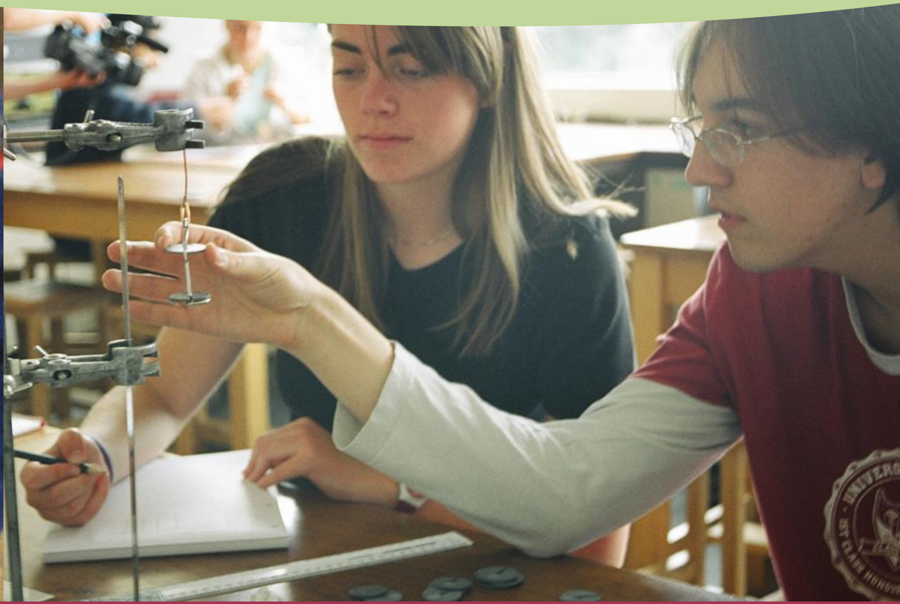
Department of Education

THE UNIVERSITY of York

Developing students' understanding of science: The role of practical work

Robin Millar



CNE Seminar: *Practical Work in Scientific Learning*, Lisbon, 12 January 2015

Practical work

A working definition:

"any science teaching and learning activity in which the students, working individually or in small groups, handle or observe the objects or materials they are studying."

The UK context

- Long tradition of practical work in school science
  - Going back to the late 19th century
  - Reinvigorated by the Nuffield projects of the 1960s
    - Guided discovery learning
    - Seeing the student as ‘a scientist for the day’
  - Public examinations include practical assessment
- Most science lessons for 11-16 year-old students are taught in laboratories
- Schools have laboratory technicians

Policy perspectives on practical work

“In our view, practical work, including fieldwork, is a vital part of science education. It helps students to develop their understanding of science, appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. Students should be given the opportunity to do exciting and varied experimental and investigative work.”

(UK House of Commons Science and Technology Committee, 2002, para. 40)

“[school science laboratories] are a vital part of students’ learning experiences … and should play an important role in encouraging students to study [science] at higher levels.”

(Roberts report , 2002, p. 66)

Two views on practical work

A teacher in England, asked in an interview about the role of practical work in science teaching:

"It's what science is all about really … getting on with some experiments. Science is a practical subject …. You know, end of story, I think."

(Donnelly, 1995: 97)

An experienced researcher, writing about his observation of practical work:

"Despite its often massive share of curriculum time, laboratory work often provides little of real educational value. As practiced in many countries, it is ill-conceived, confused and unproductive. For many children, what goes on in the laboratory contributes little to their learning of science or to their learning *about* science and its methods."

(Hodson, 1991: 176)

Is practical work effective?

- Who is right?
- Might Hodson and the teacher both be right?
- If Hodson is right, what can we do about it?

- To answer this, we need to go back to basics.
- ‘Practical work’ is too broad a category
  - We need to consider specific practical activities
  - … and ask: “Is this practical activity effective?”

Is a practical activity effective?

- The starting point for thinking about the 'effectiveness' of any practical activity is to be clear about the intended learning outcome(s) of the activity
  - What do you want the students to learn from it?

Learning outcomes of practical work

Practical activities have a range of intended learning outcomes.

These fall into three main groups:

A. Scientific knowledge

to help students develop their knowledge of the natural world and their understanding of some of the main ideas, theories and models that science uses to explain it

B. Practical skills

to help students learn how to use a piece of scientific apparatus or to follow a standard practical procedure

C. Scientific enquiry

to develop students' understanding of the scientific approach to enquiry and their competence in using it in practice

Type A: Scientific knowledge

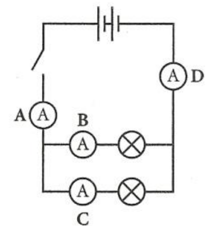
Investigating parallel circuits [redacted]

Aim

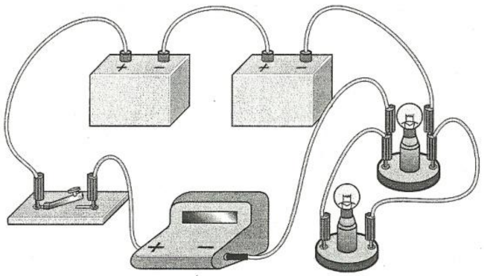
To investigate how the electric current splits up in a *parallel* circuit.

Preparation

This diagram shows a circuit with four ammeters for measuring the current at four places: **A B C** and **D**.



You will only have one ammeter, so put it at position A like this:



What to do

❶ Connect up the circuit as shown in the circuit diagram with the ammeter at position A.

❷ Check the ammeter is connected correctly.

❸ Switch on the circuit.

❹ Don't leave the circuit switched on for a long time. When you are not recording the current switch it off so that the batteries do not run down.

❺ **If the bulbs both light**: record the current in a table like this:

