1.0 **Precis**

1.1 The University of Leicester considered the issue of the STEM skills gap in 1994 and devised plans for the National Space Centre to get people excited about space and help develop the next generation of scientists and engineers. The National Space Centre opened in 2001 and welcomes 300,000 people a year of which 90,000 are children aged 8-13 in school groups. In 2008 it launched the National Space Academy to use space as a context by which to teach GCSE, A level, BTEC and apprenticeship students and their teachers, and to complement the University’s undergraduate and postgraduate courses.

1.2 The University and National Space Centre teams ("The Partnership") work together to influence and boost student attainment and course choice and to enhance teacher effectiveness in primary, secondary, further and higher education. They have further partnerships with a wide range of public and private sector organisations, have a network of teachers and affiliated colleges across the UK and share best practice internationally.

2.0 **Programmes**

The Partnership works with the following audiences (per annum). The *Outcomes (in italics)* summarise the findings that are explained further in Section 3:

**Families with children aged 6-13**

Over 300,000 visitors enjoy a space-themed day out.

*Outcomes: Family science capital (the relevance of science in family life) is enhanced and has a positive influence on children’s attitudes to science in school and life experience.*

**Pre-school**

1,000 3-4 year olds attend *small space days* with one or more parent(s).

*Outcomes: Children and their parents have a fun, space-themed time that helps develop family science capital.*

**Early primary school**

3,000 5-7 year olds enjoy a space-themed day out.

*Outcomes: Children have fun, feel positive about science and talk to their school friends and families about space and science.*

**Primary and early secondary school**
87,000 8-13 year olds visit the National Space Centre for a curriculum-focused visit that is linked to classroom study and, for 20% of students, includes a subject-specific workshop.

Outcomes: Children feel positive about science and may be influenced in their GCSE choice, although this is impossible to measure in a one-day/mass participation intervention.

GCSE and A level

9,000 students and 1,000 teachers take part in intensive half- and one-day courses to support their exam studies and development of teaching methodologies. These courses are delivered by the National Space Academy’s team which includes 30 “Lead Educators” (outstanding current teachers of science who are second to the Academy from their main teaching institutions) who work with current space scientists/engineers to develop and deliver programmes. These personnel are located across the UK and provision is delivered at local schools/colleges as well as at larger venues such as the National Space Centre, university of Leicester and other hosting sites including the Harwell Science Campus.

Outcomes: Student and teacher attainment can be improved and course choice can be influenced. External evaluation evidence and individual schools’ analyses of the performance of cohorts of students which have participated in regular masterclasses confirm that they have had a positive effect in these areas.

Post-16 Space Engineering courses and Space Studio Schools

50 students in two UK colleges (Loughborough and Salford) attend full time hybrid academic/vocational courses that are based on a Loughborough College/National Space Academy model developed in 2011-12. Students take A levels in mathematics and physics and a BTEC level 3 in engineering; all taught with a space context.

Outcomes: Both the Loughborough College and Salford College courses attract middle ability students with little family history of higher education. Since 2012, 80% of Loughborough students have progressed to university and 15% have taken good apprenticeship programmes. Three other Colleges/institutions in other parts of the UK are planning on introducing similar courses from September 2017 based on the positive impact of the Loughborough and Salford courses.

Post-18 Higher Apprenticeship in Space Engineering

This course was devised with public funds in association with six space companies to ensure course relevance. There has been little take up (one company, two
Written evidence submitted by the University of Leicester and National Space Centre/National Space Academy (GAP0023)

apprentices) since launch in 2014. The programme remains available until the impact of the apprenticeship levy (April 2017) can be assessed.

Undergraduate and postgraduate courses

The University provides a wide range of STEM programmes and is a world leader in subjects allied to space science and engineering, principally through the Space Research Centre and the Department of Physics and Astronomy. It works closely with industry to develop employability skills and promotes technology transfer and satellite applications through initiatives such as EMBRACE: a regional centre of excellence of the Satellite Applications Catapult. It has recently launched its Leicester Institute for Space and Earth Observation and plans to collate its space science expertise in a new campus on its fledgling National Space Park. A key goal of these initiatives is to link the University’s courses more closely to industry needs and develop a range of flexible CPD modules.

