International Journal of Astrobiology 5 (4): 319–324 (2006) Printed in the United Kingdom
doi:10.1017/S1473550406003041 First published online 7 December 2006

Alien worlds: astrobiology and public outreach

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Abstract: Over the last three years an outreach programme in astrobiology has been stimulating public interest in South Wales, UK. To date, 550 people have attended an accredited undergraduate course in astrobiology, *Alien Worlds*. Funded by a European Social Fund grant, this modular course has introduced students to the multidisciplinary nature of astrobiology, coupling academic content to a practical ability to recognise the constellations and objects of the night sky. This paper outlines the course's background, content, delivery and outcomes as an example of the outreach potential of the science and culture of astrobiology.

Received 29 June 2006, accepted 6 July 2006

Key words: communication, education, culture.

Introduction

Since 1996, the Centre for Astronomy & Science Education (CASE) at the University of Glamorgan, South Wales has been running astronomy courses in the community, in conjunction with the university's Centre for Lifelong Learning. This outreach programme, which has attracted over 1300 students from a variety of educational, social and cultural backgrounds, 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, the CASE launched a new undergraduate degree course in *Astrobiology*; the first such award in the UK.

The CASE approach

The possession of scientific knowledge and analytical skills is becoming increasingly important in fields as diverse as education, journalism and politics. The CASE degree awards aim to recognise the broader aspects of science as a subject of overwhelming importance to society. Our goal is to open up access to the sciences to those who are fascinated by astronomy, astrobiology and science in general, but do not want to be limited to a purely vocational style of training. 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)

This reductionist approach lies at the heart of the traditional way science has addressed big issues, but is at odds with the way that Astrobiology was and is conceived 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'. From the posted syllabi for these courses a standard astrobiology course was proposed. It included 10 broad topics:

- the history of the Universe;
- the formation and history of the Earth;
- the nature of life;
- the evolution of life;
- extraterrestrial (ET) life;
- life in extreme environments;
- life in our Solar System (Mars and Europa);
- aliens, science fiction and the search for extraterrestrial intelligence (SETI);
- the future of humankind in the Universe.

In addition, the astrobiology science communication roadmap presented by the NASA Astrobiology Institute's Science Communication working group (NAISCWG) in 2004 focuses on such strategic issues. The roadmap 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. It is hoped that such an approach reflects a common human interest, which goes beyond the rather narrow confines of ordinary science disciplines and into the broader world of human discovery, experience and rationalism.

Astrobiology at the CASE

It is often claimed that the general public feels disenfranchised by science, yet the popularity of media programmes and other scientific information suggests that there is also widespread interest in the questions science poses. Astrobiology provides an ideal forum in which to discuss questions relating to the public and cultural placement of science. Astrobiology is a rewarding study of the boundaries between science, art, religion, philosophy and pseudoscience, and also acts as a measure of the dialectic between our advancing human knowledge and that which remains undiscovered. In 1998, the CASE launched the first undergraduate module in Western Europe to examine the question of ET life. Entitled *Life in the Universe*, this third level modular course has expanded to become the flagship of our awards and contains the typical scientific, social and cultural elements of our modular courses. It has proved extremely popular not only amongst campus students but also amongst our associate students in the community. Due to the nature of our awards, we have attracted a great deal of media interest, creating a significant awareness of our outreach work in the public communication of multidisciplinary science (Brake & Griffiths 2004a, b; Brake & Thornton 2004). In 2003, the 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 of ongoing economic depression after the demise of its indigenous heavy industries in the 1980s. The European Commission responded by granting the CASE financial support to put into operation our initiatives, under the guarantee that we could attract 350 beneficiaries over a two-year period and provide a course that would address key life skills in addition to providing a pathway to further education. Market research during the summer of 2003 indicated that both astrobiology and an introduction to observational astronomy might prove popular, leading to the creation of a course addressing both topics: *Alien Worlds*.

Alien worlds

The *Alien Worlds* modular course has a community focus both in content and delivery. The curriculum is designed to act as a bridge to public consciousness on astrobiological issues. The course is 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. 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. In addition, 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 aimed 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 CASE, which uses government funds to sponsor extra-curricular science events at KS 1–5 (UK). All these activities provide a springboard for astrobiology teaching and public engagement and provide an exemplary forum for comparison, experience and normative guidance.