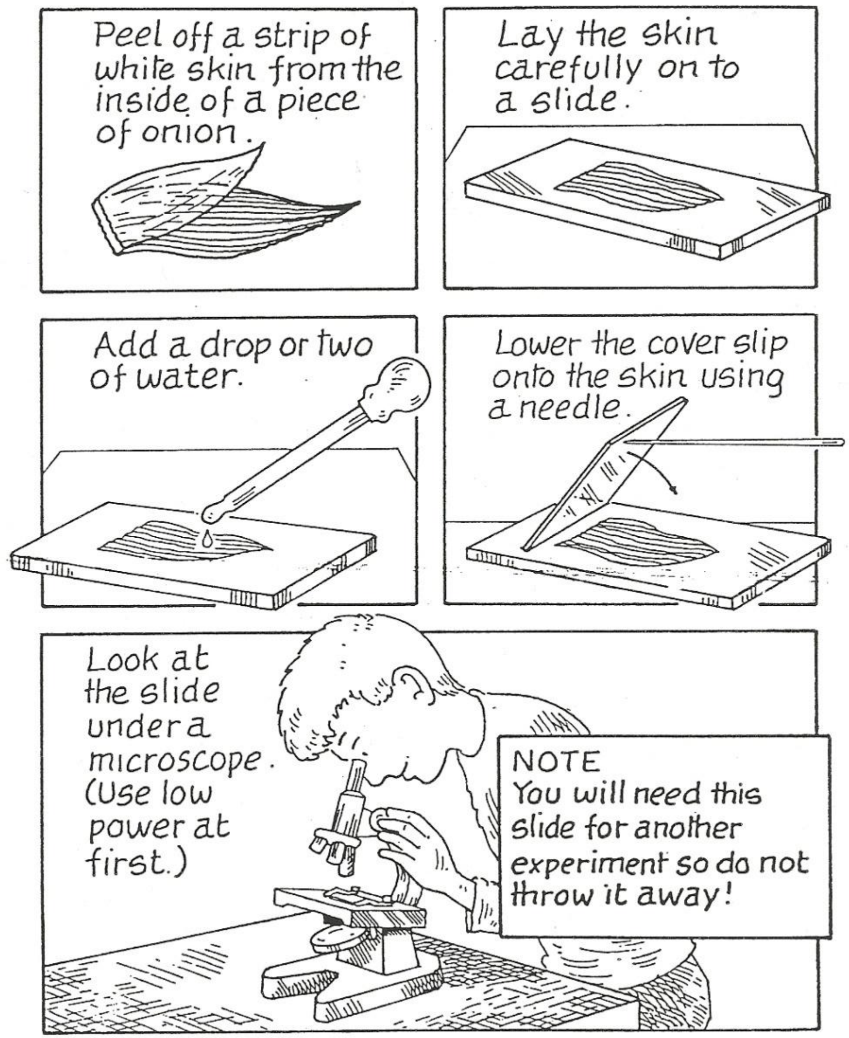
Position of the ammeter in the circuit	Current at this position in amps
A	
B	
C	
D	

❻ **If one or both bulbs don't light** find the fault by checking each component in turn.

Type B: Practical skills

1 Write the heading *Looking at cells from an onion plant* in your book.

Follow these instructions.



2 Write the heading *Diagram of onion skin cells.*

Draw a large diagram of what you can see under the microscope.

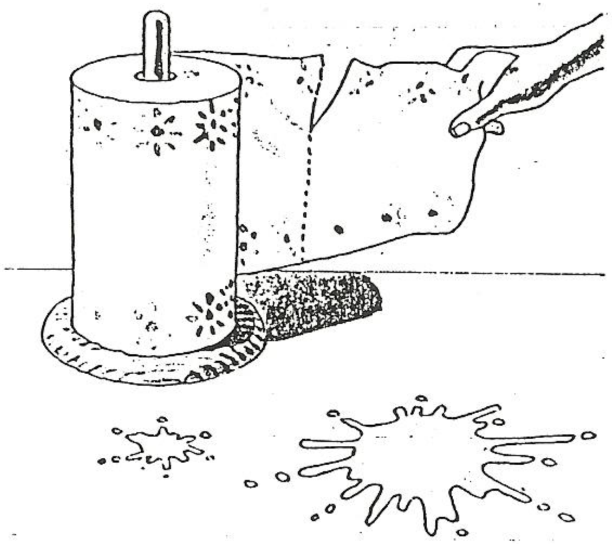
Type C:
Scientific
enquiry

1. Getting soaked

Paper towels are often used in kitchens and washrooms.
What do you think makes a ***good*** paper towel?

You will be given samples of 3 different paper towels, labelled A, B and C.

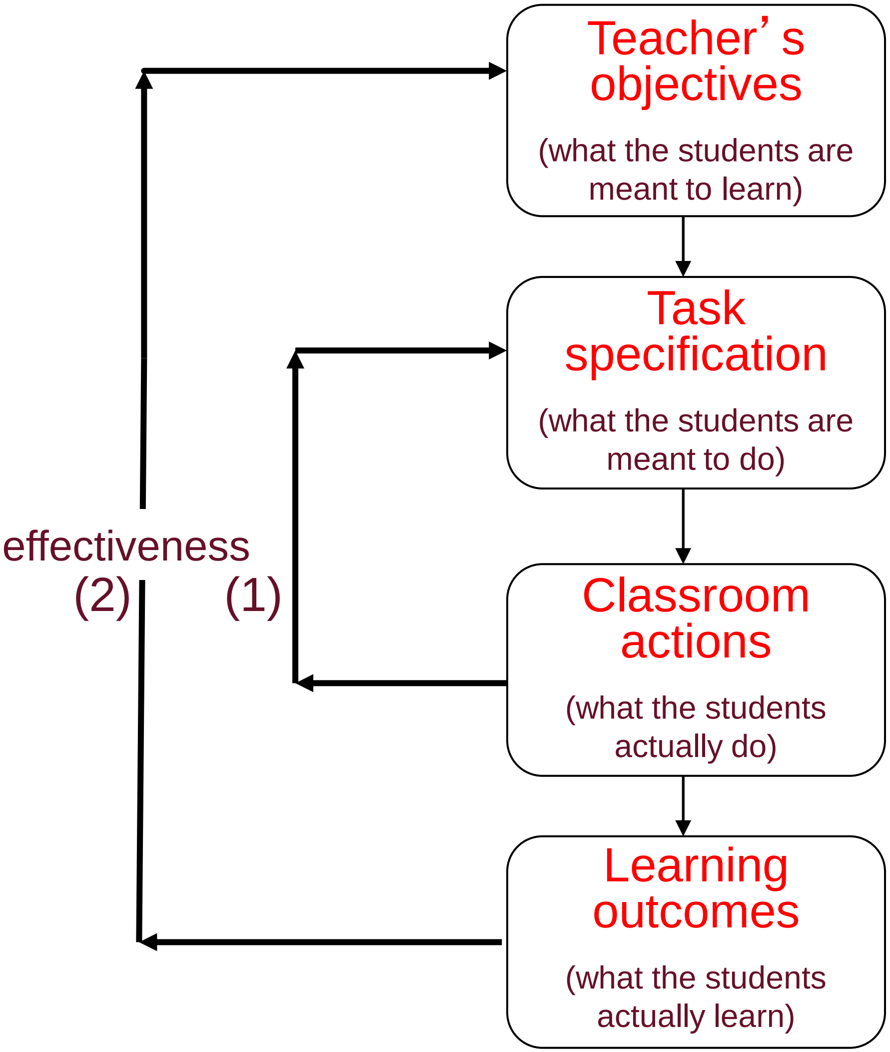
Your job is to find out which of the towels is best at soaking up water.



Which towel would you recommend to a friend?

