Science beyond the classroom

Review of Informal Science Learning

Executive summary
November 2012

wellcome trust

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1 Introduction

In June 2011 the Wellcome Trust issued an invitation to tender for a review to characterise the value of informal science learning to science education in the UK. Focusing on children and young people aged up to 19, the study sought to provide:

- a better understanding of the scope of informal science learning, its theoretical base and the types of change it can bring about in the understanding of and attitudes towards science
- recommendations for robust methods for evaluating the impact of informal science learning, based on an analysis of practice in the field
- recommendations on reaching deprived learners, schools and families
- recommendations based on best practice in linking informal and formal learning.

The invitation to tender led to two separate but interlinked commissions: one based in the UK (delivered by GHK Consulting in collaboration with Brand Driver Ltd and Red Kite Advice and Consulting Ltd) and the second in the USA (delivered by a partnership of Stanford University and Oregon State University). Both teams worked closely to develop the study methodology and research tools, and data from fieldwork in the UK was shared with colleagues in the USA. Both teams also came together for a series of stakeholder events in the UK, which offered the opportunity to discuss progress and emerging findings.

The study methodology included the development of a typology of organisations to be used throughout the study and a series of activities, as summarised below:

- A literature and data review, reviewing the 'grey literature' on informal science learning, and the analysis of data from the Wellcome Trust Monitor and Public Attitudes to Science Survey.
- In-depth interviews with stakeholders and broadcasters, featuring interviews with 55 representatives of organisations with an interest in informal science learning[1].
- An internet survey of informal science learning providers. A sample of organisations involved in or with an interest in informal science learning was developed from sources that included the STEM directories, the Wellcome Trust, ASDC and stakeholder suggestions. The survey was also promoted through Psci-Comm, GEM, Visitors Studies Group and Big Chat distribution lists. A total of 196 responses were received from individuals across a range of organisation types, sizes and activities.
- Provider case studies, featuring ten informal science learning providers drawn from organisations responding to the provider survey. The case studies included site visits and qualitative interviews with staff and partners to explore their activities, the audiences they found challenging to engage and their evaluation practice.
- Family studies, including 12 sets of in-depth qualitative interviews with children and young people aged 11–16 from different social grades, supplemented by diary keeping, interviews with parents and peer-to-peer interviews. The Family Studies

[1] NB: the Stanford/Oregon team used 51 of the 55 interviews in their analysis, excluding four interviews with funders.

element explored how the young people spend their leisure time and the role of informal science learning within this.

2 Informal science learning in the UK

Although no single accepted definition exists in the UK, the term 'informal science learning' is commonly applied with reference to activities that take place outside of the formal education system and seek to raise awareness of, interest in and engagement with science and other STEM subjects. The term applies to a wide range of activities and services, delivered by providers ranging from national broadcasters to not-for-profit organisations and sole traders, and available to individuals of all ages.

Although a spectrum of provision exists in terms of its proximity to more formal learning approaches, two broad categories of activity can be identified:

- Provision that seeks to enhance formal science learning and takes place in more formal settings but is categorically different from formal, classroom-based science learning
- A broader category covering provision accessed on a voluntary basis and taking place in formal settings (e.g. museums), informal settings (e.g. in the home) and settings in between (e.g. community centres).

Defining informal science learning

The stakeholder interviews identified a range of attributes that commonly featured in their definitions of informal science learning, including that it:

- takes place outside of the formal curriculum, is non-compulsory and is not formally accredited, and while capable of reinforcing formal learning, this is not its core purpose
- can take place in a range of settings outside of school, although not exclusively – including in museums, science centres, individual's homes and public spaces
- can inspire, stimulate interest in, encourage positive attitudes towards and lead to a more thorough understanding of science
- features learning that can be unstructured, unguided and led by the interests of the individual
- can feature 'learning by stealth', a concept that was mentioned frequently throughout the study and described as "audiences learning without being actively aware of what they are doing".

