The sky's the limit! Introducing GCSE Astronomy at Glyncoed Comprehensive School

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ABSTRACT Edexcel's GCSE Astronomy syllabus provides an opportunity for students to develop their understanding and enthusiasm for astronomy, as well as to complement and extend the reach of their study of key stage 4 science, technology, engineering and mathematics (STEM) subjects. This article, based on research conducted by the National Foundation for Educational Research (NFER) for the UK branch of the European Space Education Resource Office (ESERO-UK), also known as the UK Space Education Office, sets out how one school has taken a highly collaborative approach to delivering this course, working alongside university and industry partners to develop an interactive and varied curriculum for a group of female students.

Recent developments in our efforts to understand the universe have led to an upsurge in public interest in space and astronomy. Television series such as the BBC's *Stargazing Live* presented by Brian Cox, together with the accompanying *Stargazing LIVE* events for schools, have proven to be immensely popular with pupils. It is little surprise then, that astronomy can be a powerful medium for inspiring and engaging young people in science. This article sets out how one school has used astronomy in just this way. Glyncoed Comprehensive School has adopted a highly collaborative approach to delivering GCSE Astronomy, working alongside university and industry partners to develop an interactive and varied curriculum that enhances students' engagement and abilities in science, technology, engineering and mathematics (STEM) subjects.

About GCSE Astronomy

Edexcel GCSE Astronomy is available to students in England and Wales. The course encourages students with an interest in space to further their understanding of the solar system and to learn a range of techniques for observing and measuring the universe. The course builds on the scientific and mathematical knowledge they will have acquired in key stage 3 (ages 11–14) and is designed to complement and extend the reach of both the GCSE Science and the GCSE Additional Science curricula. The syllabus is also designed to provide a foundation for AS- and A-level Physics, as well as for further study in astronomy and astrophysics at university (Edexcel, 2008a; 2008b).

The GCSE Astronomy course comprises two units:

1. *Understanding the Universe*, which accounts for 75% of the course and is assessed by examination;
2. *Exploring the Universe*, which accounts for 25% of the course and is assessed via coursework.

The course requires a total of 60 hours of guided learning time (Edexcel, 2008a), so can be completed within one academic year.

About Glyncoed Comprehensive School

Glyncoed Comprehensive School is an urban secondary school situated in Blaenau Gwent Local Education Authority (LEA), Wales. In its most recent school inspection conducted by Estyn, the school was judged to be a highly successful school with many outstanding features. The school is situated in one of the most socially and economically deprived areas of Wales and was reported to provide an excellent service to its

local community. While the student population comprises a wide range of ability levels, a significant number of students lack numeracy and literacy skills (Estyn, 2006).

The school receives funding from the Blaenau Gwent LEA as part of the Pre-VENT Key Stage 3 intervention project. Pre-VENT is an educational initiative funded by the European Social Fund, operating across the five local authorities of Blaenau Gwent (Blaenau Gwent, Bridgend, Caerphilly, Merthyr Tydfil and Torfaen), that targets young people aged between 11 and 13 years. The Pre-VENT intervention project has a wide range of aims, including to raise young people's achievement, aspirations and motivation to learn, and increase the number of young people (particularly girls) studying STEM subjects (see *Websites*).

Before its involvement in the project, Glyncoed Comprehensive School had identified a particular need to focus on students' participation and attainment in STEM subjects, and staff were keen to put in place a programme of learning for gifted and talented key stage 3 students who had not necessarily fully engaged with science, in lessons or on an extracurricular basis. As the Pre-VENT project funding placed particular emphasis on girls' engagement with STEM, school staff worked alongside Paul Roche, the director of the Faulkes Telescope Project (FTP), to assess the GCSE Astronomy course's suitability as an opportunity for girls who had been identified as demonstrating the potential to excel in STEM subjects. The course was viewed as an excellent opportunity for students to gain an additional recognised STEM qualification, and staff aimed to use the GCSE Astronomy course as a means of increasing female students' participation, enjoyment and attainment in STEM subjects.

The course was planned and delivered by the school in collaboration with Sarah Roberts, who is the director of education at the FTP and an undergraduate lecturer at the University of Glamorgan. The course ran during the 2010/11 academic year and the students were examined in June 2011.

Selecting the students

The GCSE Astronomy course is designed to be suitable for students of all abilities but a key feature of its suitability for use at Glyncoed Comprehensive School was its value in providing additional challenge to gifted and talented students (Edexcel, 2008a). About 30 female students who met this criterion, aged between 13 and 15, were invited to participate in the programme. All of these students had also opted to study Triple Science GCSE. The course was delivered on an extracurricular basis, and so students' own motivation was perceived to be critical to their successful completion of the course. Initially, pupils from year 9 (ages 13–14) were selected to participate in the course as they were perceived to lack the examination pressures faced by older year groups and because, owing to their age, they met the conditions of the Pre-VENT intervention project funding arrangements. However, the course proved to be immensely popular, with several year 10 (ages 14–15) girls asking whether they could also join the course. The school was keen to offer the programme to as many students as possible, so additional funding to enable these year 10 students to follow the course was provided.