Course structure

Two of the course authors (Brake & Griffiths) sit on the NASA Astrobiology Institute Advisory Board for the Science Communication of astrobiology. The group's science communication roadmap aims to 'facilitate and realise effective, proactive communications about astrobiology across the spectrum of disciplines, audience types, and formats'. The 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)

The *Alien Worlds* module aimed to meet this communication challenge head-on. As has been reported at international conferences, since 1998 the CASE's astrobiology curriculum has showcased the scientific, social and cultural aspects of the ET debate. We consider the social, political, spiritual and religious agendas of the ET search, and speculate on the future of human evolution. Such a cross-curricular ethos presents our students with a dynamic and critical understanding of astrobiology, recognising the need for 'information exchange' and that 'issues of astrobiology and society' require scientific, social and cultural analysis.

It was therefore important that we continue our outreach work in this vein, and try to encourage students to engage in best practice in the science communication of astrobiology. We had developed science communication sessions in which students conduct seminars in order to critically and imaginatively communicate the nature and evolution of the ET debate. Students are trained in the best methods of science communication, illustrating how cultural forms such as science fiction are often unconscious and therefore particularly valuable reflections of the assumptions and attitudes

held by society. By virtue of its ability to project and dramatise, science fiction has been a particularly effective, and perhaps for many people the only, means for generating concern and thought about the social, philosophical and moral consequences of scientific progress. No subject captures the public's scientific imagination more than astrobiology.

It was important that, given the ESF's conditions and our market research results, we translate previous success in astrobiology to courses off campus. The CASE formulated a 20-credit university level module by synthesising materials from existing modules on astrobiology (*Life in the Universe*) and observational astronomy (*Exploring the Sky*) amongst others. It was our intention to provide both a practical and academic cross-disciplinary introduction to astrobiology enabling mature students to engage in higher education despite having no significant previous educational history. The credits would be gained through a series of assessments such as performing observations of the night sky (using our RoCCoTO robotic telescope, or their 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.

Considering that most students would be coming into the course with little or no knowledge of astronomy, Martin Griffiths, a staff member with many years of practical observing experience, prepared a guide to observing which was also entitled *Alien Worlds*. This book has 275 pages and is fully illustrated throughout by Martin's personal photographs of constellations, deep sky objects, etc., introduces the students to the night sky via observational activities and links this to astrobiology. Observing templates, celestial cartography and numeracy, observing exercises and the Drake equation are all components of the book.

Table 1 shows a general outline of the *Alien Worlds* course structure. Following the CASE experience and the guidelines from the NAISCWG, the course was structured around the themes, topics and activities shown in the table above. It was considered essential to introduce the 'tools' of science within the first few weeks, so the course was structured around an introductory phase, which detailed the topics as a necessary taster for things to come. The course could then move onto individual topics such as spectroscopy ('The message in starlight'), and outline our knowledge of stellar evolution from star birth to stellar endpoints. All lectures were interspersed with practical sessions on the telescope demonstrating techniques, instrumentation and astrophotography.

The first term of 12 weeks provides a general introductory study of astrobiology, and gives a good evaluation of our knowledge of stars and the formation of the Solar System. The second 12-week term begins with the geology and habitats of the Solar System, and extrapolates to habitable zones and extrasolar systems. The course then deals 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 an imaginative use of science fiction and its affects on SETI, drawing upon our work on campus.

Community delivery

In the first year of the project, the course was run in four centres where University courses in astronomy had already 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 (2004–2005) the number of centres where the course was held dramatically increased to 21, enrolling 254 students. These centres were identified as fulfilling 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. Traditionally, these localities have a proud history of education, self-sufficiency and development, and bore the brunt of the decimation of the coal and steel industries in the 1980s, remaining economically underdeveloped with a high proportion of long-term unemployment and associated social problems right into the 21st century. 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).

The academic year 2003–2004 provided us the opportunity to present this course, which was offered to 118 community students in that year. The year 2004–2005 saw 236 students enrol, revealing the depth of interest in astrobiology and astronomy amongst the public. In addition, *Alien Worlds* educational materials were appropriated by a local community school which had been involved with our outreach programmes for several years. The astrobiology content of the module and the practical sky observation elements were enjoyed as an extra-curricular activity by a KS 5 class. The school supported this initiative by purchasing a 200 mm guided telescope and camera equipment, and the materials were adapted by the physics teacher to form a curriculum that attracted 16 students.