The provider survey sought to explore these attributes further, testing agreement with a series of statements and showing that:

- more than half the respondents considered that informal science learning should always actively engage learners and be available to people of all ages
- between one-quarter and half felt it should always feature activities that are different to day-to-day formal learning, lead to outcomes that are less prescribed than formal learning, aim to bring about changes in attitudes to science through emotional engagement and start outside the formal curriculum
- fewer than one-quarter considered that informal science learning should always take place in a setting outside school, involve an agent other than the regular teacher, support the efforts of other science learning providers and the achievement of formal education outcomes, and involve learning with a group of the learner's choosing.

However, the study concluded that it was unlikely that any single definition can be developed that would be both sufficiently straightforward to be useful and sufficiently flexible to encompass the diversity of the sector. Any single definition would need to address the areas where significant divergence in opinion was identified – namely, the extent to which informal science learning activities always involved 'free choice participation', could take place on school premises, and should be seen as supporting the formal science curriculum rather than as distinct activities.

The informal science learning sector in the UK

Both the stakeholder interviews and the provider survey illustrated the wide range of organisations that comprise the informal science learning sector in the UK. Responses were received from individuals in organisations providing a range of informal science learning services, either as their main or their secondary area of business. While 'suppliers of STEM services' were the most common respondent group, museums, science and discovery centres, zoos and aquaria, universities, theatre and arts groups, and a range of other organisations provided data via the provider survey.

The diversity of organisations providing informal science learning activities was matched by the range of services offered and the ways in which they were delivered. In many cases larger organisations, such as museums and science and discovery centres, combined centre-based delivery with outreach provision, whereas smaller STEM providers delivered their services directly to schools. The most commonly reported services delivered by respondents to the provider survey were 'in school provision/enrichment' (80 per cent), but 'informal talks/debates', 'holiday or summer school programmes', 'after school provision' and 'science and engineering festivals' were all reported by 50 per cent of respondents or more. Interestingly, the providers commonly reported delivering multiple services, ranging from one to 16 distinct activities and most commonly between three and nine services each.

When questioned on the objectives and outcomes their services were intended to achieve, 'raising awareness' and 'understanding of and interest in science' were the most commonly reported main objectives. The majority of respondents described their main outcomes in terms of making science enjoyable and interesting, inspiring interest in and/or engagement with science, and changing attitudes to and/or raising awareness of the importance of science. A few reported outcomes such as encouraging or preparing individuals for future STEM study, or for future STEM careers, as their main outcomes.

Linking informal and formal science learning

As suggested above, a divergence of views emerged in terms of the extent to which informal science learning can, and should, be linked with and contribute to more formal learning – and the extent to which influencing the formal should be seen as the main role of the informal sector.

This was reflected in the provider survey, where responses to a series of statements on the ways in which formal and informal science learning relate to each other reflected the findings from the stakeholder interviews. While there was considerable agreement that informal learning can stimulate interest in the formal, there was an equally strong view that informal science learning has an inherent value of its own. Responses were more varied on whether the main purpose of informal learning is to support the formal: more than half the respondents disagreed with this statement.

The provider survey explored whether, and how, the informal science learning activities provided supported more formal learning. Almost two-thirds of the respondents

considered that their work supported more formal learning, and three main routes were identified:

- through provision directly or indirectly supporting formal learning – more than half described delivering services or developing materials that directly linked to the formal curriculum, delivered either on or outside school premises and commonly but not exclusively during school time
- supporting formal learning by providing activities to stimulate interest in science – just under half reported providing stimulating experiences not directly linked to the curriculum to reinforce or contextualise formal learning
- providing continuing professional development (CPD) for teachers – around one in five respondents reported providing training to enhance teachers' skills and knowledge and, as one described, bring "informal science learning principles and approaches to the mainstream".

For many providers it was clear that services to support the formal curriculum, both directly and indirectly, were an important source of revenue. Indeed, the ability to show how their provision links with, and enhances delivery of, the curriculum was considered a strong selling point for those working with schools, as well as showing their distinctiveness from formal approaches.

3 Engaging audiences and communities

Data from sources including the Public Attitudes to Science Survey (PASS) and the Wellcome Trust Monitor show that interest in science among the general public is high. According to PASS data for 2011:

- 82 per cent of respondents considered that science is an important part of our everyday lives
- 43 per cent of respondents considered they were well or fairly well informed about science
- half (51 per cent) of respondents reported wanting to know more about science.

