

STUDENT-LED SCIENTIFIC INVESTIGATIONS

A guide for supervisors of International GCSE Plus and
IPQ

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INTRODUCTION

This document is designed to help teachers acting as coordinators, supervisors and subject specialists understand how scientific investigations can be used within the framework of OxfordAQA's International IPQ and GCSE Plus qualifications.

Scientific investigations have been used successfully in classrooms at both GCSE and A-level for many years. They tend to follow a well-defined structure which is designed to replicate the main aspects of the scientific method:

- present an aim and/or hypothesis
- plan an investigation to test the aim or hypothesis, taking into account relevant variables
- carry out the investigation, making measurements, with a focus on repeatability, precision and accuracy
- analyse the data in order to come to a conclusion
- evaluate the process, data and conclusion.

Over the years, a series of standard investigations have been developed that are straightforward to carry out in the classroom, give virtually guaranteed results and easily analysed data. Examples include Hooke's law on springs, osmosis of potatoes, rates of reaction experiments and the resistance of wires.

Whilst these investigations have their place in teaching the scientific method and the techniques of science, their aims are very different from those of project-based qualifications such as International GCSE Plus and IPQ. Student-led projects are designed to allow the student to make decisions independently, gather research, critically analyse data and sources, and come to a conclusion about their work.

This document gives guidance on how to help your students make an informed decision when choosing a topic for their project and how to employ effective research methods in their work – ensuring they don't lose marks through choosing an overly simple topic or employing inappropriate methodology when conducting their research.

DUAL ACCREDITATION

At the outset, it is important to emphasise that students cannot use work from one qualification as part of an assessment in another: this is auto plagiarism. A student may carry out an investigation in a Science subject and then wish to explore that concept in further detail in their International GCSE Plus or IPQ project. However, doing so is risky if the original investigation is submitted as part of the coursework for that student's GCSE or A-level assessment or is referenced in the exam for that curriculum.

Whilst referring to data from coursework or other formally assessed work may be acceptable if fully referenced, the danger is that students will submit substantial portions of the work (for example the method or conclusions). Even if paraphrased, this constitutes malpractice.

To avoid auto plagiarism, it is therefore advisable to encourage students to think of a different topic to investigate in their project-based qualification.

AIMS OF PROJECT-BASED QUALIFICATIONS

IPQ and International GCSE Plus have similar aims and develop similar skills:

	IPQ	GCSE Plus
Planning	Identify, design, plan and complete an individual project, applying a range of organisational skills and strategies to meet agreed objectives	Identify, plan and complete a piece of extended and analytic work, applying a range of organisational skills and strategies to meet agreed objectives
Use of sources	Obtain, critically select and use information from a range of sources	Obtain, critically select and use information from a range of sources
Analysing data	Analyse data, apply it relevantly and demonstrate understanding of any appropriate linkages, connections and complexities of the topic	Analyse and synthesise data, apply it relevantly and demonstrate understanding of any appropriate linkages, connections and complexities of the topic
Communications	Select and use a range of communications skills and media to present evidenced outcomes and conclusions in appropriate format	Present evidenced outcomes and conclusions in appropriate format
Problem solving and decision making	Select and use a range of skills, solve problems, take decisions critically, creatively and flexibly, to achieve planned outcomes	Select and use a range of skills, solve problems, and take decisions critically, creatively and flexibly, to achieve planned outcomes
Evaluation	Evaluate outcomes in relation both to agreed objectives and to own learning and performance	Evaluate outcomes relating to the organisation of the work, the research and the written report

What's important is that all decisions are made by the student. If a teacher directs a student into doing a particular investigation, it limits how much the student can develop and/or demonstrate these skills. This is likely to negatively affect the results they can achieve.

CHOICE OF TOPIC AND TITLE

For International GCSE Plus, the topic and therefore title of a student's project must be linked to an OxfordAQA specification. There are three main ways that this can happen:

1. Expand on an area from within the specification

For example:

- a discussion of whether Big Bang theory is compatible with religious views of the origin of the universe
- a study of the effects of osmosis when preserving food
- a discussion of how to deal with a particular environmental problem caused by plastics.