Telescopes and sky culture

One of the centrepieces of the ESF bid was the ICT element of the University's robotic telescope. This facility is 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 that is utilised in the outreach programme to teach ICT skills. The delivered academic course could then be coupled with practical demonstrations and sessions utilising the telescope to enable students to view transient celestial objects such as comets, or sky objects with an astrobiological application such as nebulae, planets and satellites of the Solar System and stars with known extrasolar

https://doi.org/10.1017/S1473550406003041 Published online by Cambridge University Press

Table 1. *Course structure of Alien Worlds*

Topic	Lecture	Seminar	Practical
Physical	The message in starlight	Colours of stars	Seeing the stars
	The Sun as a star	Impact on Earth	Observing the Sun
	Stars: birth and death	Life and longevity	Planetary nebulae
	Our Solar System	Life on Mars?	The planets
	Extrasolar planets	Comparison	Seeking the stars
Cultural/Societal	Myths and legends of the sky	Create a constellation	Recognition
	The great demotions	The next demotion?	Observe the Milky Way
	The role of the imagination	Alien morphology	Mars
	Cosmic catastrophe	The human impact	Meteors or comets
Biological	Evolution and origins	Religion and science	Observing the Moon
	Evolution and intelligence	Define intelligence	Software and ICT
	Human origins	The next step?	Viewing the planets
	Probabilities of life	Imagining planets	The Drake equation
	Habitable zones	Terraforming	Constellations
Practical	Seasons and constellations	Planning an observing session	Constellation recognition
	Night sky photography		Taking photos
	Our Solar System	Using software	Printing and using sky charts
	Telescopes	Software and recognition	RoCCoTO
	The deep sky	Student telescopes	Messier marathon
	Astronomical software	Messier's objects	PowerPoint and ICT
		Familiarity and practice	

planetary systems. Regular sessions are also held at dark sky sites where student telescopes and binoculars are used to look at various objects, promoting the practical aspects of the course. These sessions couple a scientific view of the heavens with the cultural heritage of stories from the past; Greek, Celtic, Norse and Native American mythologies providing students with a more holistic understanding of the night sky.

Partnerships and the media

The commitment to the ESF required that 40 of the beneficiaries of the original programme would become science ambassadors via the project. The skills they would acquire would enable them to influence their communities or associated groups in order to bring astrobiology to a wider audience. In this respect, several partnership organisations were identified as 'learning gatekeepers' who could facilitate the course in the local communities. Individuals in these organisations would then be 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 who may be disadvantaged by the lack of ICT materials or providing learning support.

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.

Regional media have reacted supportively to the introduction of such a unique course. 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 the CASE in particular. The CASE Web site (http://case.glam.ac.uk) received a high number of hits which reflects the public's interest in astrobiology and our work in general. The *Rhondda Leader* now has a monthly 'watch the sky' column that 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.

Outcomes

Feedback was performed as an ongoing aspect of course contact with the tutors, with an additional final course review by anonymous questionnaire. This feedback has mainly been positive, with an emphasis on the practical elements of the course and an appreciation for the cross-disciplinary aspects connecting disparate ideas formerly considered in isolation. One of the main negative points of feedback was a reflection

on the quality of the UK weather! Due to this, several students were motivated to engage in alternate expressions towards their assessments, one producing a folio of artistic images detailing the planet Mars and its association with life and another student producing a highly detailed sculpture of the planet Saturn. Others put Web pages and video images together as a forum for future programmes focusing upon varied aspects of the ET life debate.

When the course was evaluated in March 2005 it was found that five students have been inspired to take degrees in astronomy and related subjects, one has set up a business distributing astronomical equipment, and eight others have become accomplished astrophotographers. One student is currently engaged in science activities featuring the *Starlab* planetarium, rocket and robotics workshops in conjunction with SETPOINT Wales. Another has had an article published in a popular international astronomy journal. The majority of students have gained or improved ICT skills, building personal confidence and employability. The majority are now familiar with the night sky and have had their thinking and attitudes on the subject of ET life transformed. In an intermediate questionnaire, over 100 students in 2004–2005 indicated a positive preference to take another University module, indicating a commitment to furthering their education. To consider the future roles and applications of the programme to the student's lives, many were encouraged to make an application to be Criminal Records Bureau (CRB) checked and enrolled on the DTI's Science & Engineering Ambassadors (SEAS) programme. This provided a pool of personnel who could become involved in cross disciplinary education initiatives such as science challenge workshops, robotics workshops and public lectures to schools and other public forums. Such police checks and inclusion in science activities can be added to a personal CV assuring a prospective employer of the trustworthiness of the person whilst revealing an aptitude for implicit and explicit key skills.

