nesta
creative investor

"We need more 'real science' in our school science lessons. Science learning needs to inspire our future scientists and citizens by being challenging and creative."

Science enquiry learning matters – not just to science education, but to the future of scientific research and literacy in the UK. Its status in our schools is a matter of political and public concern.

NESTA's research shows how science enquiry learning can help to engage and motivate learners, and provide them with new perspectives on science. The full report showcases some of the NESTA funded and supported projects that represent innovations in science enquiry learning, alongside those supported by other organisations. It includes well-known initiatives such as Science Year and Planet Science, but also less familiar projects. The full report is available from NESTA.

Science enquiry learning is a type of science education that involves students raising questions and hypotheses, testing and revising these hypotheses based on experiments and observations, and presenting the conclusions to others. It is a form of experimental and investigative science learning that can support students to develop their understanding of the methods, outcomes and uses of science. As this implies, genuine science enquiry learning relies on a degree of student autonomy. Science enquiry in schools is not the same as the activities undertaken by working research scientists. However, as one form of learning amongst many, it can offer an insight into 'real science'.

NESTA's research indicates how important it is that science enquiry learning occupies a prominent place in school science education.

What the research says

The UK needs more 'real science' in its school classrooms.
Our economic competitiveness and capacity for innovation depends on it. We need to nurture new talent in scientific research and in the teaching of science, and support this research with a more informed public understanding of scientific processes.

There are worrying signs that our future capacity for innovation is threatened by the current state of science education in schools.
There has been an increasing recognition, shared between practitioners and policymakers across the UK nations, of the need to make science learning more engaging and enjoyable. This has resulted in developments in curriculum design, teacher training and professional development, and in new teaching and learning resources.

However, significant problems remain. Too often teaching and learning in science fails to convey what many scientists regard as the intellectual discipline and excitement of exploring the unknown, indeed, the 'wonder of science'. The continuing imbalance between content and investigation in school science tends to convey that science is about only a fixed body of known facts. This neglects that it is also about the processes and skills necessary to discover these facts. This can give a misleading impression to learners.

Evidence from NESTA's projects, and those of other organisations, suggests that science enquiry learning could play an important role in reversing the apparent decline in young people's interest and engagement in school science.

NESTA's projects illustrate that science enquiry can engage students to develop their understanding of the processes of science, as well as the content of scientific knowledge.
By giving students experiences that are closer to the reality of science, enquiry can encourage the capabilities and confidence to pursue further science learning, even amongst those students who are disaffected and in schools in challenging circumstances. These projects show that investigations and practical experiments can increase motivation, develop thinking skills, support collaborative working, and connect learning about science to the 'real world'.

Teachers recognise that science enquiry is a crucial element of science education.
However, the opportunities for science enquiry learning, in particular more open-ended forms of practical experimental work, continue to be inhibited by familiar issues. These include resourcing, time, concerns about health and safety, and the perceived restrictions of curricula and assessment systems. Clearly more open-ended learning can be difficult to organise, manage and resource. Yet this research shows that more innovative and creative approaches to science education can support the achievement of curriculum learning objectives, and encourage learners to consider further study in science.

Without opportunities for science enquiry, students may fail to develop skills and aptitudes such as the ability to collate, synthesise and analyse empirical evidence, and to ask critical questions. These are important academic capabilities. They are also life skills that are broadly applicable to virtually every field of learning or decision-making. Indeed, it could be argued that they are fundamental to active citizenship in a highly technological society.

There are worrying signs that our future capacity for innovation could be threatened by the current state of science education in schools

This is why we need further innovation in this area. Collectively we must develop new approaches and methods. Most of the funding and support currently directed at innovations in science enquiry learning comes from charitable trusts, rather than government or local authorities, and tends to be developed in universities. This support is valuable, but it can be fragmented and lead to a lack of co-ordination.

It is also important, if innovations are to be sustainable, that teachers and schools are involved from the outset.
This is because many innovative projects are ultimately reliant on the vision, enthusiasm and energy of individual teachers and school science departments – and their ability to overcome the numerous practical difficulties that exist in developing, implementing and managing such innovations. It is especially important that innovative teachers have the active support of senior school managers.

More sustainable innovations in this area would make it likely that students' engagement and motivation will be converted into longer-term gains in attainment.
This would provide the evidence to reassure teachers and schools that more science enquiry activities can be 'justified' within the perceived constraints of their national curricula, assessment systems and available resources.

To this end, more support needs to be devoted to the dissemination, transfer and testing of the innovations that are developed.
Similarly, more evaluation and monitoring of outcomes and impacts needs to be built into innovations. This situation is not unique to science enquiry learning. The state of innovation here can be used to raise important questions regarding the opportunities for innovation in science education as a whole and indeed the education system more generally.

The danger of the present situation is that the UK's generally high reputation in scientific research will decline – and with it, our future capacity for productivity and innovation, and our ability to develop new solutions to social and environmental issues.