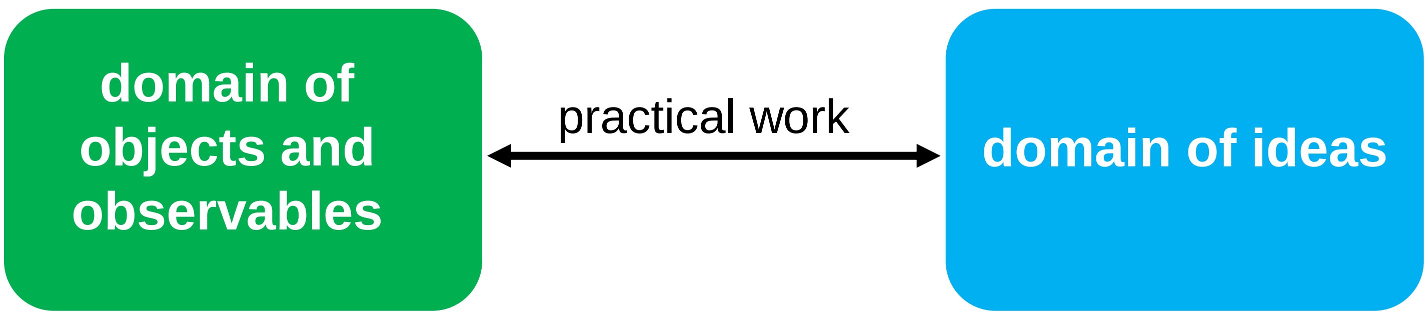
Is a practical activity ‘effective’?

To say that an activity is ‘effective’, we have to have some objective in mind.



Linking two domains

The fundamental purpose of practical work in science education is to help students make links between two domains of knowledge.



Effectiveness of a practical activity

Effective	in the domain of objects and observables	in the domain of ideas
at level (1)		
at level (2)		

Effectiveness of a practical activity

Effective	in the domain of objects and observables	in the domain of ideas
at level (1)	If students do the things they were meant to do with objects and materials (and see the things they were meant to see)	
at level (2)		

Effectiveness of a practical activity

Effective	in the domain of objects and observables	in the domain of ideas
at level (1)	If students do the things they were meant to do with objects and materials (and see the things they were meant to see)	
at level (2)	If students later recall what they did with objects and materials (and what they saw)	

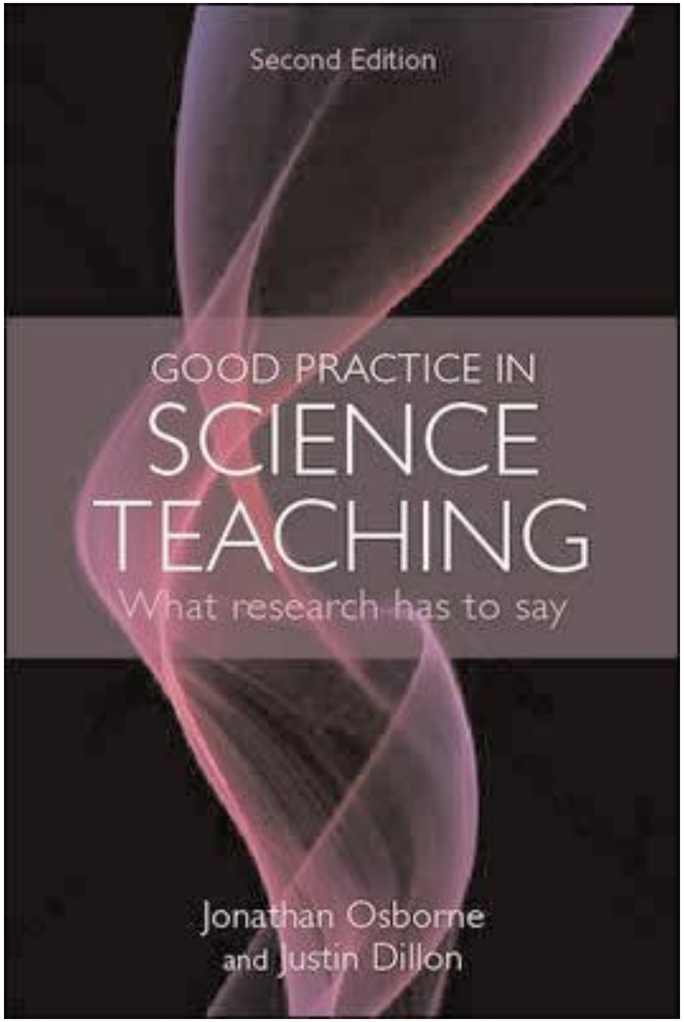
Effectiveness of a practical activity

Effective	in the domain of objects and observables	in the domain of ideas
at level (1)	If students do the things they were meant to do with objects and materials (and see the things they were meant to see)	If students think about what they are doing and what they see, using the ideas they were meant to use
at level (2)	If students later recall what they did with objects and materials (and what they saw)	

Effectiveness of a practical activity

Effective	in the domain of objects and observables	in the domain of ideas
at level (1)	If students do the things they were meant to do with objects and materials (and see the things they were meant to see)	If students think about what they are doing and what they see, using the ideas they were meant to use
at level (2)	If students later recall what they did with objects and materials (and what they saw)	If students later show understanding of the ideas the activity is meant to help them learn, and this can reasonably be attributed (at least in part) to the practical activity

What does research have to say about the effectiveness of practical work?



Review of research:

Millar, R. (2010). Practical work. In J. Osborne & J. Dillon (Eds.), *Good practice in science teaching: What research has to say*, 2nd edn. London: McGraw-Hill.

What does research have to say about the effectiveness of practical work?

Type A: Scientific knowledge

Do students gain a better understanding of science ideas, concepts and explanations if they have more opportunities to do practical work?

Research evidence

- Comparative studies
  - Of inquiry-based programmes, mainly in the US, compared with ‘typical’ instruction
    - No clear evidence of improved conceptual understanding (Minner et al., 2010)
    - Clearest evidence of gains is for ability to handle and manipulate apparatus
  - Combustion: England – Spain
    - “only a marginal effect on [students’] understanding of combustion” (Watson et al., 1995: 487)
  - Teacher demonstration – student practicals
    - “overall cognitive effects of small-group practicals and teacher demonstrations do not differ” (Thijs & Bosch, 1995: 320)

Type A: Scientific knowledge

Do students gain a better understanding of a science topic if they have more opportunities to do practical work?

- The research evidence is inconclusive
- Comparisons of student practical work and teacher demonstration show little difference in understanding of scientific ideas
- Comparisons of topics taught with and without practical work also show little difference in conceptual understanding
- Practical work is more effective in increasing students' knowledge of objects and phenomena than in developing their understanding of scientific concepts and explanations

From a recent study

Evidence:

Observation of 25 ‘typical’ science practical lessons in a sample of schools.

Interviews with teachers and students

Conclusion:

“Practical work was generally effective in getting students to do what is intended with physical objects, but much less effective in getting them to use the intended scientific ideas to guide their actions and reflect upon the data they collect.”

(Abrahams & Millar, 2008: 1945)

From a recent study

Evidence:

Observation of 25 ‘typical’ science practical lessons in a sample of schools.