3.0 Evidence of Impact

The National Space Academy’s Evidence of Impact 2008-16 document is appended. The following executive summary may be helpful:

3.1 Space is an impactful context by which to teach STEM subjects. It has direct relevance to physics, chemistry, biology, mathematics and geography curricula. Its study can lead to space-specific course and career choices, but is just as relevant to science and engineering disciplines across a range of industry and research sectors.

3.2 The National Space Academy teaching methodology boosts student attainment and influences attitudes to science and engineering. It is impactful both directly with students and in teacher development via its intensive Continuing Professional Development courses.

3.3 Demand for National Space Academy courses is (a) mostly (70%) for physics support and (b) often from schools struggling to provide high quality physics teaching and/or without specialist physics teachers.

3.4 National Space Academy courses are expensive to run and cover 50% of their costs from earned income (governed by the limit to which schools can afford to pay). Grants from the public, private and charitable sectors help cover the remaining 50%.

3.5 The availability of bursaries from organisations such as the Ogden Trust provides access to schools in areas of economic deprivation that would otherwise not be able to afford to pay.
3.6 Underrepresented and underserved audiences are defined by both the ability to pay and by gender. School groups to GCSE have a 50:50 gender split, but the imbalance is apparent thereafter. Providing female teaching staff and role models as guest lecturers appears to help. Making overt references to ‘barriers’ does not. Ethnicity can be an influencing factor, but should not be assumed to be so and must be addressed on a case-by-case basis.

4.0 Concluding observations

4.1 The industrial and societal need for STEM skills is articulated via a wide range of data and sector-specific targets. The UK Space Agency states that 100,000 new employees will be needed in the space sector by 2030. This is difficult to qualify on the basis that technological development will determine where growth and disruption will occur, but The Partnership will progress on the basis that the gap is beyond its ability to fill it and that there is no ceiling to its service provision. Data processing is regularly stated as the most likely area of greatest future demand and this should influence post-16 and post-18 course development.

4.2 Demand for National Space Academy services is driven largely by the shortage of specialist physics teachers which, in turn, suppresses the number of physics A level students in schools that are challenged in this way. The Academy’s intention is to continue offering services to students of all abilities so that it is capable of intervening both on behalf of both (a) underrepresented and underserved communities and (b) high achieving students and the organisations that need their skills.

4.3 We are becoming aware of renewed challenges regarding the recruitment of specialist STEM subject teachers, particularly in Physics. In the past 15 or so years, the Partnership has worked closely with learned societies and others, largely successfully, to reverse the shortage of such teachers that had grown in the 1990s and early 2000s. However, it is our perception that much of the ground recovered is again being lost. A key factor seems to be changes in arrangements for the training of teachers. This has undermined the viability of University teacher training support in Physics (and other sciences) which is essential for initial recruitment and subsequent retention.

In addition, previous structures established by Government to support science teacher training through a focused network of Regional Science Learning Centres working with other training organisations have had strategic and financial support slashed with very little co-ordinated support structures being offered in their place. Coupled with the increasing and well-documented extra financial challenges faced by schools/colleges in the current economic climate, many physics teachers and headteachers are reporting that it is much more difficult for schools/colleges to be able to afford to send teachers who would most benefit from training support to high-
quality courses which would enhance their practice and effectiveness. The increase in numbers of multi-academy trusts (MATs) has led to more and more clusters of schools participating in internal teacher training which is disconnected from contemporary science research and which is of varying quality and relevance to contemporary science issues.

At the moment our evidence for this problem is anecdotal, relating to local circumstances, but is worrying. The National Space Academy’s network of Lead Educators delivering physics teaching support across the UK for over a thousand teachers per year includes some of the country’s best and most experienced practitioners (as evidenced by National external assessment) and they report that our local concerns are being reflected across the UK.

Similar concerns have been expressed by other physics education providers and training organisations including the Institute of Physics, Gatsby Foundation and other Universities. A crisis could emerge rapidly, as it did in earlier decades, requiring considerable effort to reverse. We recommend that evidence be collected at national level without delay to allow early intervention if needed.

4.4 The University of Leicester’s plans for a National Science Park, incorporating the National Space Centre and National Space Academy, will bring together world class teaching resources to provide a unique suite of teaching programmes from pre-school to postgraduate students. The supply of skills and the presence of the visitor attraction as an industry showcase will help attract companies needing high level skills to a site that will prove equally attractive to their supply chain and help return a larger brown field site to world class industrial and academic use.