Engagement with science can be a passive activity (e.g. watching television) or more active (e.g. visiting a science centre). PASS data showed that television was the most common way in which respondents found out about science (more than half, or 54 per cent), followed by newspapers, the internet and on the radio. In terms of more 'active' activities, in the 12 months before the survey, 25 per cent of respondents reported visiting a zoo, 22 per cent had visited a science museum, and 11 per cent had visited a science and discovery centre, most commonly as part of family groups. In addition PASS showed that 12 per cent of respondents had attended a science lecture or talk and 3 per cent had attended a science festival. The Wellcome Trust Monitor provided data on engagement with science among people aged 14–16, and found that 29 per cent had visited a zoo and 12 per cent had visited a science centre in the 12 months before interview.

Informal science learning – main audience groups

The study fieldwork explored the main audience groups for different informal science learning providers and activities, and found that children and young people aged 5–11 or 12–16 and secondary schools were the most commonly mentioned main audiences, followed by families and primary schools. Children under five, young people aged 16–19 and adults aged over 19 were the least commonly mentioned main audiences.

However, analysis at the level of the individual provider and service showed that providers work with different audience mixes in different contexts. Museums, for example, reported their main audiences as children aged between 5–11 or 12–16 and primary and secondary school groups, but children aged 5–16 are the main audience for holiday provision, and people aged 12–16, adults and families are the main audiences for fixed exhibitions and displays.

Challenging to engage audiences

Provider views on the audience groups most challenging to engage with varied. Some considered that all groups could be reached if the right preparatory steps were taken, whereas others had not considered working with certain groups. The provider survey found that almost seven out of ten respondents had experienced difficulties engaging with one or more audience groups, and the high-level findings suggested that adults aged over 19, families and young people aged 12–19 were the most challenging groups.

When analysed in more detail, it emerged that individuals from disadvantaged areas or in households with low incomes were the most difficult to engage. This linked with the findings from PASS, the Wellcome Trust Monitor and the Family Studies research, which suggested that individuals from lower social grades or households with lower levels of education were less likely to engage with science and informal science learning opportunities. However, the fieldwork suggested that a series of social and cultural factors could also be an influence, dissuading certain individuals or groups from engaging – as one provider described, informal science learning activities were perceived by some potential audiences as “not being for the likes of us”. Indeed, the findings from the study and wider survey work suggested that social and cultural factors may pose greater barriers to engagement than financial barriers – although factors such as transport costs and availability in rural areas can be influential.

The Family Studies research provided several insights into the attitudes towards – and the motivators and drivers for – engagement in informal science learning among young people aged 11–16, including:

- Young people in this age group saw leisure time as a time to have fun and had established leisure time preferences by age 11. Parents saw leisure time as important ‘down time’ and an opportunity for tweens to develop their own interests.
- Drivers for engaging with leisure time activities included personal contacts (friends and other adults), having fun (although this was not always easily defined), being with friends, physical activity and an element of competition (team rather than personal), and an opportunity to debate issues related to their lives.

Principles and practice for engaging challenging groups

When providers were questioned on approaches to engaging challenging audience groups, a series of principles emerged as underpinning effective practice. The principles included:

- making experiences and content relevant to audiences’ interests, experiences and backgrounds, increasing the likelihood of both initial and subsequent engagement and the development of ongoing relationships
- conducting preliminary research with difficult-to-reach audiences, to ensure the accurate tailoring of services and to identify and negotiate social and cultural barriers

- establishing partnerships with other organisations or groups already engaging with the target audience, to help understand audience needs and actual and potential barriers, and to act as trusted conduits between the provider and the audience
- using community outreach methods to engage with target audiences – which, although resource intensive, can lead to embedding an organisation within its community
- ensuring experiences are stimulating, interactive and engaging for participants (particularly for young audiences), to stimulate initial engagement more broadly.

Examples of the above activities are presented in the main report, although the providers consulted considered that no single activity or approach in isolation was likely to be effective in engaging challenging audiences. Moreover, practice suggested that sustained engagement requires a strategic approach, working with challenging audiences through a range of activities over a sustained period of time. The providers showed that it can be possible to engage challenging groups if the effort is made to meet them on their own terms – whether through outreach, virtually or via broadcast approaches.

