

Encouraging Open-ended Practical Work in Key Stage 3 Science



Summary:

This best practice case study is a project in which a science centre (At Bristol) worked in collaboration with teachers and students from local schools to develop open-ended practical work/inquiry in Key Stage 3 (11-14year olds) science teaching.

Aims:

The aim of the project was to improve pupils' enjoyment of, enthusiasm for and attainment in science via open ended investigations. Also to give students opportunities to explore possible answers

to scientific questions that are related to real-life via practical, hands-on experimentation.

This was achieved through:

- Genuinely open-ended and investigative practical work that will be motivating and interesting for pupils (and teachers)
- A series of school based hands-on workshops that bring real science into the classroom
- Emphasising hands-on investigation, thinking skills and class discussion to inspire pupils to learn and fully engage with science
- A focus on teachers' skills, ensuring that the project will have an impact on students beyond this project

The aim of the project was to improve teachers' knowledge and understanding of key scientific concepts and processes and supporting teachers to develop their skills of planning and running open-ended practical work and to carry this out in their classrooms.

This was achieved through:

- Working in partnership with science education specialists
- Providing opportunities for teachers to discuss key scientific concepts and processes with experts in the field
- The use of innovative hands-on exhibits as learning tools to develop teachers' scientific enquiry skills
- Providing opportunities for teachers to work as peer-buddies in schools with support from Learning Advisors and At-Bristol staff
- Providing the opportunity for teachers to apply their knowledge and understanding of key scientific concepts and processes during the gap-task.

Main activities:

Teachers worked with science centre educators at the science centre to create and plan open-ended investigations for their students. The science centre educators then supported the teachers to carry out these plans in the classroom. Students carried out open-ended practical work that was closely linked to the curriculum and to their everyday experiences of science. Theory was carefully integrated into the practical sessions by the teachers and assessment was through observation and conversations with students about the key scientific concepts they were exploring.

Narrative:

In this project a science centre (At Bristol) worked in collaboration with teachers and students from local schools to develop open-ended practical work/inquiry in Key Stage 3 (11-14year olds) science teaching.

The project was developed in response to changes in the curriculum outlined above. The project capitalised on At-Bristol's expertise in hands-on exhibits and discovery based learning, and used their portable, interactive, out-reach exhibits as an original and



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inventive learning tool to support teachers' skills and confidence in open-ended investigatory work. Teachers co-developed open-ended practical work with science educators/communicators from At Bristol. The science centre educators then supported the teachers to carry out these plans in the classroom. Students carried out open-ended practical work that

was closely linked to the curriculum and to their everyday experiences of science. For example one investigation asked students "What makes a good toothpaste?" Students were given the ingredients for making toothpaste, explored and recorded the properties of each of the substances and investigated what happened when the substances were combined in varying amounts. Another group of students investigated "How does bread rise?, experimenting with different yeasts and sugars. In another classroom students were giving the task of designing a boat that would support a certain downward force, using a selection of raw materials and a paddling pool to test their prototypes. This sort of investigation empowers the students by giving them a degree of freedom to come up with their own results. They are not simply replicating the results of others; they are not directed towards a pre-determined outcome. Each group of students may use underlying scientific theories to come up with slightly different solutions to the problem presented to them. Theory was carefully integrated into the practical sessions and made explicit by the teachers. Throughout the investigations, teachers supported the development of students' experimental skills including: hypothesis testing, observation, repeat measurements, and controlling variables. Students also modified their processes to refine and develop their outcomes. Assessment was through observation and conversations with students about the key scientific concepts they were exploring. Teachers also engaged in professional inquiry, videoing and reflecting on their open-ended practical investigation lessons, with the support of their peers and the At Bristol science educators.

End user:

Key Stage 3 students

Involved actors: Teachers, teacher-trainers, science centre educators

Location:

Local secondary schools Science centre, At Bristol

Connection with the curriculum: There was a significant change in the National Curriculum for England, Wales and Northern Ireland at Key Stage 3 (KS3) and Key Stage 4 (KS4) phased in from September 2008, with a much greater emphasis being placed on the processes of science (Key Concepts and Key Processes).

This change resulted from of a number of drivers related to the quality of science education in schools, the need for future scientists in an increasingly technology dominated world and for increasing engagement between science and society. This project was developed with this in mind and aimed to provide a fully supported CPD model that enabled

teachers to develop their pedagogic skills, therefore leading to a sustainable change in practice.

