CREST AWARDS

INVESTIGATIVE PRACTICAL SCIENCE IN THE CURRICULUM: MAKING IT HAPPEN

How to embed open-ended extended investigative practical work into the secondary science curriculum

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Contents

About this guidance pack

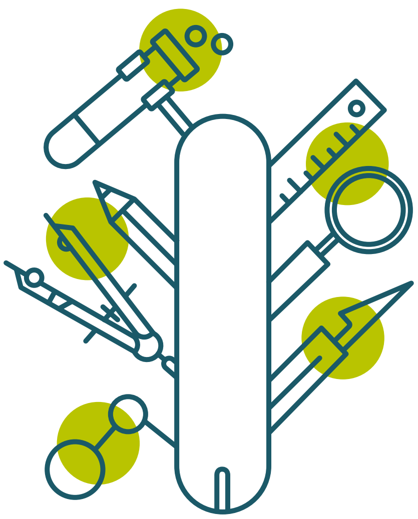
"The curriculum should evolve to include more requirements for extended projects in investigative science. In particular, an extended project should become an embedded, compulsory part of post-16 study for all students on pre-university courses. For those studying a majority of science subjects, the project should have a science focus."

Gatsby, 2017

A pilot study, funded by the Gatsby Charitable Foundation, was carried out during the academic year 2019-2020 to support ten secondary schools across England to plan and deliver CREST Awards within curriculum time. This is a guidance pack designed to explain how to embed open-ended extended investigative work within the curriculum using the experience from these pilot schools.

What is meant by 'open-ended extended investigative work within the curriculum'?

Benchmark 8, in the Good Practical Science Guide (Gatsby, 2017), recommends that *"students should have opportunities to do open-ended and extended investigative projects"*, yet less than 25% of students have the chance to do so (Cramman et al., 2019).



The key definitions for this pilot were:

- **Open-ended** – an investigation for which there is no predetermined outcome (Gatsby, 2017). There are different levels of 'openness' in investigative work. In this pilot, as in the work carried out by Dunlop et al. (2019), projects *"that are open in at least one of the six dimensions, problem/question, theory/background, procedures/design, analysis of results, communication of results and conclusions, identified by Buck, Bretz and Towns (2008), are considered open-ended."*
- **Extended** – spread across one or more weeks (Gatsby, 2017).
- **Investigative** – tasks in which students design an experiment to test a given question, carry it out and interpret the results, all within a fixed time period (Gatsby, 2017).
- **Within the curriculum** – taking place during science lessons, student non-contact time and work experience, without teachers and technicians having to supervise during lunchtimes, breaktimes, holidays or after school.

Over 30,000 students achieve a CREST Award each year, with the majority being completed outside of the curriculum; this adds to the teacher and technician workload. The pilot project was designed to see how feasible it was to complete practical investigative CREST Awards within science curriculum time to reduce this workload and maintain the positive impact for students. Ofqual (2019) suggests that the CREST programme is potentially suitable for *"integration within the framework of the reformed assessment arrangements"* or CPACs. Dunlop et al. (2019) also recommend that students' open-ended investigative projects are recognised with CREST Awards.

The British Science Association (BSA) coordinates, delivers and oversees a number of different projects and programmes aimed at engaging more people with science. This includes the CREST Awards programme, which has been used by schools for over 30 years to provide teachers with a framework of activities to engage students in running their own projects.

Committed to strengthening practical skills in STEM in UK schools and colleges, Gatsby Charitable Foundation has funded the BSA to run this pilot and produce this guidance. The support of UK Research and Innovation has also been key to the delivery of this project.

Why should students have the opportunity to do open-ended and extended investigative projects in the curriculum?

To further develop the practical and manipulative skills of students and...

To improve student motivation

"Practical work emerges as the top motivator for studying science, and students who are traditionally less engaged in science are more likely to want to do more." (Kantar, 2020)

"The chance to do extended research helped me learn more and be more interested in science." (Year 9 student)

To provide students with a wider view of the scientific methods, leading to less 'cookbook' practical work and a more realistic impression of how scientists work

The current curriculum has a tendency to promote a narrow view of the scientific method, leading to formulaic practical work and giving a false impression of how scientists operate (Erduran et al., 2020). Indeed, most practicals still only require students to follow pre-prepared instructions and to analyse data (Cramman et al., 2019).

"The project showed me there was more than one way of carrying out an investigation which I didn't think about before" (Year 9 student).

"This was the first time I had carried out preliminary work and seen why it was important" (Year 13 student).

"I liked being able to carry out my own research to learn more about the topic and consider how my investigation may be relevant to modern science" (Year 13 student).

To extend investigations beyond an individual lesson to effectively sequence and retrieve procedural knowledge

"Students' perceptions of practical work are that experiments occur within a few moments" (Cramman et al., 2019).

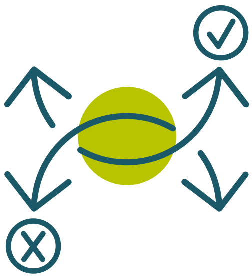
"When asked what a good practical science experience was for students prior to arriving at university, higher education staff commented that exposure to longer experiments, experience of independent working and having the opportunity to understand the rationale behind practical work would improve students' preparedness for university" (Cramman et al., 2019).

"You don't get many opportunities to do blue sky science; to show students what science is really like and that there is no quick answer from a half hour practical" (James, Head of Biology).

To know that there is not necessarily a correct outcome to practical work

"Students' perceptions of practical work are that experiments … have (usually) predetermined outcomes that are either right or wrong." (Cramman et al., 2019)

"The preliminary investigation really helped to improve my work as it showed up the flaws in my original method." (Year 13 student)



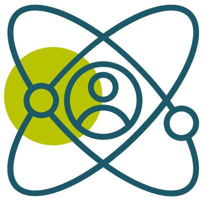
To value practical work as a learning experience in itself

Higher education staff have found that students only value practical work that contributes towards their final examination grades (Cramman et al., 2019).

"I chose the experimental method myself and I think this made me more invested in the project" (Year 13 student).

"This investigation gave me a wider interest in aspects of science. It is an added extra" (Year 13 student).

To develop independence and resilience



Open-ended and extended investigative projects can help students develop a range of higher-level qualities including independence, self-esteem, tenacity and a sense of scientific identity (Holman et al., 2016).

"I had to balance my workload, chewing off a bit at a time" (Year 13 student).

"Learning to work independently really for the first time during practical work was scary at first and enlightening at the end" (Year 13 student).

"It was an easy practical, but lots of things could go wrong and did. They had to sort them out. I loved seeing them be creative" (Amanda, science teacher).

"When we actually left them to it to make their own decisions it was incredible" (Polette, KS5 coordinator).

To provide equality of access for investigative work

By embedding this work into the curriculum all students have access to science, rather than just those who attend an extracurricular STEM club. One pilot school commented that the students who participated were not natural scientists and would never have attended after school clubs or science-based enrichment. Prior to the project they had limited opportunities to work completely independently in a practical environment. The students appreciated the fact that the CREST Award was valued outside of school and that they could use it for university applications.

To reduce the number of hours outside the curriculum for teachers and technicians

By completing the open-ended investigative practical work during lesson time rather than in STEM clubs, the number of hours teachers and technicians work outside the curriculum is reduced. Integration of CREST Awards into the curriculum involves tweaking current practice rather than wholesale change.

"We have not deviated from our curriculum plan particularly; rather, we have delivered it differently and the students have enjoyed it and learned more" (Nicola, science STEM lead).

"Using the CREST Award helped the students link lots of different skills and content together through a context rather than standalone lessons. It took approximately two more lessons than my normal route through this topic but students' understanding and skills improved more" (Sarah, STEM coordinator).