4 Impacts and evaluation

The research explored evaluation practice across the sector and featured a review of the 'grey literature' collected from providers as part of the study. The review found that:

- Evaluation was commonplace across the sector. The methodologies and approaches used were largely appropriate for the scale of funding available to them.
- Topic coverage commonly included delivery processes, audience satisfaction and attempts to identify the immediate or short-term impacts of interventions, most commonly in terms of impacts on views of and attitudes towards science and potential future engagement with STEM learning or careers.
- Assessments of medium-to long-term impacts on changes in attitudes and corresponding behaviour were rare, however. There were several reasons for this, including budgets rarely being sufficient to support the follow-up work required to identify long-term impact, methodological challenges and the absence of accepted indicators or measures.
- The evidence base for the long-term impact of informal science learning activities in the UK is highly limited. Although more evidence on impact exists from studies in the USA (see the more comprehensive literature review presented in the Stanford/Oregon State report), a significant evidence gap exists for activities delivered in the UK.

The review, and consultations with the stakeholders and providers, also suggested that the sharing of learning from evaluation across the sector was limited. While lessons may be shared between individual organisations or networks of similar organisations, more could be done to encourage the sharing of learning across the sector for mutual gain.

Evaluation activities across the sector

Evaluation activities, methods followed, and barriers and challenges experienced were explored throughout the study. The vast majority of providers (87 per cent) reported undertaking some form of evaluation activity, and 44 per cent evaluated all the services they provide.

Providers most commonly described their evaluation work as formative (91 per cent), with the resulting learning informing service development, and far fewer (15 per cent) described their activities as summative – although this is likely to be an underestimate given the requirements of funders, which emerged as a key driver for four in ten respondents. Other drivers for evaluation included responding to concerns with service delivery. One in five described having annual programmes of evaluation activity.

A range of evaluation methods were described: surveys of users (individuals and teachers) and staff were reported by 98 per cent and 85 per cent of organisations, respectively. Other methods included participant observation, visitor exit surveys, group discussions with users and the analysis of visitor data, each of which were reported by more than 70 per cent of all respondents. However, surveys or consultations with individuals not using provider services were reported less frequently (25 per cent and 32 per cent of respondents, respectively). Where undertaken, consultations with non-users were found to provide helpful insights into reasons for non-engagement and approaches that may be effective in future.

Evaluation studies were most commonly conducted by provider staff, followed by a combination of internal and externally commissioned resources. Solely externally commissioned studies were comparatively rare, and where external resources were used they focused on exit surveys, group discussions and participant observations.

Barriers and challenges

The stakeholder interviews identified a series of barriers to evaluation, which were tested in the provider survey to explore the extent to which they were shared across the sector. The findings showed that the most commonly reported barriers were:

- resource constraints, expressed as a lack of time to evaluate (reported by 80 per cent of respondents) and a lack of funding (76 per cent)
- technical issues, namely a lack of clarity on evaluation methods (reported by 47 per cent of respondents, most commonly relating to assessing impact), and the availability of internal skills and experience (46 per cent and 37 per cent, respectively)
- cultural issues and attitudes within the provider organisation, which were reported in around one-third of cases, included a lack of institutional support for evaluation and limited understandings of the value that it can provide.

Providers had taken a range of steps to negotiate their barriers to evaluation, which included:

- Appointing staff with a specific remit for research and evaluation, although this response was more common among the larger organisations. Even there, several described financial pressures that meant new recruits had to prove their value.
- Using existing staff as ‘internal evaluators’ – where existing duties were enhanced and training provided to support evaluation activities. In some cases this also offered the benefit of engaging delivery teams more closely in evaluation, from developing initial aims and objectives to interpreting and developing responses to the findings.

Methodological challenges were less easily addressed, however, and the providers reported that in addition to the availability of practicable approaches to measuring long-term impact they also faced implementation challenges (most commonly in terms of engaging individuals and schools in the evaluation process and poor response rates to survey questionnaires).

Conclusions and recommendations

This section provides our conclusions and recommendations, structured around the key outcomes set out in the study brief.

