Assessing the impact of science centres in England

A REPORT PREPARED FOR BIS

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Contents

Summary

In May 2007, the House of Commons Science and Technology Committee launched an inquiry into whether science and discovery centres should be publicly funded. The impetus for the inquiry was a widespread concern about science centres' financial sustainability after two of the 18 science centres funded by the Millennium Commission were closed down. The Select Committee recommended commissioning an independent study that would assess the impact of science centres.

The Department for Innovation, Universities and Skills (DIUS) commissioned Frontier Economics to carry out the following:

- to evaluate the impact of science centres in England on the Government's Science and Society agenda; and
- to assess whether science centres represent 'good value for money' in comparison with other STEM-related[1] organisations.

A key aim of the study was to assess whether there is a robust evidence base that would facilitate DIUS' (now the Department for Business, Innovation and Skills') decision on whether there is a case to establish a national funding stream for the science and discovery centre sector in England.

Policy context

The Science and Society agenda has two broad objectives[2]:

- Objective 1 - To increase the number of people who choose to study STEM subjects and work in research and science.
- Objective 2 - To strengthen the level of high quality engagement with the public on all major science issues. The ultimate aim is to increase the STEM literacy of the population.

In addition to these objectives, there is an emphasis on ensuring that people from a diverse range of social backgrounds can participate. This involves targeting 'hard to reach' and disengaged groups who are currently under-represented.

Our approach

- We have carried out a detailed literature review of the impacts of science centres on individuals' career choices and on STEM literacy of the population, including both UK and international sources.
- We have designed a survey and collected data on outputs and financial indicators for 39 out of 81 science centres in the UK.

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1 STEM is the acronym for Science, Technology, Engineering and Mathematics

2 Documented in The STEM Programme Report: http://www.dcsf.gov.uk/hegateway/uploads/STEM%20Programme%20Report.pdf and The Science and Innovation Investment Framework, p103-109

- We have conducted 5 case studies with science centres to collect detailed quantitative and qualitative information and gain better understanding of their impacts.
- We have examined 4 comparator organisations – the British Science Association, STEMNET, RCUK and the Royal Academy of Engineering – to collect evidence on their value for money.

Our findings

We have not been able to assess whether science centres are good value for money relative to other comparator programmes. This is because there is insufficient evidence on the long term outcomes of science centres or comparator programmes.

However, we have been able to collect a range of quantitative and qualitative indicators that illustrate, to some degree, the impact of science centres and comparator programmes. For example, we have collected:

  - quantitative measures on outputs– e.g. total number of visitors, children attending formal educational programmes, outreach activities, number of public dialogue events;
  - qualitative indicators – e.g. average length of a visit, links to the National Curriculum, types of educational programmes/workshops;
  - information on costs and sources of income.

The evidence we have collected suggests the following:

- It appears that science centres' activities and outputs map reasonably well to the Science and Society agenda. The science centres offer educational workshops for children at all stages of the National Curriculum and outreach. Some science centres offer continuing professional development (CPD) resources for teachers and organise public dialogue events.
- Large science centres appear to be financially stable. They receive income from corporate activities; grants are also made available to them from the Wellcome Trust and other charities. Small and medium science centres are more likely to struggle financially. These organisations tend to rely on volunteers and staff working overtime to keep afloat. They have few (if any) corporate visitors and insufficient resources to compete for large grants.
- On the cost data available to us – i.e. average costs per participant and average cost per participant adjusted for duration – science centres compare well with other STEM-related programmes (see Table 1 overleaf). The range of unit costs provided for the science centres reflects the fact that the science centres vary in size and potentially in 'quality of experience'. Larger centres tend to offer a greater variety of STEM activities, but are also more expensive to run (in per visitor terms).

As we have indicated, with the data available, it has not been possible to do comparative VFM, but it can be seen that science centres are focused on STEM objectives and, in terms of unit costs, they do not appear to be inferior to the comparator programmes.

	Cost per participant	Cost per participant-hour
Independent[3] science centres	**£9 - £20**	**£2.5 - £5.6**
CREST (British Science Association)	£13	£0.7
STEMNET STEM Ambassadors	£16.1	£8 – 10.7
RCUK Researchers in Residence	£123	£6.5
Royal Academy of Engineering BEST scheme	£152	£6.1
After School Clubs	£273	£11
British Science Festival	£9.5	£4.3 - £6.3
RCUK Awards for NSEW	£2.9	£1.5

Table 1: Average costs per participant and per hour for science centres and comparators

Source: Frontier Economics, detailed calculations and assumptions are presented in the full report

Overall, there is a disappointingly low amount of evaluative evidence for both science centres and comparator programmes. We have drawn on a literature review, generated quantitative and qualitative evidence on science centres and assessed the available evidence on comparator programmes. This approach has thrown some light on relative performance of science centres, but it is insufficient to be conclusive on whether there is a case to support science centres through government funding.

This is because we could not obtain any reliable information on the long-term impacts of science centres and the comparator programmes on DIUS' Science and Society objectives. Moreover, our cost comparisons are based on average costs per participant, which may be different from marginal costs, i.e. costs associated with ***additional*** participants. Marginal costs are needed to inform a decision on the most efficient allocation of funds. This information was not available to us.

Recommendations

In order to enable more robust comparative analysis in the future, we recommend the following changes to the data collection process:

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3 These science centres do not receive public funding for their core activities

- **The quality of data provided by the organisations which currently receive funding from BIS should be significantly improved.** A consistent set of indicators should be developed that would allow BIS to be in a better position to undertake some consistent cross-programme comparisons. These indicators should reflect both quantitative and qualitative aspects of the programmes. Quantitative indicators would include:

  - the number of participants (in total) and by groups of the population (from BME backgrounds, from low socio-economic classes[4], people with disabilities, etc.),
  - average length of interaction (in hours), and
  - average cost per participant.

  Qualitative indicators might include:

  - participants' satisfaction with the programme, and
  - measures of the programmes' effectiveness, i.e. whether the objectives of these programmes are achieved.

  The agreed set of indicators should be used consistently across all programmes and over time. The longitudinal aspect of the collected data would contribute to BIS' understanding of the programmes' marginal costs (i.e. how marginal changes in funding affect programmes' outcomes).

- **Science centres should be encourage d to collect similar types of information.** We recommend that the Association for Science and Discovery Centres liaise with BIS to develop a set of indicators, which would (i) capture the impacts of science centre activities on BIS' Science and Society agenda and (ii) be consistent with the indicators used for the assessment of the comparator programmes. We expect that this would encourage science centres to focus more on the types of activities that contribute to the Science and Society agenda (e.g. public debates). The longitudinal aspect of the data is expected to provide evidence on science centres' marginal costs.

This information would facilitate some comparisons between science centres and other STEM programmes, but it might not be sufficient to assess the long-term impacts, i.e. how many people choose careers in STEM as a result of their participation in a particular programme or a visit to a science centre. These long term impacts could only be assessed based on individual level longitudinal data. Alongside information on children's involvement in STEM enrichment activities[5], this data should capture children's background characteristics and other factors that might influence their career choices (e.g. parents' education, quality of primary and secondary education, test scores, etc.). It would be

4 This may be proxied by the proportion of children receiving free school meals

5 In practice, it may be difficult to measure involvement in STEM enrichment activities accurately as children might not distinguish between science centres and museums. The survey will need to rely on teachers checking that the supplied information is accurate.

important that the sample is representative of different parts of the country and different population groups.

We recognise that collecting longitudinal data on a representative sample of individuals is time-consuming and resource-intensive. It may not be cost-effective for BIS to undertake this large-scale data gathering for the purposes of this evaluation only. However, if other departments (e.g. DCSF and DCMS) would also benefit form it, it would be worth exploring whether this survey could be jointly funded.

It should also be explored whether it would be possible to add relevant questions on STEM enrichment activities and career choices to the existing longitudinal surveys, e.g. to the Pupil Level Annual School Census (PLASC). If feasible, it may be a relatively low-cost option. However, it would still require several years for the data on career choices to become available. Given the uncertainty over whether such a data set could be developed and the likelihood that it would be expensive, we recommend that a feasibility review be carried out of the costs and benefits of creating such a data set.

1 Introduction

In May 2007, the House of Commons Science and Technology Committee launched an inquiry into whether science and discovery centres should be publicly funded. Science and discovery centres are described in the report as "an extremely diverse group, with the common characteristics of the use of interactive exhibits to spark curiosity and to help people to understand scientific issues and phenomena"[6].

The impetus for the inquiry was a widespread concern about science centres' financial sustainability. Two of the 18 science centres funded by the Millennium Commission had to be closed down just a few years after the opening, while a third closed two of its three attractions. These developments raised concerns that science centres were in financial distress.

The Select Committee report focused on two broad issues:

a) the role of science centres in public engagement and attracting young people to science subjects and science careers; and

b) the funding available to such centres from central Government, alternative sources of funding and ways of supporting the long-term future of science and discovery centres[7].

In the report, the Select Committee acknowledges that:

"science and discovery centres contribute to the education of young people about science and inspire them to take up careers in science, technology, engineering and mathematics. They also engage the public with scientific issues and play important roles in their local communities."[8]

The Government, in its response to the Select Committee report, acknowledges that "science and discovery centres provide a forum for communicating and presenting scientific knowledge and debate on issues to children, families and the wider community", but emphasises that they are "one group amongst many diverse organisations which have the potential to have an impact on the nation's overall scientific literacy."[9]

The Select Committee stated that further research was required to assess the effectiveness of science centres relative to other organisations that received government funding to support their contribution to the government's Science and Society objectives.

These objectives are as follows:

6 "The Funding of Science and Discovery Centres – Eleventh Report of Session 2006-07," House of Commons Science and Technology Committee, October 2007, page 5

7 Ibid, page 6

8 Ibid, page 3.

9 "The Funding of Science and Discovery Centres – Eleventh Report of Session 2006-07," House of Commons Innovation, Universities & Skills Committee, First Special Report of Session 2007-08

- Objective 1 - To increase the number of people who choose to study STEM[10] subjects and work in research and science.
- Objective 2 - To strengthen the level of high quality engagement with the public on all major science issues. The ultimate aim is to increase the STEM literacy of the population.

In addition to these objectives, there is an emphasis on ensuring that people from a diverse range of social backgrounds can participate. This involves targeting 'hard to reach' and disengaged groups who are currently under-represented.

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A key aim of the study was to assess whether there was a robust evidence base that would facilitate BIS' decision on whether there is a case to establish a national funding stream for the science and discovery centre sector in England.

We have undertaken a detailed study both of science centres and of other STEM-related organisations. More specifically:

- We have carried out a detailed literature review of the impacts of science centres on individuals' career choices and on STEM literacy of the population, including both UK and international sources.
- We have designed a survey and collected data on outputs and financial indicators for 39 out of 81 science centres in the UK.
- We have conducted 5 case studies with science centres to collect detailed quantitative and qualitative information and gain better understanding of their impacts.
- We have examined 4 comparator organisations – the British Science Association, STEMNET, RCUK and the Royal Academy of Engineering – to collect evidence on their value for money.

Our analysis primarily focuses on independent (i.e. not publicly funded) science centres in England. However, where possible, we draw comparisons with science centres in Scotland, Wales and the Northern Ireland, which receive public funding[11], and with DCMS-funded science museums[12].

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10 STEM is the acronym for Science, Technology, Engineering and Mathematics

11 In Scotland, for example, 4 major science centres receive public funding for their core activities. The amount of funding is linked to the science centres' performance (which is evaluated based on a range of key performance indicators).

12 We understand that the DCMS currently provides funds to museums with historical collections (e.g. to the Natural History museum and the Science museum) for maintaining these collections. Independent science and discovery centres do not incur costs associated with collections, but they

The report is structured as follows:

- Section 2 – Policy context
- Section 3 – Conceptual framework for the study
- Section 4 – Literature review
- Section 5 – Analysis of science centres
- Section 6 – Analysis of the comparator programmes
- Section 7 – Our findings and recommendations

need to build and renew their exhibits on a regular basis. Although the cost structure for these two groups (science centres without collections and science museums with collections) appears to be different, it is not obvious a priori whether costs for any one group are systematically higher.

2 Science and Society objectives

In July 2008, DIUS launched its consultation, *A Vision for Science and Society*, which restated the Government's broad Science and Society objectives of creating a society "that is excited by science; values its importance to our social and economic wellbeing; feels confident in its use; and supports a representative, well-qualified scientific workforce".

Analysis of the consultation responses identified five key areas for future action, and in May 2009, the strategy was formally launched. Five expert groups, with representation from a broad range of actors, have been tasked with developing a set of action plans in the following areas:

- Science for all
- Science and Learning
- Science and Careers
- Science and the Media
- Science and Trust

Further detail on the work of the groups can be accessed at http://interactive.bis.gov.uk/scienceandsociety/site/strategy/

With its focus on development of a scientifically literate and engaged society, coupled with encouraging more young people to take STEM subjects at all levels, the Science and Society agenda is the policy area towards which science centres have the potential to contribute. This section outlines the key aspects of the Government's Science and Society agenda. It begins by considering the wider context and the processes, which led to the formulation of the agenda. It moves on to consider how the agenda fits into the broader policy framework and the aims it has. It also discusses how science centres and other STEM-related organisations can contribute to the agenda.

2.1 POLICY CONTEXT

The Government's Science and Society goals focus on the twin themes of encouraging greater take up of STEM and public engagement with science at all levels and by all groups within society.

Encouraging greater take up of STEM

The Government has long recognised innovation as a key driver of productivity gains, which in turn encourages economic growth.[13] Innovation plays a major

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13 See, for example, "Productivity in the UK 7: Securing long-term prosperity," HM Treasury and the Department for Business Enterprise and Regulatory Reform, November 2007 and "Measuring economic impacts of investment in the research base and innovation – a new framework for measurement," Office of Science and Innovation, May 2007.

role in addressing the long-term challenges facing Britain, such as globalisation, technological developments and environmental changes.[14] As a result, increasing emphasis is being placed on the value of a 'knowledge-based' economy, with growing demand for individuals with knowledge in STEM.[15]

In 2002, the Roberts Review into the supply of people with STEM skills[16] highlighted that there was a downward trend in the number of graduates in several STEM subjects, especially physics, engineering and chemistry. This led to fears of a possible skills mismatch within the economy. The Roberts Review also revealed that some segments of society were underrepresented in STEM careers, including women, ethnic minorities and people from disadvantaged families.

More recently, the Government commissioned the Leitch Review into the long-term skills needs of the economy.[17] The report found that the UK was lagging behind other developed nations in terms of technical skills and educational qualifications. The Leitch report called for more investment in academic education and vocational training, and for dramatic improvement in attainment levels. Similarly, Lord Sainsbury's review 'The Race to the Top'[18] (2007) revealed that many of the issues raised in the Roberts Review still existed, although some progress was being made towards addressing them[19].