Interviews with teachers an

Conclusion:

“P

getting

with physical

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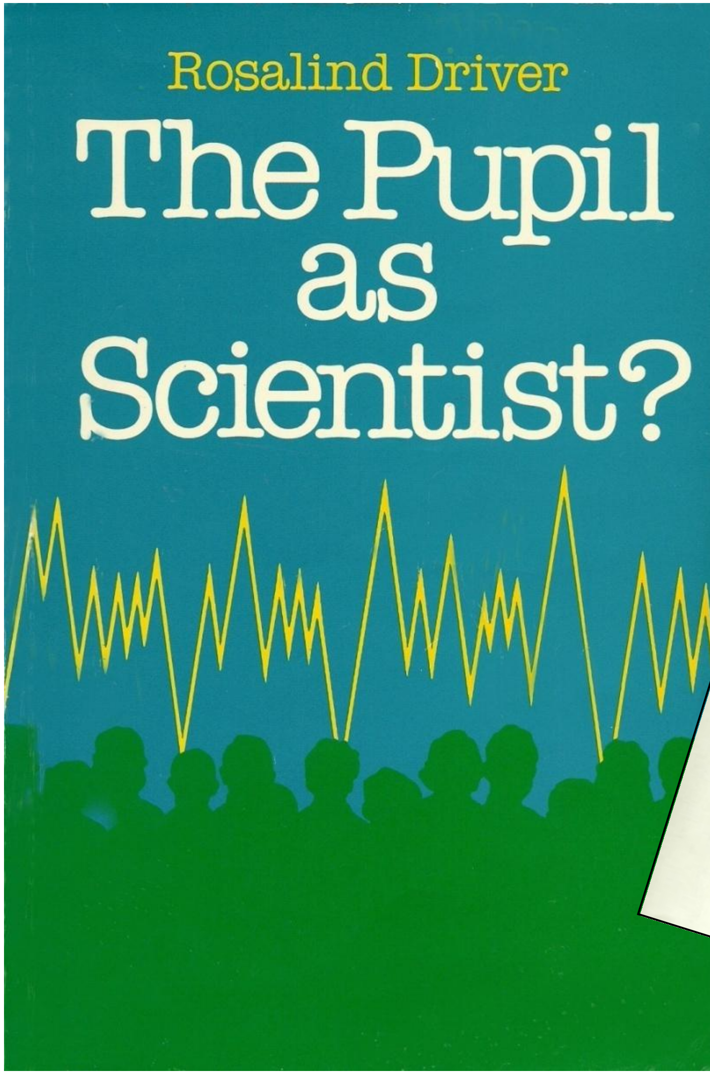
tended scientific ideas to guide their

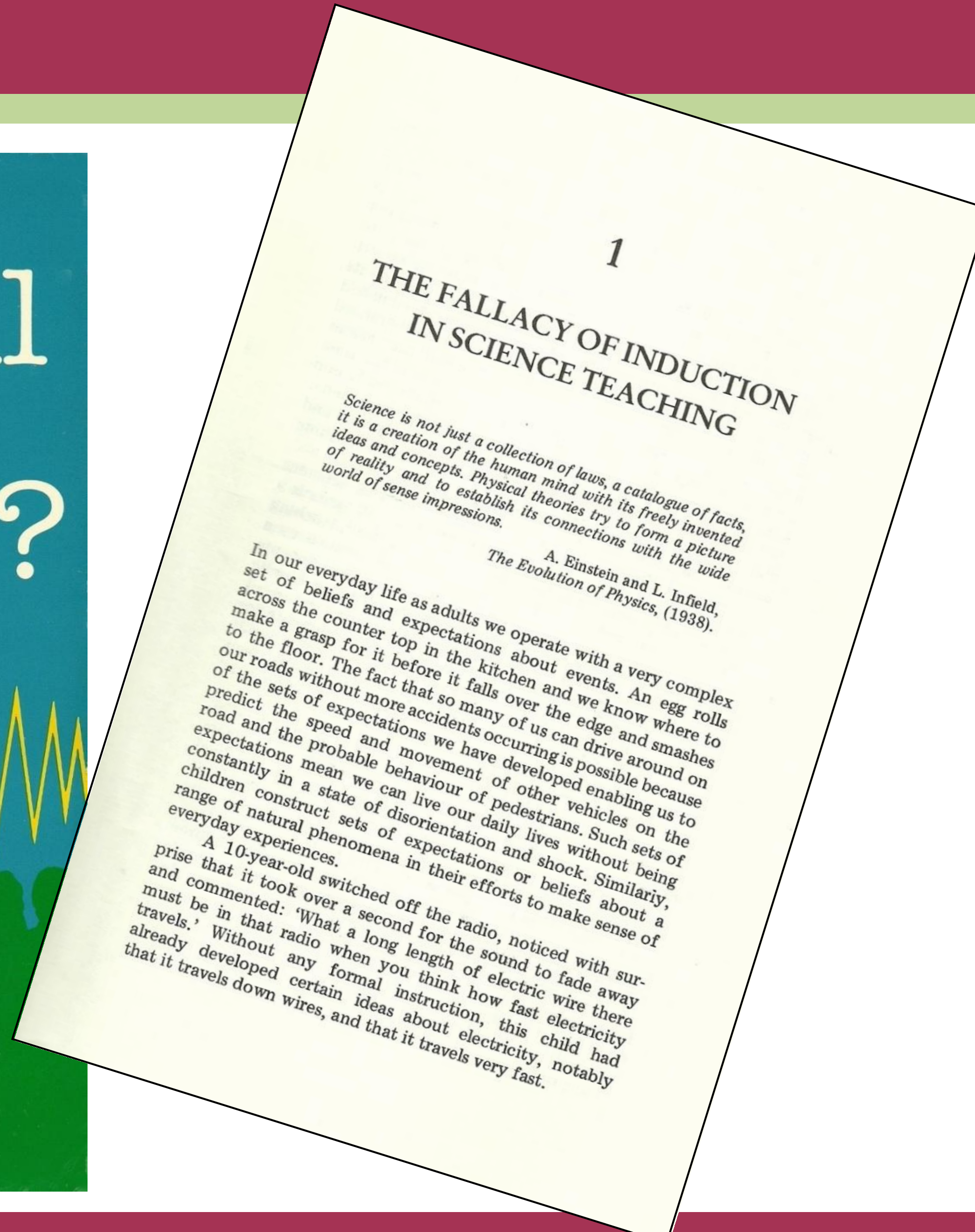
ions and reflect upon the data they collect.”

(Abrahams & Millar, 2008: 1945)

In other words, Type A practical work is often reasonably effective in the domain of objects and observables, but not very effective in the domain of ideas.

Why so ineffective?





1

THE FALLACY OF INDUCTION IN SCIENCE TEACHING

Science is not just a collection of laws, a catalogue of facts, it is a creation of the human mind with its freely invented ideas and concepts. Physical theories try to form a picture of reality and to establish its connections with the wide world of sense impressions.