How to embed open-ended and extended investigative projects in the curriculum

Share

Introduce to stakeholders (e.g. SLT) the concept and benefits of doing a CREST Award alongside the assessment of practical skills within the curriculum.

Complete a costing overview and present to budget holders. Check the CREST website as funding is often available.

Plan

Register for an account on the CREST site and follow instructions.

Develop a teacher timeline for completion of the Award and identify milestones to measure progress.

	Guidance	Research	Practical	Write up	Total (hours)
BRONZE	3	4	3	10	
SILVER	7	15	8	30	
GOLD	10	40	20	70	

- Which area of the curriculum will be used as a focus for the CREST Award?
- What core knowledge must students know in advance and when will it be taught/refreshed?
- What practical skills, techniques or procedures may be required by students and have these been taught?
- Is there a pre-existing exam board or CREST resource which can be adapted to guide students in designing an open-ended investigative project?
- When is the best time to carry out the laboratory work required in the scheme of work?
- What level of Award is likely to be targeted and how will time commitment be allocated?
- What resources and equipment may be required?
- Can outside agencies (STEM ambassadors, universities, etc.) support the students with this area?
- How will the CREST Award be assessed and does this involve teacher time?

Teach

Teach the core knowledge, practical skills and techniques required for both the curriculum and the CREST Award criteria.

> “The implementation plan we set out at the start was crucial to the success of the project. I was able to keep track of where we should be each week.”
>
> **Jackie**, STEM coordinator

Student research

Provide CREST student profile booklets and Bronze workbooks or Silver/Gold student guides.

Agree how students will work (in small groups or individually).

Highlight the requirement in the student profile for student reflection on their role in the group.

Suitable resources can be provided to support but not limit the creativity and open-ended nature of the investigation.

Risk assessments checked.

Student action

- Relevant project idea and question generated by students.
- Background to the project researched and a range of possible approaches taken. Research referenced appropriately.

Practical work

In-laboratory assessment of practical skills completed (e.g. CPAC).

Student action

- Preliminary work completed by students and changes/decisions made.
- Most appropriate equipment, techniques and data collection processes demonstrated by students.

Report & reflection

Completed assessment of written practical skills by teacher.

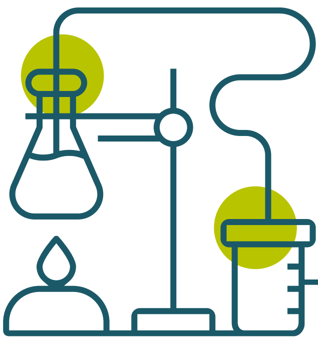
Student profiles signed by teacher.

Student action

- Student report and profile completed.
- Criteria for CREST Award cross-checked.
- Personal reflection completed.

CREST Bronze Award projects assessed by teacher(s). Student profiles and a work sample uploaded to CREST.

CREST Silver and Gold Awards are externally assessed. Student profiles and all student work uploaded to CREST.



Investigative practical science in the curriculum: How the pilot schools made it happen

What are CREST Awards?

CREST is a nationally recognised scheme designed to inspire young people to think and behave like scientists and engineers. CREST gives young people the chance to choose their own subject and methodology when completing their hands-on investigation. Secondary students can complete Bronze, Silver and Gold Award projects.

TOP TIPS

for successful implementation

- Choose an open-ended investigative project which is closely linked to your current curriculum. Tweak or expand what you already do.
- Plan to use homework and student independent study as part of the project time, e.g. research and report writing.
- Have a planned teaching route through the project, with any links to examination board specific criteria, e.g. CPAC, PAG, BTEC.
- Consider the procedural and content knowledge students require before they start planning in order to be successful.
- Encourage students to write up as they go along, rather than write a full report at the end of the project.

Why do CREST within the curriculum?

- To learn and retrieve procedural knowledge
- To develop independent and resilient students
- To motivate students who enjoy practical work

"It was interesting to have free reign and see what worked and what didn't."

Year 13 student

Encourage the students to use the workbook (Bronze) and student guides (Silver and Gold). This will help to structure the writing and ensure the criteria are considered.

Do not underestimate the guidance students need in writing up their projects, particularly at KS3.

Take it slowly – try it with one class and work through any teething problems.

Encourage preliminary work to enable students to adapt their method and let them run with their ideas first before stepping in (provided they are safe).

Make use of the CREST criteria from the beginning; 11 out of the 15 criteria need to be met to achieve the Award.

Make local contacts with universities, workplaces and STEM ambassadors to help act as mentors, particularly for Gold Award projects.

Familiarise yourself with the assessment criteria during the planning stage, particularly 'implications for the wider world'.

To enable students to take pride in their practical work

To give students an understanding of how real science works

To produce confident students in the laboratory

Who needs to know?

- Senior Leadership Team (SLT)
- Head of department
- Paired teachers
- EPQ coordinator
- Technicians
- Students

Essential documents

- Student profile
- Assessment criteria
- Student workbook
- Generating questions for CREST

What is involved when embedding open-ended investigative practical work into the curriculum?

A-level

Schools in the pilot study embedded open-ended investigative practical work into the curriculum either by extending a required practical or adapting a CREST resource to the A-level curriculum content, in order to extend and apply knowledge. Due to time constraints Bronze and Silver CREST Awards were most likely to be used, unless students were also studying the Extended Project Qualification (EPQ), where the project was extended by individual students to allow for dual entry (EPQ and Gold CREST Award).

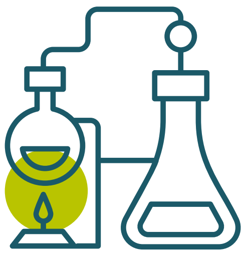
All participant schools mentioned the importance of teaching the essential procedural knowledge and basic practical skills, e.g. how to use specialist equipment or carry out a statistical test, before or during the planning stage of the project. The practical work carried out for the CREST Award can be used to assess the following Common Practical Assessment Criteria (CPAC): 2b, 2c, 2d, 3a, 3b, 5a and 5b for AQA, Eduqas, Pearson (Edexcel) and OCR.

Schools made use of a range of required practicals (RP) including:

Biology

The use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth.

Students completed the required practical and were then given the opportunity to expand the experiment to investigate the prevalence of antibiotic resistant bacteria in their local environment. The project was linked out to various topic areas in the specification, including immunity, natural selection, and the use of statistics as well as microbiology. Students completed a mixture of Bronze and Silver Awards. See case study on page 18.



Chemistry

Qualitative analysis of organic functional groups.

An adaptation of the CREST resource 'Detecting food fraud'. Students were supplied with a number of samples in order to determine whether they had been contaminated by any of the organic groups in Practical Activity Group 7 (PAG 7).

“It encouraged the more reluctant students to apply their knowledge to the real world.”

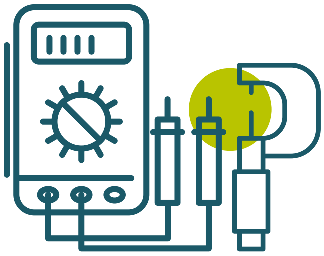
Anjna, lead practitioner and i/c Chemistry

> “As I was doing this as an assignment for my course it was not extra.”
>
> Year 13 student

Chemistry

The preparation of an organic solid and test of its purity.

Normally this RP would be completed in Year 13, but the teachers in the pilot school changed the teaching order to accommodate the practical in Year 12. Students initially made aspirin, starting with oil of wintergreen. This enabled the teacher to scaffold the practical skills and talk students through the process. Once they were familiar with the process the students carried out research to identify potential areas of investigation. There were a variety of projects covering topics such as recrystallisation, changing the acid catalyst and the bioavailability through a viscous membrane. See case study on page 16.



Physics

Determination of resistivity of a wire using a micrometer, ammeter and voltmeter.

