Astronomy & Planetary Science teaching at the Open University

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Introduction

The Open University (OU) has been one of the world's leading distance learning institutions for over 40 years. It currently has over 240,000 students supported by 1,100 full-time academic staff, 3,500 support staff, and around 7,000 part-time tutors. The OU's undergraduate population is rather different to that of other UK universities, but is not as skewed towards older students as some think. Whist the average age of new undergraduate OU students is 31, only 9% of its new students are over 50 and 27% of new OU undergraduates are under 25. In addition, the OU is the largest UK provider of higher education for people with disabilities and 45% of its students had only one 'A' level or lower qualification at entry. Over 71% of OU students work full- or part-time during their studies.

The OU curriculum is modular, with individual modules worth 30 or 60 CATS points (15 or 30 ECTS). Students typically study between 30 and 120 points per year, accumulating 360 points for an Honours degree (120 points at each of Levels 1, 2 and 3). The curriculum of the Science Faculty is largely delivered through its BSc (Hons) Natural Sciences, which has a range of subject-specific pathways through it. As of 2012 onwards, when the OU switched to a qualification-based registration system for the first time, the most popular pathway through this degree is that in Astronomy & Planetary Science.

At Level 1, the Natural Science curriculum is largely interdisciplinary, with all science students studying a range of introductory biology, chemistry, environmental science, geoscience, physics and astronomy & planetary science, as well as mathematics and practical skills. At Level 2, students can focus their study on a chosen pathway, and the OU offers a 30 point module in each of Astronomy and Planetary Science. The core study materials for these modules are text books written by the OU and co-published by Cambridge University Press. There is also a Level 2 practical science module that includes significant activities in astronomy & planetary science (see below). Finally at Level 3, further modules in Astrophysics and in Relativity & Cosmology (also largely taught through CUP co-published text books), and a project module, complete the Astronomy & Planetary Science curriculum.

In addition to supplying text books, the delivery of the modules is fully online via a dedicated VLE. All study resources are offered in electronic format such as eBooks or structured web content. A study planner sets the general study pace, assisted by electronically submitted tutor-marked assignments or interactive computer-marked assignments. All modules offer a number of topic-specific forums for students to discuss the module subject amongst each other and obtain clarifications from their tutor and module team. A study support team above module level provides general pathway and pastoral support.

Practical Science

Traditionally the OU supported its science modules with week-long residential schools to teach laboratory skills. While some short field trips remain in the science curriculum, practical science teaching is increasingly moving to online delivery via the innovative platform of The OpenScience Laboratory (http://www.opensciencelab.ac.uk/; Fig 1). This features interactive practical activities covering the breadth of the sciences based on on-screen instruments, remote access experiments and virtual scenarios using real data. Several activities are available to all, while others are available only to registered users.

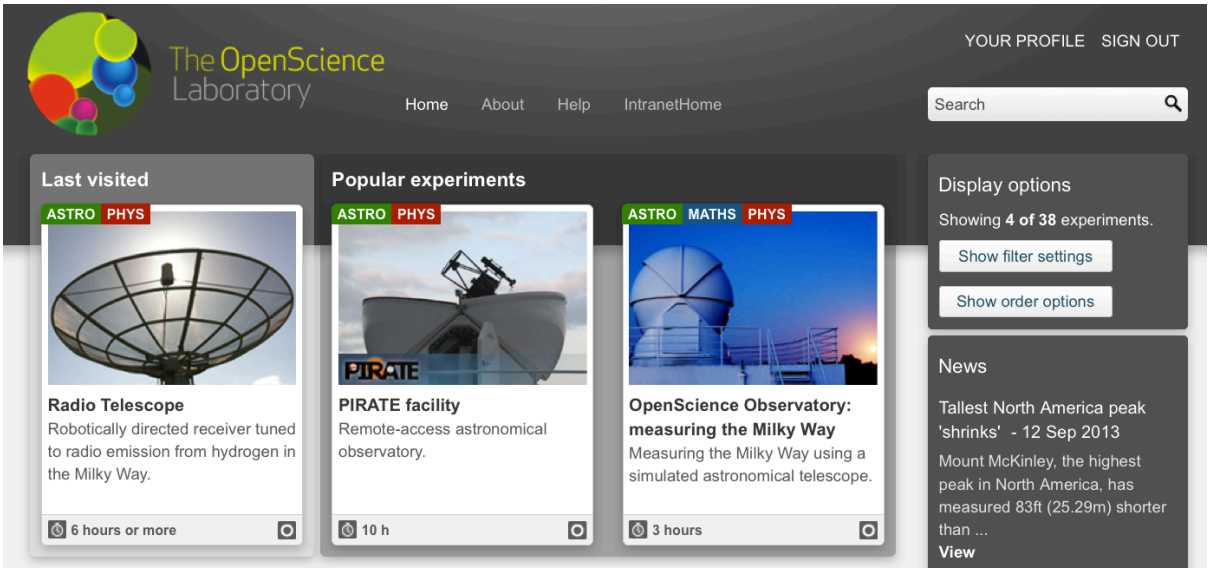

Figure 1 Astronomy activities in The OpenScience Laboratory http://www.opensciencelab.ac.uk/