A. Einstein and L. Infield, *The Evolution of Physics*, (1938).

In our everyday life as adults we operate with a very complex set of beliefs and expectations about events. An egg rolls across the counter top in the kitchen and we know where to make a grasp for it before it falls over the edge and smashes to the floor. The fact that so many of us can drive around on our roads without more accidents occurring is possible because of the sets of expectations we have developed enabling us to predict the speed and movement of other vehicles on the road and the probable behaviour of pedestrians. Such sets of expectations mean we can live our daily lives without being constantly in a state of disorientation and shock. Similariy, children construct sets of expectations or beliefs about a range of natural phenomena in their efforts to make sense of everyday experiences.

A 10-year-old switched off the radio, noticed with surprise that it took over a second for the sound to fade away and commented: 'What a long length of electric wire there must be in that radio when you think how fast electricity travels.' Without any formal instruction, this child had already developed certain ideas about electricity, notably that it travels down wires, and that it travels very fast.

Why so ineffective?

- Even when students do what they were meant to do, and see what they were meant to see, they often don’t draw the conclusion we want them to
  - Theoretical ideas and explanations do not simply ‘emerge’ from careful observation
  - They have to be communicated by someone who already understands them
  - Practical work can facilitate and enhance this communication – but cannot do the whole job on its own

Some encouraging research evidence

- Applications of ICT using ‘virtual manipulatives’ (VM)
  - Several recent studies suggest that a combination of activities using VM with others using ‘physical manipulatives’ (PM) leads to better learning than the use of PM alone
  - For example: Jaakkola & Nurmi, 2008; Zacharia, 2007; Zacharia & Constantinou, 2008

Type B: Practical skills

Does direct practical experience help students to develop their skills in handling apparatus and carrying out practical procedures?

- Research confirms that students are better at using equipment and carrying out practical procedures if they have had opportunities to practice doing these, rather than just being shown how to do them.
- There is no research evidence as to whether practical experience also helps students to understand how equipment works, or why standard procedures are followed.

Type C: Scientific enquiry

Do students become better at designing and carrying out a scientific investigation through practice in doing investigative practical work?

- The answer from research is:
  - Student performance is very variable from one investigation to another, even where these appear similar in underlying structure (e.g. Donnelly, 1987; Strang et al., 1991)
  - Ability to design and carry out a simple investigation improves rather slowly with age (e.g. APU, 1991; Zimmerman, 2007)
  - Specific teaching (which includes practical activities) of <u>specific</u> points about investigation design (e.g. the control-of-variables strategy), or data interpretation, can lead to significantly better learning than simply providing opportunities to do investigations (e.g. Chen & Klahr, 1999; Klahr & Nigam, 2004)

Type C: Scientific enquiry

Do students gain a better understanding of the nature of science through the experience of doing practical work?

- Do they gain an understanding of the values and commitments that underpin scientific enquiry, and of the nature of scientific knowledge?

- Little direct research evidence
  - It is difficult to measure these learning outcomes
  - There is some evidence that interventions specifically designed to develop understanding of the nature of science can be effective

A designed intervention (Carey, Evans, Honda, Jay & Unger, 1989)

- Teaching unit for 12-year-old students (USA)
- To discriminate between two explanations for the role of yeast in making dough rise:
  - Yeast is alive and breathes out a gas
  - There is a chemical reaction between yeast and other ingredients in which a gas is evolved
- Initial views:
  - Many thought knowledge comes directly from observation
  - Scientists are wrong only if they make a mistake, or have not yet looked at the aspect of nature being discussed
- Many were moving beyond such views in the post-intervention interviews

An underlying tension

- Is practical work in school science best thought of as:
  - an opportunity for students to discover new knowledge for themselves?
  - a communication strategy, to help learners come to their own understanding of knowledge and ideas that are already well known (to others)?

The pupil as scientist?

"The young child is often thought of as a little scientist exploring the world and discovering the principles of its operation. We often forget that while the scientist is working on the border of human knowledge and is finding out things that nobody yet knows, the child is finding out precisely what everybody already knows."

(Newman, 1982: 26)

Learning science and learning *about* science

"at the school level, … the acquisition of scientific knowledge is inescapably tinged with dogmatism.

… it is difficult to see how both objectives, an understanding of the mature concepts and theories of science and an understanding of the processes by which scientific knowledge grows, can be achieved simultaneously. … The problem of reconciling these objectives in school science teaching has been considerably underestimated."

(Layton, 1973: 176-7)

IMPROVING EFFECTIVENESS

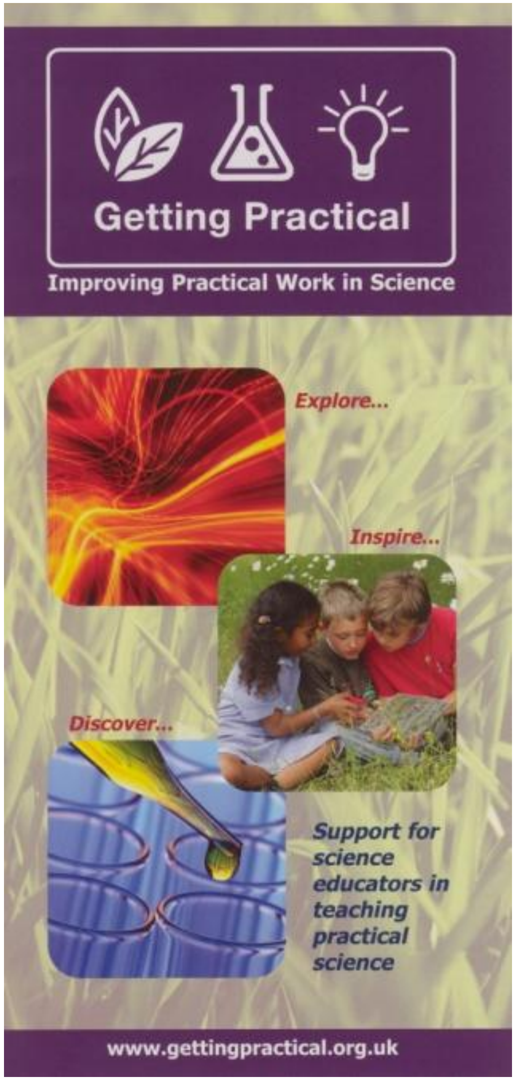
Improving effectiveness

- Research can only tell us about the effectiveness of practical work as it is currently used.
- So what might we do to make practical activities more effective?