2. Investigate an aspect of the subject that is not part of the specification

For example:

- an analysis of the long-term effects of epigenetic changes (epigenetics is not a GCSE Biology topic)
- which smart material is likely to make the biggest impact on everyday life in the next five years?

3. Link the subject with another subject

For example:

- a study of how changes in aircraft shape have affected the economics of air travel
- an investigation into whether changes in the chemical composition of gases from volcanoes can be used to predict eruptions.

Note: Where a study links more than one subject, it can only be submitted as an endorsement to one International GCSE. So, whilst the first study listed here could be linked to Physics, Business or even Geography, it can only be submitted as a GCSE Plus project for one of those subjects.

The choice of topic for IPQ is completely unrestricted. Students can choose to expand or deepen their studies, look forward to future study or work, or do something completely unrelated to both studies and career path. Teachers cannot therefore limit IPQ projects to only science-based ideas.

In most investigations, both at school and university, teachers or lecturers give a student a title and ask them to investigate it, with varying degrees of autonomy. This method is not suitable for International GCSE Plus or IPQ projects as it limits the student's decision making.

Titles chosen should allow access to higher-order critical thinking skills. Titles that simply look for the effect of something or a correlation between two concepts are likely to score low marks. Good titles will often include phrases such as "An evaluation of..."; "To what extent..." or "Is it justified to say..."

COLLECTION OF PRIMARY DATA

Many student-led projects will involve the collection of primary data. In some cases, this will be via simple observation, questionnaires or similar. It may also be via what Science teachers are likely to identify as a traditional scientific investigation.

When a student collects data through scientific investigation, this data can be used as one of the sources of information used. However, it cannot be the only source of information, as otherwise the student will be unable to demonstrate other important skills, such as critical analysis of a range of sources and referencing sources.

It is acceptable for a school to control and limit access to equipment, and responsibility for safety is always the school's responsibility. It may therefore be necessary to limit the number of investigations taking place in a school at any one time. This not only ensures investigations are conducted safely, it also reduces the danger that students develop similar titles.

One method is to let students know that, if their project requires the collection of primary data using school science equipment, they are welcome to use the school's facilities under supervision. In this case, teachers would be expected to set limits on the type of experiments carried out, when equipment would be made available and what resources students can use.

It is worth remembering that a teacher saying "no" to a student's request to use equipment or carry out an experiment is an opportunity for the student to demonstrate problem solving skills – how to find the information without carrying out an experiment themselves. It may also prompt the student to change the title of their project to something that requires a different set of data to be collected.

RISK ASSESSMENT

It is of the utmost importance when conducting student led projects that students are made aware of the importance of risks associated with their research. Risk assessment forms part of the taught skills programme for IPQ and should be considered for GCSE Plus where appropriate. IPQ students are required to carry out appropriate risk assessments as part of their project evidence. IPQ supervisors must confirm that the student has carried out a risk assessment as part of completion of the Production Log.

The use of laboratory equipment and working in a laboratory setting is an obvious area where students should learn about risk and how to complete and monitor a risk assessment. However risk assessment should also be conducted where students conduct research such as using questionnaires, conducting surveys, and using humans as part of their research, to ensure their research adheres to the principles of research ethics.

RANGE OF SOURCES

Both International GCSE Plus and IPQ require the critical analysis and use of a range of sources. Basing a project on one lengthy or complicated investigation may detract from the time the student spends finding other sources.

Supervisors for both International GCSE Plus and IPQ should not approve proposed titles where the student is likely to be limited to very few sources.

Some students may argue that a range of sources was used to plan an investigation, and that no further sources are necessary once the experiment is underway. This approach is likely to lead to lower marks as there are limited opportunities for critical analysis. It would be better for students to use secondary sources to support the findings of their investigation as well as to plan it.

