A practical guide to extended science projects
INTRODUCING EXTENDED PROJECTS

Have you ever wanted to take an idea a little bit further, or research a topic a bit more deeply? An independent research project could be just the thing for you.
What is an extended project?

FIND OUT WHAT’S INVOLVED

An Extended Project Qualification (EPQ) is awarded to students who do independent research on a topic they find interesting. EPQs are available in England, Wales and Northern Ireland and are similar to the Scottish Advanced Higher Investigation and the International Baccalaureate Extended Essay qualification.

There are other ways to do an extended research project: schemes like the Nuffield Foundation’s Research Placements and the British Science Association’s CREST Awards give students the opportunity to do practical scientific research, often working in universities. Parts of this guide are specifically about EPQs, but most of the ideas and advice could apply to other similar types of independent research projects.

WHY DO AN EXTENDED PROJECT?
HERE ARE FIVE GOOD REASONS

1. It gives you freedom to do a piece of research on a subject – or a combination of subjects – you are really interested in.

2. It can help you decide whether you want to continue to work or study in your project area.

3. It’s a good example of independent working, which you can mention in interviews – for jobs, apprenticeships or university.

4. If you are thinking of going to university, an EPQ gives you UCAS points and helps you to stand out from the crowd in university applications.

5. It helps you develop the independent research and critical thinking skills that you will need at university.

WHY DO A STEM EXTENDED PROJECT?
RESEARCHING A TOPIC IN SCIENCE, TECHNOLOGY, ENGINEERING OR MATHS CAN HELP YOU DEVELOP NEW SKILLS

You can do an extended research project in any subject you like. But if your A levels (or equivalent) are in STEM subjects (science, technology, engineering and maths) there are benefits in focusing on those for your project. Leading your own investigation is a great way to get a taste of scientific research and to develop practical problem-solving skills.

Designing your own experiment, using new equipment, collecting and analysing your own data, and testing your own hypothesis are rewarding and motivating, as well as being fun! This will challenge you too – you will often need to seek guidance from experts, which can help you improve your communication and team-working skills.

It’s a great chance to discover more than you’ve learned in class. In fact, doing original research means you might be the first person to answer your research question – some students have even had work published in scientific publications.

The range of topics that fall under the category of STEM is vast. If you’ve ever wondered whether ducks prefer rain or shine, why not research ideal weather for ducks? Or, if you’re interested in weather patterns, you could analyse Met Office data. Are you particularly good with computers? You could write a program to model the weather.

Many extended projects result in a dissertation. But they are also a fantastic chance for you to carry out a scientific investigation or to design and build something. It should take around 120 hours to complete an EPQ, similar to half an A level. This significant commitment gives you enough time to produce something really meaningful. Like an A level, an EPQ can be awarded any grade up to A*.

Until 2017, you can receive up to 70 UCAS points for doing an EPQ (for an A*) – compared with a maximum of 60 points for an AS level at grade A. From 2017, when the points system changes, you can receive up to 18 points for an EPQ (compared with 20 for an AS level or 36 for an A level).

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PERSONAL PERSPECTIVES

“Doing this project made me feel more determined to pursue a science-based degree. I loved doing laboratory practicals for my project and I love lab practicals now at university.”

Anita

“Doing a practical EPQ has helped with essay writing at uni. And I was asked about my project at two interviews – which allowed me to demonstrate my passion for biology.”

Charlotte

“We recognise the value, effort and enthusiasm applicants make in the Extended Project. We encourage you to provide further information on your project in your personal statement.”

University of Leeds

“Each university values EPQs in a different way, so make sure you check what part the EPQ plays for the university you apply for.”

Head of Admissions, University of York

“In highly selective areas, preference may be given to students with A levels who also offer the Extended Project for entry.”

University of Glasgow

“An extended project is good preparation for studying at university. Many universities value the qualification because it develops independent study skills that can help you in your degree. Some universities offer reduced A levels to students who complete an EPQ.”

“New skills can help you develop

ENGINEERING OR MATHS
SCIENCE, TECHNOLOGY,
RESEARCHING A TOPIC IN
EXTENDED PROJECT?
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ENGINEERING OR MATHS
SCIENCE, TECHNOLOGY,
Come up with a testable hypothesis or design brief; you may need help from a subject specialist.