1 Scoping informal science learning and its links to formal science learning

The study has illustrated the breadth of services and activities taking place within the UK under the umbrella of informal science learning. These range from work with school audiences, both inside and outside of schools, to the production of television and video programming for mass audiences. The study focused on individuals aged up to 19, but it is clear that participation extends well beyond this group to include individuals of all ages.

The range of provision available in the UK is extensive, and while in-school provision and enrichment was the most commonly reported activity in the survey of providers, other formats – such as talks or debates, science festivals and fairs, and holiday and after-school provision – were also widely described. The sector also embraces the use of new media: gaming and podcasting emerged as mechanisms for both communicating with and engaging specific audiences.

The review of the organisational objectives of informal science learning providers showed that inspiring audiences to take an interest in science and influencing their attitudes towards it were key drivers across the sector. Stimulating audiences to consider further study or careers in STEM subjects were also mentioned frequently. Views on the extent to which providers sought to influence further study or career choices varied – some sought to directly support the achievement of the science curriculum, while for others this link was less direct and more about raising awareness of potential opportunities. This difference was reflected in the intended outcomes reported, which most commonly related to 'stimulating interest and engagement' with science and less frequently (as a main outcome at least) related to further study or career outcomes.

Consequently, a broad spectrum of provision can be identified, which extends from services closely linked to supporting formal provision (where the audiences are schools and pupils) to others that intend to inform, inspire and engage individuals with science more broadly (the audiences for which are members of the general public). This reflects the fact that the sector has developed opportunistically and grown organically, but means that no single theory of learning underpins activity across the sector and there is no single definition of informal science learning. When a series of parameters that can apply to informal science learning were explored with service providers, agreement was strongest for variables around active engagement and the availability of services to individuals of all ages and was less strong for parameters such as location (i.e. outside school), delivery agent (i.e. not a teacher) and supporting formal science learning.

Recommendation 1: Defining the informal science learning sector

To help funders to guide their investments in informal science learning activities in the future, we recommend that funders define the outcomes they are seeking to achieve rather than the delivery methods their providers should use. We suggest two groupings of activity, which reflect the ends of the spectrum between formal and informal learning:

- the first, where informal science learning services are directly and explicitly intended to contribute to the delivery of the formal science curriculum, and where outcomes should be set in terms of enhancing and enriching the curriculum and supporting achievement

and progression for students

- the second, where informal science learning services aim to inspire, enthuse and engage individuals with science, and where outcomes include increasing awareness of, interest in, enthusiasm for and engagement with science among individuals of all ages but progression to qualifications is less relevant.

We believe this distinction would be helpful for funders in setting clear objectives for future informal science learning provision and the outcomes that can be expected, and would provide clarity on what services are trying to achieve rather than the delivery methods employed. However, we stress that investment in both 'curriculum-related' and 'inspirational' activities is equally valid: both have important parts to play in enhancing the scientific literacy of the UK population.

The study also explored the ways in which the informal science learning sector can, and currently does, link with more formal science learning. Some of the providers consulted were keen to highlight the distinction between the informal and the formal and thought supporting the latter should not be the main objective of informal learning. However, consultations across the sector, and the provider survey, found that provision to schools was commonly reported.

A variety of approaches to supporting more formal learning were identified in the study, and it was clear that many organisations involved in the informal sector have existing links with schools, colleges and others with interests in formal learning.

Recommendation 2: Linking informal and formal learning

Here our recommendations relate to how the links between informal and formal science learning can be enhanced for mutual benefit. It is important to note, however, that many teachers already use informal learning techniques with their pupils and take steps to ensure that the value of any interaction with the informal sector is maximised. However, the study also found that in some cases greater value could be added.

It is also important to remember that the decisions on whether to take advantage of informal science learning opportunities are taken by individual teachers and school leaders, and that significant efforts have already been made to improve accessibility of resources and activities (e.g. the STEM Directories and STEMNET).

Recommendation 2.1
When funding programmes designed to link with formal science learning, funders should be explicit regarding their objectives, participant groups, outcomes and the evidence required to show the outcomes have been achieved.

