Report

Second Interim Report for the National STEM Centre

Evaluation of the European Space Education Resource Office

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December 2011

Published in December 2011
by the National Foundation for Educational Research,
The Mere, Upton Park, Slough, Berkshire SL1 2DQ
www.nfer.ac.uk

How to cite this publication:
Jeffes, J., Cunningham, R. and Lamont, E. (2011). *Evaluation of the European Space Education Resource Office: Second interim report*. Slough: NFER.

Contents

Key findings

The National Foundation for Educational Research (NFER) has been commissioned by the National STEM Centre to evaluate the effectiveness and early impacts of the European Space Education Resource Office for the UK (ESERO-UK). This second interim report presents the findings of the case-study phase of this research.

Five case studies were selected to reflect the broad nature of the support ESERO-UK provides, and the different ways in which it strives to reach its target audiences. All had in common the aim to improve, increase or enhance the use of space as a context for STEM teaching and learning, drawing on the combined expertise of ESERO-UK and its partners.

Case Study 1: ESERO-UK Space Education Day

As part of the inaugural UK Space Conference in July 2011, held at the University of Warwick, ESERO-UK ran a space education day for teachers, which included workshops and lectures related to space.

Teachers were overwhelmingly positive about their experiences of attending the event. Those who participated in the research reported particular impacts in relation to their **awareness of space education resources** and their **ideas for teaching space topics**.

In relation to their classroom practice, teachers reported most strongly that the event will help them to **provide 'real-world' space contexts** for teaching STEM subjects, and **raise the profile of space** as a context for teaching STEM in their school. The vast majority of teachers reported that the ESERO-UK Space Education Day will increase their teaching of space topics in the future, both as part of the curriculum and as an enrichment activity.

Case Study 2: Promotion of the International Space Station (ISS) Education Kit

In the North East of England, a number of activities are being held to promote space resources to primary schools. This case study focused on one of the key resources being promoted, the International Space Station (ISS) Education Kit for primary schools. The ISS Education Kit is an educational resource package for teachers produced by the European Space Agency (ESA).

Promotion of this resource across the region was coordinated and overseen by the space education ambassador for the North East, who also delivered some of the sessions.

Teachers were highly positive about their experience of being introduced to the resource and, as with Case Study 1, reported that in particular it had increased their **awareness of space education resources** and **ideas for teaching space topics**.

The overwhelming majority of teachers reported that their introduction to the ISS Education Kit would have a considerable impact on their own classroom practice and, to a slightly lesser extent, the classroom practice of their colleagues.

Introduction to the ISS Education Kit appears to have resulted in positive impacts on teachers' future plans to use the resource in their teaching, as well as their plans to use space as a context for their teaching more generally.

Case Study 3: Space as a context for teaching science, a CPD course

This two-part, intensive CPD course was aimed at secondary science teachers, supported by an ENTHUSE funding grant and based around the development of the James Webb Space Telescope (JWST).

The course was organised by a team of professionals including the space education ambassador for Scotland, Royal Observatory Edinburgh and National Science Learning Centre staff. Sessions were also delivered by space education ambassadors from a number of regions. ESERO-UK also provided support in advertising and promoting the course via its website, and provided further introduction to the range of services it offers during the second part of the course.

Teachers involved in the research highly positive about the value of the course. In particular, teachers valued the opportunity to:

- learn about the JWST, and to meet with the scientists involved
- test out practical activities which can be easily applied in the classroom
- share ideas and good practice with teaching colleagues
- visit the ESERO-UK Library at the National STEM Centre.

Again, teachers reported strong impacts in relation to their **awareness of space education resources**, as well as **ideas for teaching space topics**. Almost all teachers reported that it was very likely that they would increase the use of space as a context for teaching STEM subjects in the future.

This case study in particular appeared to draw out strong impacts in relation to teachers' classroom practice. Teachers strongly reported that it would enable them to **provide 'real-world' space contexts** for teaching STEM subjects, and to **offer practical activities** to their pupils to help them learn about space.

All participating teachers reported that they had shared, or planned to share, what they had learned on the course with other teachers in their own school. Over half of participating teachers had shared, or planned to share, what they had learned with teachers in other schools.

Participating teachers reported that the greatest reported impact they had observed in students was an increase in their **enjoyment of STEM subjects**, and over half reported that their students' **confidence in STEM subjects** had increased, and their **problem-solving and investigation skills** had improved.

Case Study 4: Ticks the Box teacher training day

'Ticks the Box' was a teacher training day for primary school teachers held at the National STEM Centre and delivered by Space Connections.

Teachers were introduced to ESERO-UK throughout the day, including its STEM library and eLibrary resources. ESERO-

UK also provided support to Space Connections in organising the event, via the business manager based at the National STEM Centre, as well as the region's space education ambassador.

Teachers were extremely positive about the training day. The vast majority reported that it was both an enjoyable and informative experience. Again, all participating teachers reported that it had enabled them to develop **greater awareness of space education resources**, as well as **ideas for teaching space topics.** Teachers were also very positive about the impact of the event on their **confidence and skills to teach space topics**: this was true for most case studies, but was particularly important in this context as teachers' reported relatively low levels of confidence and skill in this area before attending the course.

Teachers were generally positive about the potential future impact of the training day on their classroom practice, particularly in relation to their ability to provide **practical activities to their pupils to help them learn about space**, and to provide **real-world space contexts** for STEM teaching.

Case Study 5: GCSE Astronomy at Glyncoed Comprehensive School

This case study focused on the delivery of GCSE Astronomy at Glyncoed Comprehensive School in Wales. The case study stands apart from the others in that the activities aim to impact on the students and the school, rather than an individual teacher or group of teachers. The course was planned and delivered by the school in collaboration with the Director of Education at the Faulkes Telescope Project, and ran on an extra-curricular basis during the academic year 2010/11. Students were examined in June 2011. The school received support from ESERO-UK's space education ambassador for Wales in setting up the project. Space education ambassadors from other regions have also been involved in the direct delivery of sessions to students.

Whilst the course has resulted in a wide range of impacts, the most immediate of these (based upon teachers' perceptions) have been realised for the students. In particular, staff observed impacts in relation to **students' enjoyment of astronomy topics**, and of science more broadly. Impacts have also been observed on **students' attainment**, by virtue of gaining a further GCSE qualification in astronomy.

The GCSE Astronomy programme has also helped to **raise the profile amongst senior leaders** of space as a context for teaching STEM subjects, and encouraged staff from across the STEM disciplines to work together to contribute to the course. As a result of the success of the project, Glyncoed Comprehensive School plans to continue to deliver GCSE Astronomy in future years.

Overview and discussion

The activities explored during the case-study phase of this research exemplify a range of different approaches to encourage, support and inspire teachers' use of space as a context for teaching and learning. These approaches fall into four main categories:

- light-touch support and guidance for teachers
- intensive CPD for teachers

- school-focused curriculum support
- direct delivery to students.

The scope of ESERO-UK's role varied according to the nature of the activity and its position relative to various partner delivery organisations involved in each case study. ESERO-UK's role included, variously:

- advertising and promoting educational provision to teachers and other audiences
- working with a range of partners to add value to existing space education providers
- directly supporting teachers to use resources more effectively, particularly at regional space education ambassador level
- promoting the resources and website of ESERO-UK at events run by a range of delivery organisations.

The findings clearly demonstrate that all five case studies have resulted in meaningful impacts for those involved. These impacts often appear to have been realised as a result of the combined efforts of ESERO-UK and its partners. This suggests that there is a place for all types of support offered within the case studies, ranging from general support for a wider audience of teachers to a much more focused, tailored and targeted approach towards smaller groups. Secondly, it suggests that there are a range of routes by which these impacts can be brought about, indicating that ESERO-UK and associated delivery organisations should be confident in the suitability of their flexible and responsive approach.

Key messages for ESERO-UK

1. The activities included in the case-studies were highly valued by teachers, indicating that the various levels and types of support provided by ESERO-UK appears to have added considerable value to its partners and beneficiaries.
2. Across all case-studies, teachers most highly regarded support which included: access to expert professionals; practical, hands-on resources for both teachers and pupils; introduction to a range of new teaching techniques; and time to share their experiences with teaching colleagues.
3. It may be possible to do more to support teachers to become aware of the organisations and agencies relating to careers in the space sector, as this impact was relatively low in comparison to other areas, and teachers volunteered this as an area where they would require further support.
4. Whilst overall, the case-studies are highly positive about individual aspects of ESERO-UK's support, it may be valuable to ensure that when teachers participate in less formal activities, they are made aware of the full range services offered by ESERO-UK.

Concluding comments

The findings presented in this second interim report highlight the wide range of approaches that can be used to support space education and the range of positive outcomes that can arise from them. It is evident that ESERO-UK can play an important role in supporting, adding value

and drawing together existing space education provision.

1. Introduction

The National Foundation for Educational Research (NFER) has been commissioned by the National STEM Centre to evaluate the effectiveness and early impacts of the European Space Education Resource Office for the UK (ESERO-UK).

1.1 About ESERO-UK

ESERO-UK aims to promote the use of space as a context for enriching science, technology, engineering and mathematics (STEM) teaching and learning in schools and colleges across the UK. ESERO-UK was established by the European Space Agency (ESA) as part of a wider group of ESERO offices operating in several locations across Europe[1], and is jointly funded by the ESA and the Department for Education (DfE).

The key aims of ESERO-UK are to:

- promote the education resources of the ESA and UK space industry to schools and support teachers to use the resources more effectively
- bring coherence and coordination to the range of existing education resources and initiatives related to space
- develop and run a website to promote the wide range of space education resources and initiatives available to schools.

ESERO-UK is led by a business manager at the National STEM Centre in York, supported by a team of regional space education ambassadors across the UK. The space education ambassadors are responsible for promoting the work of ESERO-UK to teachers, and supporting them to make use of resources and good practice to deliver space-related educational activities. ESERO-UK's operational remit does not necessarily involve setting up new activities, but rather supporting and adding value to a range of existing activities relating to space. Promotion and dissemination of teaching and learning resources is further supported by a website (www.esero.org.uk) and resources held at the National STEM Centre and National STEM Centre's eLibrary.

1.2 Aims of the research

The overarching aim of this research is to evaluate the effectiveness and early impacts of ESERO-UK on both teachers and stakeholders from universities and industry relating to space education.

[1] In addition to ESERO-UK, there are ESEROs in Ireland, the Netherlands, Norway and Belgium.

Specifically, the aims of the research are to evaluate the impact of ESERO-UK on teachers':

- awareness of the resources, organisations and agencies which support schools to deliver space education activities
- use of resources via the National STEM Centre and National STEM Centre's eLibrary
- links with, and knowledge of career opportunities within, the UK space sector
- awareness of good practice in relation to using space as a context for teaching STEM subjects
- access to a coordinated database of space-related information.

In relation to stakeholders, the evaluation aims to explore their views on the:

- coordination and coherence of the space education network, and the information provided
- degree of duplication of information and provision, and awareness amongst providers of where duplication may exist
- identification of gaps in resources/provision.