The pilot school adapted the CREST Silver resource ‘How steady is your hand?’ to link it to KS5 electricity, resistivity, current and potential difference as well as Required Practical 5 (RP5). Students were taught the practical skills and knowledge and completed RP5 in the normal way. They then undertook the CREST Award as an extension to the practical and as a means of applying their knowledge, understanding and skills. The students completed a Bronze Award (10 hours in total with approximately 5 hours of practical work). See case study on page 14.

OCR PAG 12

Research skills particularly lends itself to open-ended investigative practical work as it encompasses investigative approaches and research.

The students completed a Bronze Award (10 hours in total with 4-5 hours in the laboratory) based around the measurement of photosynthesis in pondweed, which they researched to decide their main focus (e.g. concentration of carbon dioxide or light intensity). After planning their practical work students carried out a preliminary experiment and were given time to evaluate and improve their plans before carrying out the investigation. Evidence was used for assessment against the CREST criteria and CPAC requirements. See case study on page 12.

A-level Biology case study

CREST Bronze, CPAC and OCR A-level Biology

Amanda Jones, science teacher

Beaumont School

An extension of Practical Activity Group 12 (PAG 12): Research skills - Apply investigative approaches to the measurement of photosynthesis in pondweed.

Amanda introduced the concept to the students and explained how the CREST Award complimented the PAG 12 requirements. Students undertook research to decide their main focus, for example the concentration of carbon dioxide or light intensity. After planning their practical work students carried out a preliminary experiment and were given time to evaluate and improve their plans in response. Students were incredibly creative in their choice of practical work, for example investigating the impact of oil spills on the rate of photosynthesis.

School context

Beaumont School is a comprehensive academy, with a mixed cohort between the ages of 11 and 18. There are just over 1,300 students on roll with approximately 8% Pupil Premium. There are three Year 13 classes for A-level Biology, each containing 14-16 students.

Who participated?

16 Year 13 students studying OCR A-level Biology.

> It was an easy practical, but lots of things could go wrong and did. They had to sort them out. I loved seeing them be creative.

Amanda, science teacher

When did they do it?

In the Autumn term of Year 13, completing the Award by Christmas. In-class allocation was as follows: 1 hour introduction to CREST, including how to reference and use statistics to analyse data; 2 hours for preliminary practical work; and 2 hours for the practical investigation. Students completed written work and research outside of curriculum time.

Perceived benefits to the students

Many students chose to work independently, which was probably one of the first times they had the opportunity to do so. Some students enjoyed being in control of their investigations from start to finish.

> The preliminary work really helped me to improve our method as it showed flaws in our original plan.

Year 13 student

> It was interesting to conduct preliminary experiments in order to find out the most efficient method. I liked learning more about the topic and its applications to the wider world.

Year 13 student

Who needs to be on board?

Amanda said that her technician was *"fantastic"* having *"warned him in advance that it was open-ended and there may be last minute requests."*

Barriers and how they were overcome

Some students were a little reluctant to do something which was not directly on their examination. In the beginning they asked 'how much time is this going to take up?', 'what will we not get as much teaching on?' and 'will we finish the course?'. Some students asked if they had to do it. There was one student who was really worried about it; the student was probably one of the least confident practically as well. It was probably the students who were not planning to do science after A-level who proved most reluctant. To overcome these barriers, Amanda explained the crossover between the CREST Award, the specification requirements and PAG 12.

Perceived benefits to teaching and learning

Running the PAG 12 investigation as a CREST Award actually made the class take it more seriously. Prior to A-level students were used to knowing what the expected practical outcomes should be. By carrying out preliminary work they could identify how to improve their methodology; this was a turning point for both Amanda and the students. Amanda will run Bronze in this way for Year 12 next year.

Top tip for teachers

- Have tight deadlines and stick to them to ensure all students know what is expected
- Let students run with their ideas first before stepping in
- Use the student workbook from the beginning

A-level Physics case study

CREST Bronze, CPAC and AQA A-level Physics

Sarah Heggie, STEM coordinator

King Edmund School

An extension of Required Practical 5 (RP5): Determination of resistivity of a wire using a micrometer, ammeter and voltmeter.

Sarah decided to adapt the Silver CREST resource 'How steady is your hand?' so students could carry out a Bronze Award. She linked it to electricity, resistivity, current and potential difference in the specification as well as RP5.

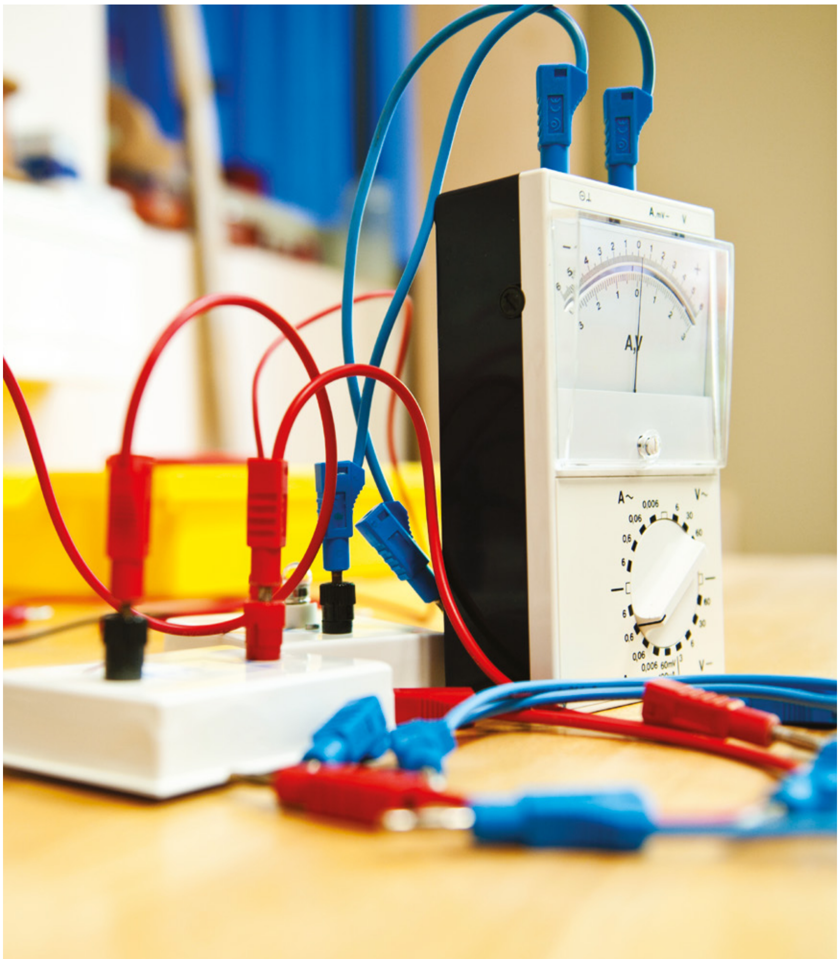
Sarah taught students the practical skills and knowledge prior to completing the practical work. Students completed RP5 in the normal way and undertook the CREST Award as an extension to the practical and as a means of applying their knowledge, understanding and skills.

School context

King Edmund School is a comprehensive academy, with a mixed cohort between the ages of 11 and 18. There are around 1,500 students on roll, with approximately 30% Pupil Premium.

Who participated?

Two Year 12 students studying AQA A-level Physics.



> "Using the CREST Award helped the students link lots of different skills and content together through a context rather than standalone lessons. It took approximately two more lessons than my normal route through this topic but students' understanding and skills improved more."
>
> **Sarah**, STEM coordinator

When did they do it?

Sarah felt that the inclusion of a CREST Award probably only added a couple of extra hours of teaching to her normal plan. Research took 5-6 hours and was completed in stages for planning, evaluation and improvements to the practical work. Some of this was completed at home and some in lesson time. The practical work took approximately 5 hours, which equated to the length of time Sarah would normally have spent on RP5. The evaluation took approximately 2 hours of lesson time.