Chas Bishop (National Space Centre)
Professor Martin Barstow (University of Leicester)
Professor Anu Ojha (National Space Academy)

January 2017
Appendix 1

National Space Academy

Evidence of Impact 2008-16

Chas Bishop                       Chief Executive, National Space Centre
Professor Anu Ojha OBE           Director, National Space Academy

October 2016

Andy’s contribution to the Physics Department and the wider Science Faculty was superb, and the students benefitted immensely from his contribution. The work of the National Space Academy was pivotal in ensuring that a highly successful Physics programme was able to keep running. He was widely respected and extremely popular across the two large groups of Year 12 students. Robert Coles: Principal, Groby Community College

Oliver did really well, and produced an excellent report on air quality around Manila. Elements of this report are now being used as part of a multi-million pound bid into the UK Space Agency. Oliver understood and manipulated satellite data, as well as modelled data, and produced an excellent plan for the deployment of 200 ground-based sensors in the Manila area. The report was well-presented, and he delivered some useful datasets in excel
Written evidence submitted by the University of Leicester and National Space Centre/National Space Academy (GAP0023)

too. Oliver was a pleasure to have with us for a week. Dr Robert Parker: University of Leicester

1. Introduction

The National Space Academy was launched as a pilot programme in the East Midlands in 2008, rolled out across England in 2012 and extended to the rest of the UK in 2014. Its mission is to materially enhance the size and quality of the UK science & engineering skills pool.

The Academy uses space as a context by which to teach science subjects and mathematics to GCSE, BTEC, A level (or equivalent) and apprenticeship students and their teachers. Its programmes fall into two broad categories:

- Full time programmes delivered by a growing network of affiliated colleges
- One day (or shorter) masterclass programmes delivered by a network of 35 teachers, scientists and engineers across the UK

Other outputs include teacher training/continuing professional development, careers events and commissioned programme development work for public and private sector clients in the UK and overseas.

The Academy has a range of stakeholders and interested parties keen to understand its impact. This document presents a method by which impact may be assessed as evidence is collated. It is updated annually.

2. Programmes

The National Space Academy:

- Delivers physics A level teaching for the post-16 course in Space Engineering (originated in partnership with Loughborough College) and provides space education training for the mathematics and engineering tutors delivering other course components
- Proactively recruits affiliate colleges to deliver full time programmes using space as a teaching context. There are five affiliate colleges to date in Banbury, Brooklands (Surrey), Loughborough, Salford and Twickenham. Colleges in Glasgow and Newcastle are considering programmes
- Delivers half-day and full-day, intensive curriculum-focused masterclasses in physics, chemistry, biology, mathematics and applied science to GCSE, BTEC and A level students
- Delivers Continuing Professional Development (CPD) workshops in the above subjects for teachers (including delivery on behalf of other organisations such as the UK Space Education Office - ESERO-UK)
• Hosts careers’ conferences to raise student awareness of the UK space sector and introduce them to some of the organisations that need their skills

• Has developed a national framework for a Higher Apprenticeship in Space Engineering in partnership with Loughborough College, and will deliver the space elements of the course on behalf of the colleges that need them

• Develops international education programmes for the European Space Agency and is progressing commercial prospects in China and the UAE

3. Definition of Outputs & Impact

3.1 The Outputs of The Academy are defined simply by the volumes of students and teachers attending programmes.

3.2 Impact is defined as the consequence of students and teachers attending programmes: how they perform and how the students’ course and/or career choices are subsequently influenced. The impact will only be positive if programme content is appropriate and delivery is of a high quality.

3.3 ‘Material impact’ can be defined if a specific UK target is declared and a percentage increase that represents a material impact can be agreed. Measurement is straightforward if The Academy’s output is short term and ‘direct to market’.

3.4 In some cases, such as the delivery of one-off masterclasses, impact is less easy to measure. As an example, 70% of masterclass demand is for GCSE physics support. The Academy would like to influence students’ consideration of physics at A level and there is occasional anecdotal evidence that this is the case, but it continues to consider a methodology by which quantitative impact can be measured. This will help determine an agreed ‘material impact’ and set volume targets to achieve such.

4. Measurement of Outputs

Output targets are set at the start of each academic year and achieved via a delivery plan that appears in the National Space Centre’s rolling three year business plan.

