Engaging Students in Astronomy and Space Exploration on a Fully Online, Non-Traditional Science Course.
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Introduction: Students are increasingly turning to the web for quality education that fits into their lives. Nonetheless, online learning brings challenges as well as a fresh opportunity for exploring pedagogical practices not present in traditional higher education programs, particularly in the sciences. On-line learning, supported with hands-on and minds-on activities, actively engages student with critical thinking skills and higher level of learning such as analysis and evaluation of information [1, 2].

A team of two dozen Empire State College-State University of New York instructional designers, faculty, and other staff are working on making science relevant to non-majors who may initially have anxiety about science courses. One of these courses, Introductory Astronomy, focuses on authentic learning experiences that provide a base for inquiry and scientific discovery from a range of astronomy concepts and planetary issues.

The Course: Empire State College (ESC) is a comprehensive, public college within the State University of New York that awards associate's, bachelor's, and master's degrees both face-to-face and through online distance programs. The college annually serves more than 16,000 students, 75 percent of whom work full time and manage family and community obligations while enrolled. Their average age is 36, and most have earned college credit earlier in their lives.

Introductory Astronomy is a lower level undergraduate course that satisfies the general education requirements in the natural sciences delivered fully online in an asynchronous learning environment. The course was designed based on a standardized approach developed at ESC, the Hassenger Model. Named after the developer, the Hassenger Model has two main parts: the course information documents and the learning modules. The course information documents provide information similar to a detailed course syllabus. In the learning module s students have access to instructor commentaries, content guides, discussion activities, and assignments activities for each module of the course. We use Angel as the Learning Management System (LMS).

Active Learning and Collaborative Tools: Many factors help foster successful online learning, such as collaboration, multi-format content presentation and exploration. Taking advantage of the proliferation of tools currently available for online learning management systems, we explore current trends in Web 2.0 applications and virtual environments to aggregate and leverage data to create a nontraditional, interactive learning environment. Using our best practices to promote on-line discussion and interaction, these tools help engage students and foster deep learning. During the 15-week term students learn through readings and interactive presentations, debate about life in the solar system, observe the real- and virtual sky, analyze Mars data to select a landing site for a mission, design a mission, and participate in a virtual environment.

Discussion Forums. An online course that does not incorporate well-crafted and facilitated discussions will fail to transmit meaningful or authentic learning experiences [3]. Discussion forums throughout the course provide a place for students to interact with one another, the instructor and the course content. In the Introductory Astronomy course discuss and communicate with others regarding topics related to: Kepler's laws, NASA's budget, and the Sun's luminosity. In addition, a debate about life in the solar system provides an opportunity to challenge students' long-held beliefs and assumptions.

Using Mars Data. According to the National Research Council (NRC), the online learning experience should strengthen science education by providing students with digital content that has the potential to enable them to gather, analyze, and display data [1]. During the solar system module, students are asked to identify a possible landing area on Mars. The assignment last four weeks and it is divided in two parts: selection of the site using the U.S.G.S. Planetary Interactive GIS-on-the-Web Analyzable Database (PIGWAD); and, mapping of the proposed landing area based on selected THEMIS Visible images.

Second Life. Many higher education institutions, particularly those involved in online learning, have discovered the great potential that virtual environments, such as Second Life (SL), bring to their programs. The integration of virtual worlds and other simulations provides students with an authentic learning experience students that may be either impossible or cost prohibitive in "real life" [4].

A series of optional activities using SL are scaffolded throughout the course. Thus, providing students with the skills necessary to navigate SL. At the end, students explore and immerse themselves on virtual field trips to environments such as NASA's CoLab, NASA's JPL Explorer Island, the International Spaceflight Museum and the Second Life Planetarium. There

they have the opportunity to learn and interact with simulations of various missions, scientific instrumentation, and datasets as well as participate on current seminars and broadcast by NASA. After their virtual experience, students use a discussion forum within the Angel LMS to reflect on their experience and share snapshots and fun facts of their travels.

Mobile Applications. We are currently exploring how we can increase access and student engagement using mobile technology to aid learning in our online courses. As part of a pilot project, a series of Apple iPhone applications were incorporated in the Introductory Astronomy course. Students are highly encourage to use the applications but their use is not required as part of the course evaluation.

Summary. Although instruction provided solely through an online learning environment is a viable alternative to the need for a "physical" space due to the growing percentage of adults going back to college, it is imperative that our courses engage students in scientific inquiry and garner students' interest in the subject matter at the same time. Our course is an example of how we can deliver a rigorous, science course fully online. Tasks employed during the development phase of the Introductory Astronomy course focus on the instructional design and organization of the course. The sequence of activities, required resources, and timing of the learning modules maximize the use of different learning styles. In addition, offering alternative assignments or making technology optional accommodates the variety of learning curves that exist when utilizing technology tools.

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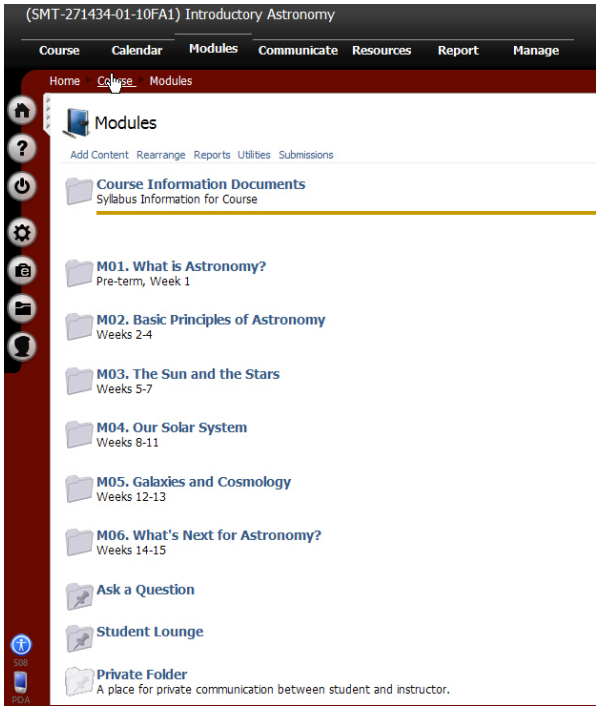

Figure 1. A screenshot of the main portal to the Introductory Astronomy course, Empire State College. The course has six learning modules that take students on a journey to the universe and the solar system through a sequence of activities during a 15-weeks term.