1.3 About this report

Since the publication of the first interim report[2] in May 2011, research activities have focused on the case-study phase of this evaluation. The aim of the case-study phase is to build upon the findings of the first report, which explored the operations and early impacts of ESERO-UK, to provide detailed exemplification of a range of activities promoted, supported and delivered by ESERO-UK, and the impacts arising from these activities. The case studies were conducted between June and November 2011. Further details of how they were selected are provided in section 2. This second interim report presents the findings of the case-study phase of this research, and is divided into two main parts:

- **section 2** of the report presents in detail the findings of each individual case study
- **section 3** of the report presents an overview and discussion around the findings from this phase of the evaluation as a whole.

[2] Jeffes, J. and Lamont, E. (2011). *Evaluation of the European Space Education Resource Office. Interim report.* Slough: NFER.

2. Case studies

This section explains how the case studies were selected, and presents an account of each individual case study included in the research.

2.1 About the case studies

The five case studies included in this research were selected by NFER from a list of suggestions provided by ESERO-UK's business manager and team of regional space education ambassadors, who were asked to provide examples of activities which drew upon the resources and support of ESERO-UK. The case-study sample was selected to reflect the broad nature of the support ESERO-UK provides, and the different ways in which it strives to reach its target audiences.

As detailed in section 1.1, in addition to supporting teachers directly, ESERO-UK also aims to promote and bring coherence to the range of existing resources relating to space. Therefore, the case-study sample was selected to include activities delivered by independent organisations that had received support from ESERO-UK, as well as activities directly delivered by the ESERO-UK team. ESERO-UK's involvement in the case studies varied from having a major role in facilitating and delivering activities, to a more supportive background role. In one of the case studies, ESERO-UK role in an organisational capacity is minimal: the purpose of this case study to exemplify ESERO-UK's capacity to promote itself and its resources as one of its stated aims. The first interim report also highlighted variations in space-related activities by region[3]: therefore, the case study sample was selected to reflect this geographical spread. However, all case studies had in common the aim to improve, increase or enhance the use of space as a context for STEM teaching and learning, drawing on the combined expertise of ESERO-UK and its partners.

The case studies comprise:

- the **ESERO-UK Space Education Day**, a national educational conference for teachers which ran alongside the inaugural UK Space Conference at Warwick University and was organised by ESERO-UK
- promotion of the **International Space Station (ISS) Education Kit**, a resource package for primary school teachers. This introduction and promotion of this kit was coordinated and overseen by the space education ambassador for the North East
- ***Space as a Context for Teaching Science***, an intensive continuous professional development (CPD) course for secondary school teachers, delivered in Edinburgh and York. The course was organised by a team of professionals including the space education ambassador for Scotland, and also included delivery of sessions by ambassadors from other regions

[3] For further details, see section 3 of the first interim report.

- ***Ticks the Box,* a space-themed training day** for primary school teachers in Yorkshire and the Humber, held at the National Science Learning Centre (NSLC), which was promoted and facilitated by ESERO-UK
- the introduction of **GCSE Astronomy for female students** at Glyncoed Comprehensive School in Wales, supported by the space education ambassador for Wales.

Whilst the activities included as case studies predominantly focus on teachers, reflecting the wide range of support ESERO-UK provides for teaching professionals, the case studies also provide an opportunity to tentatively explore wider impacts on schools and students.

Given the wide-ranging nature and scope of the case studies, the evaluation approach has been tailored to best reflect the evaluation needs of each individual case study. Therefore, these methods are described in more detail within the account of each individual case study.

2.2 ESERO-UK Space Education Day

As part of the inaugural UK Space Conference in July 2011, held at the University of Warwick, ESERO-UK ran a dedicated space education day. Specifically designed for primary and secondary school teachers, the event was free to attend and included a range of workshops and lectures related to space as a context for teaching and learning. The event included activities such as:

- lectures delivered by space science professionals, on themes such as: astrobiology and the hunt for alien life; living in the Sun's atmosphere; the search for life on Mars; and space science, conspiracy theories and science education
- workshops focused on particular space education resources such as: using space resources in primary schools; the Faulkes Telescope and the National Schools Observatory; and the National Space Centre
- workshops focused on curriculum design, such as: the use of science, maths and geography in the transition between Key Stage 2 and Key Stage 3; and re-designing Year 8 science
- workshops focused on building networks and cascading information, such as the Institute of Physics (IOP) teacher network, and careers in space.

The event was attended by approximately 100 delegates from a range of teaching disciplines. Within this case study, ESERO-UK had a direct role in organising and recruiting teachers to the event, and in delivering sessions for teachers. The resources and support offered by ESERO-UK were also promoted at the event, during sessions delivered by regional space education ambassadors, as well as at

the conference's 'marketplace'[4], which was designed to give teachers a flavour of the wide range of opportunities available relating to space science.

Evaluation activities

Evaluation activities for this case study included:

- researcher attendance and observation at the ESERO-UK Space Education Day
- an online survey distributed to all teachers following the event.

Forty-six teachers responded to the survey. Amongst those who responded, physics was the most commonly taught subject, although a substantial minority also taught chemistry and biology. The vast majority of responding teachers taught at secondary level.

Teachers' previous views and experiences

In order to gauge their previously held views about using space as a context for STEM teaching and learning, teachers responding to the survey were asked to comment on their knowledge and experience prior to attending the ESERO-UK Space Education Day. The findings are presented in Table 1.

Table 1: Teachers' previous knowledge and experience

Thinking about before you attended this event, to what extent do you agree that you were...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
aware of how space could be used as a context for teaching STEM subjects?	10	26	2	7	0	**45**
confident in using space as a context to teach STEM subjects?	7	19	6	13	0	**45**
enthusiastic about using space as a context for teaching STEM subjects?	20	15	4	6	0	**45**
skilled to use space as a context for teaching STEM subjects?	5	18	11	9	2	**45**

Source: NFER survey of teachers, July 2011

[4] The marketplace included a series of stalls hosted by universities, space employers and other stakeholders.

Table 1 shows that the majority of teachers surveyed agreed or strongly agreed that, prior to attending the event, they were **aware of how space could be used** as a context for teaching STEM subjects: 36 out of 45 teachers who responded to this question reported that this was the case. A similar proportion (35 out of 45) agreed or strongly agreed that they were **enthusiastic about using space** as a context for teaching STEM subjects.

However, teachers reported less strongly that they were **confident and skilled to use space in their teaching** prior to attending the ESERO-UK Space Education Day. Just over half (26 out of 45) agreed or strongly agreed that they were confident in using space as a context to teach STEM subjects, and 23 out of 45 reported that they felt skilled to do so.

Teachers' concerns about their confidence and skills in teaching about space, relative to their enthusiasm and awareness of how space can be used, may relate to their lack of previous involvement in professional development or training related to space. Just one-quarter of responding teachers (12 out of 46) had attended CPD activities about using space as a context for teaching STEM subjects prior to the ESERO-UK Space Education Day. Of these teachers, two-thirds (eight out of 12) had only attended one or two sessions. These findings were despite the vast majority of teachers reporting that they had regularly taught topics which used space as a context for teaching and learning in the past year, as detailed in Table 2.

Table 2: Number of space topics taught in last year (before attending the Space Education Day)

Number of topics taught	Number of teachers
None	6
1-5 topics	34
6-10 topics	4
More than 11 topics	1
Total	**45**

Source: NFER survey of teachers, July 2011

Table 2 shows that over three-quarters of teachers (34 out of 45 responding to this question) had taught between one and five topics in the past year, and five teachers had taught more than six topics. Just six teachers reported that they had not taught any topics in the past year which used space as a context for teaching and learning. Teachers' responses about their previous experience of teaching space therefore suggests that they, for the most part, were regular teachers of space topics who had identified a particular need to improve their confidence and skills to apply space in the classroom.

Teachers' views about the event

Teachers were overwhelmingly positive about their experiences of attending the ESERO-UK Space Education Day. The vast majority of teachers who responded to

the survey reported that all of the sessions they attended were both engaging and useful. Teachers reported that they found the ESERO-UK Space Education Day to be particularly valuable in providing:

- a forum to share ideas and to establish contacts with teachers in other schools
- demonstrations of practical activities with pupils, which could be easily applied in the classroom
- expert speakers, who provided valuable information about current developments in space science.

Teachers' comments about the event

This conference was one of the best I have ever attended for teachers!

I really enjoyed the conference and found it stimulating and thoroughly enjoyable.

It was an absolutely brilliant event. I hope that the school lets me attend next year!

Overall it was a very interesting and rewarding day. Lots of stimulating talks and inspiring ideas.

I really enjoyed the day – a definite top up with more cutting-edge science.

Impacts on teachers

Teachers reported that their attendance at the ESERO-UK Space Education Day had resulted in highly positive impacts in a range of areas. These findings are presented in Table 3.

Table 3: Impacts on teachers

Please indicate to what extent you agree that this event has enabled you to develop...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
greater awareness of space education resources?	27	16	1	0	0	**44**
greater confidence in using space education resources to teach STEM subjects?	19	20	5	0	0	**44**
skills to use space as a context for teaching STEM subjects?	15	21	8	0	0	**44**
ideas for using space as a context for teaching STEM subjects?	24	18	2	0	0	**44**
awareness of good practice in using space as a context for teaching STEM subjects?	17	21	5	1	0	**44**

Source: NFER survey of teachers, July 2011

Table 3 shows that the vast majority of respondents (43 out of 44 who responded to this question) agreed or strongly agreed that the event had enabled them to develop **greater awareness of space education resources**, and a similar proportion (42 out of 44) reported they had **developed ideas for using space** as a context for teaching STEM subjects. Teachers also strongly reported, albeit to a slightly lesser extent, that the event had enabled them to develop **greater confidence in using space education resources** to teach STEM subjects, and had **increased their awareness of good practice** in using space as a context for teaching STEM subjects (39 and 38 out of 44 teachers, respectively). Over three-quarters of responding teachers (36 out of 44) also reported that the course had given them **skills to use space** as a context for teaching STEM subjects, and almost half of these teachers (15) strongly agreed that this was the case.

As the survey findings suggest that teachers' confidence and skills were lacking, relative to other areas, prior to the event, it is encouraging that improvements have been observed in both of these respects. This suggests that the event has been successful in meeting the needs of attending teachers, as well as bringing about a range of further impacts on their awareness of, and ideas for using, space as a context for their teaching, as well as their awareness of good practice.

Impacts on classroom practice

In addition to the impacts reported on teachers personally, a number of impacts were reported in relation to the application of teachers' learning from the event to their classroom practice, detailed in Table 4.

Table 4: Impacts on classroom practice

Please indicate to what extent you agree that this event will enable you to...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
provide 'real-world' space contexts for teaching STEM subjects or topics?	20	21	3	0	0	**44**
offer practical activities to your pupils to help them learn about space?	19	18	5	2	0	**44**
help students to learn about space-related careers?	6	24	11	2	1	**44**
promote space as a context for teaching STEM subjects to other schools?	13	16	11	4	0	**44**
raise the profile of space as a context for teaching STEM in your school?	17	25	2	0	0	**44**

Source: NFER survey of teachers, July 2011

Table 4 shows that teachers reported most strongly that participation in the event will help them to **provide 'real-world' space contexts for teaching STEM subjects or topics**: 41 out of 44 teachers responding to this question agreed or strongly agreed that this was the case, with almost half (20) of these teachers strongly agreeing. A similar proportion (42 out 44) reported that the event will help them to **raise the profile of space as a context for teaching STEM in their school**.