A number of studies looked into the issue of declining numbers of STEM graduates and found that children are not sufficiently inspired by school science:

- A report "Perspectives on Education: Primary Science" (2008), commissioned by the Wellcome Trust, argued that "there appears to be a continuing trend for young people's attitudes to school science to become less positive as they move from primary school and into secondary school"[20].
- In 2008, the Chemical Industry Education Centre conducted a study to examine the reasons students disengage from science.[21] The study included a survey of 4,000 students aged 9-14, as well as 27 interviews with students, teachers, graduates and employers. It found that, as students progress through secondary school, science becomes "boring", "theoretical" and "not

14 "The UK economy: addressing long-term strategic challenges," HM Treasury. November 2008.

15 "Our Competitive Future – Building a knowledge-driven economy," 1998

16 'SET for Success' is available at: http://www.hm-treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/ent_res_roberts.cfm

17 "Skills in the UK: the long-term challenge", HM Treasury, December 2006

18 http://www.hm-treasury.gov.uk/media/5/E/sainsbury_review051007.pdf

19 For example, the Government's "Science & Innovation Investment Framework for 2004-2014" called for a substantial increase in science funding. The Government also paid specific attention to the diversity issue, setting up UK Resource Centre for Women as part of the Government's Strategy for Women in SET.

20 Harlen, W. and Temms, P. (2008) "Perspectives on Education: Primary Science" , the Welcome Trust , page 27

21 "Learning to love science: harnessing children's scientific imagination," Chemical Industry Education Centre, 2008

relevant". Moreover, students do not have a good understanding of the potential science careers available.

Government recognises these issues and puts a strong emphasis on encouraging young people to study STEM subjects and to choose careers in STEM. DIUS' consultation document "Higher Education at Work - High Skills: High Value" acknowledges the progress that has been made recently in this area. In particular, A-level entries in main STEM subjects have increased from 152,000 in 2004 to 166,333 in 2007 (9.4% increase). But, there are also some areas of concern, such as:

- equity – students from disadvantaged backgrounds (low income, some ethnic minorities) have the least chance of doing well in science and maths in order to progress to A-levels; and
- STEM graduates leaving STEM occupations – e.g. only one third of engineering graduates work as engineers three and half years after graduating.

The Government proposes to tackle the problem at each stage – from stimulating interest in STEM in school through to the workplace. Several departments co-ordinate their efforts:

- DCSF has developed its STEM programme, which aims to streamline numerous STEM initiatives and provide better STEM support through school, post-16 and university education. The programme is led by the National STEM director. DCSF has also appointed a national STEM careers co-ordinator who works with employers, higher education providers and other STEM partners to improve the flow of information to young people about careers in STEM.
- HEFCE is committed to spend £160 million over five years in order to increase the number of students studying STEM subjects. HEFCE STEM programme aims to both increase and widen participation in STEM subjects.
- BIS has recently announced a number of expert groups set to take forward the development of action plans on science and society issues. Science and Learning is a group which reports jointly to BIS and DCSF Ministers.

Public Engagement with Science

Another aspect of the Science and Society agenda that has become increasingly important for policy makers is the degree to which the public is engaged with science.

The Council for Science and Technology report "Policy through dialogue: informing policies based on science and technology"[22] (2005) defines 'public engagement with science' as *"an umbrella term to encompass a great diversity of activities and processes, from visits to science centres to lay membership of advisory panels"*[23].

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22 Available at: http://www2.cst.gov.uk/cst/reports/files/policy-through-dialogue/report.pdf

23 Ibid, para 12.

Different levels of public engagement are illustrated by Figure 1.

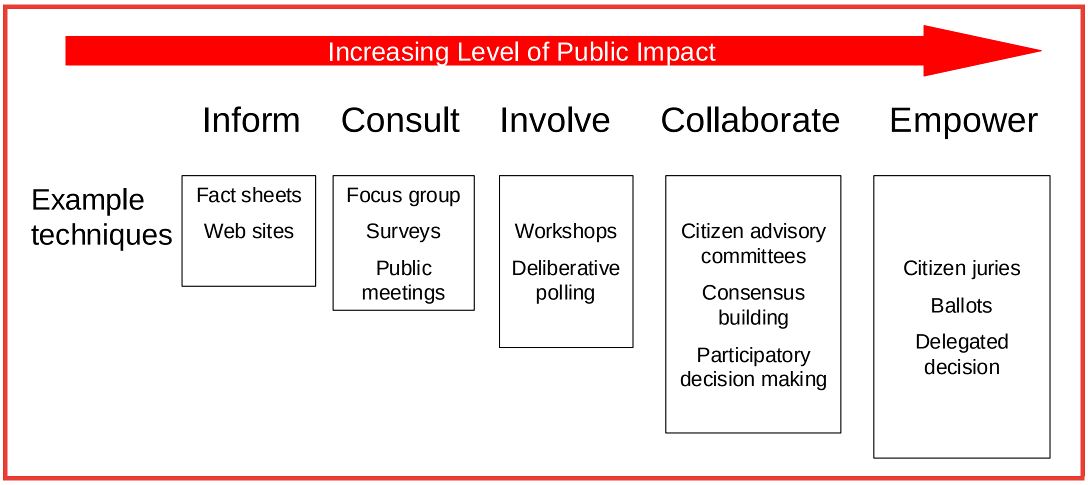

Figure 1: Spectrum of public participation

Source: International Association for Public Participation 2007

Science and Innovation Investment Framework for 2004-2014 observes that:

> "Over recent years the focus of the Government's Science and Society public engagement activities has moved forward from simply promoting public understanding of science to the wider agenda of facilitating public engagement with science and its application."[24]

'Public dialogue' is considered to be part of a wider public engagement and has two main objectives: (1) to enable the public to act as better informed citizens and (2) to make scientists and policy makers aware of public interests. DIUS' consultation document, *A vision for Science and Society* (2008), emphasises this dual role of public dialogue:

> "A public without improved scientific literacy … will be unable to make informed decisions for themselves, their families, and as part of the democratic process … If scientists and industry lack the capacity, or the incentives, to understand society's needs, we will be less able to use science to help improve our lives"[25].

BIS is involved in all aspects of public engagement. For example:

- It funds the British Science Festival and National Science and Engineering Week – the programmes, which aim to inform the public about recent scientific developments and spark interest in science.
- More advanced forms of public engagement, such as promoting two-way dialogue and influencing scientific policy making, are achieved through the Sciencewise programme, the expert resource for public dialogue in science

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24 Science and Innovation Investment Framework for 2004-2014", HM Treasury 2004

25 "A vision for Science and Society: A consultation on developing a new strategy for the UK" (2008), page 8.

1BScience and Society objectives

and innovation. Sciencewise adopts a very specific definition of "public dialogue" as "an important contribution to the evidence base on which politicians and Ministers make their decisions"[26]. Public dialogue informs and strengthens policy recommendations, provides legitimacy to decisions and leads ultimately to better legislation that benefits all society.

In our analysis we use "public dialogue" as a wide concept, which includes all aspects of public engagement.

2.2 THE AIMS OF THE SCIENCE AND SOCIETY AGENDA

The Science and Society agenda has two broad objectives[27]:

- **Objective 1** - To increase the number of people who choose to study STEM subjects and work in research and science.
- **Objective 2** - To strengthen the level of high quality engagement with the public on all major science issues. The ultimate aim is to increase the STEM literacy of the population.

In addition to these aims, there is an emphasis on ensuring *'that people from a diverse range of social groups can participate'*.[28] This involves targeting 'hard to reach' groups who are currently under-represented.

Public attitudes surveys identify females, people on low income and some ethnic minorities as the major groups, which should be targeted by policies within the two areas outlined above. For example:

- 'Public Attitudes to Science 2008' (RCUK/DIUS) finds that men and those in social grades ABC1 tend to be more engaged with science than women and those in social grades C2DE.
- The Royal Society *State of the Nation Report* "Science and mathematics education: 14-19" analyses participation and attainment in various GCSE and A-level subjects and finds that female students are less likely to participate in some STEM subjects (notably, physics and mathematics) despite having similar abilities. Some ethnic minorities also exhibit lower than average levels of participation and attainment[29].

In the remainder of this chapter, we discuss the Science and Society objectives in more detail, focusing on the progress assessment and identifying the major contributors, both public and private.

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26 Sciencewise website: http://www.sciencewise-erc.org.uk/cms/policy

27 Documented in The STEM Programme Report: http://www.dcsf.gov.uk/hegateway/uploads/STEM%20Programme%20Report.pdf and The Science and Innovation Investment Framework, p103-109

28 Ibid, p108

29 These groups are priorities by many STEM organisations. For example, 'Women in Science, Engineering and Construction' (WISE) focus specifically on encouraging young women into STEM related industry and education; while travelling science centres and science fairs target people from BME backgrounds and those living in remote areas.

2.2.1 Objective 1: Increasing the number of people who choose STEM subjects

There is a wide consensus that in order to increase the flow of young people into the STEM workplace, one needs, first, to encourage them to study and attain in STEM subjects. With regard to this objective the following broad aims have been defined:

- to achieve year-on-year increases in the numbers of young people taking 'A' levels in physics, chemistry and mathematics.[30];
- to improve the number of pupils getting at least level 6 at the end of KS3;
- to improve the numbers achieving A*-B and A*-C in 2 science GCSEs;
- to step-up recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers.[31]
- to increase access to triple science at GCSE

The main organisations which can contribute towards these educational goals are clearly schools, FE colleges and universities. It would also appear that it is these institutions that have the greatest need and capability to measure their outputs against these targets. However, science centres, as well as other STEM-related organisations, can also contribute towards these objectives.

- **STEM-related organisations**, such as STEMNET, the British Science Association and RCUK, encourage young people to choose careers in STEM through STEM Ambassadors, the British Science Association CREST Award and Researchers in Residence programmes, to name just a few. These programmes receive public funding (from BIS), but also attract sponsorship from charities, industries, and, most importantly, from volunteers, contributing their time and expertise in order to make these programmes successful.
- **Science centres** develop exhibitions, educational programmes and various 'hands on' and outreach activities, which are explicitly linked to the National Curriculum. They can encourage young people to choose careers in STEM by making science more accessible and relevant to their everyday life. Some science centres also provide Continuing Professional Development (CPD) for teachers (in collaborate with the National Science Learning centre and the Welcome Trust) and, therefore, directly contribute to the retraining objective.

2.2.2 Objective 2: Public engagement with science

DIUS' consultation document *A vision for Science and Society* (2008) acknowledges that early attempts to bridge the gap between science and the public were

30 By 2014, the aim is to have 35,000 physics entries (24,200 in 2006), 37,000 in chemistry (33,300 in 2006) and 56,000 in mathematics (46,168 in 2006).

31 By 2014, at least 25% of science teachers should have a physics specialism, 31% to have a chemistry specialism and 95% of mathematics lessons to be delivered by a mathematics specialist.

simplistic and rarely successful. Since 2000 the emphasis has been on two-way communication, or dialogue. This allows the scientific community *"to be open to a continuous discussion of values and purposes, and is sensitive to these when developing avenues of investigation"*.

Public Attitudes to Science Survey 2008 (RCUK/DIUS) shows that more work needs to be done in this area. Indeed, only 21% of respondents agree that "the public is sufficiently involved in decisions about science and technology".

To assess progress in this area of the Science and Society agenda, government tracks general public attitudes to science, including:

- public attitudes towards key science and technology issues;
- trends in public confidence in science and technology policy;
- trends in the media coverage of science and technology issues.

A number of organisations contribute to this aspect of the Science and Society agenda. For example:

- RCUK and the Royal Academy of Engineering provide grants to researchers for organising public dialogue events (e.g. during National Science and Engineering Week).
- The British Science Association runs Science Festivals with many events being particularly focused on public dialogue and engagement.
- RCUK and the Wellcome Trust have recently launched the Beacons for Public Engagement – university-based initiative "to support a step-change in recognition for public engagement across the higher education sector"[32].

Science centres also contribute to this aspect of Science and Society agenda. For example," *Inspiration, Engagement of Learning"* (2008) estimates that in 2005/06, 25 surveyed science centres organised 952 science dialogue events.

It is important to assess science centres in the context of the broader STEM landscape, which includes organisations such as the British Science Association, RCUK, Royal Academy of Engineering and STEMNET, as they all contribute to the same objectives and collaborate with each other. In the remainder of the report, we attempt to measure science centre contribution more precisely and to assess whether this method of delivery is cost-effective.

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32 Beacons for public engagement website, http://www.rcuk.ac.uk/sis/beacons.htm

3 Conceptual framework for the study

A fundamental issue that we need to address in this study is whether the existing evidence base is of sufficiently good quality to allow us to undertake a comparative VFM analysis of science centres and other STEM-related programmes. In principle, VFM analysis requires accurate information on all inputs and outcomes of each programme. Outcomes, in this case, are related to the Science and Society objectives. These are:

- the number of people who choose careers in STEM; and
- the number of people who become more engaged in scientific debate as a result of participating in a STEM-related programme or visiting a science centre.

We have analysed all available data sources (academic studies, internal and external evaluations of STEM programmes). We also worked with Ecsite UK (since renamed the Association for Science and Discovery Centres) to develop a questionnaire to be sent to science centres. We have discussed with science centre experts the potential to develop evidence on outcomes and examined the evaluation evidence that is available on key comparator programmes funded by government. They show that there is very little relevant information on outcomes that would allow a robust VFM analysis.

It follows that our first finding is that there is no reliable data on the long term impacts of various STEM enrichment activities either for science centres or comparator programmes. Indeed, in order to establish how many young people choose careers in STEM because of their involvement in a particular enrichment activity, one needs to track people over time and analyse their career choices, taking into account other factors that might influence their decisions (e.g. family and friends, quality of teaching, etc.). We were unable to find such longitudinal data and it clearly was not possible to collect this information within the timeframe of this project.

The absence of robust data on the long-term impacts has influenced our conceptual framework for this study. It has persuaded us to take a pragmatic and practical approach to try and throw some light on the likely impacts of science centres and their effectiveness relative to comparator programmes. Our analysis involves four steps

- **Step 1**: A detailed literature review of the impacts of science centres on individuals' career choices and on STEM literacy of the population, including both UK and international sources.
- **Step 2**: Primary data collection that covers information on outputs and financial indicators for science centres in the UK.
- **Step 3:** In-depth case studies with science centres to fill the gaps in the data and gain better understanding of the science centres' impacts.

- **Step 4:** Examination of four comparator organisations – the British Science Association, STEMNET, RCUK and the Royal Academy of Engineering – to collect evidence on their cost-effectiveness.

The literature review provides us with the existing evidence on the impacts of science centres. It also helps us to identify key performance indicators, which we can use to assess science centres outputs and, to some degree, their effectiveness.

Primary data collection and qualitative case studies allow us:

- To map science centres' activities to the Science and Society agenda – this would help us understand whether science centres' activities are well aligned with BIS' objectives. We also assess whether these activities and corresponding outputs vary for science centres of different type.
- To assess science centres' financial sustainability – this would address the questions raised by the Select Committee in relation to whether science centres are financially viable.

Finally, in consultation with BIS, we have chosen four comparator organisations: STEMNET, the British Science Association, Research Councils UK (RCUK) and the Royal Academy of Engineering. We examine the evidence on outputs and costs of these organisations and draw comparisons with science centres (where possible). More specifically, we calculate unit cost measures for the comparator programmes and compare those against unit cost measure for science centres. This comparative analysis, although not a substitute for a full VFM, throws some light on relative effectiveness of science centres.

