Activity 2: Is there a method to science?

This activity introduces three models of 'how science works', and asks students to apply the models to historical case studies.

Overview of learning activity

This activity concerns a key feature of the nature of science, which is the notion of a 'scientific method'. This has been (and continues to be) a very contested area within the philosophy of science, so it is not possible to offer a single prescription for how science can (or should) proceed. This type of complexity and lack of a closed answer should appeal to many gifted learners.

> *'The students all seemed to be thinking quite deeply about the topic. They spent much of the time reading individually and thinking on their own before bouncing ideas off each other. I think they also found it interesting and challenging as well.'*
>
> *(From the Observation notes of one of the graduate assistants)*

The activity introduces some basic ideas from the philosophy of science by proposing three models of ideas about how science works. These are simplified models, but nonetheless offer an authentic taste of the issues involved.

Rationale

Philosophy is considered a very suitable area for gifted learners (see chapter 4). In science there is a danger that teaching is often focused on well-accepted models (or at least curriculum models that imply the science is well-accepted), and the type of practical work often undertaken may seem to imply that interrogating nature is a rather straightforward process. As well as giving a limited and distorted view of what science (as largely an activity concerning contested or poorly understood subject matter) is actually like, this approach may well be uninspiring to the most able learners, who are ready to be challenged to engage with some of the uncertainty involved in developing scientific knowledge.

The activity

The students are asked to work in groups to discuss how historical sketches of the work of scientists support (or not) three models of the scientific method:

The three models presented are:

- **Model 1** – Induction
- **Model 2** – Falsification
- **Model 3** – Paradigm shifts

These are linked to the ideas of Bacon, Popper and Kuhn.

The vignettes provided (and teachers may wish to substitute or supplement these examples) are of the work of: Marie Curie; Albert Einstein; William Harvey; Robert Millikan; Barbara McClintock; Crick, Franklin, Wilkins & Watson; Galileo Galilei; Lise Meitner; Jane Goodall; Johann Kepler

The examples were selected to offer a range of different types of scientific work, and to make specific points relevant to the different models of the scientific enterprise.

Some additional materials are provided to help structure the activity, and scaffold learning:

A **summary table**: to help learners identify and keep in mind the key points in the three models – information has to be fitted in the appropriate cells.

Flow charts that summarise each of the three models (as an alternative form of representing the key ideas)

Tables for recording evidence that supports or is in conflict with each model.

The task ends with some questions for group discussion.

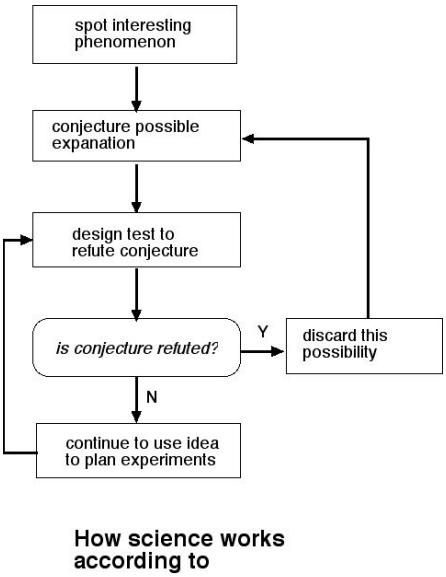

Figure 2.1: A flow chart to illustrate one model of science

Method	Philosopher	Approach	Progress
Induction	Bacon	Accumulation of facts	Collect sufficient data
Falsification	Popper	Test conjectures critically	Refute false conjectures
Paradigm shifts	Kuhn	Spot significant anomalies	Revolutions in scientific thinking

Figure 2.2: Summary table – a simplified version of three 'philosophies of science'

B1: 'so Einstein refuted other people's ideas and made his own . . .'

B2: 'yeah, it says here he developed a range of models'

B3: 'he also tried to refute his own ideas . . .'

B1: ' William Harvey also refuted other ideas as well . . . and I think Galileo did as well'

B3: 'it seems like quite a lot of people used Popper's model . . .'

(ASCEND delegates discuss the historical vignettes)

Debriefing points:

As with most of the ASCEND activities, the tasks are designed to encourage active discussion, rather than focusing on specified end points. The different vignettes do not collectively suggest any one of the models is adequate – and this reflects the lively debate among those who study such matters!

one boy suggests that 'different situations need different models depending on what you're researching on'

(From the Observations notes of one of the graduate assistants)

It may be worth pointing out that Bacon's ideas now seem naive, but were very influential for a long time. It may also be worth noting that (despite a quite lively debate on the relative merits of the two approaches) Popper's model is primarily prescriptive (what scientists should do) whereas Kuhn's sociological approach was more descriptive – reporting what scientists seemed to do.

Resources

The following resources are included on the CD:

Resource	Description	Filename
Instructions	Instructions for groups.	Act 2 Instructions
Models	Three models of how science progresses	Act 2 Models
Vignettes	Ten sketches of the work of well-known scientists	Act 2 Vignettes
Summary sheet	Summary table – and key points to complete cell tables	Act 2 Summary
Flowcharts	A flow chart giving an overview for each of the three models	Act 2 Flows
Evaluation sheets	Three sheets for recording evidence supporting or contradicting the model	Act 2 Evaluation

