quizzes and exams. Figures are now used in every unit. It is important not to ask questions described by different colors such as the tales of comets. This will make the quiz more universal for colored blind people. These questions will quiz the student on how well they can interpret tables, graphs, diagrams, and charts. These questions will also help the visual learners.

(Example)

![Figure](image)

This planet configuration is called

A. **Opposition**  
B. **Conjunction**  
C. **Inferior conjunction**  
D. **Superior conjunction**  
E. **Quadrature**

2 - **Enhancement of Students Reading Skills**
In my last education class we were told that every teacher is a teacher of learning. The students must be quizzed on different reading skills to see if they understand the material fully.
I wanted to make questions relating to all the different reading skills. These reading skills include specialized vocabulary, following directions, sequence, cause and effect relationships, inferences, comparing and contrasting, reading charts, tables, and graphs. Here are examples of questions for each reading skill.

- **Sequential** - A sequence is a list of objects or events whose order is important. Whether the order is increasing or decreasing with time, distance, or mass, these questions ask to pick a correct order. This will help the students understand orders and how things change with time, distance and mass.

  What best describes the evolution of a star like the Sun, from youngest to oldest?
  
  A. Protostar, red giant, main sequence, white dwarf, black dwarf  
  B. Protostar, main sequence, red giant, white dwarf, black dwarf  
  C. Protostar, main sequence, red giant, black dwarf, white dwarf  
  D. Red giant, main sequence, white dwarf, black dwarf, protostar  
  E. Black dwarf, white dwarf, red giant, main sequence, protostar

- **Cause and effect relationships** are relationships between one event (called the *cause*) and a second event (called the *effect*), where the second event is the direct consequence of the first. This is a nice way to know how things change without the gory math.

  (Example)  
  When the core of a star contracts, it
  A. heats up  
  B. cools down  
  C. temperature does no change

- **Comparing and contrasting** are reading skills that compare objects, ideas, models, and origins.

  (Example)  
  Neptune is about ___ times further from the Sun than Saturn
  A. 1  
  B. 2  
  C. 3  
  D. 4  
  E. 5

- **Reading diagrams** is very useful in all disciplines of science.

  (The example for this reading skill is from the figure example)

- **Reading tables** is the most convenient way to compare quantities in a visual way.
Which reaction requires the highest temperature?
A. hydrogen fusion
B. alpha fusion
C. carbon fusion
D. oxygen fusion
E. silicon fusion

- Reading Graphs is an important reading skill because it shows the relationship between a control variable and a dependent variable in a visual way. Graphs visually show how one thing changes as a result of something else changing. A good way to have the students interpret graphs is to ask them is it where increasing, decreasing, maximum, minimum, etc.

![Graph showing light changes over time.](image)

From the figure
At which point on the light curve are both eclipsing binary stars visible?
A. A
B. B
C. C
D. Not enough information

- Making Judgements is a reading skill for readers to make judgments based on what they read (inferences). The statement may not be directly quoted in the text but a conclusion can be drawn from what is read.

True or false
For a rocket to decrease the size of the orbit, a rocket must slow down.

- Interpretation is a reading skill where the student takes what they already know and apply it to the real world or to other constructs. This will help the student understand the reality of what’s going on.
3 - Three Categories of Question Making

When writing the questions, I put emphasis on three categories. I tried to keep the questions specific, clear and making sense.

First, I tried to be specific when I ask of something. For example, when stating “The larger the collecting area the more photons it gathers” should be written as “The larger the collecting area the more photons a telescope gathers”. It is very important to state exactly what the questions are asking.

Not only the questions have to be specific but they have to be clear. An example of this is $SA = \pi R^2$, pi looks like an “n”. Something else to keep the clarity of the problem is to make sure symbols are compatible with the software used to display the quizzes. Another way to keep questions clear is to italicize key words. The answers also have to be clear; a way I made them clear is that the multiple choice answers are very different from each other. This prevents round off errors such as using 10 m/s$^2$ instead of 9.8 m/s$^2$.

The last category is to keep the questions and answers making sense. I had to keep the answers realistic. For example, answers can’t be greater than the speed of light or the distance between binary stars can’t be \(~100\) light-years.

**Summary**

The goal of my REU project was to come up with an average of 20 questions per unit for all 84 units of the text and to post the question on Blackboard using Respondus for the AST 2010 course. I successfully created a bank of 1000 questions distributed in 70 units.

**Future work**
At the time this report is written, 70 out of 84 units were complete. A plan is in place to complete the rest of the questions. When the questions are complete and revised they are to be posted on Blackboard using a program called Respondus.

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