2BConceptual framework for the study

4 Literature review

In this section, we review the existing evidence on benefits of STEM enrichment activities in general and of science centres in particular. By "benefits" we mean contributions to Science and Society objectives, i.e. improvements in STEM literacy and public engagement, and impacts on career choices[33]. We draw on a wide range of international and UK-based studies in order to identify those aspects of STEM enrichment activities that are considered to be the most effective and use this information to inform our own data collection. We also investigate whether the existing studies assess science centres' costs and financial sustainability.

4.1 EVIDENCE ON STEM RELATED BENEFITS

We find that the evidence on long-term impacts of science centres is limited. While there is some indicative evidence that science centres may influence individuals' career choices and affect people's STEM awareness, none of the studies attempt to quantify these impacts. Moreover, other studies point out that science centres may vary in quality. Therefore, it may not be appropriate to generalise the impacts achieved by individual science centres (particularly, those located abroad) on the whole sector.

4.1.1 International evidence

There is evidence that participation in STEM enrichment activities improves young people's science competency. For example, the OECD study "Science Competencies for tomorrow's world"[34] (PISA 2006) surveys students in all OECD countries and assesses the extent to which they have acquired the knowledge and skills *"that are essential for full participation in society, focusing on student competencies in the key subject areas of reading, mathematics and science"*.[35] One of the issues it investigates is whether participating in extracurricular STEM enrichment activities, such as excursions, field trips, science competitions and science fairs, enhances students' understanding of science. The study shows that students in schools with more extracurricular science activities tend to perform better than their counterparts in schools with fewer activities.[36] This relationship remains statistically significant even when students' background characteristics are taken into account.

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33 There may be a range of other benefits generated by science centres, e.g. tourism, regeneration of local areas, additional jobs created, etc. While these are undoubtedly important, there are not directly related to the Science and Society agenda, and therefore are not considered in this study.

34 Available at http://www.pisa.oecd.org/dataoecd/30/17/39703267.pdf

35 "Science Competencies for tomorrow's world" (PISA 2006), page 16

36 More specifically, it shows that "students in schools with one unit more in the index of school activities to promote students' learning of science tend to perform 2.9 score points higher" (page 264)

While the study demonstrates the benefits of STEM enrichment activities in general, it also has some limitations. More specifically, it does not attempt to assess ***relative*** effectiveness of individual extracurricular activities, e.g. whether excursions to science centres are more effective than field trips or visa versa.

Some studies look specifically at the impact of science centres and assess their contribution to individuals' career choices and STEM literacy. Salmi (2003)[37] analyses a survey of 1,019 students at the University of Helsinki. This survey explores reasons for students' career choices, which range from "interest in the content of study and future work" and "social pressure from parents" to "own hobby, media and other informal sources". Salmi finds that students who cited "their own hobbies and informal learning sources" as a reason for their career choices also underscored the role of the science centre visit as an essential element of the reason for their choice of university studies.

The study, however, does not rank all reasons according to their importance. Therefore, it is not clear how many people cited "informal sources and science centres" as their main reason for the career choice.

Falk et al. (2004)[38] investigates the types of short- and long-term learning that resulted from use of interactive 'hands-on' exhibits in two science centres in Australia. The study confirms that the public understands and values the interactive nature of science centres. It also identifies some differences in short- and long-term learning outcomes.

- When visitors were interviewed immediately following their visit to the science centres, they overwhelmingly reported changes in knowledge and skills.
- After four to eight months, visitors described predominantly perspective and awareness learning outcomes.

Arguably, both types of outcomes are important from BIS' perspective.

Falk et al. (2007)[39] assess the contribution of zoos and aquariums to public understanding of animals and conservation and find similar changes in perspective and awareness. This analysis combines a 'snapshot' survey of 1,862 visitors to zoos and aquariums in North America with in-depth case studies and a smaller scale longitudinal study. They find that visits to zoos and aquariums *"prompt individuals to reconsider their role in environmental problems and conservation action, and to see themselves as part of the solution"*. Given that environmental and conservation issues represent a part of broader STEM agenda, it appears that zoos and aquariums can make a relevant contribution.

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37 "Science centres as learning laboratories: experiences of Heureka, the Finish Science Centre" in International Journal of Technology Management, Vol 25, No. 5

38 Falk, J., Scott. C., Dierking, L., Rennie, L., Jones, M. (2004) "Interactives and Visitor Learning", Curator 47/2, pages 171-199.

39 Falk, J., Reinhard, E., Vernon, C., Bronnenkant, K., Heinlich, J., and Deans, N. (2007) "Why zoos and aquariums matter: assessing the impact of a visit to a zoo or aquarium", Association of Zoos and Acquariums

Rennie and McClafferty (1997)[40] undertake a review of existing literature about interactive science centres and their role in improving STEM literacy. They find that while *"some cognitive, affective and psychomotor learning occurs most of the time, there is considerable variation across science centres and also across exhibits within centres"*. The researchers believe that one of the main difficulties with this type of analysis is that science centres may differ in their quality; therefore it is difficult to generalise the results. For example, they discuss two seemingly contradicting studies:

- Javlekar (1989)[41] compared learning in science centres with learning in classrooms and found superior learning by the students who visited the Nehru Science Centre in India.
- Flexer and Borun (1984)[42], on the other hand, concluded that a well-structured class lessons are superior to a visit to Franklin Institute Science Museum.

The fact that some studies find science centres to be very effective, while others do not, is not necessarily contradictory or counterintuitive as science centres may vary in terms of their quality. Moreover, while some science centres may be more effective in some aspects of the Science and Society agenda (e.g. in improving STEM literacy), other centres may be more effective in different aspects (e.g. in encouraging young people to choose careers in STEM or engaging older people in scientific discussions).

4.1.2 UK-based evidence

In order to estimate the long-term impact of science centres on the Science and Society agenda, ideally, one would need to assess (i) how many people decide to choose a career in STEM or (ii) how many people change their attitudes towards science, after visiting a science centre. This is, clearly, very difficult and resource-intensive as it requires a longitudinal study that would track individuals over time and take into account their background characteristics and other 'external' factors. We were unable to identify any such study conducted in the UK to date.

Instead, most studies focus on attendance figures of the centres, including total number of visitors, number of formal education visitors or those involved in 'outreach' programmes.

"Inspiration, Engagement of Learning" (2008), a study conducted by Ecsite UK, reports that in 2005/06:

19.5 million people visited the UK's Science & Discovery Centres and 15.6 million of these were to centres in England. Of these:

- 11.8 million people visited the STEM-related DCMS-funded national and regional museums; and

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40 "Science centres and science learning", Studies in science education, 27, 53-98

41 Javlekar, V. D. (1989) Learning scientific concepts in science centres, Visitor Studies: Theory, Research, and Practice, 2, 168-179

42 Flexer, B. and Borun, M. (1984) The impact of a class visit to a participatory science museum exhibit and a classroom science lesson, Journal of Research in Science Teaching, 21, (9), 863-873.

- 7.7 million people visited other science and discovery centres.

Nearly 1 million pupils took part in curriculum-linked science workshops and activities (in 25 surveyed science centres) and 952 science dialogue events were run by the 25 surveyed centres.

While this study presents relevant statistics, it is all in aggregated form. Hence, the study does not address the issue of potential variation in quality or even in visitor numbers. It does, however, address a practical problem of consistent data recording. One of the recommendations of the Ecsite's study is that *"all UK centres should begin collecting data in a consistent manner"*.

Some studies[43] attempt to estimate the impacts of centres through the use of some measures of the experience the centres offer. They use the Generic Learning Outcomes framework as a consistent framework with which to gauge impacts. The statistics include the proportion of pupils who said that they enjoyed the trip, felt they had learnt something or said that they had been inspired by their experience.

The Wellcome Trust's report, for example, found that:

- 59% of the visitors interviewed felt that they had learnt more than they had expected; and
- 43% said that the centre had made them think more about science issues/questions;
- However, only c. 12% reported that their attitude toward science had changed.

This finding may be consistent with Falk et al. (2004), which finds the strongest short-term impact on learning, and longer-term impact on awareness and attitudes (not tested in this case).

There are also "qualitative" studies that do not attempt to quantify the impacts on people's attitudes, but rather provide evidence on what visitors consider to be important. Some studies reported that the opportunity to meet a scientist was hugely beneficial.[44] A number of different reasons for this have been cited.

- Firstly, meeting a scientist helped to alter pre-conceptions about scientists. For example, it was often noted that prior to a visit students believed that scientists were *'old, dull and boring'*.[45] Meeting a practising scientist was an easy way to dispel this perception. It is not clear from the studies what impact this

43 For example, 'Inspiration, Identity, Learning: The Value of Museums', Second Study, RCMG and University of Leicester, 2007 and the Wellcome Trust's 'Impact Assessment of Trust funded Millennium Science Centres'

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44 'Report on the Real World Science programme and its impact', Educational Consultants Limited, 2007.

45 'How Science Works at the Natural History Museum', A Case Study by the Research Centre for Museums and Galleries, 2007. Included in 'Inspiration, Identity, Learning: The Value of Museums', op cit, p250

then has on the attitudes of students with regard to pursuing STEM subjects. Although there is some evidence that students recognised the benefits of having a broader view of what scientists do.[46]

- Secondly, interaction with scientists, or at least a trained 'Science Explainer', also provided access to knowledge and skills often beyond the scope of a teacher. This is partly through their specialist knowledge of the subject area. They can provide access to the latest research without using too much technical information. Additionally, due to their practical use of science, they could also assist with new elements of the curriculum. Areas addressed include the reliability of data, peer review and communicating scientific findings.

Another impact of the centres was their ability to provide specialist equipment. For many students science was perceived as boring because it was presented as *'theoretical and abstract'* in textbooks.[47] Centres allowed them access to equipment which allowed them to have a practical experience of science. Many schools would struggle to offer the equipment which centres can provide and replicate such an experience.

These findings are important as they inform our own data collection and analysis. Knowing what students and teachers value most helps us to assess whether science centres provide enough of those activities.

4.2 EVIDENCE ON COSTS AND FINANCIAL SUSTAINABILITY

We find that very few studies discuss science centres' costs and financial stability. The main reason for that may be commercial sensitivity of financial information and, therefore, certain unwillingness on science centres' part to share this information with researchers.

The Select Committee[48] reviewed financial information provided to it by science centres and found that large science centres relied on competitive grants or alternative funding sources, such as corporate hire, to fund some of their activities. The Millennium centres appeared to suffer the most. Two of the 18 science centres funded by the Millennium Commission, had to be closed down just a few years after the opening, while a third closed two of its three attractions.

'Science Centres: Paths to Financial Stability' (Anderson, 2002) focuses on the financial problems experienced by the Millennium centres and attributes them to the fact that these centres 'have all opened with impossible expectations that their revenues will fully offset their expenses'.[49] The study also looks at a range of financial parameters, such as entrance fees, operating costs per visitor; and the

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46 'Report on the Real World Science programme and its impacts', op cit, p9

47 'How Science Works at the Natural History Museum', op cit, p252.

48 The Commons Select Committee review "The Funding of Science and Discovery Centres" (2007)

49 Ibid

proportion of income earned[50]. These, however, are not linked to the STEM-related benefits.

Finally, Wellcome Trust's 'Impact Assessment of Trust funded Millennium Science Centres' provides information on the income and expenditure of each of the five Millennium Centres studied. There are slight differences in the exact information provided in each case. However, all of the centres are able to indicate the proportion of their income, which is derived from grants, admissions, retail sales and a number of other areas. Likewise, the proportion of expenditure on staff, marketing, administration, property and other costs are provided.

This data, however, is collected only to provide an overview of the centres considered. No attempt was made to link this to the benefits of the centres and there is no discussion of these costs in any detail. The study indicates that centres might have the ability to provide the more detailed cost information required in this study.

Overall, we find that there is some limited evidence of impacts of science centres on Government's Science and Society agenda. Science centres may contribute to:

- improving people's understanding of scientific issues,
- changing people's attitudes and awareness; and
- encouraging children to pursue careers in STEM.

However, it is also evident from the studies that the quality of science centres may vary, and therefore, it is difficult to extrapolate the results from small scale studies on the whole science centre sector in England. Moreover, none of the studies attempted to link science centres' contributions to their costs or to compare their cost-effectiveness against that of other STEM-related organisations.

50 From visitors and from selling goods and services (as opposed to grants).

5 Analysis of science centres

In this section of the report we present our analysis of science centres in the UK. As we discussed in Section 3, it has proved difficult to provide robust data that would allow us to quantify the long-term impacts of science centres, i.e.:

- the number of people who choose careers in STEM; and
- the number of people who become more engaged in scientific debate following a visit to a science centre.

It follows that it is not possible to undertake a full VFM comparative analysis of science centres, as these long-term impacts are a critical input into this type of analysis. In Section 7 ("Our findings and recommendations") below, we make recommendations on the types of data that need to be collected to enable this analysis in the future.

In the absence of robust data on the long-term impacts, we have taken a pragmatic and practical approach to try and throw some light on the likely impacts of science centres and their relative effectiveness. There are three parts to this approach:

- **Mapping of science centres' activities to the Science and Society agenda** – this would help BIS understand whether science centres' activities are well aligned with BIS' objectives. We also assess whether these activities and corresponding outputs vary for science centres of different type.
- **Assessment of science centres' financial sustainability** – this would address the questions raised by the Select Committee in relation to whether science centres are financially viable.
- **A comparison of unit costs** (costs per visitor and cost per visitor adjusted for visit duration) - these unit costs measures, if estimated consistently, would throw some light on cost-effectiveness of science centres.

Our analysis of science centres has two strands - quantitative and qualitative. In order to analyse the impacts of science centres quantitatively, we have designed a survey, collected and analysed data on outputs and financial indicators for 39 out of 81 science centres in the UK[51]. We have also conducted in-depth case studies with 5 science centres to collect detailed qualitative information and gain better understanding of their impacts.

Below, we discuss both strands of our analysis and our findings based on each of them.

51 We initially contacted all science centres that were included in the Select Committee Report (see the Annexe of the Report). Some of those are now closed or undergoing reconstruction. Therefore, the questionnaire was sent to 81 science centres which are currently in operation.

5.1 QUANTITATIVE ANALYSIS

Our quantitative analysis is based on the survey data we have collected from science centres. We have designed a survey questionnaire in discussion with BIS and piloted it with five science centres. We have collected information from 39 out of 81 science centres in the UK[52]. This represents a 48% response rate, with different types of science centres represented. The dataset is described in detail in Annexe 1.

We fist map the science centres' activities to BIS' Science and Society agenda.

5.1.1 Mapping of science centres' activities to the Science and Society agenda

We find that the science centres' activities map reasonably well to BIS' Science and Society agenda. We have considered each objective separately and identified science centres' activities that contribute to these objectives.

We have also disaggregated this information by science centre type (where possible) in order to understand which types of science centres are likely to have a greater impact.

