Discover materials science and engineering in primary schools

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discuss the relevance of materials science and engineering (MSE) to primary science and how they support its study

Figure 1 A group of Discover Materials Ambassadors who deliver outreach sessions

The future is what you make it, but it's also what you make it out of

Materials science and engineering (MSE) involves understanding how materials behave and how to select an appropriate material for any given application based on its properties. The scope of material properties is vast and includes characteristics such as *mechanical properties* (how much force it takes to break a material), *thermal* and *electrical conductivity* (how well a material conducts heat and electricity respectively) and *chemical properties* (how a material reacts with its surrounding environment, a great example being the rusting of iron nails). It is fundamental in the development of the world we live in, through its instrumental role in the continued transformation of areas such as sustainability, power generation, transport and medical science.

The National Curriculum specifically refers to 'Materials science' throughout key stage 2 (ages 7–11) and, as such, offers a fantastic opportunity to support teachers in delivering curriculum-linked content, and to engage with pupils before their science education is split into the three main scientific disciplines, and design and technology. Beyond this point in the curriculum, MSE is no longer explicitly referred to, at significant detriment to the discipline, and therefore many people do not know or appreciate the fundamental importance of this subject. In fact, anecdotal evidence from school engagement events suggests that a greater proportion of key stage 2 pupils know what MSE is than key stage 4 pupils (ages 14–16).

Who we are and our objectives

Discover Materials is a collaboration between a group of UK university Materials Science Departments (Figure 2), the Henry Royce Institute for Advanced Materials, and other members of the materials science community. It was set up in 2017 by the heads of materials science and engineering departments, with a remit to increase the number of applicants to MSE undergraduate courses compared to the more traditional science and engineering disciplines (see *Weblinks* – IOM3, 2021a).

Materials science ● **Interdisciplinary** ● **CPD**

Figure 2 Discover Materials partner universities

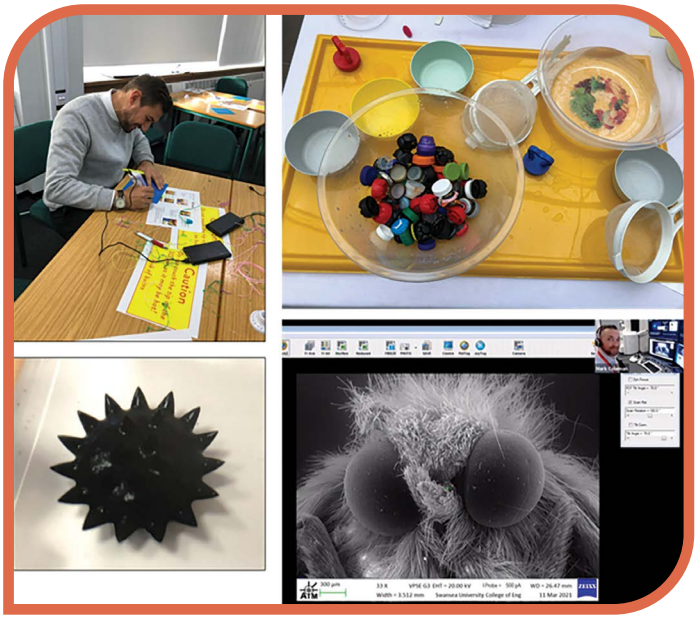

Figure 3 Examples of our in-school activities

In order to identify when, and through whom, to engage with pupils, Discover Materials commissioned a survey of 16- to 18-year-olds in 2020 (see *Weblinks*: IOM3, 2021b). The survey highlighted a large proportion of respondents were influenced by advice from teachers and families when it came to selecting programmes of further study and that interest in the subject content, and perception of difficulty, were also key factors. As a result of this survey, the scope of the programme has shifted from targeting primarily 16- to 18-year-olds to younger age groups as well as their teachers and families, which has been reflected in the design of the Discover Materials website (see *Weblinks*).