The majority of teachers (37 out of 44) also strongly reported that the event will enable them to **offer practical activities to their pupils** to help them to learn about space, and just under three-quarters of responding teachers (30 out of 44) reported that the event will **help students to learn about space-related careers**, with six of these teachers strongly agreeing. A similar proportion (29 out of 44) reported that the event will help them to **promote space as a context for teaching STEM subjects to other schools**, although a greater proportion of these teachers (13) strongly agreed that this was the case.

Teachers' comments about the impact of the course on classroom practice

The quality of speakers was excellent and the day was enjoyable as well as educational. It has given me some great ideas to use in my teaching.

I thought it was a really good event. I took lots away from it and I will be using many of the things I have learnt to help improve the teaching of science in my school.

I found two contacts at the conference one of which has already been in contact to see if we can link some extra-curricular activities.

Future use of space as a context for teaching STEM subjects

The vast majority of teachers reported that the ESERO-UK Space Education Day will have a positive impact on their future use of space in their teaching. Almost three-fifths (25 out of 44 who responded) of teachers reported that it was very likely they will increase the use of space as a context for teaching STEM subjects in the future, and over one-third (16 out of 44) reported that this was quite likely.

Most teachers (36 out of 42 who responded to this question) reported that they would use space as part of their national curriculum teaching. However, 32 teachers also reported that they would also use what they had learned for a special event or activity. Examples of such special events included:

- GCSE evening classes and astronomy events (e.g. observations of the night sky)
- events linking with other local schools and colleges
- use of space as part of off-timetable STEM enrichment days
- science clubs, astronomy clubs, and clubs for gifted and talented pupils
- public lectures, parent events
- summer schools and weekend master classes
- outreach programmes for feeder primary schools.

Teachers' comments about their future use of space topics

The International Space Station workshop was brilliant and we will definitely be using it next year for Year 6.

I have already got the whole department geared up and a theme ready for next year's STEM club.

Suggested improvements

Whilst teachers were, overall, highly positive about their experience of attending the ESERO-UK Space Education Day, a number of areas for improvement were

identified, with a view to maximising the reach of impacts on teachers in future years. Teachers reported that they would welcome:

- greater opportunities to talk to space scientists, as well as to hear them speak
- hands-on, practical sessions for teachers to consolidate learning from lectures and seminars
- more ready-to-use classroom resources and example materials
- more information on space-related careers, including details of career routes, potential employers and contacts within these organisations
- a greater number of ESERO-UK materials on display to give inspiration and demonstrate what the organisation can provide
- activities targeted at the transition between primary and secondary school, to support secondary teachers seeking to develop schemes of work around space with their feeder primary schools.

2.3 Promotion of the International Space Station (ISS) Education Kit

In the North East of England, a number of activities are being held to promote space resources to primary schools. This case study focused on one of the key resources being promoted, the International Space Station (ISS) Education Kit for primary schools. The ISS Education Kit is an educational resource package for teachers produced by the European Space Agency (ESA).

The ISS Education Kit provides teachers with a range of ideas on how to the use the International Space Station as a theme for teaching and learning across a range of curriculum areas. The resource contains four programmes of study exploring life in space, and what is it like to live and work at the International Space Station. Across the North East, in-school training events have been held, as have introductory workshops at events such as network meetings for Science Coordinators, and at the North East Primary Science Conference.

Promotion of this resource across the region was coordinated and overseen by the space education ambassador for the North East, who also delivered some of the sessions.

Evaluation activities

Evaluation activities for this case study included:

- surveys distributed to teachers at five CPD events across the North East, of which 21 were completed and returned
- at the survey stage, teachers were invited to participate in a telephone interview. Two follow-up telephone interviews were conducted with participating teachers.

Reflecting the focus of the case study on delivery of the ISS Education Kit to primary schools, the majority of participating teachers were teachers of primary science. However, a substantial minority also taught mathematics and design and technology.

Teachers' previous views and experiences

Teachers who responded to the survey were asked about their views and experiences of using space as a context for their teaching prior to being introduced to the ISS Education Kit, as detailed in Table 5.

Table 5: Teachers' previous knowledge and experience

Thinking about before you attended this event, to what extent do you agree that you were...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
aware of how space could be used as a context for teaching STEM subjects?	1	12	3	5	0	**21**
confident in using space as a context to teach STEM subjects?	1	5	6	8	1	**21**
enthusiastic about using space as a context for teaching STEM subjects?	6	10	2	3	0	**21**
skilled to use space as a context for teaching STEM subjects?	0	5	7	9	0	**21**

Source: NFER survey of teachers, 2011

Table 5 shows that teachers reported most strongly that, prior to being introduced to the ISS Education Kit, they were **enthusiastic about using space** as a context for teaching STEM subjects: over three-quarters (16 out of 21) agreed or strongly agreed that this was the case. Almost two-thirds of teachers (13 out of 21) also agreed or strongly agreed that they were **aware of how space could be used** as a context for teaching STEM subjects.

As with the findings from the ESERO-UK Space Education Day, teachers reported less strongly that they possessed the **confidence and skills** to use space as a context for teaching STEM subjects: just six teachers felt confident in using space as a context to teach STEM subjects, and nine disagreed or strongly disagreed that this was the case. A similar proportion (five out of 21) agreed that they were skilled to use space as a context for teaching STEM subjects: again, nine disagreed or strongly disagreed.

In the past year, before being introduced to the ISS Education Kit, almost two-thirds of teachers (13 out of 21) had used space as a context for teaching STEM subjects in 1-5 topics. However, over one-third (eight out of 21) had not taught any topics using space as a context for teaching STEM subjects, suggesting that a significant minority of teachers were inexperienced in teaching about space. The vast majority of teachers (18 out of 21) also reported that they had not participated in any CPD activities about using space as a context for teaching STEM subjects prior to being introduced to the ISS Education Kit.

Teachers who were interviewed reported that their main motivations for attending the workshop included a desire to:

- further their interest in space, and in teaching space
- improve their knowledge and confidence in teaching space to support a particular change in the school curriculum
- improve their knowledge and confidence in teaching space in general
- teach students about topical and current developments in space science
- build upon previous positive experiences of attending training which provided free space resources.

Views about the event

Teachers who were interviewed were asked to comment on which aspects of the course they found particularly valuable. Teachers were highly positive about their experience of being introduced to the resource, and one reported a sense that the ISS Education Kit meets a gap in the market as similar resources are hard to find. Teachers reported that they welcomed, in particular:

- the opportunity to discuss uses of the ISS Education Kit with a person who was knowledgeable about it. This was considered to be essential in maximising the value of the resource, as it enabled teachers to seek advice on how best to make use of it
- the opportunity to investigate use of the ISS Education Kit via practical tasks, enabling teachers to consolidate their understanding of how the resource works in practice
- the cross-curricular focus of the resource, which extends beyond science to a range of other topics. Therefore, the resource lends itself well to curriculum-wide projects and activities, including numeracy and literacy
- the sophistication and detail of the resource, including lesson plans and links to online materials.

Teachers' comments about the resource

The introduction to the ISS Education Kit was...

... excellent, very informative... some great ideas demonstrated.
... a very good, interesting workshop.
... very enjoyable and informative.

The ISS Education Kit is...

... just the best easy to use kit ever. It's very exciting.
... a great information pack.
... a fantastic resource! I like the cross-curricular ideas and resources given.

Impacts on teachers

Teachers who were surveyed were extremely positive about the impact of being introduced to the ISS Education Kit on their own awareness, confidence and skills. The responses of teachers are presented in Table 6.

Table 6: Impacts on teachers

Please indicate to what extent you agree that this event has enabled you to develop...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
greater awareness of space education resources?	12	9	0	0	0	**21**
greater confidence in using space education resources to teach STEM subjects?	8	13	0	0	0	**21**
skills to use space as a context for teaching STEM subjects?	4	16	1	0	0	**21**
ideas for using space as a context for teaching STEM subjects?	9	12	0	0	0	**21**
awareness of good practice in using space as a context for teaching STEM subjects?	6	14	1	0	0	**21**

Source: NFER survey of teachers, 2011

Table 6 shows that teachers who responded to the survey most strongly reported that introduction to the ISS Education Kit had impacted upon their **awareness of space education resources**: all teachers reported that they were now more aware of such resources, with almost three-fifths (12 out of 21) strongly agreeing that this was the case. All teachers also agreed or strongly agreed that introduction to the ISS Education Kit had enabled them to **develop ideas for using space as a context for teaching STEM subjects**.

Introduction to the ISS Education Kit has also had a highly positive impact on teachers' **confidence and skills** to use space as a context for teaching STEM subjects. Again, this is an important indicator of the success of the activities given teachers' previously held views. The vast majority of teachers agreed or strongly agreed that introduction to the ISS Education Kit has enabled them to develop skills to use space as a context for teaching STEM subjects (20 reported that this was the case, with four strongly agreeing). The vast majority of teachers surveyed (20 out of 21) also reported that they had developed an awareness of good practice in using space as a context for teaching STEM subjects. Whilst slightly fewer teachers overall reported that use of the kit had given them greater confidence in using space education resources (17 out of 21), a greater proportion of these (eight out of 21) strongly agreed.

This view was echoed by the teachers who were interviewed, who reported that their confidence and skills had increased as a result of being introduced to the ISS Education Kit. Critically, these teachers also reported that introduction to the resource will support not only their students' understanding of space, but also their own: the content of the ISS Education Kit is perceived to give teachers the necessary confidence to deliver much clearer information to their students.

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Impacts on classroom practice

The overwhelming majority of teachers reported that their introduction to the ISS Education Kit would have a considerable impact on their own classroom practice and, to a slightly lesser extent, the classroom practice of their colleagues. Teachers' responses are presented in Table 7.

Table 7: Impacts on teachers' classroom practice

Please indicate to what extent you agree that this event will enable you to...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
provide 'real-world' space contexts for teaching STEM subjects or topics?	11	8	2	0	0	**21**
offer practical activities to your pupils to help them learn about space?	12	9	0	0	0	**21**
help students to learn about space-related careers?	8	9	4	0	0	**21**
promote space as a context for teaching STEM subjects to other schools?	7	8	4	1	1	**21**
raise the profile of space as a context for teaching STEM in your school?	10	10	1	0	0	**21**

Source: NFER survey of teachers, 2011

Table 7 shows that, in relation to their own classroom practice, almost all teachers reported that introduction to the ISS Education Kit will enable them to **provide real-world space contexts** for teaching STEM topics. This was reported by 19 out of 21 teachers, with over half of these (11) strongly agreeing. All teachers also reported that being introduced to the ISS Education Kit will enable them to offer a greater number of **general practical activities** to their pupils to help them learn about space. Teachers who were interviewed reported that introduction to the kit had given them plenty of ideas that could be easily adapted to fit into a range of lesson types, which would also serve to increase the efficiency of their planning time.