What interests you?

Identify what equipment you’ll need to use.

Speak to a science teacher (maybe your project supervisor) and find out about access to equipment you can use in school.

Find out more about this topic. What questions does your reading make you ask?

Can you access everything you need in school? Could you answer your questions by doing an experiment or building an artefact?

Do you think your questions could make a good project?

Can you access equipment elsewhere; like a university lab? Do you want to do an experiment or build an artefact?

It looks like you’re all set to do a practical investigation or build an artefact!

It looks like a dissertation could be a good choice for you!
“I have a deep interest in astronomy [and] would like to one day have a career related to it. This project [was] an excellent opportunity to continue studying astronomy and use my interest in mathematics to collect data and analyse it to find patterns.”

Cameron

These notes will come in handy when you’re writing up your work (see ‘Writing up’ and ‘Bibliography basics’ on pages 14–16). When you’re ready, try to pose a specific question to be answered. This could be a hypothesis you want to test using an experiment or a design brief for making something for a particular purpose.

WHO’S WHO?

People who can help you with your EPQ

Your EPQ supervisor

This is your personal point of contact at your school, to support you throughout your project. You will agree your project title together, and they will assess your project. This person could have expertise in your topic area, but if they don’t, you can find it from a subject specialist.

Subject specialists

These are people who have expertise in the subject you want to explore. This could be another teacher at your school or college, someone at a university, or a local employer in the relevant area. You’ll often need to seek these people out on your own initiative.

The EPQ coordinator

This person is responsible for the overall running of EPQs in your school or college. They make sure you have the resources and skills training. They aren’t there for hands-on support.

PERSONAL PERSPECTIVE

“I knew I wanted to test a substance used in everyday life. The obvious choice was caffeine. I developed my project with my supervisor Dr Julian Foster and my parents helped me too.”

Charlotte

IN NEED OF INSPIRATION?

THERE ARE MANY ORGANISATIONS OUT THERE THAT CAN HELP. HERE ARE JUST A FEW

The National STEM Centre’s support group has information about research libraries and collections, inspiration for project ideas, research skills and how to contact subject specialists.

Biology

• Our own Big Picture magazine presents cutting-edge biological research and could help to inspire all sorts of ideas!

• Nowgen offers support for EPQ students who want to explore applications and implications of genomics.

• Science and Plants for Schools has a guide to planning an investigation and topics to help stimulate project ideas in the area of botany and ecology.

Chemistry

• Salters Chemistry makes suggestions for chemistry investigations.

Physics

• The Institute of Physics has a dedicated section for EPQs, including case studies.

• The National Schools Observatory has datasets and resources for students interested in astronomy.

• Salters Horners Advanced Physics makes suggestions for Further Investigations that could be developed into an EPQ.

Maths

• Maths in Education and Industry has resources and contacts to support maths EPQs.

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Extended projects provide an exciting opportunity to do extended and original experimental or design work. This section will help you plan.

**STEP-BY-STEP**

**BREAKING DOWN THE WORK WILL MAKE YOUR PROJECT MANAGEABLE**

Hands-on projects need careful planning. You might be keen to jump right in, but slow down and take a little time to plan. It will pay off.

First, identify the steps of your project. There are common steps in all projects: background research, developing your idea, considering ethical and safety issues, agreeing your title, doing the work, writing up, evaluating your project, and presenting your work. Within each step, break your work down into smaller tasks and identify people and resources you’ll need. For example, will you need to consult a subject specialist? Will you need lab space or equipment? Agree some dates to hand in parts of your work to your supervisor for discussion. Their feedback will help you refine your project as you proceed.

**PLANNING AN INVESTIGATION**

**INCORPORATE THESE STEPS INTO YOUR SCIENTIFIC RESEARCH**

- What question are you trying to answer? As you develop your idea, you will need to come up with a statement that you can test – your hypothesis.
- Next, you’ll need to identify what data you need to test the hypothesis. Then, work out what experiment you can do to generate the data. Make sure you will actually be able to do it! (See ‘Handling data’, pages 11–13.)
- Review your approach. Is it ethical? (See the ‘The importance of ethics’, page 10.)
- Do a trial run or a preliminary experiment. Do you need to adapt your hypothesis? Or the experimental design?
- Once you’re ready, run the full experiment and collect your data. (See ‘Handling data’, pages 11–13.)
- Analyse and interpret the data you have collected, drawing conclusions. Do you accept or reject your hypothesis? Or do you need to refine your hypothesis further?
- Write up a report about your investigation, sharing your results. (See ‘Writing up’, pages 14–16.)