The following table presents outputs for each academic year (running September to August) since the full National Space Academy programme started in 2012:

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Engineering students: post-16*</td>
<td>N/A</td>
<td>11</td>
<td>15</td>
<td>15</td>
<td>14</td>
<td>55</td>
</tr>
<tr>
<td>Space Engineering apprentices: post-18*</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Affiliate college students (space contexts)*</td>
<td>N/A</td>
<td>N/A</td>
<td>89</td>
<td>216</td>
<td>Tbc</td>
<td>305</td>
</tr>
<tr>
<td>Students – half/full day masterclasses</td>
<td>1,348</td>
<td>1,797</td>
<td>1,808</td>
<td>2,070</td>
<td>2,016</td>
<td>7,023</td>
</tr>
<tr>
<td>Students – lectures/short programmes</td>
<td>741</td>
<td>2,055</td>
<td>3,922</td>
<td>4,831</td>
<td>6,006</td>
<td>11,549</td>
</tr>
<tr>
<td>Students – careers fair</td>
<td>411</td>
<td>420</td>
<td>1,087</td>
<td>1,077</td>
<td>594</td>
<td>2,995</td>
</tr>
<tr>
<td>Teachers – CPD workshops</td>
<td>317</td>
<td>1,105</td>
<td>956</td>
<td>1,150</td>
<td>840</td>
<td>3,528</td>
</tr>
<tr>
<td>Students benefiting from better teaching**</td>
<td>19,020</td>
<td>66,300</td>
<td>57,360</td>
<td>69,000</td>
<td>50,400</td>
<td>211,620</td>
</tr>
</tbody>
</table>

*Volume of students enrolling in the first year of the course.
An indirect output, yet core to the success of the programme, is the number of students that benefit from better science teaching as a consequence of teachers attending a Continuing Professional Development (CPD) workshop. Although this is likely to vary significantly case by case and is difficult to measure, a conservative judgement may assume that 60 students, equating to two GCSE classes, are influenced by a teacher that attends a CPD workshop. Some CPD programmes use a multiplier of 100 or even 200 students, which is entirely feasible.

5. **Measurement of Impact**

Impact is both direct and indirect; short term and long term. Impact data ranges from that which is objective and easily measurable to that which is subjective and/or less easily measurable, but not necessarily less important. In grading the quality of impact data, it is assessed using the following five levels:

- **Level 1 evidence** quantifies the direct output of the National Space Academy in terms of the number of people prepared for employment or higher education in science and engineering via an appropriate, accredited qualification.

- **Level 2 evidence** quantifies the number of people whose attainment and/or course/career choice is directly influenced by participation in a National Space Academy course.

- **Level 3 evidence** provides testimonies from teachers and students that participation in a National Space Academy course has directly and materially influenced their attainment and/or course/career choice.

- **Level 4 evidence** comprises endorsement from organisations and businesses that have either benefited from National Space Academy output or that anticipate benefiting from it in the future.

- **Level 5 evidence** presents external evaluation of the quality of Space Academy programmes and their ability to influence student and teacher attitudes towards, and interest in, science and engineering.

6. **Evidence of Impact**

6.1 **Level 1 evidence**

The Academy delivers a post-16 Space Engineering course in association with Loughborough College. It comprises A levels in physics and mathematics and a BTEC Level 3 in engineering (equivalent to two further full A levels).

In August 2016 the third cohort of students received their results meaning that data is now available for 35 students (the raw data is available on request). Observations may be made thus:

(i) Students in these first three cohorts have enrolled as ‘middle ability’, with GCSE results above the minimum required by Loughborough College (five passes including C grades in Mathematics and English). Some have a clear idea what
they want to do as a career; most do not but see engineering as an interesting (and in some cases, financially rewarding) option. Over half of the students have little or no family history of higher education.

(ii) All students have done well in the BTEC Level 3 engineering course. Of the 35, 31 have achieved the highest possible grades (*Distinction* *Distinction*), three achieved at least *Distinction Distinction* and one achieved *Distinction Merit*.

(iii) AS results at the end of the first year are, on average, circa one full grade higher than expected (from GCSE results). A level results at the end of the second year are, on average, as expected or marginally higher. A grades are the exception rather than the norm; B, C and D grades dominate.