In relation to the classroom practice of colleagues, almost all teachers reported that introduction to the ISS Education Kit would enable them to **raise the profile of space as a context for teaching STEM in their school** (10 teachers strongly agreed, and a further 10 agreed). The majority also reported, albeit to a lesser extent, that introduction to the ISS Education Kit would enable them to **cascade the kit to other teachers in their own school** (eight strongly agreed, and nine agreed). Approximately three-quarters of teachers (15 out of 21) reported that the ISS event would enable them to **promote the ISS Education Kit to teachers from other schools**.

Anticipated future use of the ISS Education Kit

Introduction to the ISS Education Kit appeared to have resulted in positive impacts on teachers' future plans to use the resource in their teaching, as well as their plans to use space as a context for their teaching more generally. These findings are presented in Table 8.

Table 8: Teachers' anticipated future use of space topics and ISS Education Kit

In the future, how likely is it that you will increase the use of space topics/use the ISS Education Kit as a context for teaching STEM subjects?	Increased use of space topics	Increased use of ISS Education Kit
Very likely	14	15
Quite likely	6	2
Neither likely nor unlikely	1	4
Quite unlikely	0	0
Very unlikely	0	0
Total	**21**	**21**

Source: NFER survey of teachers, 2011

Table 8 shows that two-thirds of teachers who responded to the survey (14 out of 21) reported that it was very likely they would increase the use of space as a context for teaching STEM subjects, and a further six reported that this was quite likely. A similar proportion (15 out of 21) reported that it was very likely they would use the ISS Education Kit in their teaching in the future, with two reporting that this was quite likely. Whilst most teachers reported that they would be likely to use the kit as part of their national curriculum teaching, 12 reported that they would use it for a special event. Such special events included, for example, celebration events, cross-curricular space projects, science clubs, and space days/weeks. Teachers who were interviewed reported that they planned to run a space topic over the course of a half-term during the next academic year, and had already commenced planning to integrate the ISS Education Kit resources into this scheme of work.

2.4 Space as a context for teaching science: An intensive teacher CPD course

This two-part, intensive CPD course was aimed at secondary science teachers, supported by an ENTHUSE funding grant and based around the development of the James Webb Space Telescope (JWST). Topics covered during the course included school spectroscopy, use of space-related instruments (e.g. JWST's Mid Infrared Instrument, or MIRI), use of materials in space, rocketry and school astronomy.

The first part of the course took place at the Royal Observatory, Edinburgh (ROE) in June 2011, and included laboratory visits, practical techniques and teaching ideas, and the development of innovative learning materials. Participants produced an

action plan for implementation after the course, and shared their experiences at the second part of the course, which took place at the National Science Learning Centre (NSLC) in York in October 2011. The course was organised by a team of professionals including the space education ambassador for Scotland, ROE and NSLC staff. Sessions were also delivered by space education ambassadors from a number of regions. ESERO-UK also provided support in advertising and promoting the course via its website, and provided further introduction to the range of services it offers during the second part of the course.

Most of the teachers attending the event taught physics, and around half taught chemistry and biology. In smaller numbers, teachers also taught subjects such as mathematics, engineering, design and technology and ICT, as well as more specialist astronomy and astrophysics courses. The vast majority of teachers taught at secondary level. The course was attended by 30 teachers.

Evaluation activities

Evaluation activities for this case study included:

- researcher attendance and observation at both parts of the course
- a first, paper-based, survey completed by all 30 teacher delegates following the first part of the course
- a second, online, survey completed by 20 teacher delegates following the second part of the course
- follow-up telephone interviews with participating teachers.

Teachers' previous views and experiences

As with the previous case studies, teachers were asked about their previously held views on teaching their students about space prior to attending the course, detailed in Table 9.

Table 9: Teachers' previous knowledge and experience

Thinking about before you attended this event, to what extent do you agree that you were...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
aware of how space could be used as a context for teaching STEM subjects?	9	13	5	3	0	**30**
confident in using space as a context to teach STEM subjects?	6	14	4	5	1	**30**
enthusiastic about using space as a context for teaching STEM subjects?	15	7	4	3	0	**30**
skilled to use space as a context for teaching STEM subjects?	5	9	10	4	2	**30**

Source: NFER survey of teachers, June 2011

Table 9 shows that teachers who responded to the survey most strongly reported that, prior to attending the course, they were enthusiastic about, and aware of, how space could be used as a context for teaching STEM subjects. Teachers appeared, by comparison, to feel considerably less confident and skilled to apply their enthusiasm and knowledge. In particular, the survey revealed that:

- twenty-two out of 30 teachers were **enthusiastic about using space as a context** for teaching STEM subjects prior to attending the course, with half of course participants (15) strongly agreeing that this was the case
- the same proportion (22 out of 30) agreed or strongly agreed that they were **aware of how space could be used as a context** for teaching STEM subjects, with just under one-third of course participants (nine out of 30) strongly agreeing that this was the case
- two-thirds of course participants (20 out of 30) agreed or strongly agreed that they were **confident in using space as a context** to teach STEM subjects. However, just six strongly agreed that this was the case and a further six disagreed or strongly disagreed
- teachers reported least strongly that they were **skilled to use space as a context** for teaching STEM subjects. Just under one-half (14 out of 30) agreed or strongly agreed that they were skilled to do this, with just five strongly agreeing. Again, six participants disagreed or strongly disagreed that they felt skilled to use space as a context for teaching STEM subjects.

Most of the teachers who attended the course were new to participating in CPD activities about using space as a context for teaching STEM subjects. Just seven

teachers had participated in space-related CPD activities prior to the course, and five of these had participated in only one or two activities. Examples of these activities included events organised by ROE, the Association for Science Education (ASE), regional Science Learning Centres, Global Monitoring for Environment and Security (GMes), and visits to the European Organization for Nuclear Research (CERN). Prior to attending the course, three-fifths of teachers (18 out of 30) had used space as a context for teaching 1-5 STEM topics, and a further seven had done so for six or more topics. However, one-sixth of teachers (five out of 30) had not used space as a context for their teaching at all.

Teachers who were interviewed reported a range of motivations for attending the course. In particular, teachers were keen to:

- make their teaching more engaging and inspiring by focusing on cutting-edge developments in space science
- develop the skills needed to teach space topics at a higher level
- update their own subject knowledge and pedagogy
- gather ideas with which to develop new courses related to space
- develop their own personal interest in space, and encourage their school to increase its teaching of space as a topic.

Views about the course

Teachers involved in both the surveys and telephone interviews were highly positive about the value of the course. In particular, teachers who were interviewed reported that they particularly valued the following aspects:

- opportunities to learn about the JWST and MIRI, and to gain an insight into current developments in space technology
- opportunities to meet with scientists working on the JWST, who are at the forefront of their profession
- learning about advanced engineering techniques and their application in scientific research
- practical and affordable hands-on activities, particularly those delivered at ROE, which can be easily applied to underpinning theory and real world contexts
- opportunities to share ideas and good practice with teaching colleagues
- an opportunity to become immersed in science
- practical activities showing techniques for teaching
- opportunity to visit the ESERO-UK Library at the National STEM Centre.

Teachers' comments about the course

The sessions covering advanced engineering techniques (e.g. the image slicing mirrors) were intriguing and helpful to pass on to students as an illustration that advanced engineering is needed for cutting-edge scientific research.

The practical workshops were particularly useful especially when underpinned with the theory to accompany them.

The practical workshops fired my imagination into how to embed experiments into 'real world' scenarios.

Impacts on teachers

Teachers who responded to the survey were asked to describe the impact of the course at two time-points, at the end of the first and second parts of the course. The findings are presented in Tables 10-14.

Table 10: Impact on teachers' awareness of space education resources

Please indicate to what extent you agree that this event has enabled you to develop greater awareness of space education resources	Part 1	Part 2
Strongly agree	20	12
Agree	10	7
Neither agree nor disagree	0	1
Disagree	0	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 11: Impact on teachers' ideas for using space as a context for teaching STEM subjects

Please indicate to what extent you agree that this event has enabled you to develop ideas for using space as a context for teaching STEM subjects	Part 1	Part 2
Strongly agree	20	17
Agree	10	3
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Tables 10 and 11 shows that following the first part of the course, all teachers reported they had developed a **greater awareness of space education resources**, as well as **ideas for using space** as a context for teaching STEM subjects. In both

respects, two-thirds of teachers (20 out of 30) strongly agreed that this was the case. These impacts were sustained into the second part of the course, suggesting that impacts on teachers had continued to evolve as time progressed: all 20 teachers who completed the second survey reported that they had developed ideas for their teaching and almost all (19 out of 20) reported that they had a greater awareness of space education resources.

Table 12: Impact on teachers' confidence in using space education resources to teach STEM subjects

Please indicate to what extent you agree that this event has enabled you to develop greater confidence in using space education resources to teach STEM subjects	Part 1	Part 2
Strongly agree	20	8
Agree	9	11
Neither agree nor disagree	1	0
Disagree	0	1
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 13: Impact on teachers' skills to use space as a context for teaching STEM subjects

Please indicate to what extent you agree that this event has enabled you to develop skills to use space as a context for teaching STEM subjects?	Part 1	Part 2
Strongly agree	18	10
Agree	11	9
Neither agree nor disagree	1	0
Disagree	0	1
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Tables 12 and 13 show that almost all teachers (29 out of 30) reported after the first part of the course that it had enabled them to develop both **greater confidence and skills** in using space education resources to teach STEM subjects. Again, these impacts appear to have been sustained into the second part of the course, with 19 out of 20 teachers reporting that both their confidence and skills had increased.

Table 14: Impact on teachers' awareness of good practice in using space as a context for teaching STEM subjects

Please indicate to what extent you agree that this event has enabled you to develop awareness of good practice in using space as a context for teaching STEM subjects	Part 1	Part 2
Strongly agree	14	9
Agree	11	9
Neither agree nor disagree	3	2
Disagree	2	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 14 shows that after the first part of the course, teachers reported strongly that the course had enabled them to develop an **awareness of good practice** in using space as a context for teaching STEM subjects, albeit to a slightly lesser extent than other areas. Whilst the majority (25 out of 30) agreed or strongly agreed that this was the case, a further five reported that they neither agreed nor disagreed, or disagreed. However, teachers' perceptions of this impact appeared to have strengthened following the second part of the course, with 18 out of 20 agreeing or strongly agreeing that their awareness of good practice had increased.

Again, the findings of this case study highlight how support relating to space education can bring about positive impacts for teachers, particularly in relation to their confidence and skills. However, the findings of this case study are particularly potent because they emphasise not only the range of impacts on teachers, but also their longevity. The impacts on teachers in this instance do not appear to have waned with time, but instead have sustained or evolved as their learning has become further embedded. These findings were corroborated by the comments from interviewees, who reported that that the course had, variously, increased their awareness of many different space education resources and their potential applications, and increased their confidence. One teacher reported that when students ask them questions, they will now be able to answer with confidence based on the knowledge they have acquired during the course.

Impacts on classroom practice

Again, teachers were asked to comment on the impact of the course on their classroom practice after the first and second parts of the course. This case study in particular appeared to draw out strong impacts in relation to teachers' classroom practice. The findings are presented in Tables 15-19 below.