Teaching methods

The course was devised in collaboration with staff at the FTP, and supported by Paul Roche, who is also the Space Ambassador for Wales from the UK branch of the European Space Education Resource Office (ESERO-UK), also known as the UK Space Education Office. Teaching methods comprised a variety of approaches, including:

- after-school sessions;
- residential sessions;
- masterclasses;
- coursework;
- revision and consolidation sessions.

After-school sessions

Weekly after-school sessions were delivered by the academic staff member from the FTP. These sessions formed the foundation of the students' course tuition and the aim was to work through the curriculum content using a mixture of theoretical and practical activities.

Residential weekends

Several residential weekends were offered to the students, focusing on hands-on activities to enhance their astronomy skills and broaden their experience of practical astronomy. Residential activities included midnight stargazing walks at

Techniquest Science Discovery Centre in Cardiff and practical observations at Bryn Bach Park in Tredegar (see 'Glyncoed Comprehensive School Pre-VENT KS3 activities' in *Websites*).

Masterclasses

Weekend masterclasses were delivered by astronomy specialists, such as ESERO-UK's regional Space Ambassadors and experienced teachers. These masterclasses aimed to equip students with an in-depth, advanced knowledge of each theme within the GCSE Astronomy syllabus. Topics covered included:

- the Earth, the Moon and the Sun, and the interaction between them;
- planetary systems, including our solar system, comets and meteors, discoveries within the solar system and exoplanets;
- stars, including constellations, observing the night sky, and the physical properties and evolution of stars;
- galaxies and cosmology, including the Milky Way galaxy and the place of the solar system within the universe (Edexcel, 2008c).

The masterclasses provided an opportunity for students enrolled on the course to consolidate what they had learned in lessons. They were also made available to all students in surrounding areas, who were not necessarily studying astronomy, attracting interest from a number of neighbouring schools.

Coursework

The GCSE Astronomy course also requires students to undertake a range of observations for the coursework component of their studies. Students may make use of many different instruments to gather their data, including cameras, sundials, binoculars and telescopes. This includes the use of remote-access robotic telescopes, which are situated at sites of high altitude across the world and can be accessed from the UK (Edexcel, 2008a). The FTP is one such example and has two large robotic telescopes located in Hawaii and Australia that students are able to control via the internet. Other examples include the Bradford Robotic Telescope and the National Schools' Observatory (which was used by students at Glyncoed Comprehensive School), both of which offer students the opportunity to access a robotic telescope online.

Revision and consolidation sessions

Weekly lunchtime revision and consolidation sessions were run by school staff from across STEM teaching departments to support students in developing their understanding of the course content delivered by the academic staff member from the FTP.

Impacts of the course

The course has resulted in a wide range of impacts for students and teaching staff alike. These impacts have been realised both for direct beneficiaries of the course and for others within the school.

Impacts on students

School and university staff observed a notable impact on students' enjoyment of astronomy topics and of science more broadly. This was particularly apparent among students who had previously shown a lack of interest in science: situating their learning within an engaging thematic context appeared to inspire them and to support them in acquiring a grasp of complex mathematical and scientific concepts. FTP staff reported that '*most year 9's found GCSE Astronomy easier than some of the abstract aspects of science, possibly because you can apply it*'. In addition, there were also a number of demonstrable impacts on students' attainment in GCSE Astronomy. Of those who entered the GCSE examination in June 2011, four were awarded A grades, 16 B grades, seven C grades, four D grades and one an E grade. FTP staff reported that '*the school were very pleased, and for the short amount of time we had to do it all in, and considering they were a mix of Year 9 and Year 10, I think they did great*'.

School and university staff also observed a number of 'ripple effects' arising from the course. Firstly, it was observed that students' achievement within the GCSE Astronomy course had been transferred to their success in other subjects. Many of the students demonstrated a higher degree of knowledge in other science courses, particularly physics, and the mathematical calculations they learned in GCSE Astronomy, such as advanced logarithms, have proven to be extremely valuable in enabling them to develop their skills in mathematics. School staff reported that students '*thoroughly enjoyed the course and girls are now very knowledgeable in some science*

courses, especially physics'. Secondly, participating students' enjoyment of the GCSE Astronomy course has ignited an interest among younger students. A teacher from the school reported that the course is '*not only sparking interest amongst girls involved in project but also lower down the school, which is really exciting*'. After the course started, year 8 (ages 12–13) girls were keen to find out whether the course would be run in future years. The school decided early on to recruit students for the following year,which started in September 2011. This course is now under way, having commenced with a residential weekend at Callington Space Centre in Devon. Glyncoed Comprehensive School has also recently merged with another school, and discussions took place to ensure that gifted and talented students from the joining school were also encouraged to study the course in subsequent years.

Impacts on teaching staff

The GCSE Astronomy programme has also brought about several positive impacts on school staff, who reported that the course has helped to raise the profile among senior leaders of space as a context for teaching STEM subjects and has encouraged staff from across the STEM disciplines to work together to contribute to the course.