(iv) Nearly all students have progressed to the university (27) or higher apprenticeship (5) courses of their choice, with two students electing to take a year out from study and one continuing with an engineering HNC at Loughborough College. Of the university students, 23 have elected for science or engineering courses and 4 have chosen management-related courses. The apprentices have found places with Airbus, Rolls-Royce, Bombardier and ADS Laser.

(v) All students respond well to time spent on site visits or in the workplace as part of the course. The industrial partners take the one week internship programme seriously and an uplift in self-confidence is evident as the course progresses and as students have the opportunity to present their work.

One might conclude from these observations that the course is successful in helping students progress to higher education or onto a good apprenticeship programme and that they are well-placed to find jobs with employers who need their skills. The conversion rate to a science or engineering career path is very good. The students excel in their vocational engineering work and do better than expected in the less taxing first year of A level study, but find the second year more difficult.

The September 2016 course intake has a very different student profile to the four previous cohorts. Fifteen students have enrolled from an initial 39 who expressed interest. All have a high proportion of A* and A grades in their GCSEs, so it will be interesting to see how they progress and the reaction from potential employers or higher education institutions relative to previous years. It is notable that, for the first time, all are male.

6.2 The Academy has helped develop a similar course at Salford College (similar cohort sizes to Loughborough College). Brooklands College in Surrey starts its course in September 2017. Similar teaching methodology is used at the two space studio schools in Banbury and Twickenham. Colleges in Newcastle and Glasgow plan to start space engineering courses in 2017 and 2018 respectively.

6.3 The post-18 Higher Apprenticeship in Space Engineering was launched at Loughborough College in January 2015 but with a take up of just two students from a company called Magna Parva to date. Six companies dedicated significant time in helping develop the course content but are yet to enrol, suggesting barriers that must be
assessed and overcome if the course is to continue and, potentially, rolled out to other colleges. Highbury (Portsmouth) and Farnborough Colleges expressed initial interest.

The Academy’s response has been to work with the UK Space Agency on a survey of recruitment needs in the space sector. Initial feedback suggests that there is no such thing as a ‘space HR community’ with which to engage, but that a few individual companies would like to talk further. A meeting with Airbus is set for January 2017. Dialogue with Thales Alenia Space suggests that the Apprenticeship Levy, which takes effect from April 2017, could influence future interest.

Dialogue with business will help inform decision-making with regard to ongoing course provision. The outcome is cost-neutral to The Academy, but the colleges make a loss if courses are under-subscribed. Loughborough College is working with the University of Leicester to create a foundation degree in Space Engineering to meet the demands of the applicants for the apprenticeship programme, on the basis that this could progress without direct industry engagement.

**Level 2 evidence**

6.4 To date, four case studies may be presented that indicate a direct, measurable impact on student performance and subsequent course choice:

**Case study 1: Sir Jonathan North Community College, Leicester**

(i) In 2010, 30 girls from Sir Jonathan North Community College (an all-girls’ school) attended regular scheduled National Space Academy master classes as part of their curriculum study programme in support of their formal school-based lessons.

(ii) At the end of the academic year, Jane Shearer (Head of Biology & Teacher i/c Enrichment Opportunities) said,

“This year, 100% of our girls achieved C to A* with 63% achieving an A or A* [in GCSE physics] which is absolutely exceptional. In the past I asked students at the end of Year 11 if any of them were going to take physics A level and you’d be lucky to get one. Now, at least a third to a half of those students raise their hands and say, ‘yes, we’re going to take physics post-16’. It is absolutely incredible”.

(iii) Of the 30 students, eleven went on to do physics A level. The Academy is currently following up with the college to document what happened in subsequent years

**Case study 2: Cardinal Newman School, Coventry**

(i) In 2010, Cardinal Newman School (an all-ability comprehensive school) did not have a physics teacher. Anu Ojha, Director of the National Space Academy, agreed to spend 2 days per week with the school for the 2010/11 academic year. He used space and climate change as his teaching contexts.
(ii) A high priority group was the Year 10 Triple Science group: the first Cardinal Newman pupils to take separate GCSEs in physics, chemistry and biology. Anu taught physics only; chemistry and biology were taught by others using standard teaching contexts. The grades of the 28 students were as follows:

<table>
<thead>
<tr>
<th></th>
<th>A*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D/E</th>
<th>Mean % score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>85</td>
</tr>
<tr>
<td>Chemistry</td>
<td>2</td>
<td>4</td>
<td>13</td>
<td>7</td>
<td>2</td>
<td>73</td>
</tr>
<tr>
<td>Biology</td>
<td>2</td>
<td>4</td>
<td>15</td>
<td>5</td>
<td>2</td>
<td>73</td>
</tr>
</tbody>
</table>

**Case Study 3: Gateway College, Leicester**

(i) Gateway College is a sixth-form college serving an economically deprived part of Leicester in which physics student levels were dropping with the threat of physics departmental closure. The Academy provided significant curriculum/training support over a 12 month period.