Objective: to inspire young people to study STEM

All science centres in our sample include in their mission statements objectives to engage, fascinate, inspire and "materially influence the number of young people in the UK choosing science-related courses and careers". In practice, these objectives are achieved through a range of different activities. All science centres run educational programmes/ workshops, which are attended by over 1.2 million children annually. They also run outreach programmes, with more than 445,300[53] children participating, and a number of other activities summarised in Table 2:

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52 One of our respondents – Centre of the cell – is not open yet. This centre does not have any visitors, but incurs some costs. This science centre is excluded from the analysis.

53 Only 22 science centres could provide the numbers of outreach participants.

Activity	Number of science centres involved	Proportion of sample
Educational programmes/workshops	39	100%
Outreach	32	82%
Activities for families	36	92%
Activities for pre-school age children	28	72%
"Meet the Scientist" events	23	59%
On-line resources for teachers and pupils	32	82%
Continuing Development Courses (CPD) for teachers	28	72%
Have links with schools	31	79%
Have a formal relationship with the local educational authorities	17	44%

Table 2: Activities of science centres

Source: Frontier Economics

Science centres collaborate with other STEM-related organisations which pursue similar objectives. For example:

- 19 science centres (49% of the sample) collaborate with STEMNET STEM Ambassadors; 6 science centres (15% of the sample) are STEMNET contract holders;
- 10 science centres (26%) contribute to the British Science Association CREST Award competitions; and
- 10 science centres (26%) also contribute to the After School Science and Engineering clubs.

Almost half of science centres in our sample (44%) are listed in one of the 3 STEM Enhancement and Enrichment directories.

Objective: to improve STEM literacy of the population and to encourage public engagement with science

As we discussed in Chapter 2, there are different levels of public engagement. The first is to inform the public about recent developments in STEM. Science centres contribute to this objective through their permanent and temporary exhibitions, which attract over 19 million[54] visitors annually (8 million[55] of those are adult visitors). Moreover:

- 69% of science centres in our sample also run educational programmes for adults.
- 85% participate in National Science and Engineering Week (NSEW), organising in total 96 events.

More advanced levels of public engagement are to involve, collaborate and empower the public to contribute to the informed debate on scientific issues. It appears that science centres have the potential to contribute to these more advanced levels, but their current contribution is somewhat limited.

Only 56% of science centres in the sample report that they organise "public dialogue events"[56]. It is possible, however, that some of the NSEW events organised by the science centres also have elements of public debate.

We find that the survey provided only limited evidence on this aspect of the Science and Society agenda. We have explored this aspect further during the case studies.

Objective: to engage 'hard to reach' and disengaged groups

It is difficult to assess the contribution of science centres to this aspect of the Science and Society agenda, based on the survey responses only. Indeed, close to 60% of science centres do not collect information on background characteristics of their visitors, considering it intrusive and inappropriate.

For the remaining 40% of science centres (less on some specific questions):

- 13% of visitors are from a BME background;
- 54% of visitors are females;
- 6% of visitors are people with disabilities or special educational needs;
- 20% of visitors qualify for discounts based on their socio-economic status (e.g. retired or unemployed).

26 science centres (67%) report that they organise events for people with disabilities and 22 (56%) organise events for children with special educational needs.

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54 Our statistical analysis is based on averages for two years: 2006/07 and 2007/08. The number of visitors may vary slightly from year to year; therefore, comparing the averages appears to be more reliable.

55 Not all science centres could provide the split of their total visitors into adults and children. Therefore, this estimate is likely to be understated.

56 The nature of these public dialogue events, however, may be somewhat different compared to public dialogue events organised by other STEM providers (e.g. Sciencewise). The events organised by science centres are more likely to be debates on scientific issues rather than two-way dialogue between scientists and members of the public.

5.1.2 Contribution to the Science and Society agenda by science centre type

We group the science centres based on their key characteristics[57] into small, medium and large independent (i.e. not publicly funded) science centres. Separately, we define two groups, which receive public funding for their core activities – DCMS-funded museums and other centrally funded science centres.[58]

We assess the contributions of different groups based on the following indicators:

- number of formal educational visitors;
- proportion of science centres running outreach programmes;
- proportion of science centres providing CPD courses for teachers;
- proportion of science centres organising public dialogue and "Meet the Scientist" events[59]

The results of our analysis are presented in Table 3.

57 These are size (in terms of the number of visitors and total space), the number of FTE staff, availability of public funding and whether a science centre has a permanent location

58 The bases for these groupings are discussed in detail in Annexe 1. Three travelling science centres are excluded from the analysis because they do not have a permanent base and use a different business model (outreach only).

59 We choose these particular measures because (1) they are considered to be important by the sector and (2) the quality of responses is generally good. Responses to some other questions of our survey are sparse, precluding detailed disaggregated analysis.

	Small	Medium	Large	Ex large	DCMS[60]	Other centrally funded
Number of centres/ museums in each group	**5**	**8**	**6**	**3**	**8**	**6**
Child visitors on a formal educational visit (average per group)	8,041	16,339	37,737	62,545	85,411	36,359
Child visitors on a formal educational visit as % of total visitors	51%	22%	18%	5%	15%[61]	17%
% of centres running outreach	100%	43%	100%	67%	88%	100%
% of centres providing CPDs	25%	43%	100%	67%	100%	100%
% of centres organising public dialogue events	25%	29%	50%	67%	75%	100%
% of centres organising "Meet the Scientist" events	25%	43%	83%	100%	63%	83%

Table 3: Activities/ outputs, by science centre type

Source: Frontier Economics

We find that large/extra large and publicly funded science centres tend to contribute more across the range of activities (more outreach programmes, CPDs for teachers and public dialogue events). Small and medium science centres, on the other hand, have a strong focus on educational programmes (i.e. a high proportion of educational visitors). The survey responses indicate that the small

60 Both DCMS funded museums and Extra large science centres attract many foreign visitors. Ideally, we would like to exclude those from our analysis. However, we do not have consistent information on foreign visitors; therefore, we are unable to exclude them.

61 When calculating the proportion of educational visitors for the DCMS funded science museums, we subtract foreign visitors from the total number of visitors. This is because some DCMS funded science museums receive a disproportionately large number of foreign visitors. They, in some sense, 'distort' the picture because very few (if any) of them are educational visitors. If foreign visitors are not adjusted for, the proportion of educational visitors for DCMS funded science museums is lower – 11%.

and medium centres would want to organise more public dialogue and "Meet the scientist" events, but they claim they lack the resources to do so.

5.1.3 Assessment of science centres' financial sustainability

In the analysis of science centres' financial sustainability, we need to understand how diverse are their sources of revenue. Generally, businesses with more diversified income tend to be more stable financially. They are less dependent on each individual income stream, so that if one stream dries up, it is unlikely to lead to a collapse of the whole business.

We find that, among independent science centres, large science centres appear to be in a better position (Figure 2). Indeed, they receive more revenue from catering, retail and car parks. They also have better/larger facilities and, therefore, tend to be more attractive for corporate visitors. Small and medium science centres, on the other hand, are more dependent on ticket sales.[62]

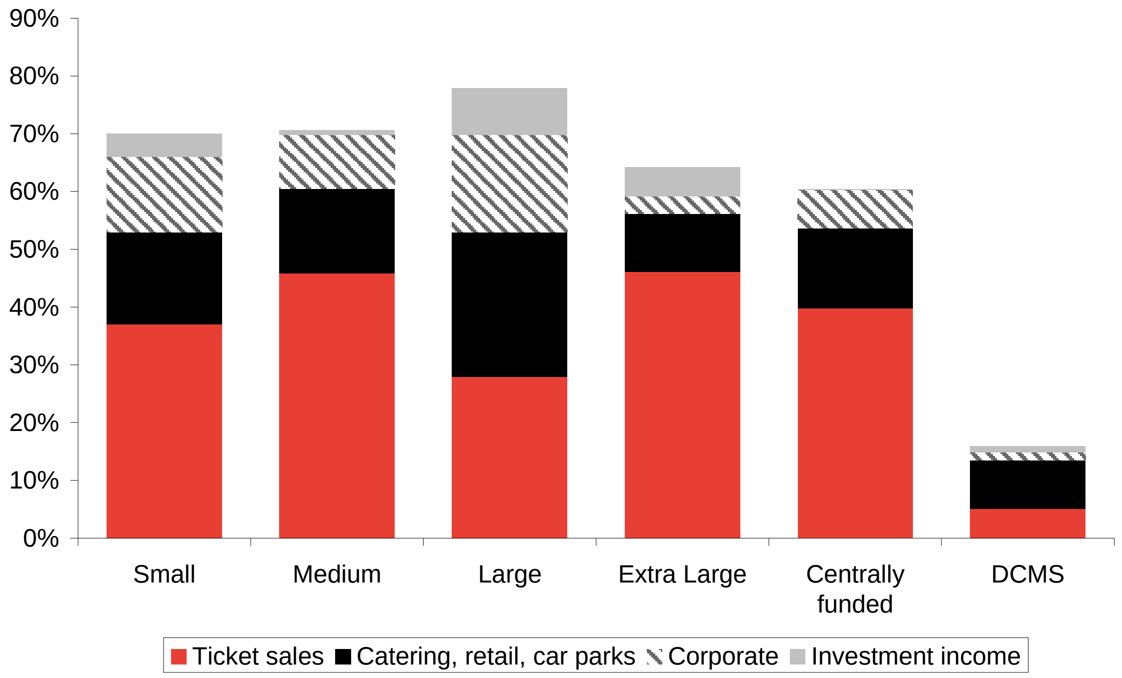

Figure 2: Sources of revenue - internal

Source: Frontier Economics

62 DCMS funded museums do not charge entrance fees for their permanent displays and, therefore, their revenue from ticket sales is low.

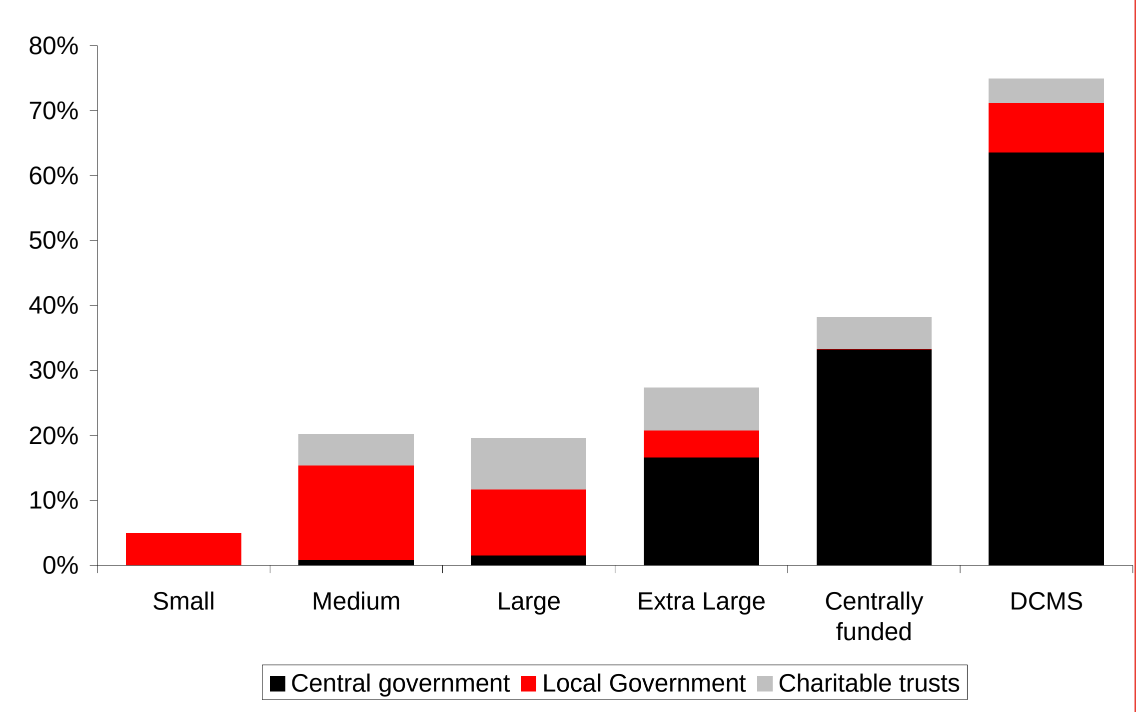

Figure 3: Sources of revenue - external

Source: Frontier Economics

Large science centres all receive a higher proportion of their revenue from charitable trusts and local government (Figure 3). This is in contrast with small science centres that do not report any funding from charitable trusts. The survey does not shed light on the issue why small science centres do not benefit from charitable trust grants to the same extend as medium and large science centres. We explore this issue in more detail during the case studies.

The impact of changes in income

In order to explore the sensitivity of science centres to changes in their income, we have asked the science centres, what they would do if their income increased or decreased by 10%. Two thirds of the sample have responded to these questions, stating that:

- With more income, they would provide more educational programmes, do more project based work, and undertake refurbishment of the existing and development of new exhibitions.
- With less income, science centres would reduce the number of educational programmes, reduce the number of staff and adjust the opening hours. Two science centres said that they will have to close down as their budget is already very tight.

We are unable to make far reaching conclusions based on these responses as the situations described are purely hypothetical. These responses, however, suggest that science centres are willing to provide more activities/ outputs relevant to the Science and Society objectives if more financial resources are made available.

4BAnalysis of science centres

5.1.4 Unit cost analysis

Finally, we combine information on the number of visitors and total costs and calculate unit costs per visitor[63]. As Table 4 demonstrates, average costs per visitor vary between £9 and £20. Large independent and publicly funded science centres tend to be more expensive compared to small and medium ones.

	Cost per visitor	Cost per visitor, adjusted for visit duration
Small	£11	£2.7
Medium	£9	£2.5
Large	£20	£5.6
Extra large	£18	£5.5
DCMS funded museums	£19	£5.8
Other centrally funded	£17	£5.9

Table 4: Unit costs by science centre type[64]

Source: Frontier Economics

We also adjust unit cost measures for average visit duration in order to make more consistent comparisons across science centres and to compare science centres with other STEM-related programmes (in Section 7 below). Given that average visit duration does not vary significantly across science centres (between 3 and 4 hours), the pattern of adjusted unit costs does not change. Small and medium science centres appear to be cheaper (£2.5-2.7 per visit/hour), while larger science centres are more expensive (£5.5-£5.6). This finding may be consistent with our earlier observation that larger science centres tend to offer a wider range of programmes and activities and, therefore, incur higher costs.

The evidence from the survey suggests that:

- Science centres' activities and outputs map reasonably well to the Science and Society agenda. The science centres offer educational workshops, outreach programmes. Some science centres offer continuing professional development (CPD) resources for teachers and organise public dialogue events. Larger science centres tend to offer a wider range of activities, while small and medium centres have a stronger focus on educational programmes.
- Larger science centres appear to be in a better financial position. They rely on a wider range of income streams, including corporate, retail, car parks. They

63 We first calculate unit costs for each science centre/ museum as total annual expenditure divided by total number of visitors and then calculate average unit cost for each group.

64 We are unable to provide confidence intervals for these central estimates because the number of observations in each group is small, between 3 and 8.

are also more likely to receive grants from charitable trusts and local government.

