Science beyond the classroom

Analysing the UK Science Education Community: The contribution of informal providers

Executive summary
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Executive summary

The aim of the work reported here has been to give an overview of the support that the informal sector provides for learning and engagement with science. In addressing this goal, we have taken the view that engagement with science and the learning of science occur both within and without schools. What is of interest is not who provides the experience or where it is provided but the nature and diversity of opportunities for science learning and engagement that are offered in contemporary UK society. Thus in approaching the work we have taken a systems perspective and looked at informal providers in particular, although we have also sought the views of those working in schools.

Methods and approach

The work reported here is based on: a set of 51 interviews which were conducted with informal and formal providers of science-based experiences across the UK; a survey of informal providers for which 196 responses were obtained; a reduced form of the same survey with schools, for which 23 responses were obtained; a systematic review of the academic literature; a further review of the existing 'grey' literature; and feedback from two symposia hosted by the Wellcome Trust.

In approaching the work, we have sought not to look at individual organisations and providers but to see science learning and engagement as a *system* of provision. To emphasise that perspective, we have drawn extensively on ideas in community ecology and compared the system of provision to that of a managed forest such as the New Forest. Doing this has enabled us to focus on what feeds the system, the extent to which it is self-sustaining or needs good management, the diversity of provision within the system, and potential imbalances that might need addressing.

Our view, based on existing research, is that there is already extensive evidence that individuals are engaged and develop much of their understanding and knowledge outside of the classroom. We begin by summarising key elements of this evidence. For instance, there is the well-known 'summer learning gap': research has shown that while students from low socioeconomic status (SES) backgrounds gain as much as high SES students over the course of the school year, they fall behind significantly during the summer, when they are not in school. Then there is the accumulating evidence of the enhanced educational attainment by children who attend pre-school where they are offered a diversity of unstructured, informal experiences. While school does matter in helping students develop formalised and general principles, it is the experiences outside the classroom that are essential to give meaning, relevance and context to the ideas that schools offer. The two are thus interdependent, and any society that provides one without the other has a less functionally effective educational system.

Major findings

Our first task was to try to identify the number of providers. Our initial hypothesis was to divide the community into 18 different sectors. However, our analysis of the survey suggests that there are at least 50 distinct niches within the system, while our analysis of the literature suggests that there are approximately 31. Thus the picture that emerges is of a diverse and rich community, although some of the niches are small and not readily recognised. Our analysis of which age groups they serve, when compared with the corresponding breakdown of the UK population (see figure 3), showed that young children under the age of five and adults are under-served. One consequence of this is a widely held perception that many of these institutions are 'for kids' – a perception which threatens their viability and opportunities to engage more adults with science. An analysis of goals and priorities, both for schools and for a range of informal providers, shows surprising unanimity where all sectors converged on just a couple of outcomes – 'make science enjoyable and interesting' and 'inspire a general interest in and engagement with science'. Whether all sectors are comparably effective at attaining such goals is unknown, but the common goal does point to sharing of a common enterprise.

Attempts to ascertain whom providers saw as important within their community tended to produce, not surprisingly, a 'me-first' response. However, all of them saw schools as being important. However, just as the trees in a forest are highly conspicuous, our view is that this finding is because of the existence of so many schools and because schools act as a gateway to the 5-to-19-year-old audience who are the focus of this study. Of particular note in the responses to the survey was that while most organisations reported collaborating extensively with one or more other members of the community, schools did so much less frequently (see figures 6 and 7). Moreover, whereas most members of the community reported collaborating with schools very frequently, schools reported collaborating with informal providers much less frequently. This finding leads us to ask whether schools are in some senses too dominant within the community, with an inward-looking nature that threatens their vitality as much as it does the other members of the community. Some organisations within the system emerged as both highly connected and highly reciprocal in their interactions. Our analysis revealed that science festivals, science and discovery centres and museums appear to be keystone sectors within the broader science education community.

Our work next looked at the knowledge that supports the system – effectively, what might be considered an important nutrient for feeding the system, enabling it to build on what has been done before and avoiding repetition of previous mistakes. Using a keyword search of major academic databases, over 4000 articles were found, which were reduced to a subset of 553 that were considered relevant to the field. An analysis of this literature would suggest that:

- There does exist a substantive body of empirical work and scholarship that addresses the field of learning science in informal contexts, but there are notable gaps.

- The field does have a theoretical base that draws on many of the ideas developed in research in formal education.
- There are a few researchers in the fields whose names arise with sufficient frequency to suggest that they have built a body of recognised scholarship.
- Research and scholarship in the field has been conducted within a very large number of disparate disciplines, making it difficult to locate and identify.

When we tested whether the 20 most highly cited elements of this literature were known to the field. At a symposium of key providers in the field, hosted by the Wellcome Trust in May 2012, we found that the modal (most common) value for how many individuals had read each publication was zero and the modal value for how many recognised but had not read each publication was two. The most read article had been read by less than 50 per cent of these key practitioners (11 people).

One response to this finding is that the field is much more reliant on the grey literature than other fields, but our analysis of a sample of this literature would lead us to question this view. Much of the literature lacks a research question, would appear to be over-reliant on surveys, fails to include the instruments used to gather the data (making it of little use to other providers), and is very difficult to find if the exact title is unknown. If this literature is considered valuable, why, we ask, has the community not established a central database and formal mechanisms for sharing it more widely? Another response is that the community is much more reliant on an apprenticeship model of learning akin to that used in medicine or teaching. However, if so, the community has failed to establish recognised means of acquiring such training. Moreover, other professions recognise the value of scholarship in helping them to identify new methods and theories that drive their thinking.