(ii) Ali Panju (physics teacher) states that Master Classes with AS and A2 students last year were extremely successful in enthusing Physics students to continue with the course and indeed to take up Physics and Engineering based courses at University. AS and A2 masterclasses will soon be held for the new cohorts at Gateway this year too. The Physics Conference... attracted students from 3 other colleges.

(iii) The pass rate in physics (AS level) increased from 32% in 2013/14 to 72% in 2014-2015, with five students progressing to A2 level. Ten students progressed to A2 in 2015/16, whilst 24 students enrolled onto the AS course: 33% higher than in any of the previous five years.

(iv) A new course called Space Science and Technology, comprising two A levels and a BTEC in Applied Physics, launches in 2016 with 4 students enrolled. The aspiration is to become a primary feeder College for the University of Leicester Department of Physics and Astronomy.

(v) Gateway College students entered the UK Space Design Competition for the first time (came runners-up) and have developed a 'Teenage Physics' show to encourage GCSE science students to take up Physics as a subject at A levels.

**Case study 4: Groby Community College, Leicestershire**

(i) Groby College has growth in the number of students wishing to study physics at A level, but lost their Subject Leader in 2014 and struggled to recruit. The National Space Academy taught physics for the autumn term until the vacancy was filled.
In complimenting the quality of teaching, Robert Coles (Head Teacher) says that the work of the Space Centre was pivotal in ensuring that a highly successful Physics programme was able to keep running.

Level 3 evidence

6.5 In 2010, six teachers from schools in Leicestershire were asked to quantify any change in attainment and the choice of science subjects by their students as a consequence of participation in Space Academy programmes. The data from Sir Jonathan North Community College appears as a Level 2 impact: see Case Study 1. A summary of responses from the other five teachers appears thus:

- 95% of students gained the Higher Level diploma at Grade C or above. 90% gained an A* or A for their projects, with the remaining 10% gaining a B Grade. In other ICT courses which did not use the Space Academy, 35% of students gained A – C grades.
  Core Curriculum Team Leader ICT Gleed Girls’ CAL & Technology School & Principal Examiner (IT Advanced Diploma) for Exexcel.

- A near tripling of numbers of students gaining the highest grades (A-A*) in Additional Science since support through masterclass programmes began (7% in 2008 to 20% in 2010). An increase in attainment in physics modules since master class support commenced, with mean scores increasing from 63 (low C) to 70 (low B) in external assessment.
  Head of Science, Crown Hills Community College

- An increase in student attainment through the use of space as a context with masterclass support, with A*-B attainment increasing from 42% to over 50%. An increase in the proportion of GCSE students choosing to pursue post-16 AS science courses ( from 33% in 2007 to 46% in 2010).
  Advanced Skills Teacher, Robert Smyth School

- Attainment rates (passes) in AS physics (85%) significantly exceeding predicted attainment from student prior attainment (37%). Although this was a small sample the teacher’s professional judgement was that masterclass and teacher CPD were significant factors that contributed to this success.
  Teacher of Physics, Regent College

- Enhanced attainment by masterclass-supported students in relevant physics modules compared to those physics modules not supported. Masterclass support being a significant factor in helping the school achieve in increase in student attainment from Key Stage 2 to Key Stage 4 of three levels.
  Head of Science, Moat Community College

6.6 Space Academy teacher masterclasses were conducted beyond the East Midlands region on behalf of the European Space Agency/UK Space Education Office (ESERO-UK) and the Learning Skills Improvement Service (LSIS). Appendix 2 includes reports on the LSIS/BIS-commissioned A-level teacher masterclass programme held in 2009-2010.
Written evidence submitted by the University of Leicester and National Space Centre/National Space Academy (GAP0023)

as well as evaluation evidence relating to the impact of Space Academy work for ESERO-UK.