We now work with a range of partners to help inspire the next generation of materials scientists and engineers. A key partner is the Henry Royce Institute (a partnership of ten UK universities who support world-class research in MSE) and we also collaborate with other partners such as the Institute of Materials, Minerals and Mining (IOM3 – the professional institute for materials, minerals, mining and associated disciplines). Through outreach grant funding we have also worked with the Royal Society of Chemistry and the UK Space Agency.

Resources, activities and CPD opportunities

We constructed our website with schools in mind and it showcases MSE by providing a range of resources and useful continuing professional development (CPD). It includes:

- Resources suitable for pupils, families and teachers, including information about the applications of materials in everyday relatable scenarios (e.g. mobile phones) to help inspire the next generation of materials scientists and engineers.
- Careers advice for pupils.
- Details of upcoming events.
- Information about the members of Discover Materials.
- Profiles of our Discover Materials Ambassadors.
- Contact information for the group.

We also host a range of activities that are suitable to run directly in primary schools or in the home. These are great for lesson or project ideas and a list can be found on our 'Activities for primary schools and families' website page (see *Weblinks*).

Examples of our online resources include a 'Materials scavenger' hunt, which challenges children to look for objects made from different materials and then think about what the object is used for and why that specific material was chosen. Another example is our 'Break a beam' activity, which involves making different beam designs using the same number of building bricks and finding out which design is the strongest. Some of our other activities use very affordable equipment such as magnets ('Separating recycling' activity) and microscope lenses that clip onto smartphones and tablets ('Surface investigator' activity, Figure 4).

We also have a specific feedback function on the website allowing teachers to provide comments on the activities, which has helped us to regularly update and improve the content to make classroom delivery more effective. This has allowed us to tailor some activities to specific groups of pupils, such as those with diverse needs.

In addition to the content we have created ourselves, our website signposts visitors to other fantastic MSE content developed elsewhere, such as the complementary resources on the IOM3 website with activities aimed at 5- to 11-year-olds (see *Weblinks*).

Activity delivery

The Discover Materials Ambassadors (Figure 1) are a group of volunteers across our CPD network who can deliver outreach sessions at schools, or at other events such as science festivals and museums. They have access to a range of equipment and eye-opening experiments

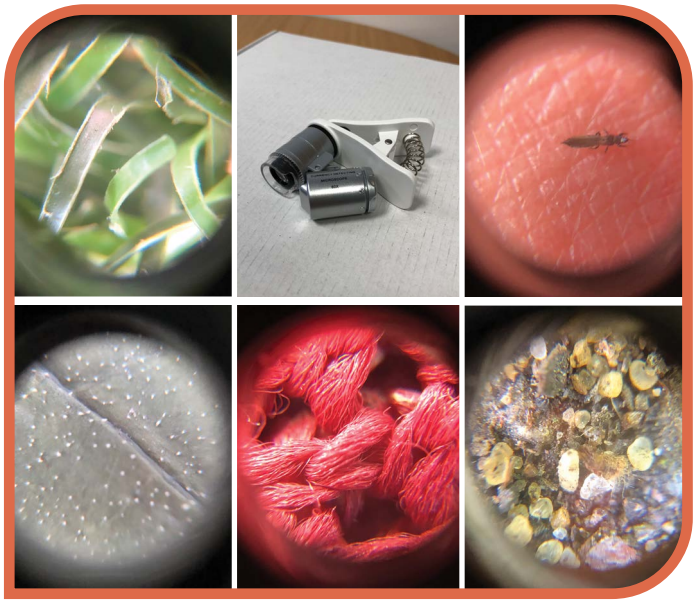

Figure 4 Images taken using the clip-on microscope

that they can bring into schools such as impact and tensile testers, used to demonstrate the mechanical properties of materials (i.e. how they break). In classrooms these are often used to test how different chocolate bars and sweets perform, depending on their internal structure. Other mind-bending examples include smart materials (such as ferrofluids and shape-memory alloys), hydrophobic (water-repellent) materials and many more classroom-friendly activities and challenges. All these resources are available for free for schools and other community groups.