- Small and medium science centres appear to have lower costs per visitor compared to large and publicly funded ones.

5.2 QUALITATIVE ANALYSIS

We have also conducted 5 case studies with science centres in order to collect detailed quantitative and qualitative information and gain better understanding of the impacts of these science centres on the Science and Society agenda. Each of these case studies consisted of in-depth interviews with senior staff, which lasted between 3.5 and 4 hours. During these interviews we discussed:

- the science centres' educational programmes and how they are perceived by teachers and pupils;
- outreach activities and, more widely, the science centres' engagement with their local communities;
- fundraising, grants' availability and financial sustainability of the science centres of different type; and
- the ability of the science centres to contribute to BIS' Science and Society objectives.

5.2.1 The choice of the case studies

We have focused specifically on science centres that do not receive funding for their core activities from central or devolved governments. The case studies were selected so as to have representation across our defined sub-groups, with efforts made to include centres from different regions, focus and history of financial stability[65]. While each centre faces unique challenges depending on their local conditions, they are considered to be broadly representative of their groups. Table 5 presents a summary of the science centres chosen as case studies.

	Size	Region	Opening date	Millenium Centre	Accredited Museum
Catalyst	Small	NW	1984	No	Yes
INTECH	Medium	SE	2002	Yes	No
At-Bristol	Large	SW	2000	Yes	No
Thinktank	Large	Midlands	2001	Yes	Yes
Eden Project	Extra Large	SW	2001	Yes	No

[65] These science centres are all members of the Association for Science and Discovery Centres. This is consistent with the fact that most science and discovery members are members of Association for Science and Discovery Centres.

Table 5: Characteristics of case studies

Source: Frontier Economics

Catalyst is a small science centres and an accredited museum with a focus on Britain's chemical industry. It opened in 1984 and received ReDiscover grants to build a new lab, interactive 3-D theatre and a careers gallery.

INTECH is a medium-size centre. It initially opened in 1985 as an educational charity providing free workshops to local schools. INTECH secured Millenium funding to be reopened in its current location in 2002. Visitor numbers have been growing steadily since then. A planetarium has recently been built (financed by SEEDA), providing an additional increase in visitors.

Explore-At-Bristol (@Bristol) represents large centres. @Bristol opened in 2001 with a discovery centre and planetarium in one building and a natural history exhibition (Wildwalk) and IMAX in a second building on the same site. Wildwalk and IMAX were closed in 2007, as the Wildwalk was too costly to maintain. The centre has undergone restructuring and is now on the road to financial sustainability.

Thinktank is also a large centre and an accredited museum. It is responsible for Birmingham's designated collections of science and industry previously held at the former Museum of Science and Industry. Thinktank receives core funding from the Birmingham Local Authority for its care and maintenance of the collection. It also has a digital planetarium and IMAX on-site.

The Eden Project is an educational charity that attracts over million visitors a year. It is located on the site of a former clay pit (quarry) in Cornwall. Eden's primary focus has been to find approaches to increase public understanding of our dependence on natural resources, and of the issues, challenges and solutions that arise from the need to sustain the environment. Two vast Greenhouses (Biomes) feature plants, crops and landscapes from the humid tropic and warm temperate regions and act as a backdrop to the outdoor temperate landscape which mirrors the world's temperate environment. Eden uses exhibitions, art, storytelling, workshops, lectures and events to present themes and topics to engage with the widest possible public audience in order to learn more about the need for environmental care.

5.2.2 Mapping science centres activities to the Science and Society agenda

As with the survey data, we attempt to link science centres' activities to specific objectives of the Science and Society objectives.

Objective: to inspire young people to study STEM

The science centres we spoke to consider delivering inspiring educational programmes for children among their top priorities. These programmes usually include an exhibition visit, a workshop and a planetarium/science show. The science centres staff believe that these programmes "add excitement to the textbook science". During the workshops, science centres claim that children can do experiments that they cannot do at school because of a lack of equipment or because of health and safety regulations. Science centres state that teachers also benefit from attending these programmes/ workshops, particularly if they do not have a science specialism (primary school teachers) or need to cover areas of science outside their specialism (e.g. DNA research).

We found evidence that workshops do provide opportunities to stimulate advanced students and engage 'disengaged' students. According to the centres' staff, teachers often comment on positive changes in attitude and behaviour of the latter group.

We found that all educational programmes offered by the science centres are linked to the National Curriculum. While some of them focus on one specific subject (e.g. light or forces in physics), others are cross-curriculum and may combine science, history, ethics and sustainability. For example:

- Eden has commissioned a theatre show using mechanical puppets, film and live performance exploring the ethical issues surrounding, for example, GM engineering.
- Thinktank develops its own planetarium shows, which combine astronomy, ecology and conservation.

Some programmes focus specifically on career choices trying to overcome preconceptions about science and engineering. For example, Catalyst has created a careers gallery ("A world of opportunities") and a 3-D film about the chemical industry featuring young scientists and technicians talking about their work (both are part of Catalysts' educational programmes).

We observed that all five science centres develop their workshops in collaboration with teachers. The education teams work with teachers to identify those aspects of the National Curriculum, which are difficult to deliver in the classroom. For example,

- INTECH conducts regular teacher focus groups when developing its programmes.
- At-Bristol has more formal links with teachers through the Science Learning Centre South West.
- Most centres hold regular free teacher preview evenings, while Catalyst meets with teachers on an individual basis on request to develop a plan for the school visit.

We found evidence of strong links with schools and significant effort put into strengthening these links. The science centres maintain school contact databases and send their marketing materials to schools regularly, keeping science teachers up-to-date about new programmes on offer. Some science centres (INTECH, for example) offer schools a whole package, which includes a tailored programme, pre-and post-visit materials, transportation and lunch.

There was some evidence that the science centres evaluated their programmes in order to ensure that they are effective. For example:

- INTECH maintains a feedback database, compiling feedback from all teachers that visit the centre with their students (this was made available to us). Responses are reviewed weekly, allowing INTECH to respond quickly to any critical feedback.
- Thinktank incorporates evaluation tools into the development of its programmes, improving the quality of programmes delivered and making it easier to evaluate programmes *ex post*. Since 2004, Thinktank has been using the MLA Inspiring Learning For All framework that has just recently been adopted by Ecsite UK for evaluating learning and demonstrating impact.
- Eden runs a research and evaluation programme which incorporates evaluation into its formal education and public education programmes. For example, in partnership with Exeter University using an adaptation of Personal Meaning Mapping technique, children are asked to produce two drawings of rainforest – before and after the visit. Education staff analyse these pictures, identifying what children have learnt.

Alongside the educational programmes, science centres also run outreach programmes. The motivation for doing outreach is to engage with children in schools that would not visit a science centre. All five science centres stated that the rationale for this approach was that high transportation costs acted as a barrier to attendance.

The outreach programmes are similar to workshops delivered on-site, but might also include some other elements. For example,

- Some centres (e.g. Explore at-Bristol) build portable exhibits, which are then lent to schools. Teachers are first taught how to use these exhibits effectively.
- Thinktank uses a mobile planetarium with digital-projection technology, which is designed to educate and inspire pupils.

The science centres consider outreach programmes as their contribution to the BIS' objective to engage with 'hard to reach' and underprivileged groups. For example, Intech finds that schools choosing outreach rather than a centre visit are more likely to be located in deprived areas.

Some science centres also believe that there is a trade-off between school visits and outreach, i.e. with an expansion of outreach programmes they might lose some of their school visitors. The latter is not desirable because science centre visits have more to offer (permanent and temporary exhibitions, full-scale shows, etc.).

All five science centres provide pre- and post-visit materials for students and teachers. There is some evidence that these types of materials positively affect children's learning[66]. Materials for teachers contain suggestions for follow-up lessons and further experiments.

Some science centres also run CPD programmes for teachers. These programmes range from one-day courses to year long research projects. The science centres' staff believe that they help to build teachers' confidence in working with children on practical activities and in teaching contemporary science. They also become a forum where teachers can share their experience and learn from colleagues.

Explore At-Bristol, for example, runs the Science Learning Centre South West - a partnership between At-Bristol, the University of Bristol and the University of Plymouth. It is funded by the DCSF and the Wellcome Trust and is part of a national network of Science Learning centres, producing courses, resources and other materials to enhance and promote science teaching. The courses offered by this centre do not only cover formal mainstream education, but also include "After School Science and Engineering Clubs leaders training", "Teaching science to students with SEN" and "Learning Outside the classroom". Smaller centres participate more informally, by offering materials on-line and attending teacher conferences.

There appears to be a potential for science centres to do more in this area. Both science centres and regional Science Learning Centres would benefit from more close collaboration.

Objective: to improve STEM literacy of the population and to encourage public engagement with science

Science centres provide opportunities for the public to learn about recent scientific developments in an accessible and engaging way. They consider themselves as centres of learning for all age groups. For example, while children are discovering basic laws of physics at Explore At-Bristol, adults may visit the "Big Bang" exhibition, which is inspired by the Large Hadron Collider experiment.

Apart from traditional, more 'passive' engagement, all science centres try to get their visitors more active and involved in a debate on topical issues. For example:

- Thinktank incorporates public engagement and dialogue into exhibits where people are presented with ethical issues related to developments in medical science, and invited to write down the implications of technological advances.
- Eden reconnects people to their environment by featuring the plants that are used every day for food, fuel, medicine and materials. That helps people to start exploring how their actions affect the environment. Visitors leave the centre with a sense of small changes they can make to their behaviour which collectively will have considerable impacts.

66 'Impact assessment of Trust funded Millennium Centres', 'Report on the Real World Science Programme and its impact'.

- Thinktank incorporates public debate in many of its Key Stage 3 and Key Stage 4 workshops, when children discuss pros and cons of technological progress.
- Thinktank signposts current STEM related Government and NGO public consultations through computer interactives that provide direct access to policy informing processes.

In practice, public dialogue events often serve as a way for centres to partner with industry sponsors, while maintaining a position of neutrality on controversial issues. Eden, for example, hosted the Sexy Green Car Show, bringing together the world's greenest cars and assessing their environmentally-friendly credentials.

We find that larger centres are more likely to run public dialogue events. Smaller centres, which operate under tight budget constraints, find it more difficult. Both INTECH and Catalyst said that their main focus is on children and education. They would like to contribute more to the public engagement aspect of the Science and Society agenda but lack resources to do so.

Objective: to engage 'hard to reach' and disengaged groups

Apart from the outreach programmes (discussed above), which focus on underprivileged children, the science centres also demonstrate commitment to their local communities. The Eden Project is a particularly good example of a science centre that engages with its community. Being built in a former clay pit in one of the most deprived areas in Britain, the centre works with the community, has many projects out in the community and, undertakes many projects with the community within the centre. Eden attracts more than one million visitors annually and makes significant contribution to local development and regeneration[67].

The Eden Project began building ties to the community even before it had actually opened. The Visitor Centre opened while construction of the rest of the site was still underway, in response to local interest in the transformation. Now Eden is a community focal point, the place where people meet, learn about environment and sustainability, attend concerts and shows. The Project's aim is to make the visitor experience personal, relevant and thought provoking.

The project promotes sustainability by trialling new techniques and technologies with energy, waste management and local procurement. Moreover, Eden considers the financial, social and environmental impacts of their choices. It directly employs several hundred local employees, uses local suppliers whenever possible (80% of our catering supplies are sourced from Cornish companies), and wherever possible encourages local businesses to be more environmentally conscious.

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67 See for example 'The economic impact of The Eden Project' (Andrew Jasper and Geoff Broom Associates, 2002)

Other examples of community engagement and work with 'hard to reach' groups are as follows:

- Explore At-Bristol runs a project 'Bright Sparks – Inspiring science in the Community', which explores attitudes of children from different BME backgrounds towards STEM subjects. An evaluation report (produced by APKA Consultants) states that "the project to date is proving to be a success and this has to be down to the commitment and enthusiasm of the At-Bristol staff team along with the co-operation and hard work of the leaders and pupils involved in the project."
- At-Bristol, among several other centres, runs a volunteering programme. Its aim is to reflect wide diversity of Bristol and to encourage involvement from all sectors of the community. Many volunteers are students who would like to become science teachers or science communicators. Volunteers receive training and support.
- Thinktank is piloting the Science and Heritage Career Ladder programme, developed by the New York Hall of Science in 1986 to promote diversity by providing a paid training programme for young people in science and maths. Under the Thinktank Science and Heritage Career Ladder young people are recruited as Trainee Enablers on a four week paid placement, followed by part-time posting as Junior Enablers, and progressing to positions with increasing levels of responsibility. Thinktank also provides work experience placements for individuals with visual impairments, Asperger syndrome and disabilities through its partnerships with the Advance 2 Work Team at Queen Alexandra College and Autism West Midlands.
- Thinktank is piloting the Science and Heritage Career Ladder programme, developed by the New York Hall of Science in 1986 to address the underrepresentation of women and minorities in science. Under the programme, students get on the ladder as volunteer programme assistants, followed by a part-time posting as an Explainer and progressing to positions with increasing levels of responsibility. Thinktank also provides work experience placements for individuals with visual impairments, Asperger syndrome and disabilities through its partnerships with the Advance 2 Work Team at Queen Alexandra College and Autism West Midlands.

5.2.3 Financial sustainability

Larger centres manage to attract more public visitors and can generate more revenue from ticket sales, catering and retail. They are also more likely to secure grants from charitable trusts and other sponsors.

Small and medium science centres are more likely to struggle financially. These organisations tend to rely on volunteers and staff working overtime to keep afloat. These organisations are active at working with local firms and corporate sponsors, but mainly receive in-kind support from them. For example:

- Intech has developed good relationships with local software companies, which provide in-kind support (computers, IT support, volunteers).

- Both Intech and Catalyst receive sponsorship for individual exhibits (e.g. a water saving exhibit is sponsored by a water company; a 3-D film about chemistry is sponsored by a pharmaceutical company).

While in-kind and targeted support is valuable, it might not solve some of the fundamental problems faced by small and medium science centres. Indeed, educational and outreach programmes are expensive to develop and run. While large science centres are able to cross-subsidise their educational programmes by doing more profitable activities (general public visitors and corporate hire), smaller centres are not always able to do so. Catalyst, for example, does not have enough staff to run educational programmes both internally and as outreach.

There may be other constraints that science centres face. For example:

- Some grants are only available to accredited museums, others - to universities and research institutes for public engagement. Science centres that do not have museum accreditation do not benefit from either of them.
- Some science centres are restricted in what they can do by planning permission. Intech, for example, can only undertake educational activities. Therefore, they cannot have concerts or other commercial activities, which may be profitable, but not education-related.

The case studies confirm our quantitative finding that science centres' activities map reasonably well to the Science and Society agenda. They have a strong focus on educational programmes and have a potential to contribute more to the public debate on topical scientific issues.

Large science centres appear to be financially stable. They receive income from corporate activities; grants are also made available to them from charitable trusts. Small and medium science centres are more likely to struggle financially. These organisations tend to rely on volunteers and staff working overtime to keep afloat. They have few (if any) corporate visitors and insufficient resources to compete for large grants.

