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Alien Worlds: Astrobiology and Public Outreach

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Abstract: Over the last three years the Centre for Astronomy and Science Education at the University of Glamorgan has been delivering an innovative outreach programme in astrobiology in south Wales, UK. 550 members of the local community have attended an accredited undergraduate course in astrobiology, *Alien Worlds*. Funded by a European Social Fund (ESF) grant, the course introduces students to the multidisciplinary nature of astrobiology, coupling academic content with practical training in recognising the constellations and objects of the night sky. This paper outlines the course's background, content, delivery and outcomes, providing an example of the potential of the science and culture of astrobiology to engage and inform the public.

1. Introduction

It is often claimed that the general public feel disenfranchised by science, yet the growth of popular science in the broadcast and print media suggests that there is also widespread interest in the questions science poses. Astrobiology, which straddles the boundaries between science, art, religion, and philosophy, provides an ideal starting point for discussions about the public and cultural placement of science. In 1998, the Centre for Astronomy & Science Education (CASE) at the University of Glamorgan, south Wales offered the first undergraduate module in Western Europe to examine the question of extraterrestrial life, *Life in the Universe*. Since 1996 the Centre for Astronomy & Science Education (CASE) at the University of Glamorgan, south Wales has been running astronomy and astrobiology courses in the local community. CASE's outreach programme has attracted over 1300 students from a variety of educational, social and cultural backgrounds. *Life in the Universe*, a third-level course which contains all the typical scientific, social and cultural elements associated with

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CASE provision, proved extremely popular not only with on-campus students, but also amongst our associate students in the community.

CASE's outreach provision has been developed alongside an evolving on-campus undergraduate programme which provides BSc awards in *Astronomy and Space*, *Astronomy and Anthropology*, and *Science: Fiction and Culture*. In September 2005 CASE launched a new undergraduate degree course in *Astrobiology*; the first such award in the UK. Our degrees and outreach courses aim to recognise the broader aspects of science as a subject of overwhelming importance to society; our goal has been to open up access to science education to those who are fascinated by astronomy, astrobiology, and science in general, but do not necessarily want to be limited to a purely vocational style of training. These developments have attracted a great deal of media attention and created considerable interest in CASE's work in the public communication of multidisciplinary science (Brake & Griffiths 2004a, 2004b; Brake & Thornton, 2004).

In 2003 CASE submitted a bid to the European Social Fund (ESF) detailing an educational strategy to increase scientific awareness, education and opportunities in the South Wales valleys, an area which has experienced widespread social and economic depression following the demise of its indigenous heavy industries in the 1980s. The European Commission subsequently granted an award of around £450,000 ($840,000), under condition that CASE should reach 350 beneficiaries over a two-year period, and must provide a course that addressed key life skills in addition to providing a pathway to further education. Previous experience at CASE, and market research during the summer of 2003 indicated that both astrobiology and an

introduction to observational astronomy might provide an effective basis for meeting these conditions. This led to the creation of a community outreach course integrating both topics: *Alien Worlds*.

2. Developing *Alien Worlds*

In *The Fifth Discipline* Senge notes that:

> …from a very early age, we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price. We can no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole. When we try to `see the big picture,' we try to reassemble the fragments in our minds, to list and organize all the pieces
>
> (Senge, 1995, p. 181)

It can be seen that the reductionist approach, which lies at the heart of traditional science's efforts to discern "the big picture", is in some ways fundamentally at odds with how astrobiology has evolved and is conceived of as a subject. In a paper presented to the Astrobiology Science Conference at NASA Ames in 2004, Sam Abrams and David Morrison surveyed 1364 science departments yielding data on 42 courses on "life in the universe". An analysis of the syllabi for these courses provided the basis for their proposal of a standard astrobiology course which would include 10 broad topics:

- History of the Universe
- Formation and History of the Earth
- Nature of Life
- Evolution of Life
- Extraterrestrial Life
- Life in Extreme Environments
- Life in Our Solar System (Mars and Europa)
- Aliens, Science Fiction and SETI
- The Future of Humankind in the Universe

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The astrobiology science communication roadmap developed by the NASA Astrobiology Institute's Science Communication working group (NAISCWG) in 2004 also clearly illustrates the inherently multidisciplinary nature of astrobiology. The roadmap, which aims to "facilitate and realise effective, proactive communications about astrobiology across the spectrum of disciplines, audience types, and formats" is an attempt to bring astrobiology to the forefront of public awareness by integrating cross-disciplinary links in science teaching with communication to diverse audiences. In doing so, it goes beyond the rather narrow confines of ordinary science disciplines and into the broader world of human discovery, experience and rationalism. The Roadmap's proposed implementation plan for astrobiology includes five goals for effective communications:

> 1: Facilitate understanding, information exchange and expansion of expertise between and among astrobiology researchers and the disciplines they represent;
>
> 2: Foster communication and information exchange between the astrobiology community and experts and professionals in other fields (philosophy, ethics, religion, history, law, psychology, social sciences, art, communications, etc.);
>
> 3: Support educators and the mass media in communicating about astrobiology and issues of "astrobiology & society";
>
> 4: Encourage Best Practices in the Science Communication of astrobiology;
>
> 5: Facilitate timely and strategic communication of astrobiology and its issues among diverse audiences including citizens, policy makers, administrators, and sponsors.
>
> (NASA, 2003)

As two of the course authors (Brake & Griffiths) sit on the NAI Advisory Board for the Science Communication of astrobiology, the design of the *Alien Worlds* module aimed to meet this communication challenge head-on.

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3. Course Structure & Content

Table 1 shows a general outline of the *Alien Worlds* course structure. The course was formulated as a 20-credit HE level 2 module by synthesising materials from existing modules on astrobiology (*Life in the Universe*) and observational astronomy (*Exploring the Sky*). It was intended to provide a cross-disciplinary introduction to astrobiology with both academic and practical components. Credits are gained through a series of assessments such as performing observations of the night sky (using the CASE RoCCoTO robotic telescope, or students' own telescopes and cameras), writing an associated observing log (demonstrating not only observational methodology and reflection, but also familiarity with word processing software and ICT), giving a formal presentation (using PowerPoint) on an astrobiological topic of their choice, and by a mathematical derivation of the Drake equation.

Table 1: Course structure of Alien Worlds

Topic	*Lecture*	*Seminar*	*Practical*
Physical	The Message in Starlight The Sun as a Star Stars: Birth and Death Our Solar System Extrasolar Planets	Colours of Stars Impact on Earth Life and Longevity Life on Mars? Comparison	Seeing the Stars Observing the Sun Planetary Nebulae The Planets Seeking the Stars
Cultural / Societal	Myths and Legends of the Sky The Great Demotions The Role of the Imagination Cosmic Catastrophe	Create a Constellation The Next Demotion? Alien Morphology The Human Impact	Recognition Observe the Milky Way Mars Meteors or Comets
Biological	Evolution and Origins Evolution and Intelligence Human Origins Probabilities of Life Habitable Zones	Religion and Science Define Intelligence The Next Step? Imagining Planets Terraforming	Observing the Moon Software and ICT Viewing the Planets The Drake Equation Constellations
Practical	Seasons and Constellations Night Sky Photography Our Solar System Telescopes The Deep Sky Astronomical Software	Planning an Observing Session Using Software Software and Recognition Student Telescopes Messier's Objects Familiarity and	Constellation Recognition Taking Photos Printing and Using Sky Charts RoCCoTO Messier Marathon PowerPoint and ICT

		Practice	

In the first few weeks of the course the "tools" of science are introduced and the students are given a general outline of the course topics. The course then moves on to engage with subjects such as spectroscopy ("The Message in Starlight"), and stellar evolution from star birth to stellar endpoints. Lectures are interspersed with practical sessions on the telescope, demonstrating techniques, instrumentation and astrophotography. Thus, the first twelve-week term provides a general introductory study of astrobiology, and an overview of our knowledge of stars and the formation of the solar system. The second begins with the geology and habitats of the solar system, and then extrapolates to habitable zones and extrasolar systems. The course then goes on to deal with evolutionary theory, the emergence of intelligence, issues of creation and evolution, panspermia hypotheses, and the probability of life elsewhere. Considerations of the role of society and culture in astrobiology are tackled through studies of science fiction and its effects on scientific investigations such as SETI.

As most students begin the course with little or no knowledge of astronomy, they are given a guide to observing (also entitled *Alien Worlds*) prepared by Martin Griffiths, a CASE staff member with many years of practical observing experience. This book, which has 275 pages and is fully illustrated throughout by Martin's photographs of constellations, deep sky objects etc; introduces the students to the night sky via observational activities. Observing templates, celestial cartography and numeracy, observing exercises and the Drake equation are all components of the book.

One of the centrepieces of the ESF bid was its ICT element, provided by students' use of CASE's robotic telescope, a Meade LX200 16" Schmidt Cassegrain telescope on a

robotic mount, coupled with a CCD camera that enables quick delivery of astronomical photographs to the observer. The telescope is driveable via an internet interface which is utilized in the outreach programme to teach ICT skills. This allows academic activities to be coupled with practical sessions utilizing the telescope to view transient celestial objects such as comets, and sky objects with an astrobiological application such as nebulae, planets and satellites of the solar system and stars with known extrasolar planetary systems. Regular observing sessions are also held at dark sky sites where students use portable telescopes and binoculars. These sessions couple a scientific observation of the heavens with an exploration of the cultural heritage of Greek, Celtic, Norse and Native American mythologies, providing students with a more holistic understanding of the night sky.