Ambassadors are also encouraged to develop their own activities to run in schools. Some examples include an investigating crystals workshop and an escape-room type activity aimed at years 5 and 6 (ages 9–11), which is full of puzzles that pupils have to solve through carrying out a series of MSE-based experiments.

If we cannot make in-person visits to schools ourselves, we send the relevant materials, consumables and documentation in advance for a teacher to run the session, with one of our ambassadors joining via video conferencing. For instance, one recent session that we ran was with two classes of year 2 pupils (ages 6–7) in which we looked at surfaces of different materials using a microscope lens connected to a webcam. They also investigated wettability, where the pupils placed water droplets on glass microscope slides that had been half coated in wax to investigate how water can behave differently on different surfaces. We have also lent schools boxes of equipment, where the class is led through a series of linked experiments by pre-recorded videos and an accompanying instruction booklet. This method of interaction has been used to great effect in our most recent project entitled 'Let's move to the Moon' (funded by the UK Space Agency).

It has also been possible to welcome groups of pupils into university laboratories; for example, last year a group of 50 year 6 and 7 students (ages 10–12), who were taking part in an Energy Sparks activity, visited one of our partner institutions (Figure 5). The pupils spent several hours at the university learning about renewable energy, making their own solar cells and constructing rudimentary batteries from household items.

In addition to in-school sessions, we have run stands at a range of public science events, from large science fairs such as the national Big Bang Fair (at the NEC, Birmingham) and the Great Exhibition Road Festival (London) to smaller family-friendly festivals such as Malvern Science in the Park and Sci Fest (Wolverhampton) (Figure 6).

We have used some of these smaller events to disseminate science kits to children and families, such as the CoCoBioMater Bag that was funded by the Royal Society of Chemistry. This provided 120 children with their very own science kit and booklet of activities to explore materials and even make their own bioplastics at home using sodium alginate (from seaweed) and inclusions such as eggshells. The resources developed for the CoCoBioMater Bag, and other similar projects we have assembled, are freely available on our website.

We are currently developing these science box style kits into science club activities, such as the CoCoMicro Box

Figure 5 School visits to university laboratories

Figure 6 Montage of our activities at festivals

project that we ran in 2021, which involved 140 boxes of science equipment being given to year 6 and 7 pupils for them to carry out a series of investigations over the school summer holidays. Some of the activities we deliver can help pupils work towards earning a CREST Award, and we have previously worked with science clubs to enable this. An example of a session we ran involved using spin coaters to change the surface properties of materials, which the pupils then examined.

How teachers can get involved

We acknowledge that the most effective way that we can help pupils engage with materials science and engineering is by supporting teachers to deliver relevant content and be comfortable in doing so. With this in mind, we have previously run an online teacher event. In advance of this, we sent teachers packs of equipment so attendees could follow along with two activities that we talked through during the session. In addition to the activities, we hosted an expert panel who took questions from the participants. The event was a big success; we received very positive feedback and plan to run a similar session again in the future.

We aim to develop activities and offer CPD sessions to support teachers in the delivery of the materials science components of the primary and secondary curriculum in an inspiring, exciting and practical way. One of our partner institutions is currently working with a local school to develop resources to support non-science specialists with the delivery of the year 5 (ages 9–10) materials topic, which will then be made available through the resources pages. We actively encourage teachers, careers advisors and parents to get in touch via our website.

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Weblinks

Activities for primary schools and families: https://discovermaterials.co.uk/resource/activities-for-primary-schools-and-families

Discover Materials: https://discovermaterials.co.uk

Energy Sparks: https://energysparks.uk/activity_types/127

IOM3 (2021a) *Developing a materials world – why (not) us?* www.iom3.org/resource/developing-a-materials-world-why-not-us.html

IOM3 (2021b) *Developing a materials world – what do students think?* www.iom3.org/resource/developing-a-materials-world-what-do-students-think.html

IOM3 *Resources for 5–11*: www.iom3.org/careers-learning/schools-outreach/resources-for-5-11.html