Perceived benefits to the students

In Sarah's experience, students can find the electricity topic challenging and a little dry. The chosen investigation added a bit more fun to the topic. She felt lots of practical techniques were used and practiced during the CREST Award which helped to apply and embed understanding of key concepts. Sarah felt that students' key practical skills and knowledge had improved as a result of the investigation.

Who needs to be on board?

The Head of Physics needed to be on board; she had experienced CREST Awards before so was keen for this to happen. The Head of Science and the science technicians were also important.

Barriers and how they were overcome

Year 13 students were coming to the Year 12 practical lessons for revision, so whilst they didn't do the project they were still present and learning too. Assessments and tests can also interrupt the normal flow. The CREST resource itself needed adapting first as well to ensure that there was sufficient demand for A-level, as it was a Silver Award targeted more towards 14-16 year olds.

Perceived benefits to teaching and learning

There would have been a similar route through the specification but doing the CREST project knitted everything together. For example, Sarah taught students how to measure current and then later they used this in the CREST project, whereas normally this would have been a standalone lesson. The chosen CREST Award linked to RP5 really well. Sarah felt that CREST engages students and provides a different context to a unit of work, as there are lots of aspects running through it concurrently. Sarah delivered knowledge more as a topic that ran over a number of interlinked lessons, rather than as standalone lessons.

Sarah is keen to continue to incorporate CREST into her A-level teaching next year because it has been of benefit to the students.

Top tip for teachers

Have a planned teaching route through the project, including how it links to CPAC skills and particular specification content.

A-level Chemistry case study

CREST Silver, CPAC and AQA A-level Chemistry

Jackie Hardaker, STEM coordinator

Oaklands Catholic School

An extension of Required Practical 10 (RP10): The preparation of an organic solid and test of its purity. Investigation into the synthesis of aspirin, including purification by recrystallisation and determination of its melting point.

Students initially made aspirin, starting with oil of wintergreen. This enabled Jackie to scaffold the practical skills and talk students through the process. Once they were familiar with the process the students carried out research to identify potential areas of investigation. There were a variety of projects covering topics such as recrystallisation, the acid catalyst and the bioavailability through a viscous membrane. Normally RP10 would be covered in Year 13, so Jackie and her partner teacher changed the teaching order to accommodate the practical in Year 12.

School context

Oaklands is a Catholic comprehensive school and sixth form college, with a mixed cohort between the ages of 11 and 18. There are just over 1,300 students of mixed background and faith, with approximately 20% Pupil Premium.

Who participated?

Year 12 students studying AQA A-level Chemistry, with 20 completing at least a Silver CREST Award. Some students are using the project at Gold level as their EPQ project.

“The technician has been one of the biggest supports. I don't think we would have pulled this off without him – he has been fundamental. He helps students think through new ideas and the students feel supported. He has built relationships with them and aids with advice on safety. He has been really invigorated by the STEM and CREST activities.”

Jackie, STEM coordinator

When did they do it?

The Chemistry students would normally have 2 hours of contact time per teacher per week. This was increased by 1 hour a week to accommodate the CREST Award programme.

Perceived benefits to the students

Jackie noticed an increase in engagement with the curriculum from the students. She found they had become more confident when manipulating equations and setting up complex apparatus. They were more likely to ‘have a go’ and more of a two-way interaction developed between the students and teacher. The students' resilience improved since much of the responsibility was placed on them and they had to plan ahead and inform the technician of their requirements in advance.

“In years gone by, the students were very much waiting for us to come to them and prompt them. It's nice that they are asking us. I sense that they are developing a passion for chemistry which is great.”

Year 12 student

The students seemed less apprehensive about organic chemistry.

Who needs to be on board?

Head of department, partner teacher and science technicians.

Barriers and how they were overcome

Jackie wanted to get to Silver but had only 4 hours a week, so time was the biggest barrier. She believes that Bronze would have been very easy and that students would not have been as interested in completing a CREST Award at this level.

Equipment availability was also an issue, so the school used the small grant to purchase extra lab glassware. The school only had one piece of equipment for measuring melting points and two vacuum pumps. This meant some students used their lunchtime to measure melting points, but this would have happened as part of RP6 anyway.

Perceived benefits to teaching and learning

Normally Jackie and her partner teacher would cover this topic area in Year 13. As a consequence they have resequenced the teaching. Jackie found that the students liked completing the organic chemistry to this level in Year 12. This format enabled the students to view organic chemistry in context and reduced the amount seen in previous Year 13 teaching programmes. Jackie is going to repeat the CREST Award with the new Year 12 and would like to do this on an annual basis.

Top tip for teachers

Get going with the practical aspects as quickly as possible. Invest time at the start in getting students organised and familiar with the paperwork and use the student profile from the beginning.

A-level Biology case study

CREST Silver, CPAC and AQA A-level Biology

James Allen, Head of Biology

Helston Community College

An extension of Required Practical 6 (RP6): The use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth.

James taught students the basic skills and knowledge needed for the required practical. Students completed RP6 in the normal way and were then given the opportunity to expand the experiment to investigate the prevalence of antibiotic resistant bacteria in their local environment. Students collected their own samples to compare with each others' and the results from peer-reviewed papers.

The project was linked out to various topic areas in the specification, including immunity, natural selection and the use of statistics, as well as microbiology.

School context

Helston Community College is a comprehensive academy, with a mixed cohort between the ages of 11 and 18. There are just over 1,300 students on roll with approximately 18% Pupil Premium.

Who participated?

14 Year 12 students studying AQA A-level Biology.

> “To look at evidence and form your own conclusions is a really important skill regardless of whether or not you want to go on to do science in later life. So, I think that helping students to develop that skill is key to them being successful humans. That's the more important thing for me – to be an individual that can actually function in the world. If we don't do that then we've failed.”
>
> **James,** Head of Biology

When did they do it?

One lesson per fortnight during the first term; one-sixth of the total teaching hours. Then approximately 10-15 minutes of each lesson with James for the remainder of the year. In addition, lessons on statistical tests and other relevant topic areas supplemented the CREST Award-specific sessions.

Perceived benefits to the students

Students looked critically at their own work, as well as the work of others, and were able to use evidence to form their own conclusions. James felt these were important skills, particularly in the current climate, where being able to interpret conflicting information is vital regardless of whether or not students want to study science in later life. He felt that students were also gaining the skills they needed to be successful in their examinations. By Christmas students had become much more independent in their approach to practical work.

Who needs to be on board?

The partner teacher, head of department, headteacher and science technicians.

Barriers and how they were overcome

Initially James introduced the CREST Award as a practical research project and asked students to investigate various methods independently – they struggled to do this without support. As the majority were Separate Science GCSE students, James assumed they would remember the practical from GCSE Science. He found that he had underestimated how competent they would be. Students needed step-by-step support through the process before they became independent.

Conscientious students worried about spending time on a project which did not directly contribute to their examinations. To overcome this issue James explained how completing the Award embedded and applied knowledge and understanding from the specification.

Perceived benefits to teaching and learning

It stimulated James to resequence the curriculum to support learning of key topic areas and equip students with skills to both pass the examination and become more capable scientists.

James is integrating CREST into his curriculum for the next academic year.

Top tip for teachers

Start really simple – assume the students know nothing.

Pearson BTEC Level 3 Applied Science

Schools in the pilot study embedded open-ended investigative practical work into different elements of the BTEC Level 3 Applied Science curriculum. Both participant schools mentioned the importance of teaching the essential procedural knowledge and basic practical skills, e.g. how to use specialist equipment or carry out a statistical test, before or during the planning stage of the project.