6.7 Space Academy programmes have been recognised by Advanced Skills Teachers (ASTs), School Leadership teams and external support agencies as being significant drivers of enhanced student attainment. Appendix 3 includes written submissions from the perspectives of an Advanced Skills Teacher (Rushey Mead School), a science teacher (Crown Hills Community College), a Deputy Headteacher (Gleed Girls’ Technology College) and an Aim Higher Development Officer.

6.8 Students who completed the post-16 Loughborough College Space Engineering course were asked for feedback on the effectiveness of the course in preparing them for further study. The comments below have been anonymised:

Student A – now at the University of Loughborough studying Mechanical Engineering

Over my two years on the space engineering course at Loughborough College I feel as though my class and I received exceptional teaching from all the teaching staff on the space engineering course. Beyond this I feel as though what separates the space engineering course from a simple sixth form experience is the fact that though the course has an intense workload it still, through the help of the organisers, manages to fit highly enjoyable activities that are practical and within the scope of the educational material. Activities such as multiple trips, workshop classes, masterclasses at the National Space Centre are just a few that I personally have taken great pleasure in experiencing. During my two years on this course I had always been made to feel as though I was a cared for individual and that the teachers genuinely had concerns for where I was headed afterwards, an opinion which I have unfortunately not heard from many of my friends who had attended sixth form. I would finally like to give a special thank you to all space engineering staff.

Student B – now at University of Nottingham studying Mathematical Physics MSc

The combination of A levels and BTEC gave me the breadth of both an assistive and independent education which prepared me for the progression to a more self-study orientated environment at University.

Student C – now at University of the West of England studying Aerospace Engineering MEng with 1 year placement

I was shocked at just how much I already knew when getting into university. I already had knowledge of almost the entire engineering maths module of the first semester, excluding McLaurin and Taylor series, and complex numbers. Our stress and dynamics module again was almost all revision material; stresses and moments for UDL's etc, with basically the only new topic being calculation of hoop and longitudinal stresses/strains. However, for my 'Intro to Aeronautics'(ITA) module, other than the basic thrust/ drag models for aircrafts, every part of the module was new (which I thoroughly liked about it). For my ITA module, 50% of the mark was to research, design, make, present and fly a full wing from a given 2D aerofoil. It became IMMEDIATELY evident that I had a huge advantage over all other students (possibly
excluding foundation students) in regards to project management, planning and workshop capability, which in the end allowed me to lead a group of 11 students to getting the full 50%. Additionally, my A-level physics will seriously help in easing me into my 'Energy and Thermodynamics' module which I’ll begin after my exams in a few weeks.

Student D – now on scholarship to the University of South Florida

Space Engineering gave me the knowledge and skills in order to be successful at university. I am currently in the process of declaring a double degree with Mechanical Engineering and Physics. The course gave me opportunities that others would never have the chance to get which gave me the confidence to apply to the universities in America.

Student E – now at the University of Nottingham studying Electrical Engineering

The level of teaching was fantastic, it really advanced my mathematical capabilities in particular. I found it put me one step ahead of most of my peers at university.

Student F – now studying a Civil Engineering BEng

Space engineering prepared me for this course through the teaching staff having a passion in their subjects which gave me the interest in engineering. Also the way the course was taught with space engineering as an example gave me a better understanding of the subject.

Level 4 evidence

6.9 The Academy has/had cash support from the East Midlands Development Agency, UK Space Agency, Science & Technology Facilities Council, Satellite Applications Catapult, European Space Agency, Lloyd’s Register Foundation, Garfield Weston Foundation, the Ogden Trust, Inmarsat, Logica, Vega, Rolls-Royce, ITP Engines, Airbus Defence & Space Ltd and PPG Paints. It has in-kind support from the Universities of Leicester and Nottingham, RAL Space and Surrey Satellite Technology Ltd. It receives occasional administrative support from the UKspace and Intellect trade associations.

6.10 The National Space Academy steering group includes representatives from all of the stakeholders recorded in 4.8, with Rolls-Royce and Airbus Defence & Space Ltd representing industry. The Higher Apprenticeship in Space Engineering steering group included representatives from Airbus Defence & Space Ltd, Avanti Communications, COMDEV, ITP Engines Ltd, Magna Parva and Qinetiq.

6.11 The Academy worked with the Open University tin 2014-15 to lead the delivery of UK teacher training on ESA’s Rosetta mission.