To answer these kinds of questions and others, the 51 interviews were transcribed and systematically analysed. This showed in more detail some of the values that members of the community operate with. For instance, informal providers are disposed to define themselves by how they are distinct from the formal community, while some in the formal community have a lack of respect for the work of the informal community. Such values are somewhat ironic when the survey would suggest that they both share common goals. The data also suggest that informal community members are overly reliant on ideas about learning and ideas about science that are somewhat simplistic. However, it must be said that the same point could probably be made about many working in the formal sector. Nevertheless, the findings point to a need for a better knowledge of salient literature and better systems of training. Another major feature of these data was the focus on engagement, making science ‘fun’ with the intent of teaching ‘science by stealth’. Our concern here is that the literature would suggest that any enduring interest in a topic not only needs an initial stimulus but also needs to be sustained, and that the community has too much focus on the former at the expense of the latter. We also ask whether attempting to cloak or hide the difficulties of learning science is ultimately

counterproductive and whether there is a lack of a vision of what can make science engaging.

These interviews also explored how the providers were addressing the needs of disadvantaged communities and engaging them with science. Few examples of good practice within the community were offered and there was less evidence that they are shared. Many providers saw schools as a conduit for addressing such concerns as they serve all communities. Give the enduring policy concern about the future supply of STEM professionals, it was surprising that more concern was not expressed about attracting and engaging more girls, women and other under-represented groups to science. From a systemic view, it is important that everyone in the community is provided for in some way – however, that does not require every provider to serve everyone. Ultimately, the responsibility for ensuring that the system addresses the needs of a diversity of audiences must be that of system managers rather than individual providers.

Recommendations

These arguments have led to the following recommendations:

Recommendation 1: There is need to build a stronger sense of a common identity among all providers of science education or educational experiences that support science learning and engagement. To this end, all those who contribute to any form of education, communication or engagement in science need a set of goals to help define their purpose and cultural contribution to society – essentially a manifesto for STEM. The Wellcome Trust should therefore establish a group of stakeholders and providers of STEM education to develop a set of goals and aims for STEM providers. These should be published as a short pamphlet and in a variety of formats.

Recommendation 2: Making the case for the value of the contribution made by informal providers of science education experiences requires better data on who works in the system, what are their goals and who they see as their audience. A central database needs to be established that registers such providers. The Wellcome Trust should establish such a database. Providers should be required to register their details as a condition of any funding and more broadly encouraged to do so by building a view that the data in this system are vital for defining the importance and contribution of the sector. As much of the data as possible on this database should be publicly accessible.

Recommendation 3: The Wellcome Trust should establish a small panel of major funders of out-of-school learning experiences whose responsibility would be to take a system overview. The aims and goals of this panel should be to:

a. commission reports and research on the functioning of different parts of the system

b. consider and review the strengths and weaknesses of the overall provision

c. take a strategic review, considering where the field needs to be strengthened, who or what is best capable of addressing that need, and how it could be funded

d. help define what are the priority aims and goals of the system as a whole.

While the focus of this panel would be on the informal sector, it would need to take a systemic view of the whole system that supports STEM learning. Hence, this panel should seek, as a priority, representation from the Department for Education and the Department for Business, Innovation and Skills so as to build a comprehensive system-wide view.

Recommendation 4: The science learning and engagement system needs support to build its knowledge base of which outcomes to measure and the ways in which they might be measured. Currently, the work on evaluating the system and building knowledge is undertaken by a large diversity of people, far too many of whom inhabit other communities. The system therefore needs to establish one or more centres for research, evaluation and training, with a particular focus on non-classroom-based STEM learning, whose function would be:

a. to help build our knowledge of how to measure the outcomes of participants' experience

b. to conduct reviews of relevant research and produce summaries for the field

c. to foster collaboration between the institutions and providers that occupy different niches so that the system can support the building of interest and the engaged science learner

d. to develop a range of training programmes for new and established members of the community who work in non-school-based provision of science learning and engagement.

To provide an incentive for providers to build and support the development of such centre(s), all bids for funding should be required to show how they have used, or intend to use, the expertise provided by these centre or alternatives.

Recommendation 5: The community needs to build on the knowledge that it is generating from its experience – that is, it needs to become a learning community. In addition, it needs to develop and keep up to date with contemporary thinking about the nature of science, practices in formal science education, and ideas about learning, motivation and engagement in the educational literature. A number of mechanisms are suggested which would encourage the community to become a learning community. These are:

a. working with other funders to establish a concordat that requires all bids for funding to show where they build on the literature and what people may have done before

b. requiring all bids for funding to show how and what they would contribute to the existing knowledge base and how such knowledge would be shared, at least within their own niche if not more widely

c. producing short focused summaries of relevant research in PDF format, which could be sponsored by the Wellcome Trust, ensuring they have status and authority within the community (a good model is the summaries of findings produced by the OECD PISA programme)

d. exploring other ways to encourage practitioners to publish and to use the existing knowledge base

e. exploring ways of offering certification and professional development for individuals working in this field, such as by establishing a Wellcome Trust fellowship for the informal sector that is competitive and enables individuals to be released to undertake a programme of professional learning.

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