Table 15: Impact on teachers' ability to provide 'real-world' space contexts for teaching STEM subjects or topics

Please indicate to what extent you agree that this event has enabled you to provide 'real-world' space contexts for teaching STEM subjects or topics	Part 1	Part 2
Strongly agree	19	12
Agree	11	8
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 16: Impact on teachers' ability to offer practical activities to your pupils to help them learn about space

Please indicate to what extent you agree that this event has enabled you to offer practical activities to your pupils to help them learn about space	Part 1	Part 2
Strongly agree	19	11
Agree	11	9
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Tables 15 and 16 show that after the first part of the course, all teachers reported that it would enable them to **provide 'real-world' space contexts for teaching STEM subjects or topics**, and to **offer practical activities** to their pupils to help them learn about space, with just under two-thirds (19 out of 30) strongly agreeing that this was the case. Again, these impacts were sustained into the second part of the course and this was supported by the findings of the telephone interviews. One teacher who was interviewed reported that modelling of potential energy using a hoop and a light directive was particularly useful in helping students to visualise concepts which are relatively abstract and difficult to grasp. The teacher reported that this 'really helps them [students] to see what's happening'. Another teacher who was interviewed reported that they were planning to use what they had learned to teach students about the electromagnetic spectrum. This teacher plans to link this subject to space from the outset to ensure that it is situated within a real-life context.

Table 17: Impact on teachers' ability to raise the profile of space as a context for teaching STEM in their school

Please indicate to what extent you agree that this event has enabled you to raise the profile of space as a context for teaching STEM in your school	Part 1	Part 2
Strongly agree	13	5
Agree	15	14
Neither agree nor disagree	2	1
Disagree	0	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 17 shows that similarly, teachers who responded to the survey reported sustained impacts in relation to **raising the profile of space as a context for teaching STEM in their school** (28 out of 30 teachers agreed or strongly agreed after the first part of the course, and 19 out of 20 after the second part).

Table 18: Impact on teachers' ability to help students to learn about space-related careers

Please indicate to what extent you agree that this event has enabled you to help students to learn about space-related careers	Part 1	Part 2
Strongly agree	8	4
Agree	11	10
Neither agree nor disagree	10	5
Disagree	1	1
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

Table 18 shows that impacts appeared to have increased between the two parts of the course in relation to **helping students to learn about space-related careers**, albeit from a lower baseline. After the first part of the course, just under half of teachers (14 out of 30) agreed or strongly agreed that the course would enable them to help students to learn about space-related careers, and one-third reported that they neither agreed nor disagreed. After the second part of the course, there appeared to have been a modest increase, with 14 out of 20 teachers reporting that this was the case.

Table 19: Impact on teachers' ability to promote space as a context for teaching STEM subjects to other schools

Please indicate to what extent you agree that this event has enabled you to promote space as a context for teaching STEM subjects to other schools	Part 1	Part 2
Strongly agree	12	5
Agree	12	8
Neither agree nor disagree	4	7
Disagree	2	0
Strongly disagree	0	0
Total	**30**	**20**

Source: NFER surveys of teachers, June and October 2011

However, Table 19 shows that impacts appeared to be less sustained in relation to **promoting space as a context for teaching STEM subjects to other schools**. Whilst five-sixths (24 out of 30) teachers agreed or strongly agreed that the course would result in this impact after the first part of the course, just 13 out of 20 reported that this was the case after the second part of the course, and seven neither agreed nor disagreed. This suggests that teachers' initial confidence about their capacity to disseminate their learning to other schools has diminished slightly as time has progressed. Nonetheless, over half of those who responded (10 out of 19) after the second part of the course reported that they had shared, or planned to share, what they had learned with teachers in other schools (compared to all teachers who reported they had shared, or planned to share, what they had learned on the course with other teachers in their own school).

Impacts on students

Following the second part of the course, teachers were asked to reflect on the impacts they had observed on their students as a result of the activities they had introduced following the course. The findings are presented in Table 20.

Table 20: Teachers' perceptions of impacts on students

Have you observed the following impacts on students as a result of the activities you have introduced following the course?	Yes	No	Don't Know	Total
increased enjoyment of STEM subjects	18	1	0	**19**
higher attainment in STEM subjects	3	2	14	**19**
increased confidence in STEM subjects	11	0	8	**19**
improved problem-solving and investigation skills	10	2	7	**19**
greater interest in further STEM study	8	3	8	**19**
greater interest in a career in STEM	5	4	10	**19**
impacts other than those related to STEM (e.g. literacy, social skills)	5	3	11	**19**

Source: NFER surveys of teachers, June and October 2011

Table 20 shows that the greatest impact on students (reported by teachers) was an increase in their **enjoyment of STEM subjects**. Almost all teachers who responded to this question (18 out 19) reported that they had observed this impact.

Over half of the teachers who responded (11 out 19) also reported that their students' **confidence in STEM subjects** had increased, and a similar proportion (10 out of 19) reported that their students' **problem-solving and investigation skills** had improved. Several teachers (eight and seven out 19, respectively) also reported that they did not know if there had been any impacts on students on these areas. Therefore, impacts on pupils may not have emerged yet.

Eight teachers reported that they had observed **greater interest in further STEM study** amongst their students although, again, a further eight reported that they did not know if this was the case. Teachers reported mixed views on the impact of the activities they had introduced on students' **interest in a career in STEM**. Of those who felt able to comment, five reported that their students now had a greater interest in a STEM-related career and four reported that they did not. Just three teachers reported that they had observed impacts in relation to students' attainment in STEM subjects and 14 reported that they did not know, suggesting that it may be too early to determine impacts in this area.

Five teachers reported that they had observed impacts other than those related to STEM (for example, relating to literacy and social skills). Other reported impacts included improvements in general scientific skills, ability to conduct extended pieces of work on a given topic, and presentation skills.

Teachers' comments about the impacts of the course on students

By teaching an engaging topic through a fully integrated Assessing Pupil Progress (APP) suite of lessons the general scientific skills of pupils has improved. Most improved was the ability of students to write and construct extended pieces of work on a topic because they were more interested in the subject content.

We used a JWST summary paper for literacy - read for understanding - which they engaged with far better than normal.

Over half of the teachers responding to the second part of the course (10 out of 19) felt that activities delivered following the course had brought about impacts for higher achieving students, and a similar proportion (nine out of 19) for gifted and talented students. Eight out of 19 teachers reported that there had been impacts for lower ability students. Six reported impacts for girls, and five for boys, although one teacher reported that the magnitude of impact for practical activities was particularly strong for boys. Just five teachers reported that there had been impacts on disengaged students.

Advantages of a themed approach

Teachers who were interviewed were asked about the ways in which this type of activity, focused on specific development in space science rather than a particular curriculum area, was helpful to them. Teachers reported that this themed approach to CPD was particularly valuable in supporting them to teach advanced courses, on top of the support it provided more generally. For example, one teacher reported that, whilst the course was valuable for all aspects of their teaching, an up-to-date knowledge of the JWST would be particularly useful when teaching astrophysics, as there is a detailed topic on telescopes. Another teacher highlighted the importance of this approach in encouraging questioning and enquiry-based learning in their teaching, rather than assuming that everything taught about space is already known.

One teacher also commented that an advantage of this approach is the range of different topics within which JWST could be explored, which would also allow connections to be made between topics. The teacher described this as an 'applications-led topic'.

Anticipated future use of space as a context for STEM teaching and learning

Almost all teachers (29 out of 30) reported that it was very likely that they would increase the use of space as a context for teaching STEM subjects in the future after the first part of the course, with 17 out of 20 reporting this was very likely or likely after the second part (11 of whom reported that it was very likely). Whilst teachers' strength of feeling appears to have diminished slightly between both parts of the course, the proportions are nonetheless encouraging in suggesting that the course is

continuing to bring about impacts on teachers. A similarly high proportion of teachers also reported, after both parts of the course, that it is very likely that they would increase the use of the JWST in their teaching (28 out of 30 reported that it was very likely after the first part of the course, and 19 out of 20 reported this after the second part of the course).

Of those teachers who are likely to use the JWST in the future, 26 out of 30 reported after the first part of the course that they would use it in national curriculum teaching, compared to 18 who would use it for a special event. After the second part of the course, however, a greater proportion planned to use it in their national curriculum teaching (17 out of 20), and a smaller proportion (seven out of 20) for a special event. This suggests that as time has progressed, teachers have become more effective in embedding their learning within the curriculum.

Examples of the curricular activities delivered by teachers included:

- space-themed topics across a range of curricula, in both Scotland and England
- classroom activities using resources introduced during the course, on themes such as exoplanet systems, infrared imaging, spectroscopy, rocketry and gravitational potential
- discussion activities introduced during the learning techniques sessions of the course. These discussion activities have been applied both in relation to space as well as to other contexts.

Furthermore, just over three-quarters of teachers (15 out of 19 teachers responding to this question) who completed the survey following the second part of the course reported that it was easy or very easy to use information about the JWST in their teaching, with four of these teachers reporting that it was very easy. However, another four teachers reported that it had been difficult to use the information about the JWST in their teaching.

Suggested improvements

Overall, teachers were highly positive about the course, as detailed in the comments below.

Teachers' comments about the value of the course

[This was an] *excellent course, well organised, fascinating and awe-inspiring subject matter.*

This example (JWST) as a context is useful now, but will become more relevant in the years leading up to the launch when I envisage discussing the mission a lot.

The course deepened my own understanding of this area of space research and gave me practical ideas I could take away and use - both specific to space and more generally. The Edinburgh part of the course was so well put together and delivered I can't really think of any way it could be improved - so thanks again for a fascinating time.

Teachers reported that they would have welcomed the following improvements to the course:

- where possible, more time for practical activities and discussion throughout the course would be beneficial, in particular to share experiences of completing the gap task
- greater tailoring and support for teachers without a physics specialism, to reflect the diversity of teachers who may attend the course
- more rigorous follow-up, with greater attention to timing to enable teachers sufficient time to apply new ideas in the classroom and to implement the goals set out in the action plan
- ensuring that all sessions were explicitly related to their potential application in the classroom
- greater encouragement of participants to share their resources and expertise with other schools in their area
- enabling all teachers are able to present their gap tasks to colleagues, to ensure that all teachers feel their contribution is valued
- opportunities to develop ideas in small groups.

2.5 *Ticks the Box:* A teacher training day

'Ticks the Box' was a teacher training day held at the National STEM Centre and delivered by Space Connections. Space Connections is a national organisation based in West Yorkshire, which delivers resources for teachers relating to space, and is the organisation that employs ESERO-UK's space education ambassador for Yorkshire and the Humber. The teacher training day was attended by 18 primary teachers, who participated in a range of talks and activities including:

- an introduction to practical activities for primary schools, focusing on using the context of a space mission to discover if life exists on Mars
- a rocket building and launch activity

- an introduction to the Bradford Robotic Telescope
- an opportunity to experiment with a box of classroom activities, which can be easily implemented in the classroom.

Teachers were introduced to ESERO-UK throughout the day, including its STEM library and eLibrary resources. ESERO-UK also provided support to Space Connections in organising the event, via the business manager based at the National STEM Centre, as well as the region's space education ambassador.