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“An important aspect of my experiment was ensuring that results were not biased by my previous knowledge of the effects of caffeine. I designed blind worm races, where I did not know which agar plate had which concentration of caffeine on it, so I couldn’t exert ‘experimenter bias’.”

Charlotte

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"I used eggs and feathers in my project. In order to collect DNA without harm or stress, I gathered feathers that had been moulted naturally. Plucking feathers pulls the shaft of the feather out as well, which contains most of the DNA, but in my opinion this would have been unethical."

Anita

Handling data

Creating, saving and analysing data is a central part of being a scientist – and of your research project. Whether you’re doing an experiment or creating an artefact, it is likely that you will need to collect data. An experiment will generate data, while creating an artefact might require you to measure how well it achieves its objectives – again, by collecting data.

PLANNING AN ARTEFACT

INTEGRATE THESE STEPS INTO YOUR DESIGN PROCESS

• Your artefact will need to have a specific purpose. Before you start creating it, write down what you’re trying to achieve. This is your ‘design brief’.
• Work out the most feasible design. Do some background research and some modelling.
• Think about the ethics of your project.
• Decide what materials you will need and where you will source them from.
• Create it, revising your design if necessary.
• Keep a logbook throughout, documenting your process.
• Will you capture data from your artefact?
• Think about how you will test your artefact to ensure it meets your original aims.

PERSONAL PERSPECTIVE

“My planning was very fluid. I set major deadlines and milestones but the timeline for how those were to be achieved was constantly shifting as new challenges arose. The basic design for my artefact was a tethered balloon capable of carrying a Wi-Fi or mobile data transmitter at a certain altitude. I spent a lot of time planning it on paper before thinking about materials. I sketched schematics of potential designs and used computer simulations to test them before settling on one I liked. Issues I had not foreseen when building the balloon meant re-designing certain aspects.”

Tal

THE IMPORTANCE OF ETHICS

CONSIDER ETHICS EARLY AND OFTEN IN YOUR PROJECT

Ethics is an essential part of research practice. As a researcher, you have responsibility to the participants in your research, your colleagues, wider society, and the environment. Of course you also need to ensure that it would be legal to conduct your project.

Time spent early on, thinking about ethical implications of your research, will pay off. Are you collecting data from people – especially information that could identify individuals? Will you need consent? Answers to questionnaires or recordings of conversations could be particularly sensitive. Imagine asking other students what they like and dislike about school – they might reveal personal details about themselves or other people. Alternatively, will your investigation have harmful effects on the environment?

“Practical EPQs can pose some real-life ethical problems,” says Dr Julian Foster, an EPQ supervisor and teacher at Peter Symonds College in Winchester. “Students need to discuss the issue of using animals in experiments and the precautions needed to safeguard human subjects. I’ve occasionally been shocked by projects in which human participants have been used with no evidence of any informed consent or attempt to provide anonymity.”

See wellcome.ac.uk/EPQethics to download a copy of ‘Ensuring your research is ethical: A guide for Extended Project Qualification students’.
Qualitative vs Quantitative
Learn the Difference Between the Two Main Types of Data

Data can be broadly categorised as quantitative (numbers) and qualitative (descriptions). Quantitative data involves things, while qualitative data involves things. For example, you could categorise rocks at the bottom of a cliff as small, medium or large — this would be quantitative, but measuring the size of the rocks or counting the number in each category would be quantitative. Quantitative data lends itself to statistical analysis, whereas qualitative data is harder to analyse in this way. Quantitative data can be used to make generalisations such as ‘prolonged exposure to sunlight increases the likelihood of skin cancer’, while qualitative data can illustrate particular examples of something, but can be harder to generalise.

Think about the following pieces of data and whether they are quantitative or qualitative:
- height
- favourite colour
- what happened during your trip to school
- what time you got up this morning
- how many siblings you have
- concentration of fluoride ions in tap water.