‘Getting Practical’

Aim:
To improve practical work in school science

Strategy:
To provide a framework to encourage teachers to reflect systematically on practical activities they currently use, or plan to use



'Getting Practical' : The underlying principles

There is no 'magic bullet':

- We have to think about individual practical tasks, and ask how each might be made more effective

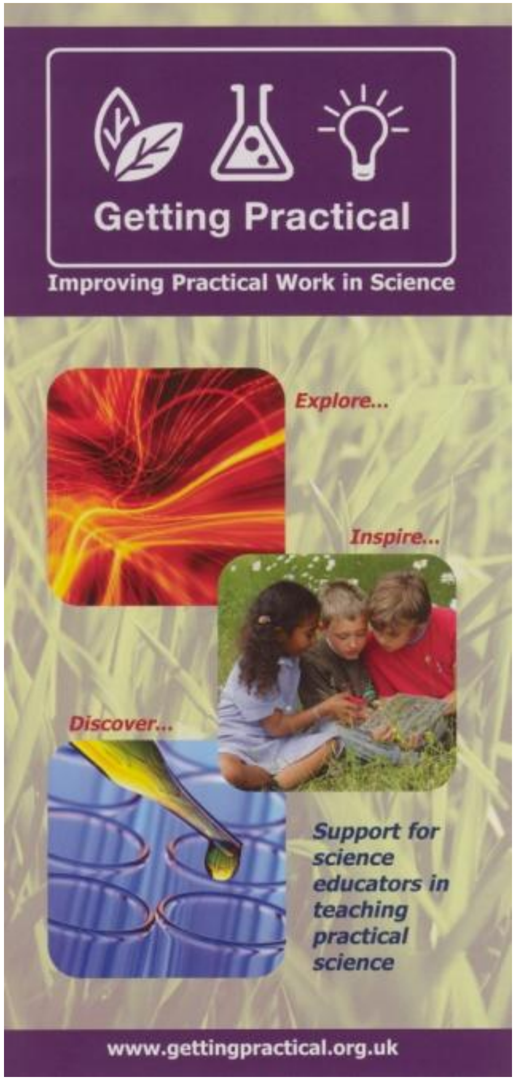
A practical activity is more likely to be effective if:

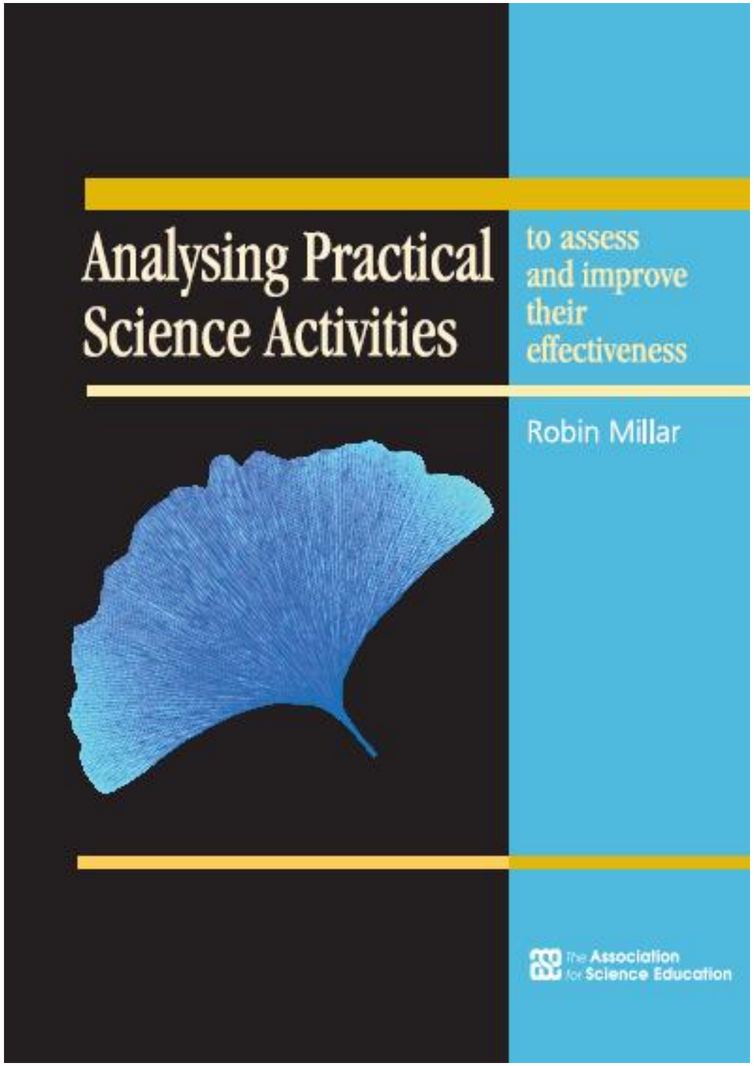
- It has clear and limited learning objectives

The effectiveness of a practical activity will depend on:

- How it is designed
- How it is presented, or 'staged', in class
- How it is integrated into an instructional unit

Auditing your current practice





1 Learning objective(s) (or intended learning outcome(s))

Objective (in general terms)	*Tick ✓ one box to indicate the **main objective***	Learning objective (more specifically)	*Tick ✓ **one** box*
A: By doing this activity, students should develop their knowledge and understanding of the natural world		Students can recall an observable feature of an object, or material, or event	
		Students can recall a 'pattern' in observations (e.g. a similarity, difference, trend, relationship)	
		Students have a better understanding of a scientific idea, or concept, or explanation, or model, or theory	
B: By doing this activity, students should learn how to use a piece of laboratory equipment or follow a standard practical procedure		Students can use a piece of equipment, or follow a practical procedure, that they have not previously met	
		Students are better at using a piece of equipment, or following a practical procedure, that they have previously met	
C: By doing this activity, students should develop their understanding of the scientific approach to enquiry		Students have a better *general understanding* of scientific enquiry	
		Students have a better *understanding of some specific aspects* of scientific enquiry	

If you have ticked this box, please complete the table below

***Specific aspects* of scientific enquiry**	*Tick ✓ all that apply*
How to identify a good investigation question	
How to plan a strategy for collecting data to address a question	
How to choose equipment for an investigation	
How to present data clearly	
How to analyse data to reveal or display patterns	
How to draw and present conclusions based on evidence	
How to assess how confident you can be that a conclusion is correct	

2 Design

2.1 How open/closed? (Tick ✓ one box)	
Question given, and detailed instructions on procedure	
Question given, and outline guidance on procedure; some choices left to students	
Question given, but students choose how to proceed	
Students decide the question and how to proceed	

2.2 Logical structure of the activity (Tick ✓ one box)	
Collect data on a situation, then think about how it might be summarised or explained	
Use current ideas to generate a question or prediction; collect data to explore or test	
Other. Please describe:	

2.3 Importance of scientific ideas (to carry out the activity well) (Rate: 4= essential; 3=fairly; 2=not very; 1=unimportant)	
Importance of an understanding of scientific ideas	

2.4 What students have to do with objects and materials (Tick ✓ all that apply)	
Use an observing or measuring instrument	
Follow a standard practical procedure	
Present or display an object or material	
Make an object	
Make a sample of a material or substance	
Make an event happen (produce a phenomenon)	
Observe an aspect or property of an object, material, or event	
Measure a quantity	

2.5 What students have to 'do' with ideas (Tick ✓ all that apply)	
Report observations using scientific terminology	
Identify a similarity or difference (between objects, or materials, or events)	
Explore the effect on an outcome of a specific change (e.g. of using a different object, or material, or procedure)	
Explore how an outcome variable changes with time	
Explore how an outcome variable changes when the value of a continuous independent variable changes	
Explore how an outcome variable changes when each of two (or more) independent variables changes	
Design a measurement or observation procedure	
Obtain a value of a derived quantity (i.e. one that cannot be directly measured)	
Make and/or test a prediction	
Decide if a given explanation applies to the particular situation observed	
Decide which of two (or more) given explanations best fits the data	
Suggest a possible explanation for data	