Evaluation activities

Evaluation activities for this case study included:

- researcher attendance and observation at the teacher training day
- a survey distributed to all participating teachers following the event.

All but one of the attending teachers (18) responded to the survey. All 17 respondents are primary teachers, who teach pupils up to and including 11 years of age.

Teachers' previous views and experiences

Teachers who responded to the survey were asked about their previous experience and perceptions of teaching space topics, detailed in Table 21.

Table 21: Teachers' previous knowledge and experience

Thinking about before you attended this event, to what extent do you agree that you were...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
aware of how space could be used as a context for teaching STEM subjects?	0	7	5	2	3	**17**
confident in using space as a context to teach STEM subjects?	0	8	2	5	2	**17**
enthusiastic about using space as a context for teaching STEM subjects?	2	6	6	3	0	**17**
skilled to use space as a context for teaching STEM subjects?	0	4	7	4	2	**17**

Source: NFER surveys of teachers, June and October 2011

Table 21 shows that about half the teachers who attended the training day (8 out of 17) agreed or strongly agreed that, before attending the training day, they were **enthusiastic about using space as a context** for teaching STEM subjects, and

seven agreed that they were **aware of how space could be used as a context for teaching** STEM subjects, though none of them strongly agreed that this was the case. About half the teachers (8 out of 17) agreed that, before the event, they were **confident in using space as a context** to teach STEM subjects, but a similar number either disagreed or strongly disagreed (five and two teachers, respectively). Teachers were least positive regarding the extent to which they were **skilled to use space as a context for teaching STEM subjects**: only four agreed (and none strongly agreed) that they were skilled in this area before the training day.

The above findings show that the profile of teachers' responses about their views on using space as a context for teaching and learning was similar to that of the preceding case studies, although the baseline appeared to be somewhat lower as in at primary level teachers' subject specialism would not necessarily be science, design or mathematics. This may be attributable to teachers' relatively low levels of engagement in teaching space topics, in comparison to other case studies. During the year prior to the event, more than half of the teachers (9 out of 17) had not taught any topics using space as a context for STEM teaching, and only one of the 17 responding teachers had previously attended any CPD activities about using space as a context for teaching STEM subjects. This teacher attended one session, which was a NASA space course at a university.

Views about the event

The teachers that responded to the survey were extremely positive about the training day. The vast majority reported that it was both an enjoyable and informative experience. In particular, the teachers praised:

- the quality of the resources that they were introduced to
- the wealth of practical activities they learned about, and their applicability to the classroom
- the 'hands on' nature of the day
- the ideas and inspiration that the day provided.

Teachers' comments about the event

I really enjoyed today and was particularly impressed by the first workshop on Mars. A great way to teach lots of different areas of science.

It's wonderful to have resources to take away and use with children. Having 'hands on' experience of the activities is also a great benefit.

Resource library amazing. Wonderful opportunity for CPD. STEM website excellent resource.

This has provided a great stimulus for STEM!

Impacts on teachers

Teachers reported substantial positive impacts from the training day, as detailed in Table 22.

Table 22: Impacts on teachers

Please indicate to what extent you agree that this event has enabled you to develop...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
greater awareness of space education resources?	12	5	0	0	0
greater confidence in using space education resources to teach STEM subjects?	7	10	0	0	0
skills to use space as a context for teaching STEM subjects?	6	10	1	0	0
ideas for using space as a context for teaching STEM subjects?	11	6	0	0	0
awareness of good practice in using space as a context for teaching STEM subjects?	6	8	3	0	0

Table 22 shows that all of the teachers who responded either agreed or strongly agreed that the event had enabled them to develop **greater awareness of space education resources**, with 12 strongly agreeing. Similarly, all of the respondents indicated that they had developed **ideas for using space** as a context for teaching STEM subjects. Teachers were also very positive about the impact of the event on their confidence and skills. They all reported **greater confidence in using space education resources,** with seven strongly agreeing that this had occurred. Similarly, 16 of the 17 respondents indicated that the course had enabled them to develop **skills to use space** as a context for teaching STEM subjects. Most of the responding teachers (14 out of 17) felt that the event had helped them to develop greater **awareness of good practice** in using space to teach STEM subjects.

Impacts on classroom practice

Teachers were generally positive about the potential future impact of the training day on their classroom practice. Teachers' responses to the survey are presented in Table 23.

Table 23: Impacts on teachers' classroom practice

Please indicate to what extent you agree that this event will enable you to...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
provide 'real-world' space contexts for teaching STEM subjects or topics?	5	10	2	0	0
offer practical activities to your pupils to help them learn about space?	14	2	1	0	0
help students to learn about space-related careers?	1	7	7	2	0
promote space as a context for teaching STEM subjects to other schools?	2	7	6	1	1
raise the profile of space as a context for teaching STEM in your school?	4	11	2	0	0

Table 22 shows that in particular, responding teachers were very positive about their ability to provide **practical activities to their pupils to help them learn about space**. The majority (14 out of 17) strongly agreed that the event had enabled them to do this, while a further two agreed. Similarly, most of the teachers (15 out of 17) agreed or strongly agreed that the training day had enabled them to provide **real-world space contexts** for STEM teaching, with five strongly agreeing. They also reported a positive impact on their ability to **raise the profile of space as a context for teaching STEM in their school**, with 11 agreeing and four strongly agreeing that this had occurred. Teachers perceived the training as comparatively less influential on their ability to **help students to learn about space-related careers**. About half (8 out of 17) agreed or strongly agreed that the event had enabled them to do this, with just one strongly agreeing. Similarly, nine of the responding teachers agreed or strongly agreed that the training day had enabled them to **promote space as a context for teaching STEM in other schools**, with just two strongly agreeing.

Teachers' comments about the impact of the course on classroom practice

A great 'hands on' course with lots of practical activities and ideas that can be taken back into the primary classroom.

Learnt about some very good practical activities to take back to school to use – looking forward to using them.

After today I feel I can use the practical activities to inspire children in their interest of space.

Anticipated future use of space as a context for teaching STEM subjects

All of the responding teachers indicated that, following the training day, they were likely to increase their use of space as a context for teaching STEM subjects, and about half (8 out of 17) said this was very likely. The teachers were also asked how likely they were to use what they learned in each of the four main sessions of the day and whether they would use them for curriculum teaching and/or for special events.

Regarding the **practical activities for primary schools** (with a focus on a space mission to Mars), most teachers (14 out of 17) said they were likely to use this session, with six of these indicating that this was very likely. If they *were* to use these activities, seven teachers said they would do so as part of their curriculum teaching, four said they would use it for a special event and five said they would use it for both.

When asked about the **Bradford Robotic Telescope** session, most of the teachers who responded (12 out of 16) thought that they were likely to use what they had learned, though only one of these thought this was very likely. About half the teachers (8 out of 15) reported that, if they were to use this session, they would apply it to the curriculum, while six thought they would apply it to a special event, and one said both.

Teachers' attitudes to the **introduction to ESERO-UK, STEM library and eLibrary** were very similar to the telescope session. Most of the teachers (14 out of 17) indicated that they would use what they learned in this part of the training, with two of these saying this was very likely. In terms of context, seven teachers reported that they would apply this session to curriculum teaching, three said to a special event, and five said both.

The teachers strongly endorsed the **'Ticks the Box' classroom activities** with 16 out of 17 saying they were likely to use them as a context for their teaching, and 11 of these saying this was very likely. Furthermore, half of the teachers (8 out of 16 who responded to the question) thought they could apply these activities to both curriculum teaching and special events.

Where teachers indicated that they would use the activities from the training for a special event, the types of events they mentioned included:

- Science Week
- after school clubs
- themed school days e.g. 'Rocket Day'.

In additional feedback provided after the survey, one attending teacher was particularly enthusiastic about future plans for a special event using the 'practical activities for primary schools' element of the training and incorporating the Bradford Telescope. The teacher commented:

I will be using the pack of activities as a backbone for a week's activities called 'Out of this World' which the whole KS2 will be working on. It will link in with work in lots of other areas of the curriculum including literacy, numeracy and art! We might even kick the week off by finding evidence that Martians have visited the school during the half term holiday! We will also be observing Mars through the Bradford Telescope and following the progress of the latest mission to Mars!

Suggested improvements

As previously mentioned, teachers' experiences of the event were extremely positive and, as a result, there were very few suggestions for improvements. A small number of teachers reported that it would be helpful if:

- there were more resources in the 'Ticks the Box' kit to provide for a whole class or year group
- the activities could be cross-referenced to specific objectives, learning outcomes and pupil self-assessment.

2.6 GCSE Astronomy at Glyncoed Comprehensive School

This case study focused on the delivery of GCSE Astronomy at Glyncoed Comprehensive School in Blaenau Gwent Local Education Authority (LEA), Wales. The case study stands apart from the others in that the activities aim to impact on the students and the school, rather than an individual teacher or group of teachers. The course was planned and delivered by the school in collaboration with the Director of Education at the Faulkes Telescope Project, and ran during the academic year 2010/11. Students were examined in June 2011. The school received support from ESERO-UK's space education ambassador for Wales in setting up the project. Space education ambassadors from other regions have also been involved in the direct delivery of sessions to students.

Evaluation activities

Evaluation activities for this case study included:

- in-depth telephone interviews and data collection from two school and project delivery staff, focusing on implementation of the project
- collation of GCSE attainment data.

About Glyncoed Comprehensive School

In its most recent school inspection conducted by Estyn, Glyncoed Comprehensive School was judged to be highly successful with many outstanding features[5]. The school has implemented GCSE Astronomy on an extra-curricular basis for female students using funding from the Pre-VENT Key Stage 3 intervention project, an educational initiative funded by the European Social Fund.

Prior to involvement in the programme, 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 extra-curricular basis. As the Pre-VENT project funding placed particular emphasis on girls' engagement with STEM, school staff worked alongside the space education ambassador for Wales to assess the GCSE Astronomy course's suitability as an opportunity for girls who had been highlighted 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.