Large science centres offer a portfolio of activities and events, which are both more costly and more attractive. This gives them the opportunity to charge reasonable entry fees and secure other income from visitors. There is much less opportunity for small and medium sized science centres to do this.

6 Evaluation of the impact of the comparator programmes

In this section we evaluate the impact of several STEM-related publicly funded organisations on government's Science and Society objectives. In consultation with BIS, we have chosen four main STEM-related organisations (hereafter called comparator organisations):

- STEMNET,
- British Science Association;
- Research Councils UK (RCUK); and
- the Royal Academy of Engineering.

While some of these organisations focus exclusively on the Science & Society agenda (e.g. STEMNET), others may have a wider focus. In our evaluation, we concentrate only on those activities that directly contribute to the Science & Society agenda[68]. Therefore, it is important to bear in mind that our evaluation is not a general assessment of the above mentioned organisations, but is specific to the Science & Society agenda.

The remainder of this section, we first provide a brief description of the main Science and Society programmes run by the comparator organisations. We then assess the existing evidence on the impacts of the comparator programmes and calculate their unit costs, where possible. It is worth noting that these unit cost estimates need to be interpreted with caution. In the absence of any data on long-term impacts (i.e. on the programmes' effectiveness), we are unable to determine whether certain programmes are more expensive because they offer better quality or because they are less efficient.

6.1 INDIVIDUAL PROGRAMMES

In this section, we describe the programmes that fit the Science and Society agenda. The table below summarises the main STEM initiatives by our comparator organisations, separated into two categories – "**Inspiring young people to study STEM"** and "**Public engagement with science"** – based on their objectives and target audience[69].

68 For example, RCUK provides research grants and runs the "Researchers in Residence" programme, among other things. The latter is an example of a programme we would like to evaluate, while the former is outside the scope of our analysis.

69 Clearly, there may be overlaps and programmes classified as contributing to public engagement may also inspire young people or vice versa.

	STEMNET	British Science Association	RCUK	Royal Academy of Engineering
Inspiring young people to study STEM	After-School Science and Engineering Clubs STEM Ambassadors STEM brokerage	CREST Awards CREST Investigators Science and Engineering Fairs and Competitions	Researchers in Residence Nuffield Bursaries School resources Teacher CPD	BEST Programme National Engineering Programme Programme for Science Teachers
Public engagement with science		British Science Festival National Science and Engineering Week Science Communication Conference	Beacons for Public Engagement NSEW awards Training for researchers Public dialogue events	Public Engagement Awards Public Engagement Fellowships Public Engagement Events

Table 6: Comparator Programmes

Source: Frontier Economics

6.1.1 STEMNET

STEMNET aims to ensure that more young people in the UK make a choice to enter science, technology, engineering and mathematics (STEM) related careers at all levels, and that future generations are properly informed about the science and technology that surrounds them. One of its objectives is to target 'hard to reach' and disengaged groups.

STEMNET objectives are primarily aligned with the 'inspiring young people' component of BIS' Science and Society agenda.

Inspiring young people to study STEM

- **STEM Ambassadors Programme** – this programme provides an opportunity for volunteers with STEM skills to work closely with young people in the UK in order to inspire them in STEM subjects and to encourage them to choose STEM related careers. There are currently c. 18,000 STEM Ambassadors involved in this programme. STEM Ambassadors provide a variety of activities, depending on their expertise and the school's needs, including career talks, organising STEM competitions and offering one-to-one career advice.
- **After-School Science and Engineering Clubs** – pilot programme provides funding and training for schools to start clubs, with an engaging and stretching programme of activities for Key Stage 3 pupils. This programme is

funded by DCSF. The pilot began with 250 clubs in 2007-08 and expanded to 500 clubs in September 2008.

- **Brokerage in STEM Enhancement and Enrichment (STEM E&E)** – STEMNET provides information and advice to schools about STEM enrichment activities and programmes, which support the curriculum and increase the number of students moving into further STEM education, training and employment. This brokerage is undertaken through 52 regional STEMNET contract holders ('brokers').

6.1.2 The British Science Association

The British Science Association (formerly known as the BA) was founded in 1831 to promote the advancement of science in the UK. The British Science Association envisions a society in which:

> "The scientific community, policymakers and the public share a common and open culture of science and its applications, enabling people from all walks of life to access science, engage with it and fell a sense of ownership about its direction".[70]

Through its activities, the British Science Association seeks to engage and inspire adults and young people with science and technology. With public engagement as its principle reason for existing, the British Science Association's aims fit closely with the public engagement aspects of the Science and Society agenda.

Inspiring young people to study STEM

- **CREST Awards** – a national accreditation scheme for project work in science, technology and engineering for students aged 11-19 years. Student involvement can range from under 10 hours for Bronze Awards to over 100 hours for Gold Awards, with over 28,000 awards granted in 2006. Students working on Silver and Gold projects have access to mentors from industry or research institutes. Building on the success of the CREST Awards, the British Science Association has recently introduced a programme for students aged 5-12 years (CREST Star Investigators)

The British Science Association is also part of the consortium for the After-School Science and Engineering Clubs pilot project and provides support and resources for club leaders.

Public engagement with science

- **The British Science Festival** – the British Science Festival has historically taken place in a different university city each year. The goal is to celebrate scientific advances, explore the new developments and stimulate dialogue

70 "Vision for Science and Society: Response to Government by the British Association for the Advancement of Science", 17 October 2008

about STEM-related issues. Over 50,000 people attended festival events in York[71] in 2007 and 31,300 - in Liverpool in 2008[72].

While Festival events are concentrated in the host city, the Festival generates substantial coverage in national and international media outlets. Moreover, some host-cities continue holding an annual science festival, sometimes in conjunction with National Science and Engineering Week.

- **National Science and Engineering Week** – an annual, week-long celebration of science featuring thousands of grassroots events across the UK. The British Science Association plays a coordination role and acts as a point of contact for the media, while the event itself is decentralised, with events organised by schools, businesses and research institutes. In 2008, an estimated 1.4 million people attended over 3,500 events nationwide. The events within NSEW are diverse in terms of type of engagement, target audience, aim and subject.

The British Science Association also offers training courses in communications and media relations and organises Science Communication Conference that brings together professionals to discuss issues and best practices in communicating science and improving the quality of STEM media coverage.

6.1.3 Research Councils UK

The UK Research Councils are Non-Departmental Public Bodies, and are the main UK public investors in fundamental research, managing c. £3bn funds annually allocated via the Government's science budget. The Councils represent the range of research disciplines as follows:

- Arts and Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- Economic and Social Research Council (ESRC)
- Engineering and Physical Sciences Research Council (EPSRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science and Technology Facilities Council (STFC)

RCUK (http://www.rcuk.ac.uk) is a strategic partnership between the seven UK Research Councils, through which the Research Councils work together to enhance the overall impact and effectiveness of their research, training and knowledge transfer activities. As well as developing and promoting world-leading research, the Research Councils also raise the public's awareness of science and innovation, and encourage their involvement in these subjects.

71 The festival in 2008 has not yet been formally evaluated,

72 http://www.britishscienceassociation.org/NR/rdonlyres/B5EDDC28-992B-44FD-88E2-B14ED0E7B71E/0/BAFestivalofScience2008Evaluationreport.pdf

Inspiring young people to study STEM

- **Researchers in Residence** – this programme fosters links between researchers and secondary schools. Researchers receive training and are placed in schools for 14-24 hours, allocated over a period of days or weeks. Experiences are varied and tailored to the needs of the school. The scheme is wholly funded by RCUK.
- **Nuffield Bursaries** – students aged 16 years and over are placed in universities, industry or research institutions to undertake science-based projects with practicing scientists. The placements last 4-6 weeks and take place during the summer holidays. The programme is managed by the Nuffield Foundation, but part-funded by RCUK[73].

RCUK funds the website **schoolscience.co.uk**, managed by the Association for Science Educators, which provides online resources for science teachers across the key stages, and also part funds the BSA CREST Awards (until December 2009). RCUK also funds a major national **teacher CPD programme**, designed to bring researchers and teachers together to support teachers' use of contemporary research in the classroom.

Public engagement with science

- **NSEW Awards** – researchers can receive grants up to £2,000 from RCUK to hold public engagement events during National Science and Engineering Week. In 2008, RCUK awarded c. £50,000 to 31 researchers.
- **Beacons for Public Engagement** – Beacons for Public Engagement are university-based collaborative centres to help support, recognise, reward and build capacity for public engagement work across the UK. Research Councils UK, the UK funding councils and the Wellcome Trust, have together invested £9.2 million into this initiative in order to support a step-change in recognition for public engagement across the higher education sector. There are six Beacons around the UK, and one National Co-ordinating Centre.

Royal Academy of Engineering

The Royal Academy of Engineering (the Academy) strives to "promote excellence in the science, art and practice of engineering" in all disciplines[74]. The Academy aims to enhance engineering capacity in the UK, inspire the next generation of engineers by celebrating excellence and lead debate.[75]

The Academy has a comprehensive range of educational programmes for students of different ages; facilitates and organises a number of public engagement events, and works to build public engagement capacity and activity within the engineering community. The following are examples of some of the programmes.

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73 Given that we do not have comprehensive information on costs of this programme, we are unable to include it in our evaluation.

74 Royal Academy of Engineering website http://www.raeng.org.uk/about/default.htm

75 The Royal Academy of Engineering Strategic Plan 2005-2010

Inspiring young people to study STEM

- **BEST Programme** – the Better Engineering, Science and Technology (BEST) programme is a series of initiatives for engineering enthusiasts from primary and secondary school, through university and on to early career development. Details of these diverse initiatives are provided in the Annexe 2.
- **National Engineering Programme** – Following the success of the London Engineering Pilot Project, the National Engineering Programme is being expanded to six more cities[76]. Its aim is to create more people with engineering skills, forming a pipeline that takes students from school, through FE and HE and into the profession. It particularly seeks to engage those under-represented in the profession: student's from lower socio-economic groups, women, and certain minority ethnic groups. The approach is to provide inspiring STEM outreach activities in schools and promote attractive engineering courses in colleges.

Public engagement with science

The Academy's public engagement grants programme, *Ingenious – engaging citizens; engaging engineers,* provides two streams of support:

- **Public Engagement Fellowships** –offer fellowships to engineers to build dialogue with the public, policy makers and other stakeholders and to gain knowledge and skills in engaging with the public and the public policy process.
- **Public Engagement Awards** - offer funding for projects that enhance the public engagement skills of engineers and provide opportunities to engage in debate with the public on engineering and its impact on society:
- **Public Engagement Events** – the Academy facilitates and organises a series of activities, debates and dialogue activities for young people and adults to raise awareness of engineering and its implications and applications in society.

6.2 EVALUATION OF THE COMPARATOR PROGRAMMES

We have examined the existing evidence base that includes the comparator organisations' financial accounts and external and internal evaluations which were made available to us. One of our key finding is that this evidence is insufficient for us to undertake a robust VFM comparison of these programmes. More specifically, there is not enough evidence on the long-term impacts of these programmes:

- the number of people who choose careers in STEM; and
- the number of people who become more engaged in scientific debate as a result of their participation in the comparator programmes

76 http://www.raeng.org.uk/education/nep/default.htm

Some existing evaluation studies estimate the number of participants who have changed *their attitudes* towards STEM careers[77]. However, whether these people actually choose careers in STEM, remains unknown.

As in our analysis of science centres, we adopt a pragmatic approach and try to evaluate these programmes based on key performance indicators – the number of participants and total costs.

6.2.1 Quality of evidence base

Generally, we find that the quality of information varies by programme. While the British Science Association, RCUK and the Royal Academy of Engineering are able to provide detailed quantitative information on their programmes (the number of participants, duration of events), quantitative information on STEMNET STEM Ambassadors is relatively more limited. STEMNET currently collects information on the number of STEM Ambassadors, the number of events for secondary schools facilitated by STEMNET contract holders and the corresponding number of secondary school students. However, due to the limitations of the data collection used, similar figures for primary schools and primary age pupils are not currently available. That makes our calculations of unit costs of STEMNET STEM Ambassadors programme less precise. We understand the new, significantly more sophisticated date collection systems has recently been introduced, which will provide a more accurate picture of numbers of pupils, schools and volunteers involved in STEMNET in the future.

Other issues affecting our analysis

Apart from variable quality of information available to us, we face two additional issues, which further complicate the analysis.

- Firstly, there are significant overlaps between organisations. CREST programme, for example, is coordinated by the British Science Association, receives funding from RCUK and in some cases may be delivered by STEMNET STEM Ambassadors.
- Secondly, STEMNET brokerage service contributes to the uptake of a number of STEM Enrichment programmes[78]. Ideally, we would want to allocate STEMNET brokerage costs to these programmes according to the contribution this service makes. This, however, is not currently possible due to the data limitations.

Because of these overlaps, it may be difficult to fully allocate costs to individual programmes and accurately calculate their unit costs. If some of the costs of a programme are not taken into account, the resulting unit cost measure will be biased. The programme will appear to be cheaper per individual/hour than it

[77] See, for example, "CREST awards evaluation: Impact study" conducted by the University of Liverpool

[78] STEMNET brokerage is defined as "the provision of impartial, tailored advice on STEM E&E." to schools.

actually is. The most extreme example of this problem is NSEW, where most costs are unknown.

Secondly, the comparator programmes appear to benefit from science centres' contribution (captured in our quantitative analysis in Section 5.1). More specifically, the science centres organise events for NSEW, host regional CREST competitions, and other national and regional events, in which STEMNET STEM Ambassadors are involved. However, these contributions tend to be in-kind and, therefore, are not reflected in the programmes' costs. Therefore, the comparator costs tend to be understated because these contributions are not accounted for.

In our analysis we deal with these problems on a case-by-case basis. Where it is reasonable to assume that most costs are adequately captured, we estimate the programmes' unit costs. Alternatively, if costs of a programme are unknown (e.g. NSEW), we do not attempt to calculate unit costs.

We first calculate and compare unit costs of the programmes, which main emphasis is on young people and their career choices. We then proceed to comparing the programmes with main focus on public engagement.

Inspiring young people to study STEM

As Table 7 demonstrates, we are able to calculate average costs per participant for five out of six programmes[79]. These are CREST, STEMNET STEM Ambassadors, After-school clubs, RCUK Researchers in Residence and the RAE BEST scheme. Their average costs vary significantly, between £13 and £273 per participant.

Partly these differences in costs may reflect variation in the programmes' duration. Indeed, average duration of events organised by STEMNET STEM Ambassadors is 1.5-2 hours, while After School Clubs, CREST and BEST programmes require longer involvement – between 19 and 25 hours.

Another potential reason for costs' dispersion is programmes' maturity. STEMNET After School clubs, for example, is a new programme, which appears to be particularly expensive (£273 per child, £11 – per hour). However, one should bear in mind that costs tend to be higher in the beginning of a programme. Indeed, teachers need to invest time and develop a set of activities for the clubs, which they will be able to use in the future. In the following years, when the clubs are up and running, the costs are expected to fall.