Recommendation 2.2
For informal science learning programmes that are intended to link with formal learning, funders should require the following issues to be addressed in proposals:

- The potential links with the school and college curriculum, to engage teachers, support planning and illustrate the contribution that informal learning can make.
- The role of materials for use in schools pre- and post-intervention, which can help teachers and pupils prepare for and build on informal learning activities. Many providers currently provide such materials but report that their use can be variable. Consequently, consideration should be given to how to maximise the use of such materials by schools.
- How the value of the different experiences that the informal sector can provide, and which cannot necessarily be offered in the classroom setting, can be most effectively

demonstrated to teachers.

- How it can be made easier for schools to take advantage of informal science learning experiences – for example, by providing specific funding to address barriers such as transportation costs.

Not all activities will, or should, include these elements of 'good practice', but proposals should explain why they are or are not relevant to a particular activity.

Finally, services seeking to 'inspire and enthuse' audiences are also widely considered to contribute to individual decision making around continued study and potential careers in science. However, beyond short-term 'intentional' effects there is little evidence in the UK outside the anecdotal for any longer-term and behaviour-influencing impacts. Our recommendations below include how this evidence gap can be addressed.

2 Evaluating the impact of informal science learning

The study found that providers of informal science learning services commonly evaluate the services they provide and that an appetite exists for learning about the effectiveness of provision to inform ongoing service development and improvement. Practices varied considerably across the sector, and while evaluation activities were broadly commensurate with budgets allocated to the services or activities, evidence of the medium- to long-term impacts of informal learning were highly limited. There are a range of reasons for this, including:

- the nature of the activities and the resultant outcomes, which, by definition, can be difficult to capture
- the variable availability of resources, both financial and in terms of staff skills, among individual providers to undertake the type of study that would allow longer-term outcomes to be identified
- the awareness and availability of appropriate evaluation methods and approaches that can be practicably applied across a range of settings, services and delivery approaches.

While many evaluation reports were reviewed as part of the study, the evidence they presented suggested that at least short-term impacts in terms of raising interest in and engagement with science were commonly reported. However, the extent to which these effects were sustained, and resulted in behavioural change in terms of STEM study or careers uptake, remains largely unknown.

Recommendation 3: Evaluating informal science learning

Recommendation 3.1
Our principal recommendation, which is presented with reference to evaluation but has wider implications, is the establishment of a forum for leading funders of informal science learning provision. Convened and chaired by the Wellcome Trust, the aims of the forum should include:

- stimulating discussion among the funders of informal science learning at a strategic level, with a view to providing a coordinating function where no such body currently exists
- developing a strategic approach to supporting informal science learning to guide investment in a coordinated manner across the sector, with enhanced clarity on the aims, objectives and outcomes expected to result

- acting as an advocate for the sector, to exert influence as a collective and communicate opportunities identified
- establishing, as far as possible, common performance management and evaluation requirements, indicators and metrics across different funding streams and services
- supporting cross-sectoral programmes of research to ensure the sector can build upon lessons from the field in the UK and internationally
- enabling funders to account for their investments, where they face similar issues over prioritising investment in a period of wider austerity.

The forum may also consider whether providing funding for informal science learning on a longer-term basis would help support the wider assessment of impact over time. Other practical roles we recommend the forum also consider include:

- offering clarity to providers on what is expected from them in terms of evaluating funded services and making them aware of the range of evaluation guidance currently available across the sector
- providing briefings, and training where appropriate, on what is expected in terms of evaluation and potential approaches when it is a requirement of a funding award
- providing an environment and mechanisms where providers feel confident in sharing the lessons from their evaluation (and wider experiences) for the benefit of the sector.

Membership of this group should include key Government departments (e.g. the Departments for Education, Business Innovation and Skills, Communities and Local Government, Health, and Culture, Media and Sport), the Research Councils, learned societies and large corporate bodies with interests in science learning. The forum should also be able to draw upon the experience and expertise of stakeholders and providers operating in the informal sector to ensure decisions are made on a best-informed basis.

Recommendation 3.2
In addition to establishing common performance indicators and metrics across the sector, the funders' forum, in consultation with appropriate experts, should support a programme of evaluation research to provide an evidence base on the medium- to long-term impacts of informal learning in the UK.

