Key Resource: Using investigations in the classroom

Children are naturally curious. Good teaching exploits this very human characteristic. Over the past few decades increasing attention has been given to using investigative approaches in the classroom. Rather than just telling pupils something, why not make them think about a topic or area of enquiry? At its simplest, this might just be 'asking a question' rather than 'telling'. This promotes a more active approach that is much more effective than passive 'telling' in promoting lasting learning. Increasingly, however, teachers plan to use investigations to promote active learning.

Investigations are already well established in the teaching of science (through experiments) but the same technique can be used in all subjects. Mathematics or numeracy, for example, becomes much more interesting if pupils have to work out real problems. The same is true of other subjects. In geography or social studies, rather than just telling pupils about environmental problems, why not set them a task? You will find a number of examples of topics that can be taught in this way in the TESSA modules.

There are different strategies for approaching investigations. Below is a detailed example when looking at the teaching of science topics, but you can take a similar approach in any area. The following basic steps can be taken.

Beginning

Use brainstorming to open a topic (see **Key Resource: Using mind maps and brainstorming to explore idea).** You can do this with the whole class, or begin with groups and then have a whole-class session. The important things are to make pupils think actively about the issues being raised and to establish their current knowledge of the topic.

Choosing the focus

A brainstorming session will throw up many different ideas: these will probably have been recorded on the chalkboard or on a chart of some sort. You, as the teacher, now have the opportunity to focus on the key area that is to be investigated. For example, you may wish to teach about the link between human activity (for example farming) and the local environment. In the brainstorm, some pupils talk about local worries about the declining fertility of

the soil. You might decide that an investigation into 'whether the local soil is less fertile and if so why' should be the focus.

Planning your investigative approach

All sorts of methods are available to you. You could carry out detailed interviews with local farmers or discuss with grandparents or older members of the community 'what things used to be like' or 'how crops used to grow'. It is important that pupils think about the methods to be used and why. This helps them develop personal investigative skills.

Carrying out and reporting the investigation

The pupils then have to carry out the investigation. Before they do this, it is important to establish the way the findings are going to be reported back. The form this takes depends on the nature of the investigation. You can have a fairly informal investigation, for example where pupils ask older family members what the village was like 20 years ago. The report back might then be 'verbal reporting' to the whole class. You might have asked each member of the class to ask the same five questions to at least two older members of the family. The report back then could be in the form of a chart, so that you can show similarities and differences in the findings.

Interpreting findings

Once the data is reported and recorded, the findings have to be interpreted. This is key and it is very important that you, the teacher, do not dominate discussions initially. Make the pupils voice their own ideas (in verbal or written forms) before beginning to steer them, perhaps through questioning, to the key learning interpretations you are looking for.

The investigative approach should become habit for the good teacher. Set out below is a much more detailed way of using investigations in science.

An investigative approach to science

A possible approach to teaching investigation

Step 1 - Brainstorming/getting ideas	**Step 2 - Choosing the variables**
Step 3 - Asking a question	**Step 4 - Planning the experiment**
Step 5 - Carrying out the experiment	**Step 6 - Recording & Presenting**
Step 7 - Interpreting & Evaluating	
Step 8 - Reporting back	

Step 1 - Brainstorming or getting ideas

Planning [1] **What could we investigate?**		
What could we measure or observe?		

This table is made available to the children. This may be put up on the wall as a poster or written on the board. The teacher then initiates a class discussion on the investigation topic.

Planning [1] **What could we investigate?**		
light	temperature	quantity of medium
acid rain	seed type	closeness of seeds
What could we measure or observe?		
light	temperature	volume of water

Example: *Investigation into factors that affect germination and growth*.

The teacher may begin by reminding the children about what germination means, then pose the question: What affects germination? The purpose of the investigation is to discover if and how a particular factor affects germination in a particular plant, e.g. cress.

The children are asked to suggest any factor that **might** affect the germination of cress.

Step 2 - Choosing the variables

Planning [2]		
I am going to find out what happens to ...		
... when I change ...		
I am going to keep these the same (constant) to make it fair ...		

Once again the table is made available to the children. This may be put up on the wall as a poster or written on the board or copies given to group leaders or to all the pupils.

The group are asked to select **one** variable that they will change (independent variable) and one that they will measure (dependent variable). All the other variables must be kept the same if there is to be a fair test.

Fair Testing

The concept of a **fair test** is crucially important in planning an investigation. The pupils should be taught to control the variables other than the dependent and independent variables in a conscious way. Often the more 'obvious' a variable is, the more likely it is to be controlled, but the pupils should be trained to consider their set-up and **decide** on the variables to be controlled.

A fair test is one in which only the independent variable is seen to cause a change in the dependent variable. If, for example, two things change, say temperature and humidity, you cannot be sure which of these causes the change in the dependent variable; it may be temperature or it may be humidity or it may be a combination of both.

- It is only by carrying out a fair test that you can be sure that it is what you have changed (independent variable) that is affecting what you measured (dependent variable).
- It is easier to recognise that a test is fair than it is to plan and carry out a fair test.
- You will need to encourage the pupils to make sure that all relevant aspects have been controlled (kept the same).
- Most pupils need only say that they intend to keep certain things the same, but the most able pupils should be encouraged to discuss what value each control variable should have.

Note: the words independent variable and dependent variable do not need to be taught at this stage!