Researcher in Residence (RinR) and BEST are more mature programmes, and their average costs are, consequently, lower: £123-152 per child or £6.1-6.5 per hour. These two programmes, however, differ in size. RinR only involves approximately 3,250 children, while the Academy's BEST scheme is estimated to be over 10 times larger.

79 STEMNET E&E brokerage provides marketing of various enrichment activities and, therefore, is not directly comparable to other programmes discussed in this section.

When one evaluates individual programmes, it is important to assess the scale of each programme alongside its unit costs. If a programme has low unit costs, but is small in size, one would need to understand whether this programme could easily be expanded. We understand that for the RinR programme, there are in theory no significant barriers to expansion. With more researchers participating in the programme, more children should benefit from it.

STEMNET STEM Ambassadors programme appears to be slightly more expensive - £8-10.7 per hour. However, in our calculations we do not take into account the number of primary school pupils involved in this programme (as this information is not available). We expect that with more accurate information on the number of participants, the programme would be more in line with the RinR and BEST programmes.

Finally, CREST appears to have the lowest unit costs (£13.3 per child and less than £1 per hour[80]). While there is clear evidence that children benefit from the CREST programme (they report improvements in research skills, practical science skills, IT skills, etc.), it is not clear whether this programme can be easily expanded. Indeed, CREST participants tend to have strong pre-existing interest in STEM:

- 68-92% of them report pre-existing interest in science,
- 73-85% - in technology; and
- 40-79% - in engineering, depending on the level of involvement[81].

If the programme were to expand and tap into the pool of students with no pre-existing interest in STEM, its average unit costs might increase (as more marketing and mentoring would be required).

Public engagement with science

Calculating unit costs for "public engagement" programmes proved to be difficult. Many initiatives (e.g. Beacons for Public Engagement, the Academy's public engagement programmes) are new and their impacts (numbers of participants) are not yet known.

In Table 8, we summarise information available on three programmes – the British Science Festival, NSEW and RCUK NSEW Awards. As we discussed earlier, most costs associated with NSEW are unknown - they are incurred by participating organisations and businesses. Therefore, we are unable to calculate unit costs for this programme.

Costs of the remaining two programmes are £9.5 and £2.9 per participant. Given that Science Festival and NSEW events typically last for 1.5-2 hours, the British Science Festival costs per participant adjusted for event duration is £4.3-6.3, i.e.

80 Note, however, that some of the programmes' costs are not taken into account. These are STEMNET costs of brokerage and mentoring, and opportunity costs of venues used for regional and national competitions.

81 See "CREST awards evaluation: impact study", University of Liverpool for more details

broadly comparable to the unit costs of programmes aimed at young people. The RCUK NSEW Awards costs are even lower – approximately £1.5.

There is a possibility, however, that we underestimate the costs of these programmes. Indeed, we do not take into account the opportunity cost of venues and speakers' time (this information is not available). Therefore, the true unit cost of these programmes is likely to be higher.

To summarise, we are unable to undertake a robust VFM analysis of the comparator programmes because information on long-terms impacts is not available. Therefore, we adopt a more pragmatic approach and calculate the unit cost measures. These measures are compared against the science centres' unit costs in the following section.

Programme	No. of children involved annually	Average Duration	Cost	Average cost per child	Average cost per hour	Sources of information
Crest (the British Science Association)	28,000	21 hours Weighted average of Bronze, Silver and Gold awards	£372,475 Contributions not accounted for: STEMNET, venues provided by universities and science centres	£13.3	£0.65	"CREST Awards Evaluation: impact study" Financial accounts 2007
After-School Science & Engineering Clubs (STEMNET)	c. 10,000 (500 clubs, 22 per club)	25 hours (1 hour, once per week for 25 weeks - 2 terms)	£3,000,000 £6,000 per school, 500 schools	£273	£11	"DCSF evaluation"
STEM Ambassadors (STEMNET)	c. 184,800 secondary school pupils (number of primary school pupils currently unknown)	Duration per child – variable 1.5 - 2 hours on average	£2,971,543 (STEM Ambassadors costs + 60% of brokerage costs)	£16.1	£8 – 10.7	Financial Accounts 2007-08 STEM Ambassadors internal statistics 2007/08
Researchers in Residence (RCUK)	c. 3,250 (100-150 researcher placements)	19 hours 14-24 hours per researcher	c. £400,000 (RCUK + Wellcome trust)	£123	£6.5	Interview with RCUK
BEST pre-university scheme (RAE)	c. 35,541 9,541 children in pre-university programmes, plus 26,000 children in clubs	Duration per child – variable[82] Assume 25 hours as for After School Clubs	£5,436,000	£152	£6.1	Scorecard 2006-07

82 We understand that BEST is an extremely diverse programme. Some events for young students cost typically 10 pounds per pupil and last a day. The high-intensity interventions with older students are more costly and last longer.

5BEvaluation of the impact of the comparator programmes

Table 7: Cost-effectiveness of the programmes for young people

Source: Frontier Economics

	No. of events per year	Attendance	Cost	Cost per person/event	Coverage & Frequency	Sources
British Science Festival	170	55,000	£522,000	£9.5	Regional 1 week annually	British Science Association Financial Accounts 2007 Evaluation
National Science & Engineering Week	3000	860,000*	£363,000 British Science Association cost only External costs unknown	unknown	National 1 week annually	British Science Association Financial Accounts 2007 Evaluation
RCUK Awards for NSEW	42	24,489	£71,317	£2.9 Does not include any cost to organiser above grant	National 1 week annually	NSEW Awards 2007 Evaluation

Table 8: Cost-effectiveness of public engagement programmes

Source: Frontier Economics

5BEvaluation of the impact of the comparator programmes

7 A comparison of science centres with other STEM programmes and recommendations

In this section of the report, we undertake a comparison of unit costs of science centres against those of the comparator programmes. We find that, generally, science centres compare well with other STEM-related programmes (see Table 9 below).

If we exclude two 'public engagement' programmes (shaded in the table) from the comparison, our findings are as follows:

- The costs per participant for the science centres vary, on average, between £9 and £20.
- The costs per participant for the comparator programmes are between £134 and £273 (except the CREST programme with the average cost of £13)

This variation largely reflects differences in models of operation. Indeed, an educational visit to a science centre tends to be a one-off event that lasts 3-4 hours. The comparator programmes, on the other hand, involve prolonged activities/ repeated interactions over a number of days or even weeks (18-25 hour on average, up to 100 hours for Gold CREST Award)..

When we adjust for duration, the science centres still have lower costs, £2.5-5.9 versus £6.1-11 for the comparators (except CREST, which costs less than £1 per participant-hour).

	Cost per participant	Cost per hour
Small science centres	£11	£2.7
Medium science centres	£9	£2.5
Large/extra large science centre	£18-20	£5.6
DCMS-funded museums	£19	£5.9
CREST	£13	£0.7
STEMNET STEM Ambassadors	£16.1	£8 – 10.7
Researchers in Residence	£123	£6.5
BEST	£152	£6.1
After School Clubs	£273	£11
British Science Festival	£9.5	£4.3 - £6.3
RCUK Awards for NSEW	£2.9	£1.5

Table 9: Average costs per participant and per hour for science centres and comparators

Source: Frontier Economics

A comparison of science centres with 'public engagement' programmes produces a mixed result. RCUK Awards for NSEW programme has lower unit costs, while the British Science Festival has comparable costs. However, the unit costs of these programmes may be underestimated (for the reasons discussed above); therefore, one needs to be cautious when interpreting these figures.

Importantly, one should bear in mind that the unit costs used in these comparisons are average costs. They may or may not accurately reflect additional (marginal) costs that need to be incurred to expand outputs[83].

As we have indicated earlier, there is a disappointingly low amount of evaluative evidence for both science centres and comparator programmes. We have drawn on a literature review, generated quantitative and qualitative evidence on science centres and assessed the available evidence on comparator programmes. This approach has thrown some light on relative performance of science centres, but it is insufficient to be conclusive on whether there is a case to support science centres through government funding.

This is because we could not obtain any reliable information on the long-term impacts of science centres and the comparator programmes on BIS' Science and Society objectives. Moreover, our cost comparisons are based on average costs per participant, which may be different from marginal costs, i.e. costs associated with ***additional*** participants. Marginal costs are needed to inform a decision on the most efficient allocation of funds. This information was not available to us.

In order to enable more robust comparative analysis in the future, we recommend the following changes to the data collection process:

- **The quality of data provided by the organisations which currently receive funding from BIS should be significantly improved.** A consistent set of indicators should be developed that would allow BIS to be in a better position to undertake some consistent cross-programme comparisons. These indicators should reflect both quantitative and qualitative aspects of the programmes. Quantitative indicators would include:
  - the number of participants (in total) and by groups of the population (from BME backgrounds, from low socio-economic classes[84], people with disabilities, etc.),
  - average length of interaction (in hours), and
  - average cost per participant.

  Qualitative indicators might include:
  - participants' satisfaction with the programme, and

83 In general, if marginal cost is constant, it is equal to average cost. Alternatively, if marginal cost is output-dependent, average cost may be lower or higher than average cost.

84 This may be proxied by the proportion of children receiving free school meals

- measures of the programmes' effectiveness, i.e. whether the objectives of these programmes are achieved.

  The agreed set of indicators should be used consistently across all programmes and over time. The longitudinal aspect of the collected data would contribute to BIS' understanding of the programmes' marginal costs (i.e. how marginal changes in funding affect programmes' outcomes).

- **Science centres should be encouraged to collect similar types of information.** We recommend that the Association for Science and Discovery Centres UK liaise with BIS to develop a set of indicators, which would (i) capture the impacts of science centre activities on BIS' Science and Society agenda and (ii) be consistent with the indicators used for the assessment of the comparator programmes. We expect that this would encourage science centres to focus more on the types of activities that contribute to the Science and Society agenda (e.g. public debates). The longitudinal aspect of the data is expected to provide evidence on science centres' marginal costs.

This information would facilitate some comparisons between science centres and other STEM programmes, but it might not be sufficient to assess the long-term impacts, i.e. how many people choose careers in STEM as a result of their participation in a particular programme or a visit to a science centre. These long term impacts could only be assessed based on individual level longitudinal data. Alongside information on children's involvement in STEM enrichment activities[85], this data should capture children's background characteristics and other factors that might influence their career choices (e.g. parents' education, quality of primary and secondary education, test scores, etc.). It would be important that the sample is representative of different parts of the country and different population groups.

We recognise that collecting longitudinal data on a representative sample of individuals is time-consuming and resource-intensive. It may not be cost-effective for BIS to undertake this large-scale data gathering for the purposes of this evaluation only. However, if other departments (e.g. DCSF and DCMS) would also benefit from it, it would be worth exploring whether this survey could be jointly funded.

It should also be explored whether it would be possible to add relevant questions on STEM enrichment activities and career choices to the existing longitudinal surveys, e.g. to the Pupil Level Annual School Census (PLASC). If feasible, it may be a relatively low-cost option. However, it would still require several years for the data on career choices to become available. Given the uncertainty over whether such a data set could be developed and the likelihood that it would be expensive, we recommend that a feasibility review be carried out of the costs and benefits of creating such a data set.

85 In practice, it may be difficult to measure involvement in STEM enrichment activities accurately as children might not distinguish between science centres and museums. The survey will need to rely on teachers checking that the supplied information is accurate.

Annexe 1: Science centres - data description and grouping

In this Annexe we summarise the main descriptive characteristics of our data set, including their size, location and sources of funding.

In terms of the annual number of visitors[86], the science centres in our sample range from 1,700 to 3.8 million, with the average of 485,500. In total, they received c. 19 million visitors annually in the last two years.

The majority of the science centres are located in urban areas:

- 28 are urban;
- 8 are rural; and
- 3 are travelling (do not have a permanent base).

The science centres are spread throughout the country, with all regions being represented except East Anglia[87] (see Figure 4).

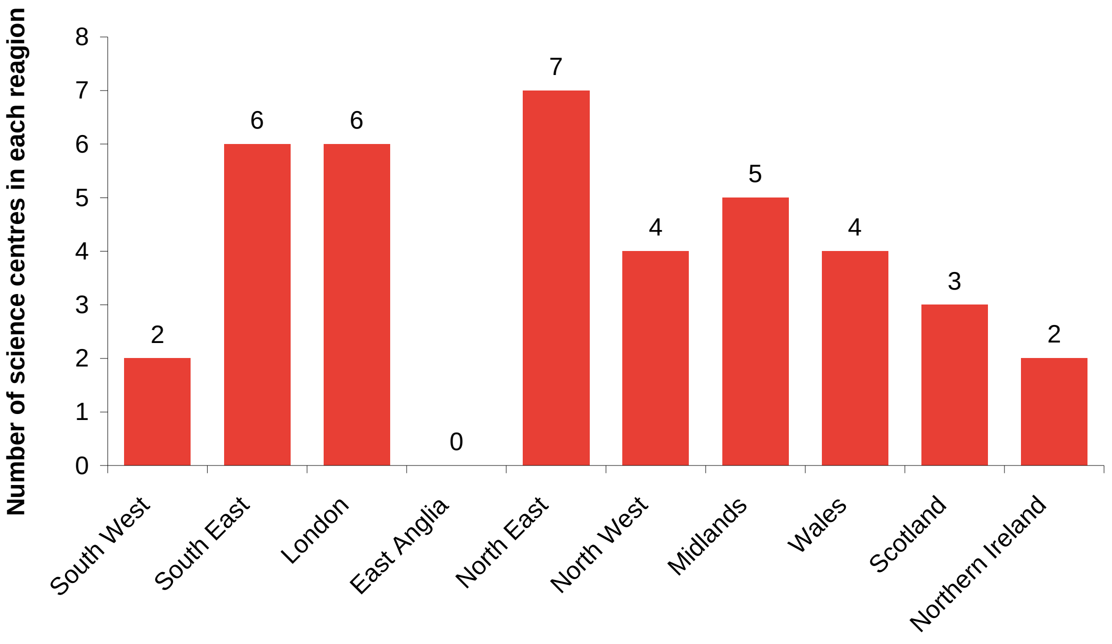

Figure 4: Regional distribution of science centres in the sample

Source: Frontier Economics

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86 In our analysis, we do not make an adjustment for repeat visitors. This is because most science centres could not provide accurate information on how many visitors are repeat visitors.

87 There is just one science centre in East Anglia, which is currently undergoing significant restructuring.

Science and discovery centres appear to be a diverse group, some of which has museum accreditation or classify themselves as botanical gardens, zoos or aquaria. More specifically:

- 26 out of 39 centres describe themselves as science & discovery centres. Of these:
  - 14 describe themselves as primarily science and discovery centres and include planetariums and observatories;
  - 6 also classify themselves as a Science or Industrial Museum;
  - 3 are also a botanical garden, including one centre that is also a zoo;
  - 1 science centre has an aquarium.
- Of the 13 centres that do not describe themselves as Science & Discovery Centres, 9 are museums:
  - 3 are primarily Science or Industrial Museums, including a medical museum; 2 are children's museums, 1 is a natural history museum;
  - 2 are museums covering science, industry and natural history, one of which also has a botanical garden; and
  - 1 describes itself as a natural history museum, children's museum, botanic garden and aquarium.
- Among the 4 centres that are not science centres or museums, 1 is a botanical garden, 1 is an observatory and 2 are travelling/outreach only.