The study found that most informal learning providers struggle to isolate their impact beyond short-term effects (i.e. changes in attitude and intentions to change behaviour at the end of service delivery). Attempts to explore longer-term impacts, for example to identify whether short-term intentions convert into actual change, are rare – not least as the scale and nature of the task requires investment beyond the reach of any single provider. We consider that providing robust and 'nationally credible' evidence of the benefits of informal science learning is a requirement for the sector looking forward, and a shared investment between funders offers the opportunity to do this.

Recommendation 3.3
This recommendation relates to the development of a more coordinated and strategic approach to investment in evaluation studies across the sector. Any studies that aim to explore these long-term impacts will require significant investment, which again suggests a cross-sector and cross-funder approach. However, we believe that funders could use the resources they currently commit to evaluation in a more strategic manner – investing to develop an evidence base for different types of activity to give funders confidence in the efficacy of particular approaches. The current approach, where evaluation can form a condition of contract and which can confuse accountability with evaluation, should be reviewed to enable providers to demonstrate they have spent funding received effectively without the expense of formal evaluation activity. This would allow funding to be directed towards larger-scale evaluation studies, which could make a real contribution to the longer-term evidence base. The forum should work closely with experts in performance

management and evaluation, and stakeholders in the sector, to draw on their collective expertise and knowledge to ensure the resulting studies are practicable and fit for purpose.

Recommendation 3.4
This recommendation focuses on the development of indicators that can be applied in the evaluation of informal science learning. As part of developing a more strategic and coordinated approach to evaluating and investing in services, the funders' forum should lead – again drawing upon appropriate expertise – on the development of a common set of indicators and measures that can be used in evaluating informal learning activities. Any indicators and measures proposed must capture the intended effects of investments and be practicable to implement, proportionate to the funding received and capable of being reported on.

There is a wide range of potential indicators that have already been developed by funders and others to capture many of the elements of informal science learning. These can be drawn upon to inform the indicator development process, and we suggest that a single list is drawn up to allow specific measures to be selected to fit funders' objectives and the activities in question. Below we provide an illustration of the potential indicators that could be applied, although we emphasise the importance of the final set being developed and owned by the forum in line with their wider remit of developing a more strategic approach to informal science learning in the UK.

Indicator	Measure	Data collection approach
Enjoyment of experience	Numbers that report enjoying the experience. What was liked most and least, and why. Interest in repeating the experience or aspects of it.	Collection of quantitative and qualitative data from participants during or after participation (e.g. through surveys, observations, interviews or focus groups).
Increased interest in science	Numbers that report being more interested in science after their experience. Factors that provoked an interest. Numbers that report an intention to find out more about the subject in question. Actual follow-on activity.	Collection of quantitative and qualitative data from participants during or after participation (e.g. through surveys, observations, interviews or focus groups).
Increased intent to study/continue to study STsubjects Actual take-up/ continuation of study of STEM subjects	Numbers reporting intention to study STEM subjects at completion of intervention. Numbers evidencing take-up/continuation of study. Reasons for intentions and actual outcomes.	Collection of data from participants on completion. Follow-up surveys (e.g. six months after completion, after key transition points at ages 14,16 and18). Progression and management data from schools/colleges. Interviews, focus groups with participants.

The table above shows that data collection can combine data collected directly on completion of the service or activity and that collected through longitudinal or follow-up

approaches, which will have different resource requirements and so should be applied appropriately.

In addition, baseline data should be collected to show change following the intervention. This may not be possible or practicable in certain circumstances, so the questions used to elicit the data may need to be specific on views before and after the service (although baselines can be estimated from initial 'show of hands' questioning and other techniques, which can be followed with audiences at the start of the intervention).

3 Engaging challenging-to-engage audiences

The study explored common audience groups across the sector, as well as the particular audiences that providers of informal science learning found challenging to engage. The suggestions from providers on challenging-to-engage groups supported the notion that financial deprivation was a key barrier to engagement, although this review also showed that the picture was complex and that a range of interlinked and wider social and cultural factors can deter involvement in activities. Level of education (both young person and parental) was an important factor here, as were ethnicity and limited aspirations (to a lesser extent), which in many cases combined to limit engagement.

