Learning Through Inquiry: Confronting student misconceptions through lecture tutorials

REBUILDing STEM Education at Michigan
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Student misconceptions are pernicious and can inhibit learning of new content unless confronted. Lecture tutorials are one method, used by both astronomy and geoscience educators, requiring students to confront their own misconceptions about the operation of the physical world and explore, through data, which aspects of their understanding are accurate and which are inaccurate. Similar methods of implementing inquiry learning have been developed in other science education circles.

Resources on Inquiry in Science Courses

Lecture Tutorials
http://serc.carleton.edu/sp/library/lecture_tutorials/index.html
This website includes an overview of Lecture Tutorials, step-by-step instructions for writing your own lecture tutorial and example lecture tutorials in the geosciences.

Process Oriented Guided Inquiry Learning (POGIL)
www.pogil.org
This website provides visitors with information about the history of POGIL (it was developed by chemistry education specialists in the 1990’s), how guided inquiry can be implemented in high school or post-secondary institutions, and disciplinary specific resources about POGIL.

Predict-Observe-Explain (POE) model of inquiry learning
http://goo.gl/uxhp6E
This type of lesson has students engage in three critical steps of the scientific method: predicting what should happen under the given circumstances, analyzing data to understand what did happen and explaining what they have learned from their predictions and observations.

Concept Tests
http://serc.carleton.edu/introgeo/interactive/conctest.html
Originating out of Eric Mazur’s physics classroom at Harvard, these multiple-choice questions are used in class to focus students on a single concept. These questions do not require calculations or equations to answer. The website above provides additional information about Concept Tests and resources for developing your own.
Part I: Equal Area in Equal Time Intervals

Kepler's second law of planetary motion states that a line joining a planet and the Sun sweeps out equal amounts of area in equal intervals of time.

Imagine the situation shown at the right in which a planet is moving in a perfectly circular orbit around its companion star. Note that the time between each position shown is exactly one month.

1) Does this planet obey Kepler's second law? How do you know?

2) If you were carefully watching this planet during the entire orbit, would the speed of the planet be increasing, decreasing, or staying the same? How do you know?
Kepler's Second Law

In the drawing below, a planet that obeys Kepler's second law is shown at nine different locations (A–I) during the planet's orbit around its companion star.

3) Draw two lines: one connecting the planet at Position A to the star and a second line connecting the planet at Position B to the star. Shade in the area swept out by the planet when traveling from Positions A to B.

4) Pick any two planet positions (C, D, E, F, G, H, I)—note, they do not have to be consecutive—that you could use to construct a swept-out area that would have approximately the same area as the one you shaded in for Question 3. Shade in the second swept-out area using the planet positions that you chose. Note: Your shaded area needs to be only roughly the same size; no calculations or quantitative estimates are required.

5) How would the time it takes the planet to travel from Position A to Position B compare (greater than, less than, or equal to) to the time it takes to travel between the two positions you selected in Question 4? Explain your reasoning.

6) During which of the two time intervals for which you sketched the shaded areas in Questions 3 and 4 is the distance traveled by the planet greater?

7) During which of the two time intervals for which you sketched the shaded areas in Questions 3 and 4 would the planet be traveling faster? Explain your reasoning.