6.12 It supports the work of the Department for Education /ESA-funded UK Space Education Office (ESERO-UK) by leading on the development of new National secondary level space education methodologies/resources and delivery of secondary teacher CPD
sessions at the annual residential ESERO-UK space education conference and other ESERO-UK National and Regional events. Several Academy team members are ESERO-UK “space ambassadors”.

6.13 On behalf of the UK Space Agency, it developed the in-flight teaching demonstration experiments performed by Tim Peake and created the associated teaching films and guides that are now available to teachers. The methodology has been requested for future ESA and Chinese in-flight teaching programmes.

6.14 It has contributed to several National and International strategic studies including ESA/EU strategies for skills and education in the 21st Century (2010), the UK’s Space Exploration Review (2009), Innovation and Growth Strategy (2010) and Space Growth Action Plan (2013). In 2014/15/16 it has delivered programmes in China, and has further delivery contracts in China and four Gulf states.

6.15 It has had successive contracts from the European Space Agency to originate and deliver education programmes and methodologies for its member states. In 2013-2014, it was contracted to write and present 20 short educational films and teaching guides on missions including Gaia, Rosetta, ATV (Automated Transfer Vehicle) and generic themes including Satellite Applications, Satellite Operations and Launchers. To date 12 are available for use on the ESA website.

6.16 In 2016 it delivered a one day pilot programme to 18 inmates of Leicester Prison.

6.17 Several Academy team members have received National recognition/awards as a direct result of their involvement with, and work for, the Academy programme:

- Judith Green (Chemistry): RS Hauksbee Award (2010)
- Anu Ojha (Physics): Sir Arthur Clarke Award (2010), OBE for services to science education (2014)
- Mike Grocott (Physics): Principal of the Space Studio School Banbury (2014–)
- Keeley Arundel-McConachie (Physics): IoP Teacher of the Year National Award (2012)

6.18 Two pieces of external evaluation were performed during the course of the pilot programme to assess the impact of the Space Academy on teaching methods (2010) and young people’s attitudes towards science (2009). The full documents are available on request. Results and conclusions may be summarised thus:

- The masterclasses appear to have immediate positive effects on GCSE students’ confidence in both understanding and using specific core physics concepts. This effect is still largely present after two months.

- Attitudes became more positive about physics as a career option and largely remain so. They see the subject as difficult, but are willing to be challenged.
A-level student data showed rises in confidence that continued across the sampling phases. This effect was particularly marked in questionnaire items with low initial ratings (subject areas that, prior to the masterclass, were identified as being more challenging).

Delegates attending the 2009 and 2010 Teachers’ Conferences were unanimous in their praise for the overall quality of provision, some describing the events as “inspirational” and/or the best CPD (Continuing Professional Development) they had ever experienced.

In pre-Conference interviews delegates showed some concern that they would have sufficient subject knowledge to deal with the presentations and workshops. None expressed similar sentiments after the Conferences having found that their learning was mainly pedagogical and rich in usable ideas in a wide range of contexts.

7. Assessment of Impact, October 2016

7.1 The outputs of the National Space Academy are encouraging. General demand for its programmes is good and the quality of course content and delivery is high.

7.2 The cumulative Level 1 evidence is building, with data from 35 Space Engineering students showing academic attainment level at/above expectation and strong progression to preferred university and apprenticeship courses. The first student cohort will graduate in 2017: their work destinations will be tracked. Recruitment of students with little or no family history of higher education is not deliberate but is to be welcomed. The enrolment of students with significantly better GCSE grades in September 2016 is as interesting as the lack of girls is disappointing. The reasons behind these phenomena will continue to be investigated and any indication of unconscious bias in course advertising will be assessed.

7.3 With volume at Loughborough College stable at c.15 students pa, the development of courses at affiliated colleges seems the correct way to grow overall volume nationally. Evidence of impact is needed from each. The Higher Apprenticeship programme has not been populated as expected and remains under review.

7.4 Evidence of impact at Level 2 is developing with four case studies making clear the case for intervention in inner city schools or schools that otherwise struggle to provide high quality physics teaching. New bursary schemes with the Ogden Trust and PPG Paints will provide more data in 2016-18.

7.5 Evidence at Levels 3-5 is becoming dated: fresh evidence is needed and several studies are underway. This must include independent research work.

CB/BO
December 2016