Selecting the students

The Edexcel GCSE Astronomy is a QCA approved science qualification, which 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 upon the scientific and mathematical knowledge they have acquired in Key Stage 3, and is designed to complement and extend the reach of both GCSE Science and 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[6]. Whilst the course is designed to be suitable for students of all abilities, a key feature of its suitability for use at Glyncoed Comprehensive School was its value in providing additional challenge to gifted and talented students.[7]

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[5] Estyn (2006). *Inspection Report: Glyncoed Comprehensive School.* Available online: *http://www.estyn.gov.uk/english/provider/6774045/* [Accessed 16th December 2011]

[6] Edexcel (2008b). *Edexcel GCSE Astronomy: Student Guide.* Available online: http://www.edexcel.com/migrationdocuments/GCSE%20New%20GCSE/GCSE09-Astronomy.pdf [Accessed 12th November 2011]

[7] Edexcel (2008a). *Teacher's Guide - Your guide to Edexcel GCSE in Astronomy.* Available online: http://www.edexcel.com/migrationdocuments/GCSE%20New%20GCSE/Edexcel%20GCSE%20Astronomy%20-%20TSM.pdf [Accessed 12th November 2011]

Approximately 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 extra-curricular basis, and so students' own motivation was perceived to be critical to their successful completion of the course. Initially, pupils from Year 9 were selected to participate in the course as they were perceived to lack the exam pressures faced by older year groups and because, due to their age, they met the conditions of the Pre-VENT intervention project funding arrangements. However, the course proved immensely popular, with several Year 10 girls asking if 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

Teaching methods comprised a variety of approaches, including:

- **after school sessions**, delivered by the academic staff member from the Faulkes Telescope Project. These sessions formed the foundations of students' course tuition and the aim was to work through the curriculum content using a mixture of theoretical and practical activities
- **residential weekend sessions**, focusing on hands-on activities to enhance their astronomy skills and broaden their experience of practical astronomy. Residential activities included, for example, midnight star gazing walks at Techniquest Science Discovery Centre in Cardiff, and practical observations at Bryn Bach Park in Tredegar[8]
- **master classes**, delivered by astronomy specialists, such as the UK Space Education Office's regional Space Ambassadors and experienced teachers. These master classes aimed to equip students with an in-depth, advanced knowledge of each theme within the GCSE Astronomy syllabus
- **observation coursework**, using the National Schools' Observatory online robotic telescope
- **revision and consolidation sessions**, run by school staff from across STEM teaching departments, to support students in developing their understanding of the course content.

Impacts on students

Whilst the course has resulted in a wide range of impacts, the most immediate of these (based upon teachers' perceptions) have been realised for the students. In particular, staff observed impacts in relation to students':

[8] National Grid for Learning Cymru (2011a). Glyncoed Comprehensive School Pre-VENT KS3 activities. Available online: http://www.ngfl-cymru.org.uk/eng/pre-vent/pre-vent-glyncoed.htm [Accessed 12th November 2011]

- enjoyment of astronomy topics, and of science more broadly. This was particularly apparent amongst students who had previously shown a lack of interest in science
- attainment in GCSE Astronomy. Of those who entered the GCSE examination in June 2011, four were awarded A grades, 16 were awarded B grades, seven C grades, four D grades, and 1 E grade.

> *Most Year 9's found GCSE Astronomy easier than some of the abstract aspects of science, possibly because you can apply it.*
>
> *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!*
>
> Faulkes Telescope Project staff member

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 have learned in GCSE Astronomy, for example advanced logarithms, have proved extremely valuable in enabling them to develop their skills in mathematics.

> [Students] *thoroughly enjoyed the course and girls are now very knowledgeable in some science courses, especially physics.*
>
> School teacher

Secondly, participating students' enjoyment of the GCSE Astronomy course has ignited an interest amongst younger students. A teacher from the school reported that the course is 'not only sparking interest amongst girls involved in the project but also those lower down the school, which is really exciting'. After the course started, Year 8 girls were keen to find out if the course would be run in future years. The school decided early on to recruit students for the following year, beginning in September 2011. This course is now underway, 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 brought about several positive impacts on school staff, who reported that the course has helped to **raise the profile amongst senior leaders** of space as a context for teaching STEM subjects, and 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, leading to a number of practical considerations to ensure effective delivery. These considerations include:

- **staff familiarity with the content of the course:** university and school staff alike reported that they experienced challenges in familiarising themselves with the content and structure of a new syllabus, which was considerable in size and scope. School staff reported that one of the key challenges has been making use of the limited time available to support their students effectively. Therefore, a considerable investment of time was required at the outset to ensure that the design, format and delivery of the course maximise students' chances of success
- **availability of resources:** the school used a range of GCSE Astronomy teaching and learning resources, including those accessed online. 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, although they had not made extensive use of the resources offered through the National STEM Centre's dedicated eLibrary
- **dedication of students:** students' own motivation was considered essential to the success of the course. Faulkes Telescope Project 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, interviewees suggest that 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 extra-curricular basis
- **support of the school's senior management team:** interviewees reported that the support and buy-in of Glyncoed Comprehensive School's senior management team was 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 approach and in fostering support amongst 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'
- **master classes for students:** interviewees reported that the master classes delivered by regional space education ambassadors and experienced teachers working as part of ESERO-UK's regional networks were particularly valuable in drawing in external expertise from university and industry providers, and in enabling the school to cover substantial proportions of the curriculum relatively quickly. The wider accessibility of these master classes has increased their appeal, making learning accessible to students across the region.

Next steps

As a result of the success of the project, Glyncoed Comprehensive School plans to continue to deliver GCSE Astronomy in future years. Whilst 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, interviewees report that word of mouth and the availability of master classes 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 science more generally, and is valuable in inspiring and engaging students in science, and helping them to achieve.

3. Overview and discussion

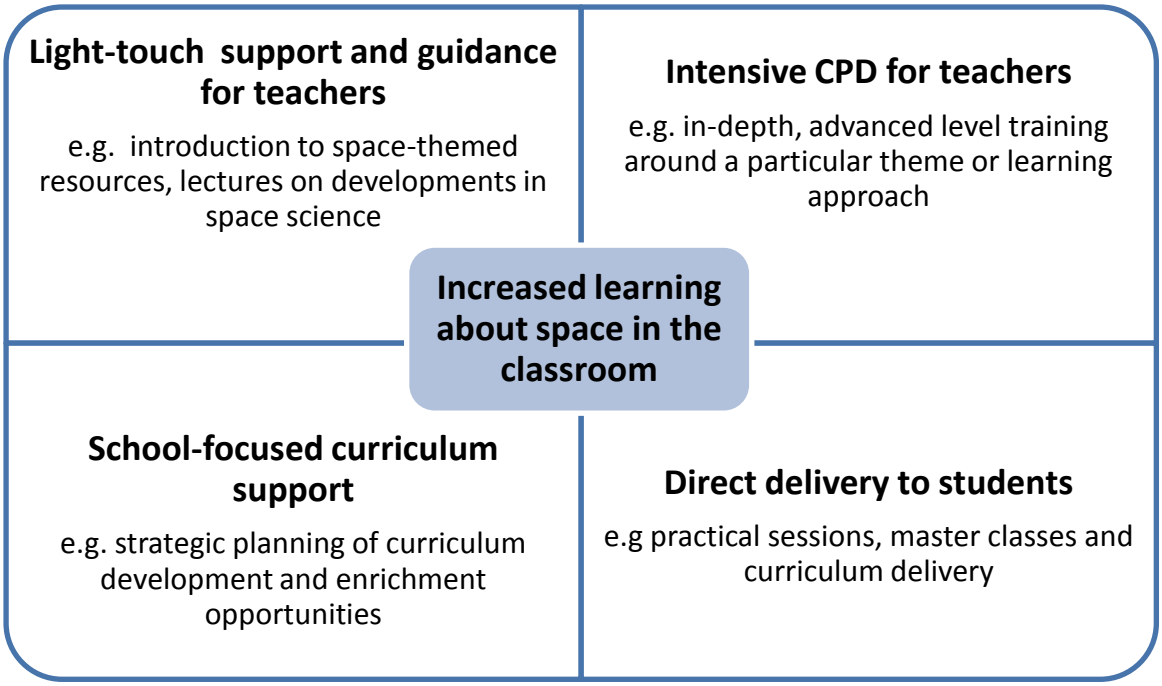
Drawing upon the individual case-study data presented in Part 1, the following section presents an overview and discussion of the data arising from the case studies. In particular, the section considers:

- the range of approaches taken to support teachers in using space as a context for their STEM teaching and learning
- the role of ESERO-UK in supporting these approaches
- impacts on teachers, schools and students
- key messages for ESERO-UK, to help inform future developments.

3.1 Approaches taken to supporting teachers in using space as a context for STEM teaching and learning

The activities explored during the case-study phase of this research exemplify a range of different approaches to encourage, support and inspire teachers' use of space as a context for teaching and learning. These approaches fall into four main categories, detailed in Figure 1. Each of these approaches are characterised by particular features which may provide a useful framework for our understanding of the activities offered by, and in association with, ESERO-UK.

Figure 1: Approaches to using space as a context for STEM teaching



Light-touch support and guidance for teachers

The 'light-touch' support and guidance offered to teachers tended to be characterised by one-off activities suitable for teachers at all levels. It is important to note that 'light-touch' in this context is used to describe the type of support offered to teachers, rather than for the role of ESERO-UK. The activities within this category tended to be relatively short, usually lasting not more than two hours. They most commonly focused on introducing a particular educational resource, or providing a general overview of a topical issue relating to space. The case study detailing promotion of the ISS Education Kit is an example of such a light-touch activity, as are the individual lectures delivered by space scientists at the ESERO-UK Space Education Day.

Light-touch activities were sometimes delivered on a standalone basis, but were also sometimes situated within the context of a wider event. For example, whilst the *individual sessions* delivered within ESERO-UK's Space Education Day may be understood as 'light-touch' activities, they were situated within a much broader and more extensive programme of teacher engagement throughout the event as a whole.

Intensive CPD for teachers

By contrast, some of the support and guidance offered to teachers was much more in-depth, characterised by detailed exploration of a particular theme. *Space as a context for teaching science*, focused around the development of the JWST, is an example of this type of intensive CPD. Another example is the *Ticks the Box* teacher training day delivered at the NSLC. Both of these activities were targeted at teachers seeking to extend the reach of their teaching skills at a more advanced level, which is a defining feature of this approach. However, unlike the light-touch support described above, this approach was more closely targeted towards specific groups of teachers (for example, secondary science teachers). Given the in-depth focus of this approach, at an individual level these activities are unlikely to hold a universal appeal for teachers. Intensive CPD activities can, as with light-touch support, be delivered as a standalone event, but may also include follow-up or action planning to help teachers act on what they have learnt (as demonstrated in *Space as a context for teaching science)*.