There are three units within the qualification which particularly lend themselves to embedding a CREST Award:

Unit 2: Practical scientific procedures and techniques

In one of the pilot schools the students completed a Bronze Award (10 hours in total with 4-5 hours in the laboratory) based around the comparison of the nutritional value of fresh and frozen vegetables. Evidence was used for assessment against the CREST criteria and Learning Aims C and D. See case study on page 22.

Unit 3: Science investigation skills

The centre provides students with a mock assessment using past paper material.

For the pilot of CREST in the curriculum the teacher decided to use the mock assessment time to complete a Bronze Award instead (10 hours in total with 4-5 in the laboratory). The teacher adapted past paper material so any guidance was removed. This ensured the investigation remained open-ended and did not limit the students in terms of creativity and decision making. See case study on page 22.

Unit 6: Investigative project – Diploma and Extended Diploma courses only

Learners carried out an investigative project of their choosing. Many linked this directly to the courses they were hoping to study at university and found it beneficial to be able to discuss their research at interviews. Students planned to complete a CREST Gold Award (70 hours in total) alongside Unit 6.

Cambridge Technical Level 3 Applied Science award

Several units would be appropriate to run a CREST Award concurrently with a Cambridge Technical Level 3. Students would need to be taught the techniques in advance, and use of the CREST student workbook or guide would ensure the criteria were understood.

There are three units within the qualification which particularly lend themselves to embedding a CREST Award:

Unit 2: Laboratory techniques

The CREST resource entitled 'Detecting food fraud' would be suitable for investigating and building upon the skills taught during this unit and preparing students for the external examination component.

Unit 3: Scientific analysis and reporting

This includes the techniques which underpin the work of scientists in the collection, analysis and the presentation of data and information. The 'Everything is brighter after a cup of tea' CREST Award resource could be a suitable investigation that could build upon the techniques taught in Unit 3.

Unit 8: Microbiology

This is one of the most popular optional units chosen by centres. A Bronze, Silver or Gold CREST Award could be completed to investigate the growth and effective use of microorganisms.

> "The CREST work was low-stakes and allowed the students to take the time to consider why we carry out practicals, what data we can gather and how results could be used."

Louise, science teacher

BTEC case study

CREST Bronze and Pearson BTEC Level 3 Applied Science Units 2 and 3

Polette Baghdasarian, KS5 coordinator and Nina Heidelmann, science teacher

Hylands School

Unit 2: Practical scientific procedures and techniques – Compare the nutritional value of fresh and frozen spinach.

Unit 3: Science investigation skills – Investigate the energy content of carbohydrate-based foods.

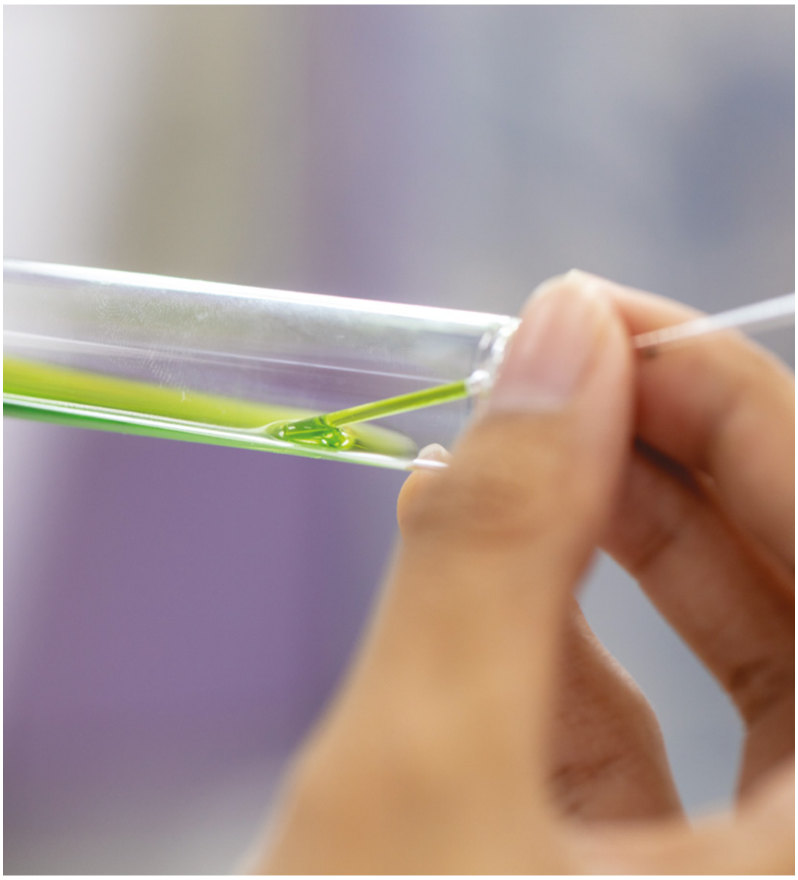
The projects were directly linked to the BTEC Units and assessments. In Year 12 Nina taught the basic technique of chromatography. Students were then asked to independently research and try out different methods before settling on the best one. In Year 13 Polette used Unit 3 past paper questions and adapted them to fit the CREST Award criteria by removing the scaffolding to make them open-ended. These were then used as a mock Unit 3 examination. All students worked in groups.

School context

Hylands School is a comprehensive academy, with a mixed cohort between ages 11 and 18. There are 741 students on roll and 94 in the sixth form, with approximately 20% Pupil Premium.

Who participated?

Five Year 13 and five Year 12 students studying BTEC Applied Science. Polette is an experienced teacher who has responsibility for KS5 in science and Nina is an NQT.



> “As a new teacher I don’t really feel confident giving students much freedom, but here I had to and it was amazing.”
>
> **Nina,** science teacher

When did they do it?

BTEC has 6 teaching hours a fortnight. Both teachers carried out the CREST Award in the Spring term using a block of lessons. In-class allocation was as follows: 2 hours research, 4-5 hours practical investigation and 3 hours analysis and evaluation.

Perceived benefits to the students

Nina and Polette felt the students who participated were not natural scientists and would never have attended after school clubs or science-based enrichment. They benefited from the chance to design and plan a piece of investigative work from start to finish, honing their practical skills whilst being involved in a project which was relevant to them. Prior to the project they had limited opportunities to work completely independently in a practical environment. The students appreciated the fact that the CREST Award was valued outside of school and that they could use it in university applications. An increase in engagement was seen in both Year 12 and Year 13. Students began to talk about how the results potentially impacted on their lives and culture which was totally unexpected. Polette and Nina felt it better prepared them for the real world of science and being able to think outside the box.

Who needs to be on board?

Head of science and the technician team.

Barriers and how they were overcome

The Head of Science was concerned that the CREST project would take up too much teaching time. Polette was able to demonstrate that this was not the case. Students in Year 13 were reluctant to complete extra work and needed persuading to see that they could be accredited for a CREST Award whilst completing their mock assessment for the Unit 3 examination, so the work was not extra. In future the teacher is going to introduce Unit 3 and the CREST Award at the same time to explain the crossover. Student absence was a concern in some cases. However, because the students were in groups, they developed effective team working and communication skills as a result. Nina is an NQT and is used to following a specification closely. While this meant that she was less confident initially, being able to plan with Polette was beneficial.

Perceived benefits to teaching and learning

Both teachers are keen to integrate CREST into the BTEC curriculum again next year with their new cohort as they could see clear benefits within a short time. Polette was particularly surprised by the improvement in practical skills. She assumed the same levels of development would occur, but the CREST Award forced the students to become much more independent and creative practitioners. Polette found that when they *“actually left them to it to make their own decisions it was incredible.”*

Top tip for teachers

The student work booklets are good and gave the students confidence to work through their project step-by-step. Use them from the start.

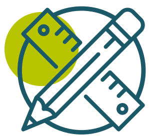
Extended Project Qualification (EPQ)

The Extended Project Qualification (EPQ) is a natural fit for a CREST Gold Award as there are a number of overlapping features within the assessment criteria.