Note that you can create quantitative data from qualitative data: for example, by collecting descriptions from different people about how they get to school and counting the number of times that they mention using the bus.

Recording Your Data
Take a Methodical Approach

You’ve identified what data you need. You’ve planned an experiment to collect it. But how will you record the data that you generate?

- Write things down in a notebook. If you’re out in the field this may be the easiest way, but you could use a tablet or take photos.
- Use a data logger, or some other device that creates digital data. You will need to think about how you will save or transfer it elsewhere so that you can use it (see ‘Keeping your data safe’, page 13).
- Enter your data directly onto a computer. Set up a spreadsheet (for example, using Microsoft Excel) that has the right columns for your data.

Remember: you cannot collect more data once the experiment is done (you would have to repeat the experiment), but you can always discard data you decide is not needed. As a minimum, every experiment should include:
- the date and time of the experiment
- where the experiment took place
- the title of the experiment or the type of procedure you’re doing
- the variables you’re controlling (control variables) and their values, including units: for example, ‘temperature 20°C, humidity 80%’
- the variables you’re adjusting (independent variables) and their values, including units
- the variables you’re measuring (dependent variables) and their values, including units

Taking time to ensure that you collect all the data you need and record it in the most appropriate way will make your next steps much easier!

Analysing Data and Drawing Conclusions
Looking for Significance

Once you’ve collected your data and recorded it safely, you can start to make sense of it. At this point, data can start to become information.

“After each experiment, I recorded my data from my lab book into an Excel spreadsheet. I was accumulating a lot of data and it was vital to ensure that no data was lost or misinterpreted. I also analysed my data after each experiment, trying to ensure that I did not ignore any important results.”

Charlotte

Keeping Your Data Safe
Always Have a Backup

You’ve carried out your experiment and carefully written down your observations. But then you lose your notebook. Disaster! Here are some ways to take care of your data:
- If you’re writing down observations, make a backup by taking a photo of your notes using your phone.
- If your data has been collected electronically, write down a copy (if that’s feasible) or save it on a USB key and transfer it to another computer.
- Make sure that electronic data will be readable by other software and isn’t saved in a format that only the data logger can read. Saving data as ‘comma separated values’ (CSV) files is a safe way of moving data around.

When looking at quantitative data, scientists typically try to compare two datasets: a control set (data collected under ‘normal’ conditions) and a test set (data collected where one or more independent variables have been deliberately changed).

An important question is whether the two sets of data are significantly different. To answer this, you’ll need to use a statistical test. You should decide what test you will use at the start of your planning as it may affect what data you need to collect. It is not always possible to compare data in a meaningful way (for example, because too little is collected), so plan ahead.

Once you establish whether or not there is a significant difference, you can interpret what that difference (or lack of difference) means. Can you accept your hypothesis (or, more accurately, reject your null hypothesis)?

With qualitative data, you may need to look for patterns in people’s answers to questions. Consider ‘coding’ — using categories to classify particular elements of a response. For example, if you ask people what they find least enjoyable about school, they might mention school meals or the range of subjects on offer. Even though different people will not use exactly the same wording, the sentiment may be similar.

In this example, you would create a code for ‘dissatisfaction with school lunches’ and another one for ‘frustration at limited number of subjects available’ and count how many responses there are that fit each code.
REPORTING YOUR INVESTIGATION
EXPLAIN THE WORK YOU’VE DONE TO OTHERS

Many students fall into the trap of thinking that writing up is the final step of your project. Quite the opposite: writing as you go along will help, even if it’s just to make notes to refer back to or to keep track of your sources.

A typical 5,000-word report might include:

**Abstract**
A single paragraph or summary of your entire project.

**Introduction**
A short explanation of your investigation, which includes your hypothesis.

**Literature review**
An analysis of existing research relevant to your topic. Often this explains or justifies how your investigation will help to address an unanswered question in the field. Sometimes the literature review is part of the introduction.

**Method**
A step-by-step explanation of your experiments, including the equipment you used.

**Results**
Set out the data that you collected in the most appropriate way – often this will be tables or graphs.

**Discussion**
Analysis of your data, including an assessment of whether you can accept or reject your null hypothesis. Sometimes the results and conclusion can be part of the discussion.