However, one of the main drawbacks of any outreach course is student retention. Although initially high (96%), retention declined markedly during the latter stages of the courses. It was difficult to get students to attend every class, and as student numbers dwindled in some areas, it became necessary to integrate some classes to make them viable. It was evident that courses of 10–12 weeks duration were preferred by most students rather than a 24 or 30 week course. Due to ESF funding justifications, it was not possible to chop the course down as delivered hours were tied to a scale which would not have made the project financially viable if the class contact times were cut. 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 Haverfordwest, Pembroke Dock, Llanelli and other major towns in the region, but student numbers were poor; possibly due to the amount of travelling involved in rural communities and where public transport was not available. These courses were eventually dropped, the students being unable to integrate classes across a wide geographical area.

Some problems were also encountered with student assessment. Many students apparently join the courses for the element of scholarship and learning, without the intention of 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.

Conclusion

The *Alien Worlds* course has developed an innovative cross-disciplinary approach to teaching astrobiology and increasing public understanding of core science fundamentals through a programme that highlights the cultural, anthropological and societal aspects of the study of pluralism. Flexibility and adaptability are the key qualities that have enabled the courses to run since 2003. Flexibility not only on the part of the students but also on the part of the staff (two tutors, two assistants and two part-time managers) who have made Herculean efforts to run the courses and maintain them. The course has created an opportunity to increase the public's awareness and understanding of astrobiology beyond the traditional 'test tube and textbook' methods. Many of the associate students matriculating from the *Alien Worlds* outreach programme have developed into better-informed members of the public; some have become critical and voluble advocates for science. Moreover, some previously socially excluded citizens have been empowered in the process and methodology of science, engaging and participating in the skills associated with science's investigative approach and potentially applying their educational experience in their own lives. Some associates have become full-time students and have earned their degrees, or are currently in the process of doing so. *Alien Worlds s*tudents have participated in extra-curricular activities and research outside the normal confines of the course and in general have responded well to the opportunity to engage in reflective practise and public communication. One group has set up its own astronomical society, whilst other students are engaging in further HE activities. All have an improved appreciation for the value of scientific disciplines and application, a more critical and informed approach to science and are more aware of the placement of science and its technological spin-offs within our modern culture. A review of the programme in late 2004 realised the future potential to recruit students and effect a local change in social attitudes towards HE whilst continuing to enable key skills necessary for employment. On application, the ESF granted the CASE a further £500 000 ($935 000) to run the *Alien Worlds* astrobiology course alongside a course in *Space Exploration* and robotics, with a target figure of 500 beneficiaries over two years. Over 250 adult learners have already experienced this new approach as of March 2006. The CASE was also nominated for the Queens Anniversary Prize, a national prize awarded to UK institutions for higher or further education in recognition of an outstanding contribution to the intellectual, economic, cultural and social life of the nation.

References

Brake, M. & Griffiths, M. (2004a). Science Fiction and Curriculum Innovation. In *Bioastronomy 2002: Life Among the Stars, IAU Symposium*, vol. 213, eds Norris, R.P. & Stootman, F.H., pp. 572–576.

Brake, M. & Griffiths, M. (2004b). Broad Horizons: SETI, Science Fiction, and Education. *Int. J. Astrobiol.* **3(2)**, 175–181.

Brake M., Griffiths M, Saunders, D. & Thornton, R. (2004). Astronomy, science fiction and access. *Journal of Active Learning in Higher Education* **5**, 27–42.

Brake, M. & Thornton, R (2004). Taking the fiction out of science's portrayal. *The Times Higher Education Supplement*, 5 March, 2004.

Brown, L. & Phelps, A. (2005). Education & Public Outreach at Penn State Astrobiology Centre. In NAI2005 Biennial Meeting, Boulder, Colorado, April 10–14, 2005. Available at: http://nai.nasa.gov/nai2005/abstracts

NASA (2003). *NAI Astrobiology Roadmap*. http://astrobiology.arc.nasa.gov/roadmap/index.html

Senge, P. (1995). *The Fifth Discipline*. London, Random House.

Sullivan, W. (2005). *Project Astrobio*. http://www.astro.washington.edu/projastrobio/index.html

https://doi.org/10.1017/S1473550406003041 Published online by Cambridge University Press