

SPACE EDUCATION:

A Lifeline to the Skills Shortage

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ABSTRACT

There is a crisis in education relating to science, technology, engineering and maths (STEM). In the UK, universities are closing physics and chemistry departments in favour of subjects such as media studies. Astronomy and space science may hold the key to engaging and captivating new audiences who may go on to be the scientists and engineers of the future. Orbit Research Ltd is carrying out practical research and development to work cooperatively with teachers and pupils in schools, colleges and universities, and industrial partners such as ESA, the National Science Learning Centre and the UK Space Industry Best Practice Club to rekindle the sense of excitement that space science can bring. The research includes the development of a 'space education centre' where the aim is to link elements of current national curriculum science to contemporary space research and space missions.

INTRODUCTION

This paper addresses the issue of how space education might be a way forward to encourage more students to choose science, engineering and maths subjects for their studies both at university and in school. Analysis has already been carried out, in particular in a report, "SET for Success" by Sir Gareth Roberts. Relevant findings of this report are reviewed.

It is generally agreed that the subjects of space and astronomy can be used to engender a spirit of interest and learning in young people, and indeed these subjects are already covered within the formal curriculum in many countries. However, the material is often covered superficially or repetitively year on year—particularly because of the lack of specific knowledge of teachers, most of whom are non-physics specialists in primary or lower secondary schools. This in turn exacerbates the problem, and many potential engineers, mathematicians and scientists are turned off the subject by the age of 13 or 14.

To counter this problem, a new pilot project aimed at supporting both formal and informal education providers is proposed. The aim of the project is to develop links between education providers and industry to showcase space related careers as exemplars of exciting options for young people who are making subject choices. At the same time, we are developing a space education centre which is aimed at not only

covering UK National Curriculum aims, but pushing new boundaries in interactive activities on space related themes.

In 2001 the Chancellor of the Exchequer in the UK commissioned a report into the supply of people with STEM based qualifications into the UK economy. It is considered to be a vital component of both the European and UK strategy to ensure that we remain competitive especially in relation to emerging technology regions.

Sir Gareth Roberts, Chair of the Science Council, undertook the review, and whilst he found that overall there was a small increase in the number of university places in these subjects, a more detailed analysis showed that the increase was in specific areas, such as microbiology and bio-engineering. Physics, traditional engineering subjects and maths are declining at an alarming rate. This is reflected through a wide age range with, for example, A-level physics entrants down 21% between 1991 and 1999, and PhD Physics degrees awarded down 9% from 1995 to 2000.

In the UK there is a shortage of specialist teachers in Physics and Maths and in general it is considered that the teaching laboratories for these subjects are inadequate. Courses fail to inspire students—particularly girls—and careers advice in these areas is poor. There appears to be a lack of correlation between young people's expectation of career prospects for these subjects and the actual situation. Physics, maths and engineering graduates are amongst the top economically active group. Many young people seem to believe that these subjects will limit their choice of employment and opt for more 'vocational' sounding degree subjects. In fact employers are very keen to employ STEM graduates because of their special understanding and capabilities.

For many young people, physics and maths are considered to be difficult options, which they feel will yield lower grades for them in their exams. When they consider that any degree will improve their prospects for getting a well paid job, they do not always receive advice that physics and maths would actually be a better option, because of the enhanced job opportunities such degrees bring.

A number of recommendations of Sir Gareth Roberts' report are now beginning to be implemented to address the falling number of STEM graduates, and space education projects can easily be seen to meet the requirements of these recommendations.

Space and astronomy capture the imagination. People, young and old, retain a fascination with a quest for understanding of these subjects. Astronomy and cosmology push the boundaries of our understanding of the Universe, whilst space engineer-

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THE CASE FOR SPACE

ing and science provide our daily weather forecast, guide our holiday or business flight, warn us of an impending speed camera, and for many hundreds of millions, provide TV images to our living rooms from remote parts of the world. Space probes make discoveries about our solar system, and help us to understand and support our own planet.

Yet, the vast majority of the population now take all of this capability for granted, and have collectively forgotten about the technological achievements that have made it all possible. There are hundreds of niche technology areas, with highly rewarding (intellectually and financially) prospects for bright new graduates. Space Education is not just about the Sun, Moon and Earth; the motion of the planets and their generic properties; day and night; the seasons; or about the difference between geostationary and LEO satellites. It can be used to demonstrate many scientific laws, to explore ecosystems, to understand heat, cold, water, light, waves, communication, cooperation, languages, programming, planning, design, materials, and so on across many multilinked curriculum areas.

An excellent example of a space education project is the Starshine satellite project. Young people, from the age of 6 to 18, at schools and colleges throughout the world took part in polishing over 1,000 aluminium mirror blanks from their original rough cut to achieve an optically flat surface with a measured accuracy close to a single wavelength. The task in itself was exciting and informative, requiring precision work to be undertaken. Then the optical flats were sent to be assembled onto a satellite to create a super-reflective 'disco-ball' which was launched from the US Space Shuttle. Students were able to track the Starshine satellite as its orbit decayed in the rarefied upper atmosphere. Further science was carried out by determining the rate of decay in relation to solar activity—which has the effect of increasing the density of the upper atmosphere.