School-focused curriculum support

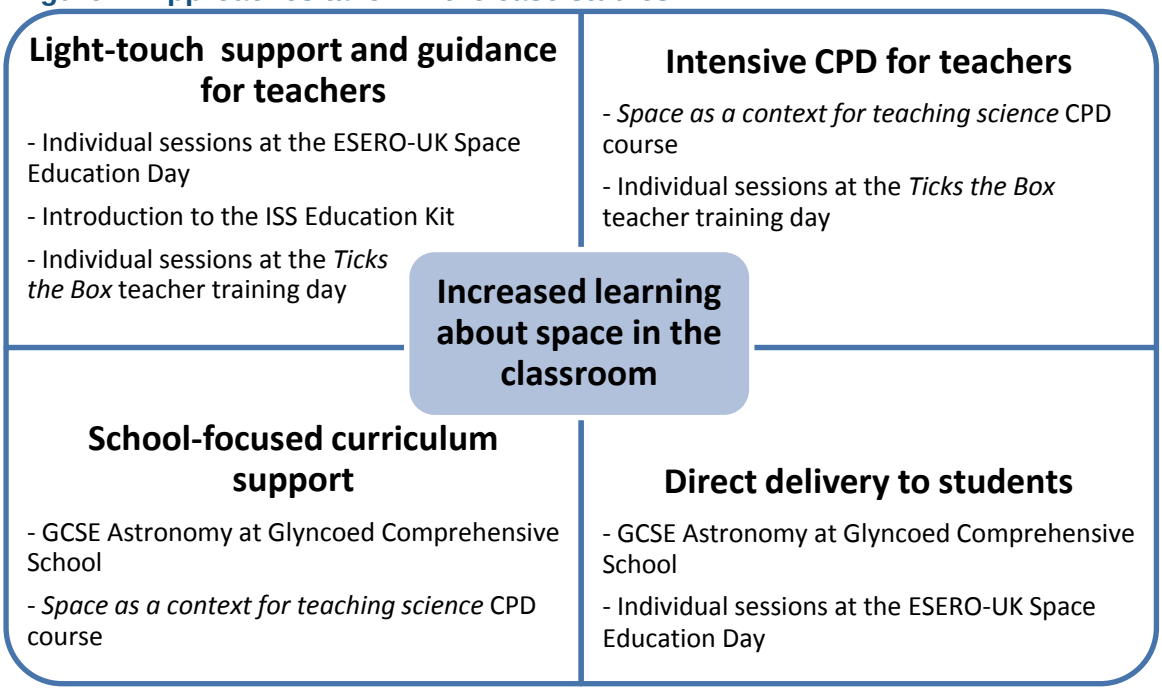
Support for teachers may also be characterised by ongoing, school-focused support and guidance (e.g. GCSE Astronomy at Glyncoed Comprehensive School). This type of activity is characterised by intensive, practical support for individual or a small group of schools, and provides specific curriculum support for teachers, alongside the direct delivery of curriculum activities to students by experts. The approach is characterised by long-term planning, and appears to be highly suitable for schools with an interest in school-wide change.

Direct delivery to students

Approaches involving activities directly delivered to students could be integrated into any of the above strategies. For example, the introduction of GCSE Astronomy at Glyncoed Comprehensive School involved direct delivery to students as part of school-focused curriculum support. However, practical sessions to students were also included in an individual session of the ESERO-UK Space Education Day, which is an example of more light-touch support.

In practice there was a considerable degree of overlap between each these approaches and case-study organisations often adopted one or more of these strategies, thereby aiming to increase learning about space in a range of different ways. Figure 2 presents the approaches adopted by each of the case studies, taking into account the multifaceted strategies they employed.

Figure 2: Approaches taken in the case studies



3.2 The role of ESERO-UK

As detailed in Part 1, the scope of ESERO-UK's role varied according to the nature of the activity and its position relative to various partner delivery organisations involved in each case study (e.g. Space Connections, ROE, NCSL, and the Faulkes Telescope Project). ESERO-UK's input was at times direct, for example through the delivery of activities to teachers, as well as more indirect, by supporting, encouraging or bringing coherence to existing activities or programmes. ESERO-UK's role included, variously:

- advertising and promoting educational provision to teachers and other audiences

- working with a range of partners to add value to existing space education providers
- directly supporting teachers to use resources more effectively, particularly at regional space education ambassador level
- promoting the resources and website of ESERO-UK at events run by a range of delivery organisations.

3.3 Impacts on teachers, schools and students

The findings presented in Part 1 of this report clearly demonstrate that all five case studies have resulted in meaningful impacts for those involved. These impacts often appear to have been realised as a result of the combined efforts of ESERO-UK and its partners. Whilst it was possible to explore more far-reaching impacts in some case studies more so than others, where comparisons could be made it appears that, broadly speaking, no individual case study resulted in more strongly reported impacts than another. The implications of this are two-fold. Firstly, this suggests that there is a place for all types of support offered within the case studies, ranging from general support for a wider audience of teachers to a much more focused, tailored and targeted approach towards smaller groups. Secondly, it suggests that there are a range of routes by which these impacts can be brought about, indicating that ESERO-UK and associated delivery organisations should be confident in the suitability of their flexible and responsive approach.

Impacts on teachers

In all case studies where a survey was conducted, impacts on teachers personally were particularly strong. The strongest impacts appeared to relate to their increased **awareness of space education resources**, and the **repertoire of ideas** that they had acquired for implementation in the classroom.

However, when asked about their baseline position, most case-study teachers appeared to feel less **confident and skilled** in using the topic of space in their teaching. This may be attributable to teachers' relative lack of previous professional development opportunities relating to space education. In general, confidence and skills levels were lower amongst primary school teachers. Possible explanations for this may include primary school teachers having taught fewer topics relating to space over the past year, and being less likely to have a specialist background in science than, for example, a secondary physics teacher. This suggests that primary school teachers can particularly benefit from participating in these types of activities in terms of improvements in their confidence and skills. In all of the case studies where teachers were surveyed, positive impacts were observed in both of these respects, although, overall, they were more modest than in other areas. Therefore, there may be a need to focus and develop activities to more closely meet the needs of teachers in terms of increasing their confidence and skills in using space in their teaching.

Across most of the case studies in which teachers were surveyed, the area in which the impact was less strong relative to others (although still very positive) was an increase in teachers' **awareness of good practice** in teaching STEM subjects. This suggests that schools would welcome replicable models to support them in implementing good practice within their own schools. However, where follow-up surveys were conducted with teachers in relation to *Space as a context for teaching science*, teachers reported a greater increase in their awareness of good practice as time progressed. This may suggest that when follow-up activities and support is built into teachers' development, they benefit from the opportunity to test out their own models and ways of working.

Impacts on classroom practice

In general, impacts in relation to classroom practice were very high. Impacts on teachers' *own* classroom practice were particularly strong. For example, teachers reported strongly that they would be able to apply their teaching to a range of real-world contexts, and increase the range of practical activities they offered to their students. This was closely followed by positive impacts on teachers' plans to cascade their learning further afield. Whilst this impact was reported most strongly where activities were more intensive or sustained, some teachers appeared to lose confidence in their ability to share their learning with other schools as time progressed. For example, a high proportion of teachers attending *Space as a context for teaching science* planned to disseminate their learning to other schools after the first part of the course, but by the second part of the course the strength of this impact had diminished. Therefore, the transfer of learning between schools may be an area in which teachers would benefit from additional, specific support. Generally, impacts relating to teachers' awareness of space-related careers also appeared to be lower than in other areas, suggesting that teachers would welcome further specific information about career routes and employment opportunities to enable them to guide their students more effectively.

Across all case studies, there was a highly positive impact on future likelihood of teachers and schools using space as a context for teaching and learning. Whilst at Glyncoed Comprehensive School it is apparent that this future use will focus around curriculum activities, in particular the GCSE Astronomy curriculum, the findings from other case studies suggested that the activities would have a useful application in the curriculum as well as within a range of enrichment activities. Interestingly, where follow-up surveys were completed, a greater proportion of teachers reported that they would use what they had learned in the national curriculum as time progressed. This suggests that teachers are becoming more conversant with the range of potential applications of their learning within the curriculum as their skills become more embedded. Related to this, it also appears to be the case that where activities were focused around a specific resource, plans for future use do not appear to be restricted to just this resource. For example, teachers who were introduced to the ISS Education Kit reported that they planned to make greater general use of space in their teaching, as well as greater use of the kit itself.

Impacts on students

Whilst the remit of this study did not extend to detailed exploration of impacts on students themselves, in two of the case studies (the ESERO-UK Space Education Day and Glyncoed Comprehensive School) it was possible to explore teachers' perceptions of how students had benefited.

In both case studies, school and university staff observed considerable impacts on students' **enjoyment of STEM subjects.** At Glyncoed Comprehensive School, this was particularly apparent amongst students who had previously shown a lack of interest in science: situating their learning within an engaging thematic context appeared to inspire them, and supporting them in acquiring a grasp of complex mathematical and scientific concepts. Teachers also observed impacts in relation to students':

- confidence in STEM subjects
- problem-solving and investigation skills
- attainment, in the case of Glyncoed Comprehensive School, by virtue of gaining an additional formal qualification in GCSE Astronomy
- ability in other STEM subjects, particularly physics and mathematics
- skills outside of STEM (e.g. literacy and social skills, ability to conduct extended pieces of work on a given topic, and presentation skills).

It should be noted, however, that the impacts observed by teachers, particularly at Glyncoed Comprehensive School, relate to students who had been selected as having the potential to excel at STEM subjects. Where these activities are extra-curricular, student motivation was considered to be particularly important in bringing about these impacts.

3.4 Key messages for ESERO-UK

The case-study findings highlight four key messages, which may be valuable to ESERO-UK in supporting future activities.

1. The activities included in the case-studies were highly valued by teachers, indicating that the various levels and types of support provided by ESERO-UK appears to have added considerable value to its partners and beneficiaries. The case studies appeared to meet a demand amongst teachers for this type of professional development. The findings show longevity as well as a range of impacts, with positive outcomes for teachers and schools continuing to evolve with time. This is particularly noticeable when follow-up support for teachers is built in. It should be noted that, in some case studies (e.g. Glyncoed Comprehensive School, and *Space as a context for teaching*

science, impacts took some time to become embedded. This suggests that the impacts of these activities for teachers and schools will continue to grow.

2. Across all case-studies, teachers most highly regarded: access to expert professionals who could inform them about topical debates in space science; practical, hands-on resources for both teachers and pupils; introduction to a range of new teaching techniques; and time to share their experiences with teaching colleagues. It was also considered essential that activities delivered could be easily applied in the classroom. Where these features were included within a case study, this was highly valued by teachers. By contrast, these features were identified as areas for improvement where teachers felt they were lacking. Therefore, these features appear to be to the success of supporting teachers effectively.
3. The case studies reveal particularly strong outcomes in relation to teachers' increased awareness of space education resources, as well as their increasing substantive knowledge of space topics. The case studies also demonstrate a range of ways in which ESERO-UK has helped teachers to become more aware of the organisations and agencies operating within the space sector. However, it may be possible to do more to support teachers to become aware of the organisations and agencies relating to careers in space. Compared to other aspects, teachers reported that the impact of the courses they had attended on their knowledge of space-related careers was relatively low. Teachers also volunteered this as an area where they would require further support. Most of the activities did not specifically focus on this, but it suggests there may be a gap in the market for this type of provision. Teachers reported that they would welcome provision including details of career routes, potential employers and contacts within these organisations.
4. Whilst overall, the case-studies very positively reflect ESERO-UK's activities to date, there may be a need to raise teachers' awareness of the full range of support offered. For example, Glyncoed Comprehensive School had drawn upon considerable support from the space education ambassador network but, despite purposely seeking out resources online, had only made limited use of those available from ESERO-UK. This suggests that it may be valuable for teachers receiving support from ESERO-UK via a particular channel to be made more aware of the full range of support available.

3.5 Concluding comments

The findings presented in this second interim report highlight the wide range of approaches that can be used to support space education and the range of positive outcomes that can arise from them. It is evident that ESERO-UK can play an important role in supporting, adding value and drawing together existing space education provision.

This report has focused on ESERO-UK's more direct work with teachers and schools. The next phase of the research will include an exploration of ESERO-UK's progress towards meeting its aims in relation to stakeholders, and, in particular, its role in supporting the coordination of space provision. It will include interviews with strategic partners and an exploration of the development of the space education ambassador networks and the benefits of these collaborations. In addition updated data on web usage will be collected to explore the effectiveness of this element of ESERO UK's activities.

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