Transforming the Online Course via an Innovative Astrobiology Course

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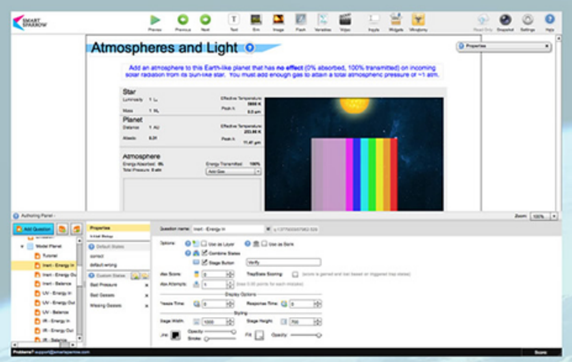
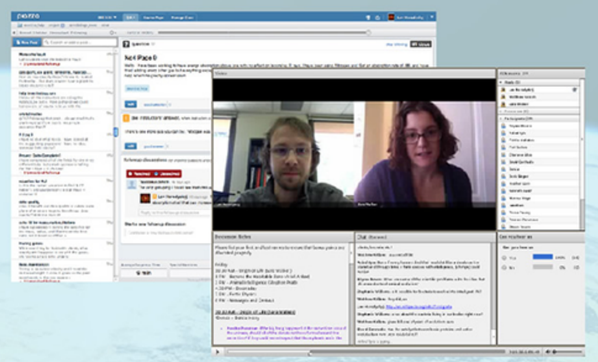
SES 106: Habitable Worlds

Organized around the Drake Equation, "SES 106: Habitable Worlds" is a 4-credit online-only fully interactive astrobiology lab course that teaches astrobiology as an integrative science, covering topics from stars to civilizations. This course is a digital native built using Smart Sparrow's Adaptive eLearning Platform (AeLP), which gives the instructor the power to set the content of the stage, granularity of feedback, and adaptive pathways. The system provides robust data and analytical tools that allow us to investigate how students interact with the exercises, both in aggregate and at the individual level.



To teach basic concepts, we build our lessons (which use text, video, and simulators to illustrate concepts) and their adaptive feedbacks and pathways in the AeLP.

Common pathways and errors can be analyzed afterwards to identify problematic areas and assist in redesigning the lesson.

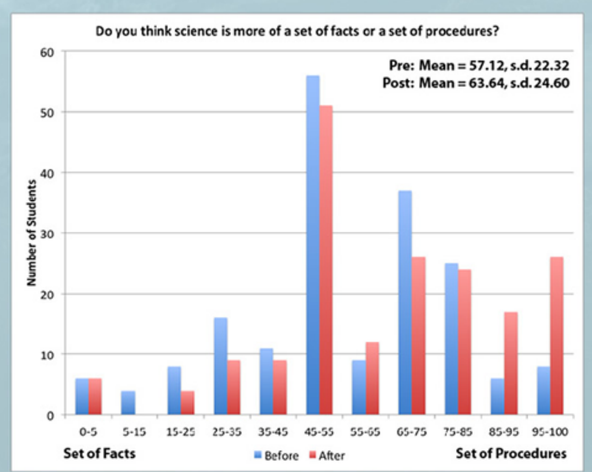


We also utilize interaction tools such as the Piazza discussion platform and Adobe Connect for live chats with students and guest speakers

All tasks feed into the completion of a game-like project where students hunt for habitable worlds in a randomized field of stars.

Attitudes Towards Science

A major goal of the course is to improve students' perception of science. To investigate this, a short survey was administered in the introductory and concluding exercises. Questions on attitudes and perceptions of science were evaluated on a Likert scale (1 = strongly disagree, 5 = strongly agree). To evaluate what students thought science is, they were asked to set a slider between "set of facts" (1) and "set of procedures" (100). The results here represent 240 students who completed both the introductory and concluding surveys.



When scientists have a good explanation, they do not try to make it better.
Pre: Mean = 1.73, s.d. 0.921 Post: Mean = 1.75, s.d. 1.01 p = 0.778

Scientific ideas can be changed.
Pre: Mean = 4.38, s.d. 0.803 Post: Mean = 4.46, s.d. 0.928 p = 0.230

Some scientific ideas have been proven.
Pre: Mean = 4.07, s.d. 1.07 Post: Mean = 3.80, s.d. 1.20 p = 0.001

Scientific questions are answered by observing things and reasoning from evidence.
Pre: Mean = 4.33, s.d. 0.795 Post: Mean = 4.25, s.d. 0.997 p = 0.331

I would enjoy studying science.
Pre: Mean = 3.80, s.d. 1.12 Post: Mean = 3.72, s.d. 1.21 p = 0.249