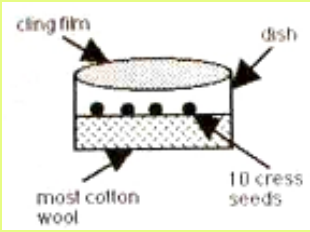
Step 3 - Asking a question

Planning [3]	
Making a prediction/hypothesis	
When we increase/decrease	**temperature**
... we think that the	**number of seeds germinating**
will increase / decrease / stay the same	

At this stage, pupils are being asked to select the variable they want to investigate. They choose **one** of the things that they have said they could change and one of the things that they said they could measure.

The question posed is: If I change this (the chosen variable or independent variable), what will happen to that (the chosen measurement or dependent variable)?

Step 4 - Planning the experiment

Planning [4]	
Designing the experiment	
Listing what you need	**Describe how you will use them. Make a diagram if you want.**
30 cress seeds cotton wool 3 dishes cling film thermometer water	
1. Put a layer of about 2 cm depth of cotton wool in each dish. **2.** Add 5 cm^3 water to each. **3.** Lay 10 cress seeds on top of each piece of cotton wool. **4.** Cover the dish with cling film. Leave dish **A** at 10 °C, dish **B** at 20 °C and dish **C** at 30 °C. **5.** Leave each for three days, then count how many seeds have sprouted in each dish.	

The pupils now plan the experimental procedure. It is very important to stress that only **one** of the variables can be changed during the experiment. As a result the variable being measured will, presumably, change. All other variables must be kept constant to ensure a fair test.

Step 5 - Carrying out the experiment

Before they carry out their experiment it is important that the teacher makes sure that the procedure to be followed is safe. For this reason it is important to include a **TEACHER CHECKPOINT** before the pupils are allowed to continue with the practical and to ensure that suitable safety precautions are used.

The pupils **collect evidence** by carrying out the experiment and carefully noting the changes occurring in the dependent variable. They may also measure the variables they are keeping constant to ensure that they are kept constant throughout their experimental procedure.

Step 6 - Recording & Presenting (1)

What we changed	What we measured
temperature (°C)	no. of seeds germinating
10	5
20	7
30	9

The pupils are encouraged to record the results from their investigation by producing a table of results. The table includes the independent variable (what they were changing) and the dependent variable (what they were measuring).

The production of the table of results will help the pupils in constructing a bar chart or graph of their results.

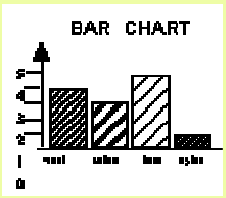
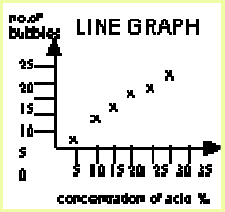
An average may need to be taken to get more accurate results.

Graphs and charts are powerful tools because they enable pupils to see the result of what they changed (the independent variable) affecting what they measured (the dependent variable). This gives a picture of the information they have collected and helps them to identify patterns and trends. It also helps the pupils to develop understanding by relating pattern and trends to their scientific knowledge.

The type of graph that is appropriate depends on the type of variable used for the key variables i.e. what they change (independent variable) and what they measure (dependent variable). The table below shows the types of graphs that should be drawn for different types of variables.

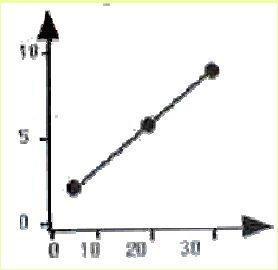
Step 6 - Recording & Presenting (2)

What type of graph should be used?

What is ...		Type of table	Type of graph
... changed? (independent variable) e.g.	**... measured? (dependent variable)** e.g.		
WORDS type of cloth	**WORDS** amount of wear		no graph
WORDS type of cloth	**NUMBERS** size of stain (cm^2)		
NUMBERS length of elastic band (cm)	**WORDS** pitch of note		no graph
NUMBERS concentration of acid (%)	**NUMBERS** no. of bubbles		

Step 6 - Recording & Presenting (3)

Looking for a pattern in the results

What we measured		By careful examination of the bar chart or graph, the pupils should be able to identify any trend or pattern that appears in their results. In this case, there is an increase in the number of seeds germinating with increasing temperature.
number of seeds germinating		
	temperature (°C)	

Step 7 - Interpreting & Evaluating (1)

Finding a pattern in the results

When we increased	**temperature (°C)**	The pupils are now asked to 'make sense' of their results.
There was ...	**number of seeds germinating**	
an increase in the		
~~a decrease in the~~		
~~no change in the~~		

Step 7 - Interpreting & Evaluating (2)

Drawing a valid conclusion

Was the investigation a fair test?	**Yes**	**~~No~~**	If they are satisfied that the experiment represented a fair test, they may now draw a conclusion from their investigation.
The conclusion from our investigation is ...			
The number of seeds germinating is controlled by temperature. When you increase the temperature the number of cress seeds germinating increases.			If the experiment was not a fair test, no conclusion may be reached.

Step 8 - Reporting back

After the practical part of the investigation is over, a **reporting back** session is vital. The importance of this stage is frequently underestimated and sometimes bypassed altogether (although admittedly often because of pressure of time). The reporting back session needs careful handling if the learning outcomes are to be fully achieved. Here the pupils should try to use their own evidence to justify the conclusions at which they have arrived.

The reporting stage can be followed by a 'consolidation' stage where the pupils are encouraged to use the information they have gained to further advance their knowledge and understanding. This kind of reflective discussion, where the group outcomes are shared, can be very useful.

http://www.ise5-14.org.uk/Prim3/New_Guidelines/Investigations/Poss_aproach.htm