3 Presentation

3.1 How is the purpose, or rationale, communicated to students? (Tick ✓ one box)	
Activity is proposed by teacher; no explicit links made to previous work	
Purpose of activity explained by teacher, and explicitly linked to preceding work	
Teacher uses class discussion to help students see how the activity can help answer a question of interest	
Purpose of activity readily apparent to the students; clearly follows from previous work	
Activity is proposed and specified by the students, following discussion	

3.2 How is the activity explained to students? (Tick ✓ all that apply**)**	
Orally by the teacher	
Written instructions on OHP or data projector	
Worksheet	
(All or part of) procedure demonstrated by teacher beforehand	

3.3 Whole class discussion before the practical activity begins? (Tick ✓ all that apply)	
None	
About equipment and procedures to be used	
About ideas, concepts, theories, and models that are relevant to the activity	
About aspects of scientific enquiry that relate to the activity	

3.4 Whole class discussion following the practical activity? (Tick ✓ all that apply)	
None	
About confirming 'what we have seen'	
Centred around a demonstration in which the teacher repeats the practical activity	
About how to explain observations, and to develop conceptual ideas that relate to the task	
About aspects of investigation design, quality of data, confidence in conclusions, etc.	

3.5 Students' record of the activity (Tick ✓ one box)	
None	
Notes, as the student wishes	
A completed worksheet	
Written report with a given format	
Written report in a format chosen by the student	
Other. Please describe:	

4 Learning demand

In the light of your entries above, how would you judge the **learning demand** of this activity? (Rate: 5=very high; 4=fairly high; 3=moderate; 2=fairly low; 1=very low)	
Learning demand	

5 Assessment of effectiveness when used

A Effectiveness at level (1)

Key question: Did students do what they were intended to do, and see what they were intended to see?

		Mainly yes	Mainly no	Not applicable
1	Did students know how to use the equipment involved?			
2	Were students able to set up the apparatus, and handle the materials involved, correctly and safely?			
3	Were students able to use the apparatus with sufficient precision to make the necessary observations or measurements?			
4	Were students able to carry out any routine procedures involved?			
5	Were students able to follow any oral or written instructions given?			
6	Did students observe the outcome(s) or effect(s) you wanted them to see?			
7	Could students explain the purpose of the activity if asked? (what they were doing it for)			
8	Did students talk about the activity using the scientific terms and ideas you would have wished them to use?			

B Effectiveness at level (2)

Key question: Did students learn what they were intended to learn?

		Most	Some	Only a few
1	How many students could recall what they did, and the main features of what they observed?			
Summarise the evidence for your answer above:				
		Most	Some	Only a few
2	How many students have a better understanding of the ideas the activity was intended to help them understand?			
Summarise the evidence for your answer above:				

Design and staging: The key issues

- To be effective, activities must be ‘minds-on’ as well as ‘hands-on’
  - Students need to be thinking about what they are doing, and why they are doing it, not just following instructions or routines
- Design the task, and plan its staging, to help students build bridges between the domain of observables and the domain of ideas

Focusing on Task Design

How might you modify a practical activity to make it more ‘minds-on’?

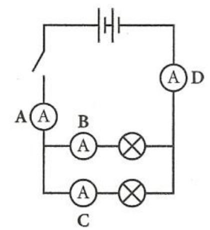
Investigating parallel circuits

Aim

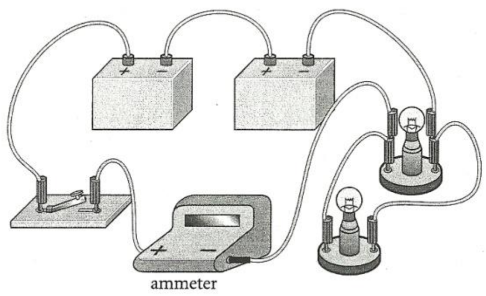
To investigate how the electric current splits up in a *parallel* circuit.

Preparation

This diagram shows a circuit with four ammeters for measuring the current at four places: **A B C** and **D**.



You will only have one ammeter, so put it at position A like this:



What to do

1. Connect up the circuit as shown in the circuit diagram with the ammeter at position A.
2. Check the ammeter is connected correctly.
3. Switch on the circuit.
4. Don't leave the circuit switched on for a long time. When you are not recording the current switch it off so that the batteries do not run down.
5. **If the bulbs both light**: record the current in a table like this:

Position of the ammeter in the circuit	Current at this position in amps
A	
B	
C	
D	

6. **If one or both bulbs don't light** find the fault by checking each component in turn.

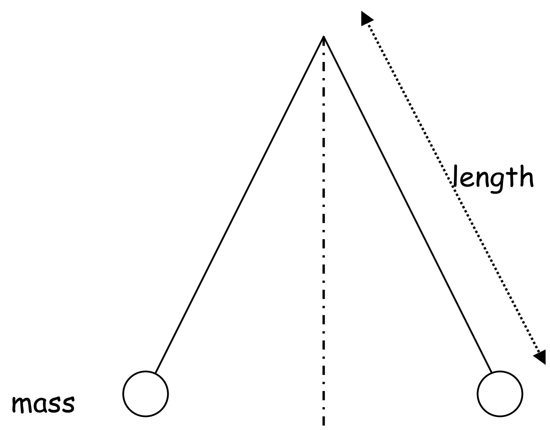
How might you modify this activity to make it more 'minds-on'?

Ways of improving ‘Investigating parallel circuits’

- Don’t do it until you are sure most (ideally all) know how to measure the electric current at a given point in a circuit
  - If necessary, have a previous Type B practical task on just this skill
- Convert to a POE (Predict-Observe-Explain) task
  - What would you expect to notice if you measured the electric current at A, B, C and D? Write down your prediction.
  - Now do it and see if your predictions are correct.
  - Whether you were right or not, now explain your results.

Investigating how a pendulum swings

A pendulum consists of a **mass** tied to a **string**, hanging from a **fixed point**.



Your task:

- Investigate how the time for 10 swings of a pendulum depends on the mass of the object tied to the string.

Equipment provided:

- A fixed support to hang your pendulum from
- Five lengths of string: 20 cm, 40 cm, 60 cm, 80 cm and 100 cm
- Five objects to hang on the string: 20g, 40g, 60g, 80g, 100g
- A digital stopwatch

How might you modify this activity to make it more 'minds-on'?