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Recommendations

Science enquiry learning needs to be at the core of science education in the UK. Where it is currently weak or under threat, it should be encouraged and enhanced, especially through the development of innovative approaches. Collectively, we need to harness the potential of science enquiry to engage and motivate learners and to counter the misleading impressions of science that can be generated by an over-reliance on more 'traditional' forms of learning. However, at the moment, even though there are numerous innovative projects in science enquiry which aim to do just this, too few are able to demonstrate that their practices have been adopted more widely within the system.

For national policymakers:

- → Recognise that unless science enquiry learning as practised in schools is enhanced and extended there are likely to be negative consequences for scientific research and public scientific literacy in the UK.

- → Promote more effectively the opportunities for science enquiry learning that already exist within the established national curricula.

- → Challenge the misapprehensions that may exist amongst teachers and schools around risk, health and safety, and potential litigation relating to the practical experimental aspects of science enquiry learning.

For funding and support organisations:

- → Create and support more opportunities for partnership with other similar organisations in order to coordinate the development of innovations and the transfer of professional knowledge of innovations in science education.

- → Generate a stronger evidence base on the effectiveness of science enquiry learning by supporting innovative projects to evaluate their outcomes and impacts.

- → Support the sustainability of innovative projects by devoting more resources and support to dissemination, transfer and testing after the formal funding period has ended.

For teachers and schools:

- → Take advantage of the opportunities in recent and forthcoming curriculum developments in the UK nations to enhance science enquiry activities.

- → Network with other teachers, schools, subject associations and funding organisations in order to learn about new approaches to science enquiry.

- → Consider the key elements of effective practice in innovative projects in science learning, such as dedicated project managers, making links to topics beyond the traditional science curriculum, making connections with the real lives of learners, and securing the commitment of senior management within schools.

More generally, all those involved in the education systems of the UK nations - from national policymakers and agencies, to local authorities and teachers - need to consider more systematically the nature of the barriers and enablers to the transfer and adoption of innovations in learning within the education system, and develop policies and resources that will encourage and support the dissemination and testing of innovations.

Real science
Encouraging experimentation and investigation in school science learning

NESTA Research Summary

NESTA and science enquiry

NESTA invests directly in innovations in science education. This investment has been a significant one: over £1.6 million for projects promoting science in schools and £3.5 million for projects supporting the public appreciation of science.

In particular, NESTA has supported a wide range of innovative projects related to science enquiry through our Learning Programme and through other initiatives. A selection of these projects is described briefly below.

- The Planet Science website, which began as the portal for Science Year, includes teaching ideas and materials as well as quizzes, interactive games and practical activities for students and parents (there are also three e-newsletters aimed at primary and secondary students and teachers).

- The Planet Science Outreach programme, which worked with schools in England with low levels of achievement in science and focused on increasing students' enthusiasm for science and improving their attainment.

- Digital Science, in partnership with the Wellcome Trust, which aims to bring together curriculum developers and teachers with digital experts, designers and programmers to develop digital resources targeted at aspects of the newer science curriculum that are intended to address the desire of students to learn about science in the context of its relevance to contemporary society.

- Einstein Year, co-ordinated by the Institute of Physics to celebrate the 100th anniversary of the publication of Einstein's seminal papers in 1905, includes projects funded by NESTA.

- The Genetic Futures programme in 2003, marking the fiftieth anniversary of the discovery of the structure of DNA, which was intended to inform and elicit the opinions of young people about the role of genetics in the modern world. Other sponsors included The Medical Research Council (MRC), The Department for Education and Skills (DfES), The Royal Society, The Biotechnology and Biological Sciences Research Council (BBSRC), and the Department of Trade and Industry (DTI).

- The Motivate project, which focused on mathematics principles using real world scientific examples in order to enrich the mathematical experience of the students by providing them with experience of collaborative working on mathematical tasks and of communicating reports of their work to an audience.

- Creative Space, organised by CapeUK with support from the Centre for Science Education at Sheffield Hallam University, which formed project teams in order to design school based projects which investigated scientific concepts through the exploration of 'space'.

- The Brain Games project, which involved primary and secondary students learning about parts of the brain and their functions by working with mentors who were science postgraduates and science explainers based at the science learning centre Explore-At-Bristol.

- 'Flipside' magazine, which demonstrates that it is possible to communicate relevant science topics to teenage audiences in an engaging way.

NESTA, the National Endowment for Science, Technology and the Arts, aims to be the strongest single catalyst for innovation in the UK. In everything we do, we are seeking to increase the UK's capacity to fulfll its vast innovative potential.

We invest in every stage of the innovation process; providing early stage seed capital for promising ideas for new products and services; investing in UK talent to ensure it stays in the UK; and experimenting with new ways of engaging the public in science, technology and the creative industries.

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