Despite these differences in self-identification, we include them all in our analysis. This is because all of them have interactive STEM-related exhibits and a potential to contribute to BIS' Science and Society agenda.

Approximately 35% of science centres in our sample receive public funding for their core activities:

- 8 are DCMS-funded museums;
- 6 receive funding from devolved governments; and
- the remaining 25 do not receive any public funding for core activities.[88]

15 science centres in our sample have historic collections (e.g. steam engines or other industrial heritage) and have received museum accreditation.

7.1.1 Grouping of the science centres for further analysis

Given that the science centres are so diverse in terms of their characteristics, it may be misleading to rely on averages for the whole sample, as they may not be representative of particular groups. Therefore, we group the science centres

[88] Some of these centres may receive public funding for specific projects.

based on their key characteristics[89] and analyse each group separately (where possible). These groups are as follows:

(1) travelling science centres;

(2) small independent (i.e. not publicly funded) science centres;

(3) medium independent science centres;

(4) large independent science centres;

(5) extra large independent science centres;

(6) DCMS-funded museums; and

(7) other centrally funded science centres.

Groups (1), (6) and (7) are identified on Figure 5 below, with all remaining science centres being independent.

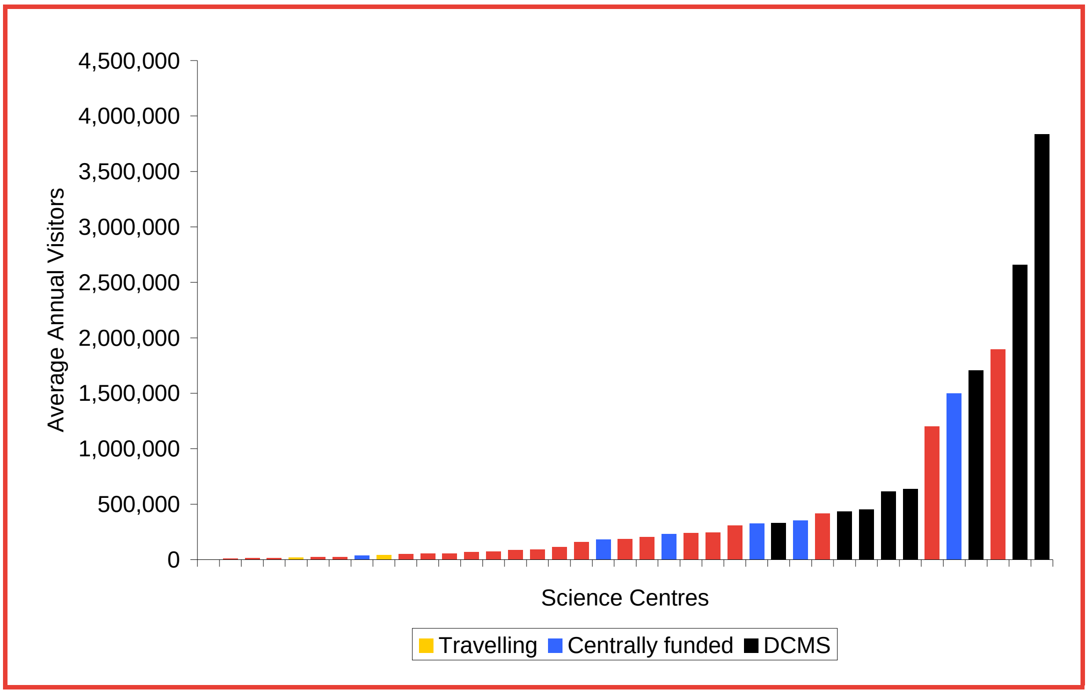

Figure 5: Average annual visits - all centres

Source: Frontier Economics

The independent science centres are split into small, medium, large and extra large science centres based on the number of visitors, exhibition space; and the number of full-time equivalent (FTE) staff.

The criteria for the split are presented in Table 10 below.

89 These are size (in terms of the number of visitors and total space), the number of FTE staff, availability of public funding and whether a science centre has a permanent location

	Number of visitors (annual)	Exhibition space (in sq meters)	Number of FTE staff
Small	Less than 50,000	Up to 1,500	Less than 10
Medium	50,000 – 160,000	1,500 – 2,700	10 - 24
Large	160,000 – 400,000	2,700 – 8,500	25 - 100
Extra large	More than 400,000	More than 8,500	More than 100

Table 10: The definition of small, medium, large and extra large science centres

Source: Frontier Economics

Most science centres satisfy all three criteria. However, there are a few borderline cases, where only two out of the three criteria are satisfied. The decision is then based on the two dominant characteristics.[90]

The graphs below illustrate the split of the science centres by size. Figure 6 shows the small, medium and large science centres; while Figure 7 shows the extra large centres, and how they relate to the smaller ones.

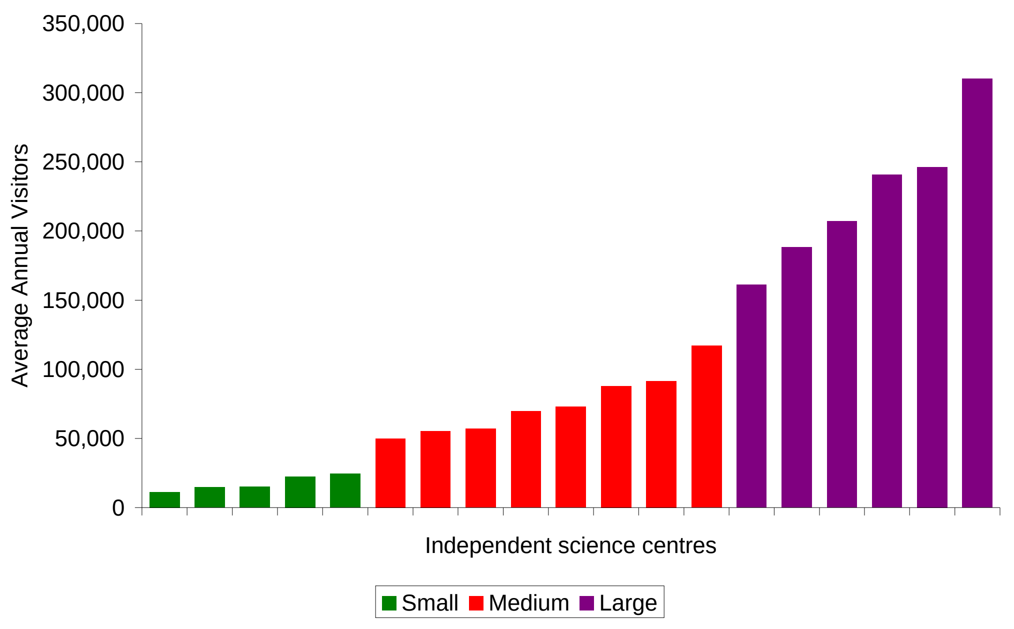

Figure 6: Average annual visits, by science centre size

Source: Frontier Economics

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90 For example, if the number of visitors and the exhibition space suggest that a science centre is medium, while the number of FTE staff is less than 10, the centre is still classified as medium.

7BAnnexe 1: Science centres - data description and grouping

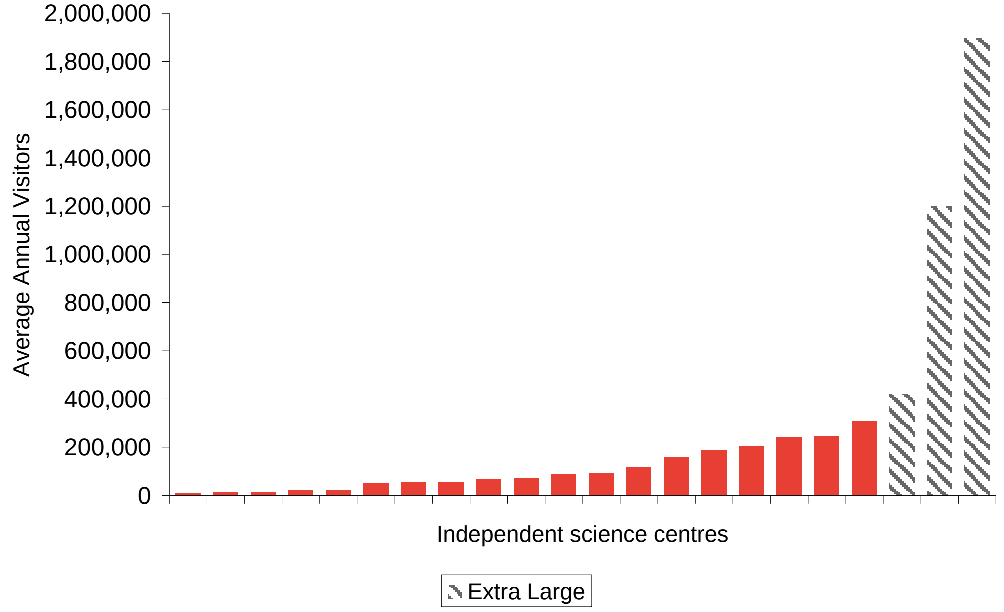

Figure 7: Average annual visits – extra large vs. other independent centres

Source: Frontier Economics

Figure 8 shows the average number of visitors for each group. It appears that all science centres that do not receive public funding for their core activities (except the extra large group) have fewer visitors than both the DCMS-funded museums and other centrally funded science centres. This is, at least to some extent, due to the fact that the DCMS-funded museums and some other centrally funded centres are free of charge.

Overall, it appears that the proposed grouping of science centres reflects their key characteristics and could be used for further analysis, i.e. in order to map science centres' activities to the Science and Society agenda and to analyse science centres' financial sustainability.

7BAnnexe 1: Science centres - data description and grouping

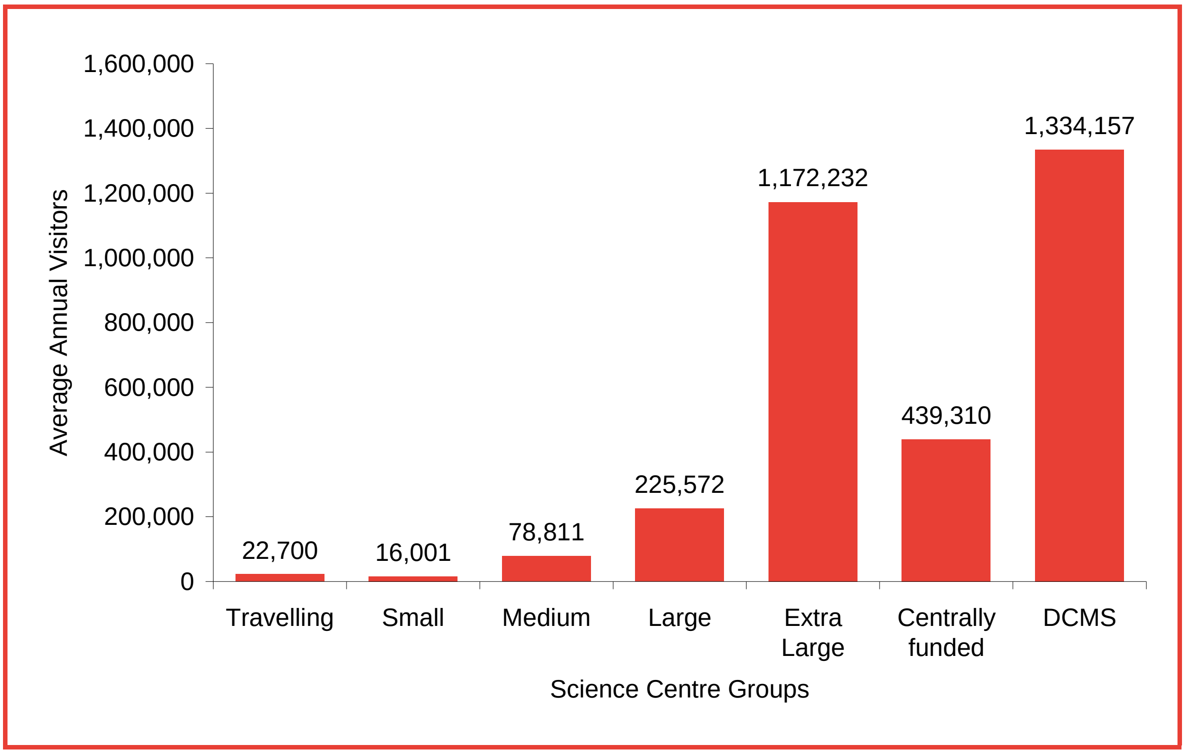

Figure 8: Average annual visitors

Source: Frontier Economics

7BAnnexe 1: Science centres - data description and grouping

Annexe 2: Details of the Royal Academy of Engineering BEST programme

The Better Engineering, Science and Technology (BEST) programme is a series of initiatives for engineering enthusiasts from primary and secondary school, through university and on to early career development.

Pre-university schemes

- **Young Engineers** - provides a range of resources and funding for a network of roughly 1,600 clubs for young people aged 7 to 19 years, with 26,000 members nationwide.

  http://www.raengbest.org.uk/schemes/pdf/YoungEngineersSchoolSchemes.pdf

- **Go4SET** – students aged 12-14 undertake 10-week STEM projects, linking students with companies for work-related learning and raising awareness of career opportunities.

  http://www.raengbest.org.uk/schemes/pdf/Go4SET_overview.pdf

- **Smallpeice Trust Engineering Courses** - students between 13 and 18 years receive training from professional engineers through enrichment activities in schools or residential courses in universities. http://www.raengbest.org.uk/schemes/pdf/Smallpeice_Inspirational_Courses_leaflet.pdf

- **The Engineering Education Scheme** – students 16-17 years do project work for companies with support from their teachers, advice from an engineer from the company and workshops led by university staff. The students produce a report and present their results.

- **Headstart** – students aged 16-17 years are placed in an engineering department at a university, providing an opportunity to learn about options for courses and careers.

http://www.raengbest.org.uk/schemes/pdf/Headstart.pdf

- **Year in Industry** – gap-year work placements in industry for 18-21 year olds, with comprehensive training over 11 months. Roughly 750 students are placed in 300 companies across the UK annually.

  http://www.raengbest.org.uk/schemes/pdf/YinI.pdf

University schemes

Series of awards and activities available to students in undergraduate engineering programmes who have participated in at least one BEST programme before university.

- **Engineering Leadership Standard Awards** - series of courses and workshops on a variety of engineering topics, as well as personal development, negotiation and public engagement. This scheme is open to all BEST students pursuing undergraduate degrees in engineering in the UK.

- **Engineering Leadership Advanced Awards** - an accelerated personal development programme over the final three years of an MEng programme, plus awards of up to £5,000. BEST students compete for a maximum of 30 awards each year.

http://www.raeng.org.uk/education/undergrad/default.htm

Professional schemes – fellowships, bursaries and awards for professional engineers.

- **Sainsbury Management Fellowship** – covers the costs of an MBA at selected business schools for chartered engineers. Sainsbury Management Fellowships in the Life Sciences are also available to scientist for personal development, though these are not part of the BEST programme.

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