Ways of improving ‘Investigating how a pendulum swings’

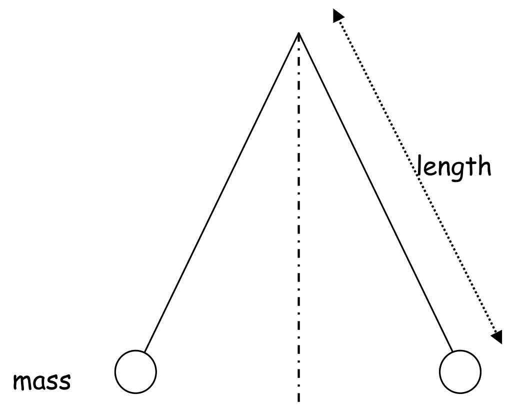
- If you are using it as a Type A practical
  - Convert to a POE

- If you are using it as a Type C practical
  - Restrict the number of measurements

Modification 1:
Convert to a POE

Investigating how a pendulum swings

A pendulum consists of a **mass** tied to a **string**, hanging from a **fixed point**.



Your task:

- How do you think the time for 10 swings will change if you change the mass on the string? Write down your prediction.
- Use the equipment provided to test if your prediction is correct.

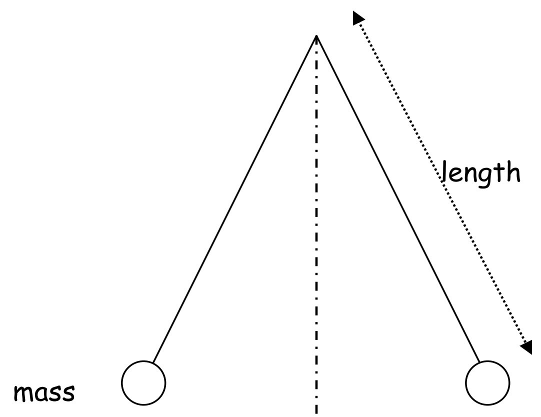
Equipment provided:

- A fixed support to hang your pendulum from
- Five lengths of string: 20 cm, 40 cm, 60 cm, 80 cm and 100 cm
- Five objects to hang on the string: 20g, 40g, 60g, 80g, 100g
- A digital stopwatch

Modification 2:
Restrict the number of measurements

Investigating how a pendulum swings

A pendulum consists of a **mass** tied to a **string**, hanging from a **fixed point**.



Your task:

- Investigate how the time for 10 swings of a pendulum depends on the mass of the object tied to the string. You are allowed to take just three measurements.

Equipment provided:

- A fixed support to hang your pendulum from
- Five lengths of string: 20 cm, 40 cm, 60 cm, 80 cm and 100 cm
- Five objects to hang on the string: 20g, 40g, 60g, 80g, 100g
- A digital stopwatch

Focusing on the staging of a practical activity

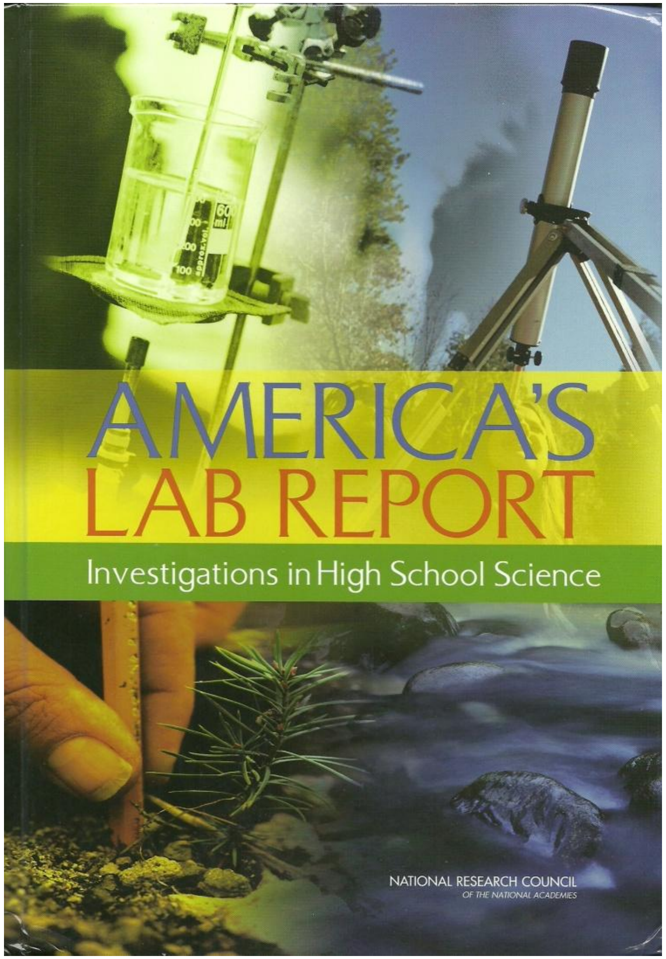
- Make sure the practical activity grows naturally out of the topic and the ideas the students are studying
- Help students to see the *purpose* of the activity
  - What are they doing it *for*?
  - What question might it help them to answer?
  - How might it advance their understanding?

Purpose ≠ Objective

- What do I want students to learn from carrying out this practical activity? (objective)
- What do students think they will learn from carrying out this activity? (purpose)

A useful exercise: After a practical activity, ask some students what they think they have learned from it – and see if it matches your intentions.

Integrated instructional units



(National Research Council, 2006)

- Rather than thinking about individual practical activities in isolation, it may be more productive to think about 'instructional sequences that include laboratory experiences along with lectures, reading and discussion' (p. 195)
- Although research on such sequences (or units) is still quite limited, there is evidence that they are more effective than 'traditional' (isolated) practical experiences.

Principles of instructional design

"Four principles of instructional design can help laboratory experiences achieve their intended learning goals if
(1) they are designed with clear learning outcomes in mind,
(2) they are thoughtfully sequenced into the flow of classroom science instruction,
(3) they are designed to integrate learning of science content with learning about the processes of science, and
(4) they incorporate ongoing student reflection and discussion." (p. 197)

(From: National Research Council (2006). *America's Lab Report: Investigations in High School Science.* Washington, DC: The National Academies Press.)

Two views on practical work

A teacher, asked in an interview about the role of practical work in science teaching:

"It's what science is all about really … getting on with some experiments. Science is a practical subject …. You know, end of story, I think."

(Donnelly, 1995: 97)

An experienced researcher, writing about his observation of practical work:

"Despite its often massive share of curriculum time, laboratory work often provides little of real educational value. As practiced in many countries, it is ill-conceived, confused and unproductive. For many children, what goes on in the laboratory contributes little to their learning of science or to their learning *about* science and its methods."

(Hodson, 1991: 176)

Two views on practical work

A teacher, asked in an interview about the role of practical work in science teaching:

"It ...

)

Practical activities should not be used unthinkingly, as a matter of routine, but planned and used with a specific learning purpose in mind – chosen as the best way to achieve the learning objective you have in mind – and thoughtfully integrated into classroom instruction sequences.

An experienced researcher, writing about his observation of practical work:

"Despite its often massive share of curriculum time, laboratory work often provides little of real educational value. As practiced in many countries, it is ill-conceived, confused and unproductive. For [...] children, what goes on in the labo[...] [...]utes little to their lea[...] [...]ir learning *abou[...]*

(Hodson, 1991: [...]6)

'As practiced' ... it doesn't have to be like this; we can do better.