Students should complete the open-ended practical work as per the EPQ criteria, ensuring they have also covered the following CREST Gold Award assessment statements:

- **1.2** The student explained a wider purpose for the project
- **1.3** The student identified a range of approaches to the project
- **1.4** The student described why they chose that approach
- **3.1** The student explained the implications for the wider world
- **3.2** The student explained how their actions and decisions affected the project's outcome
- **4.2** The student made decisions taking account of ethical and safety issues

These could be covered with the addition of one or two paragraphs and a risk assessment.



There is **no** expectation that students re-write the EPQ project for the purposes of completing a CREST Gold Award.

KS3 science curriculum

Most of the pilot schools set aside an hour a week, within curriculum time, to focus on the open-ended investigative project and completed it within 18 weeks. They identified an area of the KS3 curriculum which best lent itself to this or identified a CREST resource which linked well to their curriculum. Schools who completed a Silver CREST Award ensured they adapted the content to the KS3 curriculum. In some cases the project was used as part of the sequencing of procedural knowledge, to act as a means of assessing students. All schools emphasised the importance of completing the write up and student profile as the students went along.

Examples of KS3 projects from the pilot study include:

- **Year 9** - Bronze CREST Award investigating the suitability of various metals for making jewellery. See case study on page 26.
- **Year 8** - Bronze CREST Award investigating the biodiversity of a nearby park.
- **Year 8** - Bronze CREST Award investigating insulating materials.
- **Year 7** - Silver CREST Award using the CREST resource ‘Detecting food fraud’.

“Extended research has helped me learn more about metals than I would have done in a normal lesson.”

Year 9 student

“The project showed me there was more than one way of carrying out an investigation which I didn’t think about before.”

Year 9 student

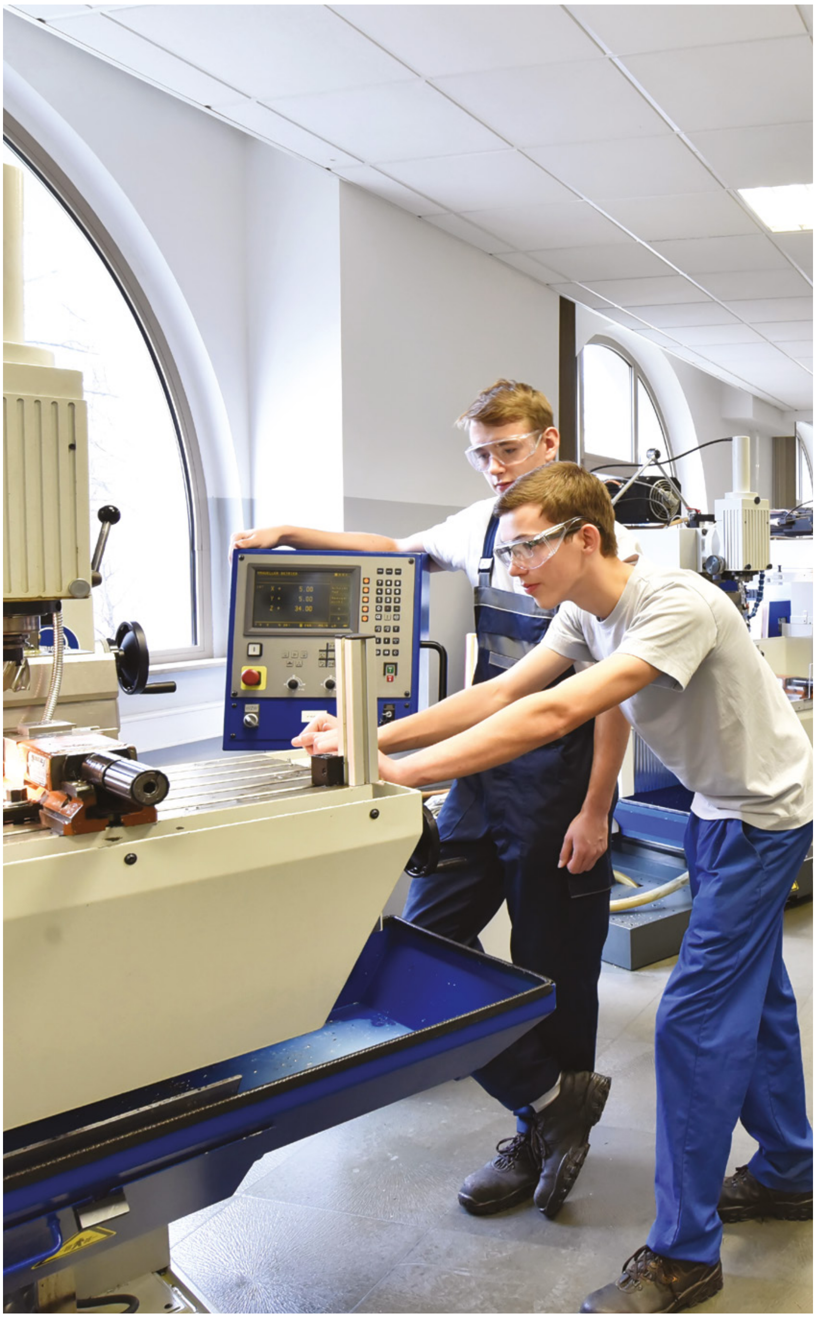
KS3 case study

CREST Bronze and Year 9 Separate Science

Nicola Hunt, science STEM lead   Aston University Engineering Academy (AUEA)

Investigate the properties of metals which make them suitable for producing jewellery:

Students were taught about properties of metals, including extraction methods, as per the scheme of work. The students were involved in finding out about rare metals to ensure they were confident in using research skills before the project was introduced. Most students were able to visit a jewellery maker during the project.



School context

Aston University Engineering Academy is a mixed University Technical College (UTC) for students between the ages of 13 and 19. There are approximately 610 students on roll with over 350 of these in the sixth form. Approximately 11% are Pupil Premium.

> “In hindsight maybe we should have arranged the visit at the beginning, before they completed any of the planning, but after the research. This would have helped them think about the properties of the different metals during their planning.”

Nicola, science STEM lead

Who participated?

All 81 students in Year 9 participated.

When did they do it?

One lesson a week was allocated to the CREST project in the Autumn term. Students carried out most of the research and writing up during homework sessions in school or at home. Many students visited a local business, School of Jewellery, to make a ring using metal.

Perceived benefits to the students

Students were completing practicals that would normally be done in later years such as Young's modulus. 13-year-olds were able to discuss and demonstrate understanding of thermal conductivity, ductility and malleability.

Students enjoyed the opportunity to do research over a longer period of time rather than just for one practical. They began to see how different aspects linked together through this context.

> “I felt like I was thinking like an engineer.”

Year 9 student

Who needs to be on board?

Head of science, headteacher, parents, Year 9 leader and technicians.

Barriers and how they were overcome

The classes have different abilities and so groupings had to be thought through by the teacher. Within one lesson there would be lots of different projects ongoing so the teacher and technicians needed to be very flexible and aware of the open-ended approach here. Initially teachers were scripting the lessons too much and expecting students to achieve a set of expected results.

Students enjoyed the practical work but did not enjoy writing up their work. Competing demands from other subjects meant that in-school homework sessions, and IT availability, were not always focussed on CREST.

Perceived benefits to teaching and learning

The teachers did not know much about the practical skills of their students as the UTC takes students from Year 9 onwards. Teachers felt that the CREST project enabled them to gain information about the students' skills and abilities more rapidly than in previous cohorts.