If a student carries out a particularly unusual or unique experiment, it may be difficult to find enough sources on the topic to include in their report. On the other hand, if a student attempts to expand a "standard" school investigation (eg osmosis of potatoes), they may find that there are many sources, but that the vast majority of sources are aimed at GCSE students carrying out that particular investigation, with little or no literature that can be used to widen discussion or to demonstrate the ability to critically analyse sources. These opposing issues should be considered carefully before signing off the title at the start of an investigation.

KEY ROLES

There are three roles teachers can play in development of an International GCSE Plus or IPQ project.

Centre coordinator: This role ensures the smooth running of International GCSE Plus and/or IPQ at a whole-school level. The centre coordinators are responsible for training supervisors and have final sign off on all project proposals. As this is mainly an oversight and administration role, there is no issue with the centre coordinator also being a subject specialist.

Supervisor (International GCSE Plus): As the International GCSE Plus is an endorsement to a traditional International GCSE, the supervisor is likely to be a subject expert. Supervisors should ensure that the topic is sufficiently linked to the main subject and ensure that, if there is more than one student in a class preparing a GCSE Plus project, that they are sufficiently different.

Supervisor (IPQ): For IPQ, it is strongly recommended that the project supervisor is not a subject expert. This is because subject experts are more likely to recommend a certain course of action or give students unacceptable levels of guidance in their work. They may also have too strong an influence over the choice of topic or title, whether unconsciously or not.

Subject expert: Some students will need a subject expert to assist with their project. This is an optional role but is likely to be required when a student attempts to collect primary data from a scientific investigation. Science teachers or technicians should always oversee students when doing practical work to ensure that the experiments are safe and ethical. Whilst subject experts may help to solve practical problems (for example how to set up an experiment or identify variables that need to be controlled), they should not have undue influence on the student's report. For example, they can check that the science within a report is sound, but they cannot offer advice on how best to structure the report or how to analyse the sources used.

EXAMPLES OF GOOD AND BAD PRACTICE

- A student has carried out an investigation into the effect of length in the resistance of wire and wants to look at whether this effect is the same in coaxial cable. The student carries out an investigation into the resistance of different lengths of coaxial cable.
- This investigation is likely to lack two things: a range of sources and the opportunity for critical analysis. There are likely to be limited sources apart from very basic GCSE level sources or unhelpfully technical information. The outcome of the investigation is also likely to be very simple: the correlation between the length of the cable and the resistance; meaning the project would lack analysis and evaluation.
- A student read a claim that a particular exercise regime works well, but the sample group only included women aged 20–29. The student wanted to repeat the investigation with teenage boys.
- Whilst using primary data to analyse whether a particular claim can be extrapolated onto another group is a good way of using primary data within a project, this project would have potential health and safety implications. Before making a group of students take part in an exercise regime, the student would need to discuss the potential safety and ethical aspects of such an investigation with their supervisor.
- A student read some articles from America suggesting that the use of antibacterial soaps could actually help the spread of bacteria. The student used aseptic techniques to investigate the growth of bacteria after washing hands with different types of soap available in Malaysia. They compared their results with the American study to see if the conclusions were similar.
- This project is a good example of how scientific investigations could be used to expand on data from a published investigation or series of investigations. An alternative spin on this project could be to look at whether claims made in Malaysian newspapers but based on the American study were justified.
- A student wanted to investigate whether more expensive brands of suspension springs give a better experience in cars. The student used a number of consumer magazine articles to define “better experience” when driving in terms of suspension. She then discussed the physics of forced and damped oscillations using a number of textbook and journal articles and carried out an investigation that identified the behaviour of different suspension springs under similar conditions.
- This project brings together a consumer problem and some fundamental physics. The investigation is the culmination of a number of strands of research but is not the focus of the project. The student also has multiple opportunities to demonstrate critical analysis of the sources used and is likely to be able to demonstrate higher-order critical thinking skills throughout their work.

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