The students involved in this project will never forget their experience, and for those lucky enough to be involved, it will hopefully positively influence their outlook in relation to science and engineering.

The lessons learnt from this experience were that hands-on science is an excellent way of learning, and although the task of polishing a mirror is repetitive and laborious, the fact that the end-product would become part of a space mission added an incredible sense of awe in the minds of the participants. It enabled them to achieve far more than would normally be expected, and they were fully prepared to learn more too.

Many organisations exist in the formal or informal education sector that can provide access to projects that promote science, engineering and maths through a range of space-related projects. Orbit Research Ltd has been working to build a relationship between some of these organisations to test out novel ways of developing solutions to inspire young people to want to find out more about STEM subjects.

Initially we were invited to take part in a programme funded by Yorkshire Forward, a UK government regional development agency, entitled 'Constructive Partnerships'. This project linked young people to local businesses, challenging gender stereotypes. We trained a group of Girl Guides and Scouts to take part in an international space competition.

Following this success, many other organisations wished to capitalise on the interest raised, and a number of other education partners joined the project. These included: local education authorities, where space-club activities were developed and supported; further work with Girl Guides and Scouts organisations, links with Science Discovery Centres such as Eureka were developed; the Children's University, where children can enhance their learning experience with fun, non-compulsory, after school activities. We also engaged with Aim Higher (an organisation promoting access to undergraduate courses), with teacher CPD (continued professional development) providers and SETNET (an organisation developing links between professional scientists, engineers and schools).

Within the space industry, we found that the European Space Agency and the Russian space programme had education programmes in their infancy, whereas NASA had a huge education machine with extensive resources (mainly aimed at the USA). It remains a challenge to engage with private industry to any significant degree, but we are exploring ideas for encouraging better links. Many organisations are happy to participate in low impact activities, such as site visits.

Astronomy, and visits to observatories is a challenge in the UK, but several excellent public outreach observatories exist, and new projects such as the Faulkes robotic telescope provide real time access to the night sky during school hours. The concept of developing loose partnerships between these organisations has worked extremely well so far, as many enthusiastic individuals see the huge potential that space education has to offer. Pilot projects carried out by partner organisations with their students have been universally successful and appreciated. There now remains a task to consolidate and expand these relationships, whilst maintaining the overall level of interest.

PARTNERSHIP APPROACH TO SPACE EDUCATION

STAR CENTRE – A MODEL FOR REGIONAL SPACE EDUCATION

We developed the concept of a regional space education centre to provide a focus for the space education ideas we were developing, and a location to engage directly with our young audience. Working again with Yorkshire Forward and Keighley College (a further education college), we have created a relatively compact and low cost area containing a Mars floor, mission control room, science/engineering lab, teaching room, radio room and science dome (planetarium). The centre is fitted out to look like a space scene in order to enhance the visual impact.

The mission control room is seen as a key element of the centre. Software is being developed which, rather than being a tightly scripted system like some existing space education simulators, is based around elements including mission time line segments and timers, underlying spacecraft ephemeris data and telemetry data. This in turn can control open source planetarium software, orbital tracking visual displays and individual telemetry screens. The aim is to create a broad range of mission simulations to cater for a wide age range audience by means of diverse graded interface screens. As different education scenarios are needed, then new mission segments can be easily added to the software library.

On the Mars floor, remotely controlled robotic rovers will carry out experimental work under the guidance of students in the adjacent laboratory. The radio communication room contains amateur radio equipment capable of communicating with astronauts and cosmonauts onboard the International Space Station, and we have also made contact with former cosmonauts in Star City, Russia. This radio facility has sparked considerable interest in electronics and communication, and the centre has been able to apply for status with the Radio Society of Great Britain (RSGB) as a training and examination centre.

Over the next year, the plans are to encourage as many groups as possible to trial and test the space education resources that are being developed; to use this feedback to improve the range and specifications of the programmes, and to develop plans for new centres.

Funding and sustainability are always significant issues in any project such as this. We are carefully selecting low cost solutions that can be maintained by a body of existing teaching staff and technicians. We believe that this approach will have a highly positive impact on the long term survivability of any such centre.

CONCLUSION

Space Education is a potential key to reversing the alarming trend of declining student numbers studying physical science, engineering and maths subjects. Space

and astronomy are perceived as exciting subjects, and so can also be enabling subjects linking other cross-curricular studies.

There are a wide number of organisations already engaged in space education, and a larger number who, judging by the enthusiasm we have encountered, will readily accept well developed education resources. They are willing to undergo professional development courses to enhance their skills in leading these activities. As government initiatives move to fill the well reported issues relating to skills shortages in STEM subjects, there will be opportunities to build better links between the education providers and industry.

The STAR Centre at Keighley College, UK is one such initiative that is seeking to develop new and innovative solutions to this problem which can be replicated in other regions with low start up and operational costs.