Through the use of interactive exhibits teachers examined how the underlying science principles of three themes: Energy, Forces and Structures, could be explored through open-ended scientific investigation. Teachers focused on their students' experimental skills including: hypothesis testing, observation, repeat measurements, and controlling variables.

Languages available:

English

Where to find the application or case:

www.azteachscience.co.uk/projects/encouraging-open-ended-practical-work-in-key-stage-3-science-at-bristol-science-centreinnovative-project.aspx
www.at-bristol.org.uk/

Evaluation parameters:

The evaluation of this project will focus on the three key project objectives and it will investigate the impact of the project beyond the scale of individual

participants, at a department and whole school level. Evaluation will consider the following questions:

How effective has the project been in improving pupils' enjoyment of and enthusiasm for science?

What impact has the project had on pupils' attainment in science?

How effective has the project been in developing teachers' skills and confidence in teaching open-ended practical work?

How effective has the project been in improving participating teachers' knowledge and understanding of key scientific concepts and processes?

How have the main project outcomes been disseminated within the wider department and/or school? How has this impacted on teaching and learning in other classes?

Duration:

Several months

Teachers' Competencies

1	subject matter/content knowledge	x
2	nature of science	x
3	Multidisciplinary	x
4	knowledge of contemporary science	x
5	variety of (especially student-centred) instructional strategies	x
6	lifelong learning	x
7	self-reflection	x
8	teaching/ learning processes within the domain	x
9	using laboratories, experiments, projects	x
10	common sense knowledge and learning difficulties	x
11	use of ICTs	
12	knowledge, planning and use of curricular materials	x
13	Information and Communication Technologies with Technological Pedagogical Content Knowledge	x

Mapping best practices with main principles



1. Building interest in natural science phenomena and explanations:

The hands-on open-ended investigations are engaging and enable the students to develop an understanding of natural science phenomena by 'doing'. Teachers are careful to ensure that the explanations are made explicit and are discussed.

2. Building up informed citizens: Students understanding the nature of Science & Science in society:

All of the open-ended inquiries were related to students' lives and involved everyday items such as bread or toothpaste. This highlights to students the science that can be found in daily life. Undertaking their own practical, open-ended investigations allows students to develop an understanding of the nature of science and what scientists might do when trying to find solutions to problems.

3. Develop multiple goals:

- understanding big ideas in science including ideas of science, and ideas about science
- scientific capabilities concerned with gathering and using evidence
- scientific attitudes

The practical work in this project includes ideas of science and about how science and scientists work – as detailed above. Throughout the investigations, teachers supported the development of students' experimental skills including: hypothesis testing, observation, repeat measurements, and controlling variables.

4. Understanding students' concepts and learning style about of science phenomena:

Theory was carefully integrated into the practical sessions by the teachers and assessment was through observation and conversations with students about the key scientific concepts they were exploring. This enabled both students and teachers to address misconceptions.

5. Relevance of the content to daily life of students:

All of the open-ended inquiries were related to students' lives and involved everyday items such as bread or toothpaste. This highlights to students the science that can be found in daily life.

6. Understanding science as a process not as stable facts. Using up to date information of science and education:

The very nature open-ended practical work is that not all students are directed towards a pre-determined outcome. Each group of students may use underlying scientific theories to come up with slightly different solutions to the problem presented to them. They may also modify their processes to refine and develop their outcomes.

7. Activities for gaining knowledge, not for entertainment, nor for simple imitating of results:

In open-ended practical work students they are not simply imitating results, they are developing their knowledge of scientific theories by applying them to investigations that do not have a predetermined outcome.

8. Doing science: experimenting, analyzing, interpreting, redefining explanations:

Throughout the investigations, teachers supported the development of students' experimental skills including: hypothesis testing, observation, repeat measurements, and controlling variables. Students also may also modified their solution to develop a better ones.

9. Assessment: formative ~ of students' learning and the summative ~ of their progress:

Teachers make explicit the learning that is happening within the investigations and students reflect on this. Whilst the students are involved in practical work teachers talk to pupils and listen to pupils talking to each other, matching their understanding to level descriptors.

10. Cooperation among teachers and with experts:

Teachers worked with science centre educators at the science centre to create and plan open-ended investigations for their students. The science centre educators then supported the teachers to carry out these plans in the classroom.