4. Delivering *Alien Worlds*

Alien Worlds has a community focus both in content and delivery. Although there are astrobiology outreach programmes in several universities, such as Pennsylvania State University (Brown & Phelps, 2005), University of California at Los Angeles and the Australian Centre for Astrobiology, these projects are in-house and are arranged strictly on campus rather than having a community base. Additionally, other outreach programmes are limited to single days in the year or a monthly public lecture, and are not accredited courses. Project *Astrobio* at the University of Washington is an interesting case in that it integrates KS12 activities into astrobiology linked teaching in local schools, attracting around 1900 students in the Seattle area (Sullivan, 2005). *Alien Worlds* differs from these projects in that it is designed to be outreach in the true sense of the word; classes are delivered in off-campus community centres - the University's mission statement is that students should be able to dictate the pace and

place of study. It is also aimed exclusively at adult audiences, although its activities and applications filter down to schools via the work of *SETPOINT Wales*, a UK Department of Trade & Industry (DTI) funded body also housed at the Centre for Astronomy and Science Education, which uses government funds to sponsor extra-curricular science events at KS 1-5 (UK).

In the first year of *Alien Worlds* (2003-4), 118 community students were enrolled and the course ran in four centres where University courses in astronomy had previously been developed and taught. It was necessary to appoint a full time tutor to cover the teaching commitments on the module and then to identify other part time tutors to run the project in the second year. In year two (2004-5) the number of centres where the course was held dramatically increased to 21 and 254 students were enrolled. The centres in use met ESF guidelines on economic regeneration as they were located in some of the most economically depressed areas of South Wales ranging from the Neath and Swansea Valleys in the west to Ebbw Vale in the east, an area encompassing almost one million people. Most of these course centres were either community halls or miner's welfare institutes around which a number of regenerative projects were grouped, providing an educational focal point for the communities (Brake *et al.*, 2004). Also in 2004-5, *Alien Worlds* educational materials were appropriated by a local community school which had been previously involved with CASE outreach programmes. The astrobiology content of the module and the practical sky observation elements provided extra-curricular activities for 16 KS 5 students, with the school purchasing a 200mm guided telescope and camera equipment.

Russian cosmonauts Dr Alexander Martynov, head of ballistics at mission control and Colonel Alexander Volkov, one of the commanders of the Mir space station, were invited to give a public lecture during Science Week in March 2004. The community classes were invited to an evening exposition on spaceflight to Mars and how scientists were currently engaged in plans to travel to the planet, but also in how to determine if there was life present. Question and answer sessions were dominated by astrobiology themes; between the two visits over 450 persons attended the lectures. During the courses students are also encouraged to enrol on, and participate in, the DTi's Science & Engineering Ambassadors (SEAS) programme, which necessitates a Criminal Records Bureau (CRB) check. Successful CRB checks and participation in science activities can be added to a student's personal CV, assuring a prospective employer of the trustworthiness of the person whilst revealing an aptitude for implicit and explicit key skills.

5. Course Outcomes

Student feedback, which was solicited as an ongoing aspect of course contact with the tutors and through an additional final course review by anonymous questionnaire, has mainly been positive, with learners emphasising their enjoyment of the practical elements of the course and expressing appreciation for its cross-disciplinary approach. One of the main negative points of feedback concerns the quality of the UK weather and its impact on observational activities. A post-course evaluation in March 2005 found that the majority of students had become familiar with the night sky and found their thinking and attitudes on the subject of extraterrestrial life transformed. Five students had been inspired to take degrees in astronomy and related subjects. One set up a business distributing astronomical equipment, another has had an article

published in a popular international astronomy journal, and eight have become accomplished astrophotographers. Others are currently engaged in regular astronomy and astrobiology science communication activities with SETPOINT Wales. The majority of students were also found to have gained or improved ICT skills, building personal confidence and employability. In an intermediate questionnaire, over 100 students in the 2004-5 cohort indicated a positive preference to take another University module, indicating a commitment to furthering their education.

One of the main difficulties facing of any outreach course is student retention. While delivering *Alien Worlds* it has proven difficult to get students to attend every class, and it has become evident that courses of 10 – 12 weeks duration are preferred by most, rather than the 24 or 30 week courses required to meet funding targets. Although initially high (up to 96% in the first three months), retention often declines markedly during the latter stages of the courses. As student numbers dwindle in some areas, it becomes necessary to integrate classes to maintain viability. In 2005 a large advertising campaign was launched across west Wales to encourage adult learning and enrolment on the course. Teaching centres were identified in major towns in the region, but recruitment was poor, probably due to the amount of travelling involved in rural communities with poor public transport provision. As a result these courses were eventually dropped, it proving impracticable to integrate classes across such a wide geographical area. Some problems were also encountered with student assessment. Many students have apparently joined the courses for the element of scholarship and learning, but are uninterested in working towards gaining accreditation. Although the

practical observing was enjoyed by most, only 56% actually produced work toward the assessment or completed the course to gain full accreditation.