Only highly trained scientists can understand science.
Pre: Mean = 1.91, s.d. 0.900 Post: Mean = 2.13, s.d. 1.11 p = 0.004

Scientific work would be too hard for me.
Pre: Mean = 2.45, s.d. 1.03 Post: Mean = 2.67, s.d. 1.23 p = 0.010

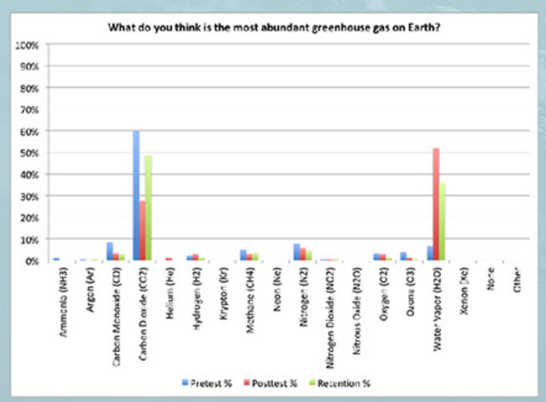
Most people can understand science.
Pre: Mean = 3.38, s.d. 1.16 Post: Mean = 3.35, s.d. 1.18 p = 0.704

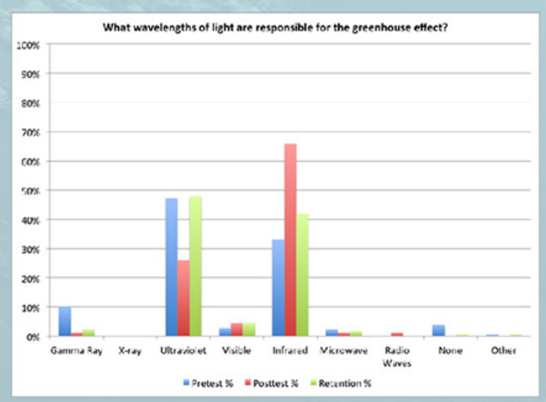
Overall, students have a good understanding that scientific questions are answered through observations and reasoning from evidence, and that scientific ideas are subject to change, with no statistically significant changes from pre to post course. Students show a statistically significant gain in understanding that scientific ideas cannot be proven. When asked to rate whether they believe science is a set of facts or a set of procedures, students show a significant shift towards understanding that science is a set of procedures used to discover a body of facts, rather than just that discovered body of facts.

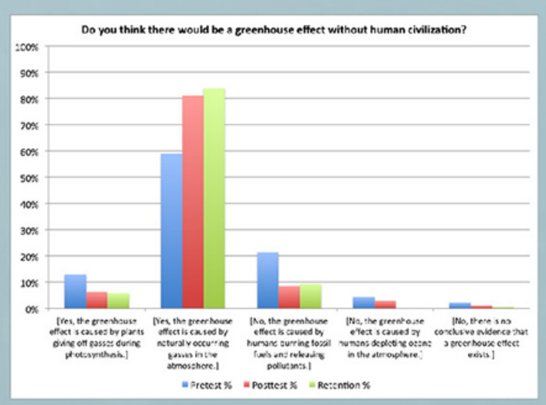
When asked about their attitudes towards science, students on average agree that they would enjoy studying science and that most people can understand science with no significant changes from pre to post course. Interestingly, students began the course disagreeing that only highly trained scientists can understand science and that scientific work would be too hard for them, but show statistically significant shifts towards agreeing with both statements by the end of the course. Overall, this shows that students may retain the belief that science is an elite subject that may not be accessible to all.

Greenhouse Effect Concepts

A major topic in planetary habitability and sustainability is the greenhouse effect. Students were asked several questions concerning common misconceptions about the greenhouse effect both before and after the exercise that dealt with the greenhouse effect in order to gauge the effectiveness of the lesson. They were asked the same questions two weeks later at the end of the term to investigate retention.







Results here represent the responses of 200 students who completed all three surveys. In general, students learn and retain the idea that the greenhouse effect is natural. However, despite strong gains in learning about the details of the process (infrared light is responsible for the effect and that water vapor is the major greenhouse gas on Earth), these gains tend to fade towards pre-test results by the end of the term. A major misconception in the primary characteristic of greenhouse gasses (that they "trap other molecules") persists during the course.

These results indicate that the knowledge gained in this lesson is not properly reinforced during the rest of the semester. Indeed, subsequent lessons focus specifically on carbon dioxide in the context of geochemical cycling and photochemistry in the context of biosignatures. Combined with the fast pace of the course (7.5 weeks), it's likely that these concepts begin to blur together towards the end of the term.