Top tip for teachers

Do not underestimate the guidance students need in writing up their projects, particularly at KS3. One Year 9 student said that finding time to complete the write up alongside other subjects was difficult: *“I knew where I was going but when I got to writing it up I got a bit confused with the conclusion and evaluation as they are hard.”*

Embedding open-ended investigative practical work into the curriculum in Wales, Northern Ireland and Scotland

Wales

The Curriculum for Wales guidance was published in January 2020, setting out the proposed curriculum requirements for learners aged 3 to 16 to ensure all schools cover the same core learning. The new curriculum is designed around four purposes and identifies integral skills which are critical to these purposes. These include creativity and innovation, critical thinking and problem solving, planning and organising; all of which can be developed through the use of Bronze and Silver CREST Awards.

The descriptions of learning ('Being curious and searching for answers') in the Science and Technology strand is closely linked to the criteria for open-ended investigative practical work. For example:

- I can identify questions that can be investigated scientifically and suggest suitable methods of inquiry.
- I can suggest conclusions as a result of carrying out my inquiries.
- I can evaluate methods to suggest improvements.
- I can engage with scientific and technological evidence to inform my own opinions.
- I can understand how my actions and the actions of others impact on the environment and living things.

The Welsh Baccalaureate, at both KS4 and KS5, offers the opportunity to complete a CREST Award as part of the Skills Challenge Certificate, which consists of four components. One of these is the Individual Project which is linked to a future career or future study and is often used as part of UCAS applications. Many students complete a project which is linked to research being carried out at their first choice or local university. At KS4 learners spend approximately 40 hours on the individual project, which would equate to a Silver CREST Award. As students are encouraged to take 120 hours at Advanced level (including a 40-hour teaching and learning programme) this would equate to a Gold CREST Award (70+ hours).

Students completing open-ended practical investigative work for the Individual Project benefit from the expertise of the teacher who is supervising the certificate. There are several avenues that can be followed to overcome this barrier, including using STEM Ambassadors as mentors, the Trio Sci Cymru Programme and partnerships with local universities.

There were no pilot schools in Wale; however, supportive advice was provided by WJEC representatives for the completion of CREST Awards at KS4 and KS5, and the Welsh Government regarding the new Curriculum for Wales.

Northern Ireland

The KS3 curriculum focuses more on the relevance of learning for life, work, society, the economy and environment and less on specified content. It emphasises the development of creativity and the skills to manage information, problem-solving and making decisions in order to create new knowledge.

The science curriculum includes carrying out the following elements which have direct relevance to a Bronze or Silver CREST Award through an open-ended extended investigation:

- Investigate the effects of pollution
- Investigate what can be done to conserve and promote biodiversity

Schools carry out many practical activities during KS3, in addition to those highlighted above, and encourage the development of scientific thinking to enable students to decide how to generate a question and design methods of answering the question through the use of practical investigative work.

It is possible that completing an open-ended investigative CREST Award project may act as a link from the flexible skills based curriculum at KS3 to the more content driven KS4 specification.

Students must complete a number of prescribed practicals during the KS4 course. Students must demonstrate the ability to carry out three tasks based upon, but not identical to, the prescribed practicals in a practical examination. Students also complete a written external examination which assesses knowledge and understanding of practical science. The opportunity to carry out a CREST Award at the end of KS3 or an adaptation of one of the prescribed practicals at KS4 may benefit the students in these assessments.

KS4 and KS5 centres can choose to deliver specifications from CCEA, AQA, OCR, Eduqas, Pearson BTEC, etc.

CCEA GCE Life and Health Sciences is a qualification which can be taken as a single or double award qualification. Unit 7 in the A-level specification is entitled ‘Scientific Method, Investigation, Analysis and Evaluation’. Students have the opportunity to demonstrate an understanding of what makes an investigation scientific. They carry out research and choose, plan and undertake a scientific investigation, communicate results and make conclusions with a final evaluation of their work. This unit is internally assessed and would lend itself to a CREST Award. Teachers would need to ensure that students considered a wider purpose for their project and also that a range of approaches were identified to match the CREST Award criteria.

There were no pilot schools in Northern Ireland; however, supportive advice was provided by CCEA representatives for the completion of CREST Awards at KS3.

Scotland

Science National 5 and Higher qualifications both contain an assignment which forms 20% of the final grade. The assignment topics are chosen with guidance from the teacher and must involve experimental work. Candidates produce a report on their research which is conducted under controlled conditions and is submitted to SQA for external marking.

For both qualifications it is recommended that students spend 8 hours on the whole assignment, therefore an addition of 2 hours would equate to a CREST Bronze Award. Students complete the open-ended practical work as per the assignment criteria. They can then use the additional 2 hours to ensure they have also covered the remaining CREST criteria which includes:

- 1.2 The student explained a wider purpose for the project.
- 1.3 The student identified a range of approaches to the project.
- 1.4 The student described why they chose that approach.
- 3.1 The student explained the implications for the wider world.
- 3.2 The student explained how their actions and decisions affected the project’s outcome.
- 4.2 The student made decisions taking account of ethical and safety issues.

These could be covered in a paragraph or so with a risk assessment.

There is no expectation that students re-write the assignment for the purposes of completing a CREST Award.

The Advanced Higher includes an in-depth, individually planned investigative/research project. The project is completed independently by the student under some supervision and control, and is submitted to SQA for marking. Although the SQA does not prescribe a maximum time allocation for the project, students are expected to spend 10-15 hours on experimental work, and can spend longer if they wish. Given the length of the report, 2,500-4,500 words, students could dual submit the project for a Silver or Gold CREST Award depending upon the length of time spent on the work. The majority of the CREST criteria are covered in the project marking criteria.

The SQA Baccalaureate in Science (2 Advanced Highers, 1 Higher and a Project) also offers the opportunity to complete a Gold CREST Award as the Interdisciplinary Project.

There were no pilot schools in Scotland; however, supportive advice was provided by an SQA representative for the completion of CREST Awards at National, Higher, Advanced Higher and Baccalaureate levels.

Frequently asked questions

What are CREST Awards?

CREST is a nationally recognised scheme designed to inspire young people to think and behave like scientists and engineers. CREST gives young people the chance to choose their own subject and methodology when completing their hands-on investigation.

What are the different levels of CREST for secondary aged students?

Award level	Bronze	Silver	Gold
Description	An introduction to STEM project work for students aged 11+ working individually or in teams	A challenge for students aged 14+ running their own STEM projects in teams or individually	An extended open-ended project for students aged 16+, ideal for enhancing UCAS applications
Key Stage (suggested)	England: KS3/L1 Wales: KS3/L1 Scotland: S1, S2 and S3 Northern Ireland: KS3	England: KS4/L2 Wales: KS4/L2 Scotland: S4, S5 and S6 Northern Ireland: KS4	England: KS5/L3 Wales: KS5/L3 Scotland: S6 Northern Ireland: KS5
Total time allocation guidance	10 hours	30 hours	70 hours
Planning and research	3	7	10
Practical investigation	4	15	40
Reflecting and evaluating	3	8	20
Assessment	Internal using the assessment framework	External assessor (online)	External assessor (online)
Upon completion	Personalised certificates	School professional assessment Personalised certificates	School professional assessment Personalised certificates
Cost	£6 per student Funding may be available	£15 per student Funding may be available	£30 per student Funding may be available

Do students who are aged 16+ have to complete a Gold Award?

No, the age ranges in the table on page 30 are for guidance only. Sixth form students can complete a Bronze, Silver or Gold Award. If a 16-18-year-old student is completing a Bronze Award, the content and techniques involved should be adapted to be equivalent to their education stage. Most schools in the pilot project working with A-level students chose to complete a Bronze or Silver Award.

Do I have to use one of the CREST Award resources?

No, CREST is about tackling an issue that interests the student. The skills and content of the area chosen must be equivalent to the age of the student. This could involve expanding a practical already in the curriculum, e.g. a required practical or practical unit, to make it open-ended and investigative. See case studies for examples.

Can I use the CREST resource projects in lessons?