The commitment to ESF indicated that 40 of the programme beneficiaries should be encouraged to become science ambassadors, enabling them to influence their communities or associated groups bringing astrobiology (and science in general) to a wider audience. In order to meet this commitment, several partnership organizations were identified as "learning gatekeepers" who could facilitate the course in the local communities. Individuals in these organisations were then in a position to adapt their knowledge acquired through the course to a local need or provide experience that would encourage others. The University of the Third Age, community support groups, Communities First, SETPOINT Wales and a number of other local organisations filled this role predating the broader issues relating to the third goal of the NAISCWG science communication roadmap. The interaction between these groups has been positive, identifying community needs and providing assistance to individual students disadvantaged by a lack of ICT materials or learning support.

Finally, the regional media have reacted supportively to *Alien Worlds*. Newspapers such as the *Western Mail* (with Wales largest distribution) along with local papers (*Merthyr Express, Pontypridd Observer, Rhondda Leader, South Wales Argus, South Wales Echo*) have run stories on several aspects of the course, leading to increased public interest in the University's activities and those of CASE in particular. The CASE website (http://case.glam.ac.uk) received a high number of hits which have reflected public interest in astrobiology and our work in general. The *Rhondda Leader* now has a monthly "watch the sky" column which is written by one of the

students. Media attention has also been focused by tutor appearances on BBC television, BBC Radio Wales and the local radio stations Real Radio and GTFM.

6. Conclusion

The *Alien Worlds* course has attempted to develop an innovative and cross-disciplinary approach to teaching astrobiology. The aim since its inception in 2003 has been to increase public understanding of core science fundamentals through a programme which highlights the cultural, anthropological and societal aspects of the study of pluralism. To some extent this aim has been achieved. The majority of associate students matriculating from the *Alien Worlds* outreach programme have developed into better-informed members of the public with an more critical and informed approach to science, and an improved awareness of the placement of science and its technological spin-offs within our modern culture. Their greater appreciation for the value of scientific disciplines and application has led some to become critical and voluble advocates for science. Many *Alien Worlds s*tudents have participated in extracurricular activities and research outside the normal confines of the course; one group has set up its own local astronomical society, while other associate students have enrolled as full-time undergraduates. In recognition of these achievements, CASE was nominated for the 2005 Queens Anniversary Prize, an award for UK further and higher education institutions which recognises outstanding contributions to the intellectual, economic, cultural and social life of the nation.

The keys to this success have been flexibility, adaptability and hard work, on the part of both students and staff. A review of the programme in late 2004 highlighted the further potential of astrobiology and astronomy to recruit students, effect a local

change in social attitudes towards HE, and even enable key skills necessary for employment. In March 2005 the European Social Fund granted CASE a further £500k ($935K) to continue to run *Alien Worlds* alongside a new course in *Space Exploration & Robotics*, with a target of reaching 500 beneficiaries over a two-year period. More than 250 adult learners have already participated in these activities as of March 2006.

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Presentation on theme: "Catherine Tryfona Astrobiology and public outreach Alien Worlds University of Glamorgan Prifysgol Morgannwg Mark Brake Martin Griffiths Neil Hook Allan."â€” Presentation transcript: 1 Catherine Tryfona Astrobiology and public outreach Alien Worlds University of Glamorgan Prifysgol Morgannwg Mark Brake Martin Griffiths Neil Hook Allan Trow Catherine Tryfona. 2. 3 University of Glamorgan Prifysgol Morgannwg. Astrobiology Research Group, Center for Astronomy and Astrophysics (ZAA), Technische UniversitÃ¤t Berlin, Hardenbergstr. 36, 10623 Berlin, Germany. 3. Section Geomicrobiology, German Research Centre for Geosciences (GFZ), 14473 Potsdam, Germany. 4.Â In principle, what the specific elements or molecules would be in an alien biological scheme is less pertinent than the specific functional properties they would provide. We have to realize that our knowledge is extremely limited, based on only one biosphere and one biochemistry of life (Section 3.1). Although this known biosphere is very diverse, we probably extremely underestimate the forms and functions life can take. Intriguing suggestions on the possibilities of alien chemistries have been provided by Bains [76]. Astrobiology Magazine [astrobio.net]. Company. SpaceFlight Insider.Â METI International. August 29 at 8:41 PM Â·. The astrobiology of alien worlds https://www.airspacemag.com/â€¦/astrobiology-alien-worlds-1-â€¦/ A comprehensive review of life as we know itâ€”and may not know it. airspacemag.com. The Astrobiology of Alien Worlds. A comprehensive review of life as we know itâ€”and may not know it. A comprehensive review of life as we know itâ€”and may not know it.