Carrying out an investigative science project

Why carry out a project of this kind?

Effective science education develops the natural intellectual curiosity and creativity of young people. Creative and experimental approaches are particularly important for keeping students interested and engaged in science, and for equipping them well for the future, whether or not they pursue a career in science.

Taking part in successful projects of this kind can give young people a sense of pride and ownership and build transferable skills such as time and project management, teamwork and communication. They also provide a great opportunity to help young people understand what it is really like to be a scientist.

What is an investigative project?

Investigative projects can take place in a range of contexts where students manipulate a number of independent variables and measure the outcome (or dependent variable). Some investigations involve the processes of identification and classification, whilst others require participants to conduct surveys and search for patterns or correlations.

Students can also explore and extend their explanations, hypotheses or theories through the use of models, including mathematical models and IT simulations. Ideas for investigations may emerge from a deeper interest in a curriculum topic, or from a hobby or other personal interest. In some cases local 'events' such as the staging of a concert or exhibition or changes to the locality such as the construction of a new road may also give rise to opportunities to carry out investigations.

How do I start?

The quality of your students' projects depends on their selection of viable and motivating topics for investigation. If given a totally free choice, many students face difficulty and indecision in coming up with a suitable project idea and they will benefit from being shown a range of possibilities which are suitable for their age, ability and interests.

Pick a topic that your students are interested in, perhaps based on one of the resource packs that you know well or one of the topics still to come and encourage the whole class to think of questions around that topic. Two commonly used 'thought starters' on any topic are 'What would happen if…' and 'I wonder how….'. You can ask them to vote on each other's questions and pick the most popular.

Encourage students to select a question that has a few aspects to it so that a number of experiments are involved to discover an answer, and that does not just lead to a simple yes or no answer, for example 'What would happen if …?'

So an example question might be ‘how much can we reduce the energy consumption in our school’ or ‘what would happen if we kept plants in the dark?’

Note: you may have to rule out some suggestions or amend questions before voting if they are likely to be impractical to investigate.

Once students have settled on a topic to investigate for their project help them to set some ‘SMART’ (Specific, Measurable, Achievable, Realistic and Time-bound) targets for their work.

- S – Specific (has well-defined goals. This could be identifying a concise ‘Research Question’ or ‘Product Specification’ to be accomplished by the project work)
- M – Measurable (has agreed outcomes and success criteria – including timelines. Monitoring progress is essential to good time / project management)
- A – Achievable (includes goals and proposed research methods which are within the capacity of the student to deliver)
- R – Realistic (students are both willing and able to work toward the goal set)
- T – Time-bound (interim checkpoints and final delivery date for completion of project agreed at the outset)

I know what we’re investigating, what next?

Now is the time to develop the methods of your investigation. What materials do you have available or could easily acquire? How could you put together an experiment to answer your question?

If you have restricted funding, this may limit the range of feasible topics and can also reduce access to some types of investigation, but it does bring out the best in terms of the design of creative alternatives with recycled and modified apparatus. Sometimes projects can be boosted by support from local or national businesses in the form of funding or access to resources. Why not speak to parents or a local university or business and see if there is someone who can help with your project?

If your students are carrying out an experiment to look at how one factor influences an outcome, it is important to ensure they arrange a fair test so that they can better understand what is causing the effects they observe. They therefore need to make sure they are controlling as much of the rest of the environment as possible. For example, could human error affect their results, are there other factors which could influence the outcome?

Encourage the students to come up with ideas of investigation and learn for themselves what will and won’t work.

Remember to do a brief risk assessment before each activity.

Keeping records

It is a good idea to provide students with project notebooks and remind them of the importance of recording their thoughts, plans and investigation notes as an integral part of their project management. You may want to invite them to create a research plan which gives the overview of the proposed aims, investigation design, methods of data collection and analysis, and anticipated outcomes. This parallels the 'real world' where research teams have to substantiate their bids for funding with details of the research and development methods which will be used to meet the contract requirements.

Encourage your students to log thoughts as well as events, to include failed attempts as well as successes, interim data sets and graphs and photos of experimental set ups during the preliminary investigations and not just 'staged' photographs of the final arrangement. Depending on the nature of the project, it may generate evidence in the form of electronic data – video evidence, captured data logger outputs, images of transitory effects, etc. so notes will be supplemented by a dedicated project folder stored and backed-up on a reliable server. Even if they are working as part of a team, students should keep their own notes.

What do the results mean?

The students should carefully observe the results of their experiments and record them in an appropriate way. It may be possible to take numerical measurements or photographs of the experiment, or writing descriptions of what they see may be more appropriate.

If they have numerical results, it may be appropriate to create graphs and charts of their results to display pictorially. Otherwise, it may just be a case of comparing the different pictures or descriptions to see what has changed and what happened.

Students should reflect on their experiment. Why do they think they got that result? Is there anything else that could have interfered with the outcome? How could they have improved their experiments? If they repeat it do they always get the same outcome?

Presenting work

Once your students have completed their investigation encourage them to present their work. This could be to the rest of the school, to their parents, on the school website or at a public event. They could create a poster, presentation or video about their project, as well as writing up their results. Have a look around your local area as there may be science fairs or competitions they can attend. You could share the results on the Schools' Online discussion board.

Make it a theme

If you're running a project for a few weeks, why not make it a theme in other classes too? Are there related historical figures to learn about? Can the students produce some creative writing or artwork around the topic? How does the analysis of results link to your mathematics curriculum?

Find out more:

TeenTech's project resources: http://www.teentech.com/teentech-awards/supporting-materials/

CREST award project resources: http://www.britishscienceassociation.org/crest-awards

Publish your work in Young Scientists Journal: http://ysjournal.com/

STEM clubs activity resources: http://www.stemclubs.net/activity-categories/

Carrying out an investigative project draws on pedagogy from inquiry-based learning and there are many resources available online for this.

Parts of this resource are taken from the British Science Association's STEM Projects Toolkit, which can be accessed in full here: https://www.stem.org.uk/elibrary/collection/3926