Residential activities

The stand-alone, week-long second-level residential school for astronomy and planetary science, hosted at the Observatori Astronomic de Mallorca (OAM; http://www.oam.es ; Fig 2), ceased in 2011 after a total of 49 weeks serving nearly 1500 students over 8 years. The current OAM field trip option at Level 2 offers 3 observing nights (2 trips per year, 30 students per trip) and is part of the astronomy topic integrated into a wider 30 CATS point practical science module comprising four different topics in the physical sciences. Students taking the astronomy topic work on colour-magnitude diagrams of star clusters to gain skills in CCD astronomy and aperture photometry. Aspects of planetary science are covered in two further, screen-based topics on the formation and habitability of planets and on planetary atmospheres.

Figure 2 Aerial view of the Observatori Astronomic de Mallorca. The seven small teaching domes are equipped with 12 inch Schmidt-Cassegrain reflectors and CCD photometers. The 100-seat planetarium doubles up as a lecture room. The main observatory building houses a computer lab and hosts the PIRATE Facility on top of the east (right) tower.

The PIRATE Facility

Alongside this residential activity at the OAM the main vehicle for teaching practical astronomy is the PIRATE (Physics Innovations Robotic Astronomical Telescope Explorer) Facility http://pirate.open.ac.uk (Kolb et al 2010, Holmes et al 2011). This comprises a remotely operable 17-inch astrograph (PlaneWave CDK17) on a robotic mount (Paramount ME) with a 4kx4k 9µ CCD photometer (SBIG STX-16803, with Baader RGB and Hα filter), providing a 43 arcmin field of view, in a 3.5m clam-shell robotic dome (by Baader planetarium). PIRATE is located on the east tower of the main observatory building of the OAM campus. The facility utilizes the commercial control software ACP (by DC-3 Dreams) that provides an intuitive web interface for real-time access, but also enables a fully robotic, queue-scheduled mode. Webcams, all-sky cameras and environmental diagnostics complement the live status information delivered by ACP.

To provide distance learning students with effectively "hands-on" practical work, PIRATE is operated in direct access mode throughout the student projects. Observer teams of 2-4 students stay in Skype contact throughout the session and simultaneously access the web control interface to obtain real-time status information. Team members take turns at observing duties such as operating the telescope, keeping logs and assessing environmental conditions and data quality. The OU provides a night duty astronomer on call in case of technical issues that require administrator-level access to solve. For the Level 2 astronomy topic an observer team has access to PIRATE for half a night (in place of the OAM field trip), to acquire star cluster data for later analysis. At Level 3, a small number of teams collaborate in a project group with PIRATE access on 7 full observing nights over a 2-month period. The aim of the group project is to obtain a long-term phase-folded light curve of a periodic variable identified by SuperWASP, and to write up the findings in a collaborative project report. Occasionally some enthusiastic students develop their reports further towards publication (Faillace et al 2013, Bruce et al 2013).

The annual student numbers on these practical astronomy activities are resource-limited to typically 120 at Level 2 (60 on OAM field trips, 60 on PIRATE) and 60 at Level 3. An alternative Level 3 collaborative data analysis project on SDSS quasar spectra using the SkyServer portal to access the SDSS data archive has no such limit and is taken up by about 100 students per year.

Astronomy in The OpenScience Laboratory

PIRATE is one of currently three astronomy experiments that are accessed via The OpenScience Laboratory. The second experiment is the OU's 3m radio telescope which allows real-time remote access and is soon to be used in a student project mapping out the spiral structure of the Galaxy in the 21cm hydrogen line. The third experiment is the virtual OpenScience Observatory (OSO).

The OSO uses the same web control interface as PIRATE and communicates with a server set up in ACP's simulator mode, but with no telescope or camera hardware attached. This PIRATE simulator responds in the same way as its real counterpart, and returns realistic FITS files of the requested star fields synthesized from a star catalogue. The OSO is used in a number of activities, including one that prepares students for the use of PIRATE itself.

In conjunction with planetarium software or image manipulation software the OSO becomes a versatile tool for teaching a variety of aspects of observational astronomy, from basic facts about the night sky to CCD data reduction techniques. Work to expand the portfolio of OSO-based activities at different levels is on-going. This will complement, not replace, the provision of real-time access to

facilities such as PIRATE, which is recognized as an ideal vehicle to provide distance-learning students with an authentic experience of practical astronomy.

References

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