**Conclusion**
A clear concise statement of what you have actually found out.

**Evaluation**
A chance to wrap up and evaluate your work. What might you do differently next time? How might someone take this further?

**Bibliography**
A list of all of your references (see ‘Bibliography basics’ on page 16).

Tailor the sections of your report to suit your specific project.

**PERSONAL PERSPECTIVE**

“I wrote my project in this order – literature review, discussion, conclusion, introduction, and abstract – because this order made the most sense to me. It is important to do the bibliography from start to finish to ensure everything is referenced accurately.”

Charlotte

“I separated the different sections – such as methods, background information, etc. – and then tidied up the formatting before submission. This helped me to keep the report structured. I left the introduction until last, as then I knew exactly what was in my report. I felt then I could introduce the topic properly.”

Anita
As a design student, I found it easiest to create a portfolio that meant I could put text and images side by side. I found it easier to work on paper, then scan it in and annotate it digitally. Some people may like this method, though others might want to have data and images separate. Write in a way that’s most comfortable to you and allows you to fully express what your idea is about.

Tal

**KEEP A RECORD**

**DESCRIBE THE DESIGN PROCESS**

If you’re producing an artefact, you should keep a notebook – sometimes called a log book, diary or journal – which will act as evidence of what you’ve done. It often includes several visual elements, such as sketches or technical drawings, and could also include interactive elements such as film. Depending on what you create, it may also include a computer database.

The written elements usually include:

- Original design brief: what is the problem your artefact will solve?
- Conclusion: an evaluation of your final product and your learning.

**KNOW YOUR LITERATURE**

**WHAT RESEARCH HAS BEEN DONE BEFORE?**

You might find that you write much of your literature review at the beginning of your project, especially given that you will have done lots of research in choosing your topic. Ideally, the work you do on this section towards the end of your project will be more about bringing together and tying up the research you did at the beginning so that it’s suitable for your final report.

It may seem counterintuitive to spend part of your report talking about other people’s research, but if you don’t explain it, others may not understand why your investigation is important. Your supervisor will want to see that you have read and understood the work published already on your topic.

When writing your review, one approach to take is the ‘inverted triangle’ approach. Start with a wide perspective, touching on the general issues related to your project. Next, narrow down by looking at studies that have something in common with your research. Finally – and in the most depth – discuss research directly related to your specific research question.

When you’re reading, don’t forget to take note of your references – and ensure you understand what type of source you are citing.

A primary source is an original piece of work, such as a scientific article (called a paper) published in a specialist magazine (a journal), written by the person or people who did the research. Other examples include dissertations, PhD theses, conference papers, interviews, log books or lab notebooks. Generally, these are the strongest sources to cite.

A secondary source is a work that discusses primary sources, such as a newspaper article about a paper published in a journal. Other examples include a book that contains commentary about other resources, or even your own literature review. If you cite a secondary source, ensure you note the author, title, publisher and date of when you accessed the information in addition to the primary source information.

**BIBLIOGRAPHY BASICS**

**KEEP TRACK OF YOUR SOURCES**

At the end of every published piece of academic research is a bibliography, or list of any books or other resources that the author has referred to or used during the course of the research.

Referencing other papers is an important way of communicating research and supporting a strong scientific community. Not only does it show your own research to be transparent and thorough, it also allows others to follow up on a piece of research that they find most interesting – perhaps for their own research.

Recording all of this information is daunting, and it’s easy to make small errors. Consider using free bibliography software to help you; some students use Mendeley or Zotero. Whichever approach you use, the most important point is to be consistent.

Once you’ve written your report or created your artefact, presenting it comes next. For advice on this next step, see: bigpictureeducation.com/extended-projects

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Special thanks to Julian Foster, Elizabeth Swinbank, Becky Parker and the Big Picture teachers’ advisory board for reviewing this guide.
Teachers! While this Big Picture supplement is designed to help students through the process of an extended project, we know that teachers need support too.

We’ve put together some online advice on:

- the overall process
- supervision
- where to provide guidance
- in-school resourcing
- getting external help and expertise.

gpipictureeducation.com/extended-projects

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