Many different opinions on engaging challenging audiences, and approaches found effective in doing so, were described. Some providers reporting 'designing in' breadth of participation from the outset. For others the challenge was to attract new audiences for existing and new services, and the use of outreach approaches was common as a means of engaging more challenging groups and as a means of delivering services to them.

A series of approaches and principles were identified as underpinning efforts to engage audiences that providers found challenging. In many cases the lessons from these experiences resonated with good practice in engaging with audiences more widely. Approaches that actively engage the audience groups for which they were intended, that offer experiences clearly differentiated from standard school practice and/or that may be less explicitly linked to proscribed learning outcomes are also factors that were reported as attractive to all audiences, not solely the challenging to engage.

Our recommendations for engaging challenging audiences are provided below.

Recommendation 4: Understanding and engaging challenging audiences

Recommendation 4.1
Providers should consider the extent to which there may be groups within their respective communities who do not currently use their services but who could benefit from them. Acknowledging that engaging all members of their communities not using their services may require significant resources, providers should seek to:

- identify groups who are currently underserved by comparing data on their existing audiences to the demographics of their local communities
- undertake research with non-user and challenging-to-engage groups to identify why they do not attend, the type of activities that would be attractive to them, and the most appropriate means of promoting their services to facilitate engagement
- develop new provision or amend aspects of existing provision to address barriers to engagement
- review the effectiveness of the new approach followed, with a view to 'mainstreaming'

any revised approach or service.

The funders' forum also has a part to play in delivering this recommendation, by considering and resourcing pilot approaches to researching and engaging with hard-to-reach groups based on effective practice elsewhere.

Recommendation 4.2
In developing new approaches to engage potentially challenging audiences, providers should consider the principles for reaching challenging-to-engage groups identified in the study and proactively apply them in planning service delivery by:

- ensuring that services and their content are relevant to audiences' interests, experiences, backgrounds and needs – as well as being stimulating, interactive, engaging and culturally attuned to the circumstances of their intended target audiences
- establishing partnerships with other organisations or groups already engaging with the target audience in question
- employing community outreach approaches with challenging audiences, with a view to raising awareness of opportunities, addressing actual and perceived barriers to access, and engaging to cultivate long-term relationships.

However, providers should consider whether it is realistic for them to serve all the potential users of their services or whether to simply prioritise resources towards specific audiences in their communities. Here preliminary research is important in identifying and prioritising target groups, as well as identifying their specific barriers and how they should be addressed.

Recommendation 4.3
Looking beyond challenging-to-engage groups, the Wellcome Trust, through the funders' forum, should support a programme of research to develop a more detailed understanding of demand and participation in informal science learning among different audiences. While this should draw on the experiences of different providers, improved knowledge of challenging-to-engage/underserved audiences would be a key element in promoting a more strategic approach to informal science learning provision nationally. This information could then be used to develop appropriate informal learning services locally and nationally.

Specific areas for additional research include:

- Undertaking a more comprehensive audit of informal science learning providers to understand in more detail the nature of their current audiences for different services offered, the audiences they currently find challenging to engage, and their experiences of approaches to engage challenging groups to provide a broader understanding of issues and good practice across the sector.
- Extending the Family Studies research undertaken as part of this study, using a qualitative research approach with tweens aged 12–16, and including fathers as well as mothers, to capture any differences in their views.
- Undertaking similar exploratory ethnographic work with children of primary school age (5–11), to explore the drivers and barriers to engagement as they are developing.
- Expanding the young people's element of the Wellcome Trust Monitor to include people aged 12–13, increase the sample size for the 12–18 group and cover additional topics such as how tweens access music and video, their use of social media, and sources of information on careers and subjects to study. Paired parent and child interviews should be included to explore how parental views and behaviour relate to their tweens' views and behaviour.

Recommendation 4.4
The Trust and other funders should consider setting expectations or soft targets for

participation in funded activities by specific socio-demographic groups. This could be considered on a pilot basis, to include a programme that aims to stimulate providers to develop sustained links with their communities and share the learning from their experience with the sector more widely.

Wellcome Trust

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