Practical considerations

Overall, staff at Glyncoed Comprehensive School report that the course has been a great success, commenting that '*it's been an absolutely worthwhile and successful project*'. Nonetheless, there were a number of obstacles to overcome in delivering the GCSE Astronomy course and the following practical considerations should be borne in mind for schools seeking to take a similar approach.

Timing of the coursework component of the course

Coursework accounts for 25% of the total assessment for GCSE Astronomy. It requires students to undertake a series of aided observations (using astronomical instruments) and unaided observations (conducted using the naked eye). Assessment of students' ability is based on the quality of design, observations, analysis and evaluation of these observations (Edexcel, 2008b). This course provides an opportunity for students to develop their expertise in a range of astronomical techniques similar to those used by professional astronomers (Edexcel, 2008a) but undertaking the coursework element is highly weather dependent. While FTP staff reported that it may be tempting for teachers to allow students time to develop their knowledge of astronomy before attempting coursework, the time taken to gather sufficient data for this should not be underestimated. In particular, teachers seeking to deliver GCSE Astronomy may wish to avoid the potential pitfalls of poor weather conditions by attempting coursework early to allow ample time for students to complete this part of the course. Staff at the FTP reported that '*you have to start as early as possible*'. This issue is also relevant to the model selected by teachers to deliver the course. Edexcel suggest a range of possible models of delivery to support teachers in planning the course (Edexcel, 2008a), and teachers may wish to consider the prominence and timeliness of coursework when deciding which of these models to pursue.

Staff familiarity with the content of the course

As with any new syllabus, university and school staff alike experienced challenges in familiarising themselves with the content and structure of the course. School staff reported that the '*content of the GCSE Astronomy course is considerable, so it wasn't just a case of going over everything once and saying "good luck", we really had to go through everything and reinforce it*'. A further challenge for Glyncoed Comprehensive School in particular was the delayed start to the course. School staff reported that one of the most challenging obstacles has been making use of the limited time available to support their students effectively. Considerable energy, therefore, is required upfront to ensure that the design, format and delivery of the course maximises students' chances of success.

Availability of resources

GCSE Astronomy teaching and learning resources are plentifully available, many of them free, through specialist providers such as Starlearner as well as via the National STEM Centre's dedicated eLibrary. Such resources have proven highly valuable to teaching staff as a basis for devising teaching and learning activities. Staff also reported that access to resources and contacts made available by the ESERO-UK Space Ambassador network were highly valuable in enriching the variety of activities offered to their students.

Dedication of students

Students' own motivation is considered essential to the success of the course. FTP staff reported

that the '*students were very dedicated … one week the year 10's had four hours of physics lessons and still came for two hours of astronomy after school*'. Likewise, school staff reported that they had been lucky '*to have really motivated girls who were willing to get involved*'. Therefore, considerable emphasis should be placed on selecting students who have a genuine interest in pursuing this subject, particularly if the course is delivered on an extracurricular basis.

Support of the school's senior management team

The support and buy-in of Glyncoed Comprehensive School's senior management team has been critical to the success of the programme. One member of school staff reported that they had been '*really lucky to have supportive management who backed everything I decided to do*'. This support has been highly valuable in allowing school staff the freedom to pursue this innovative approach and in fostering support among the wider school staff. The course has achieved a high profile within the school as a result of this, and colleagues have expressed a great deal of interest in the course. School staff reported that colleagues '*often ask what you've been doing this week and some have become involved in the course*'.

Masterclasses for students

The masterclasses delivered by regional Space Ambassadors and experienced teachers working as part of ESERO-UK's regional networks have been particularly valuable in drawing in external expertise from university and industry providers, and enabled the school to cover substantial proportions of the curriculum relatively quickly. The wider accessibility of these masterclasses has increased their appeal, making learning accessible to students across the region.

Next steps

The success of the project has ensured the place of GCSE Astronomy at Glyncoed Comprehensive School in future years. While the course has not yet been expanded to be offered to boys as well (because of the focus of the Pre-VENT funding used to run the course), this is a priority for the future. Furthermore, word of mouth and the availability of masterclasses to a number of local schools has led to considerable demand for GCSE Astronomy in other schools in the area. As a result, university staff have now commenced delivery of the course at a greater number of schools. Such progress is indicative that the GCSE Astronomy course can provide an excellent context for enhancing participation, engagement and attainment in astronomy and in science more generally, and is valuable in inspiring and engaging students in science and helping them to achieve.

About the research

The National Foundation for Educational Research (NFER) was commissioned by the National STEM Centre to evaluate the activities of ESERO-UK. ESERO-UK is funded by the European Space Agency and the Department for Education, and aims to promote the use of space as a context for enhancing the teaching and learning of STEM subjects in UK schools and colleges. Glyncoed Comprehensive School is one of five case studies involved in this research. Staff delivering the course were interviewed in Summer 2011.

References

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Websites

Pre-VENT Key Stage 3 project (National Grid for Learning Cymru): www.ngfl-cymru.org.uk/eng/pre-vent.htm.

Glyncoed Comprehensive School Pre-VENT KS3 activities (National Grid for Learning Cymru): www.ngfl-cymru.org.uk/eng/pre-vent/pre-vent-glyncoed.htm.

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