Yes, although currently CREST Awards are most commonly completed in STEM clubs after school. This project was carried out to show that CREST Awards can be completed in curriculum time to provide opportunities for students to experience open-ended extended investigative work. Mapping tools which link practical CREST resources to each content area of the KS3, KS4 and KS5 national curricula of all four home nations are available. There are also partner resources which can be accessed through the CREST website.

Can students work in groups?

Students can work in groups but each student must have a defined role. Every student must complete a student profile sheet which is submitted online.

How are CREST Awards assessed?

Make sure that you fully understand the criteria for assessment of the CREST Award before you begin. Students must pass at least 11 of the 15 criteria to be successful. Bronze Awards are assessed in-house, while Silver and Gold Awards are assessed externally online by trained assessors.

Can it be used with EPQ?

Yes, a Gold Award can be completed alongside EPQ. Ensure that all the criteria are covered for the CREST Award if using the EPQ structure and vice versa. There are slight differences. You do not need to produce two separate reports. See EPQ guidance on page 24.

Can CREST be used in conjunction with the Duke of Edinburgh's Award scheme?

Yes, a CREST Award can be completed for the skills section.

Using CREST for the Duke of Edinburgh's Award

What resources do I need and where can I find them?

- Create a free account on the CREST website.
- There are a variety of secondary CREST resources which can be downloaded from the CREST website. CREST Awards Library The resources provide some context and ideas for students to consider before defining their own question to investigate.
- The resources are also mapped for areas of the national curriculum.
- Download the teacher guide for the relevant level. Teacher guide – Bronze
- Download the Assessment criteria
- Download the Student profile (one per student)
- Download the Student workbook
- Download the Generating questions for CREST

Can CREST be used at KS4 in England?

Yes, the pilot schools chose to embed CREST Awards into the KS3 and KS5 curricula in England. A Required Practical at KS4 could be extended in a similar way to A-level to incorporate a Bronze or Silver CREST Award.

Brief overview of the main research considered

A review considering the following research was carried out prior to the pilot study.

Students becoming researchers

In 2019, Dunlop et al. carried out a study of 39 students aged 16-19 to investigate students' experiences of independent research projects (IRP) in order to answer two questions:

- What is the impact of IRPs on students' learning to become a researcher?
- What is the impact of IRPs on students' aspirations in relation to science?

The schools sampled had a strong culture of IRP work. Research projects with scientists in universities, industry and non-governmental organisations had been set up by teachers.

Young people's views on science education – Science Education Tracker 2019

The Science Education Tracker (SET) survey was first completed in 2016 with a small sample of students in Years 10-13. The survey was repeated in 2019 with a larger random sample of 6,409 students aged 11-18 attending state-funded secondary schools. Respondents were asked questions about a range of topics including their experience of science education, their plans for the future and their attitudes towards science-related careers. The questions built on those asked in SET 2016, although many questions were redeveloped to allow for changes in policy priorities since 2016, and also to build new content suitable for the younger age group (school Years 7-9) covered for the first time in SET 2019.

British Science Association: CREST Silver Award - enquiry based learning in science

At the time of the pilot, the CREST programme was being evaluated by a team from NatCen, who carried out an effectiveness trial with 180 schools randomised to 'treatment' or a 'business as usual' control. Year 9 students were offered the opportunity to attend a CREST club and a standardised test was taken, where progression onto GCSE study and a character measure were investigated. The report was published in the autumn of 2019.

The impact of qualification reform on the practical skills of A-level science students

Ofqual recently undertook a programme of research evaluating the impact of qualification reform on the practical skills of A-level students. Five reports were produced in total, the fifth (Ofqual, 2019) being a final report on the evaluation. The research included semi-structured interviews with 38 teachers from 12 schools and colleges to examine their perspectives on A-level reform after the first year. It also evaluated the ability of 14 experienced Chemistry A-level examiners to assess the performance of five students as they undertook four different short practical tasks. In addition, in 15 universities over three years (2016, 2017 and 2018), the research evaluated the ability of undergraduates to carry out specially designed, 'hands-on' practical science skills assessments (Practical Skills Measures).

Open-ended and extended investigative projects in science: Report to the Gatsby Charitable Foundation

The University of York Science Education Group, funded by the Gatsby Charitable Foundation, published a report into teachers' use of open-ended investigative work post-16 (Dunlop et al., 2019). It investigated the types of work undertaken, why it was done, the organisation, and the perceived opportunities and challenges. A total of 17 teachers responded to the short questionnaire, of which 12 took part in extended, semi-structured interviews. The teachers in the sample had been in the classroom for more than five years and in state schools which were rated Good or Outstanding by Ofsted. The report only includes data from those who were dedicated to providing open-ended investigative projects, not the wider teacher population.

Monitoring practical science in schools and colleges: Project Report

In February 2019, Cramman et al., from Durham University, published a report into the quantity and breadth of practical work being undertaken in England and Scotland between 2015 and 2017. The study, funded by the Gatsby Charitable Foundation and the Wellcome Trust, surveyed school staff, higher education students and higher education staff. It carried out school focus groups, as well as higher education and school staff telephone interviews. There were 4,176 respondents comprising of science teachers, heads of science, science technicians, first year science undergraduate students and university staff responsible for first year science laboratory-based courses. The institutions covered included state and independent schools in England and state schools in Scotland, with respondents being more highly qualified than the overall teaching workforce.

Quantifying CREST: What impact does the Silver CREST Award have on science scores and STEM subject selection?

In 2016, the BSA published an independent quantitative review (Stock Jones et al., 2016), which investigated the impact of extra-curricular Silver CREST Awards on both the outcomes of students at GCSE, and the likelihood of them continuing to AS levels in STEM subjects. The sample focused on students in English state schools who took part in the Silver CREST Awards between 2010 and 2013. This equated to 2.4 million students at KS4, of whom 3,800 undertook a Silver CREST Award, and 1.0 million students at KS5, of whom 2,300 participated in a Silver CREST Award.

A Rapid Evidence Review of Practical Independent Research Projects in Science

Bennett et al. (2016) carried out a rapid evidence review for the Wellcome Trust in order to identify schemes available in the UK for encouraging the use of practical independent research projects (IRPs) in secondary/high school science. They reviewed 39 publications from 12 countries, interviewed students and 27 key informants (funders of IRPs, those with responsibility for implementing large-scale IRPs, teachers and others responsible for local implementation), and included five international case studies (Australia, Israel and USA, identified from literature review, and the Netherlands and Singapore, recommended from personal contacts).

Rapid evidence review of Good Practical Science

In December 2015, Cukurova et al. produced a rapid evidence review for the Gatsby Charitable Foundation. This was a small-scale systematic review of the literature and policy documentation around practical science work, carried out using a Rapid Evidence Assessment (REA). The purpose of the review was to answer the question: ‘What does practical work in secondary school science look like when it is good?’ It included international comparisons, curricula breakdowns and research literature. The top ten performing countries in the 2012 PISA rankings were selected for policy review, alongside England, Scotland, Wales and Northern Ireland.

Maintaining Curiosity: A survey into science education in schools

The Maintaining Curiosity report was published by Ofsted in 2013. It examined science teaching in 91 primary schools, 89 secondary schools (including 53 with sixth forms) and six special schools between 2010 and 2013. Examining both the acquisition of knowledge and the development of investigative and practical skills, there was a particular focus on the time spent developing the practical skills necessary for future work in science, technology or engineering. It also investigated the opportunities provided for students to work independently, particularly when developing their individual manipulative skills during practical work.

References

“Having several lessons to complete their work allowed them to see an investigation from start to finish, without being rushed or having to rely on a ‘this is what should have happened’ set of results.”

Louise, science teacher

“I can see how my independence is being built with this investigative project.”

Year 13 student

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CREST AWARDS

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