WARM-UP: WHAT IS SCIENCE?

'Science' is a familiar idea in our society and you should, therefore, have a reasonable idea about the concept and be able to visualise various characteristics (and, by extension, the characteristics of non-science) when you hear the word itself.

In small groups, use the following table to identify and categorise your thoughts about science. Once you've exhausted all possibilities, as a class decide what constitutes science and non-science (and, of course, why).

Science is:	Science is not:
Factual Physics	Opinion Theatre studies

generally considered to be a *superior* form of knowledge, it's hardly surprising that sociologists would like a piece of the action – like anyone else, sociologists want their ideas to be taken seriously and one way for this to happen is if sociological knowledge has a similar status to natural scientific knowledge.

Preparing the ground: The nature of science

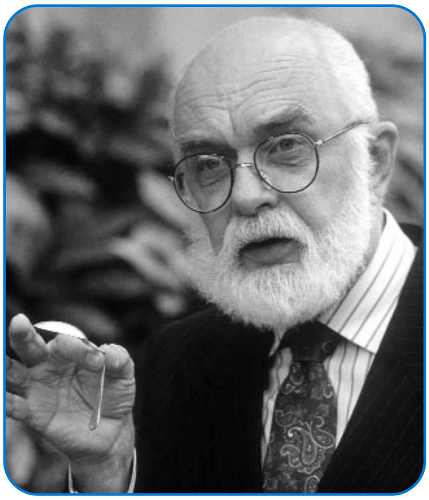
When we think about the concept of science, two initial ideas need to be clear:

Knowledge: 'Science' is *not* a 'body of knowledge' – it isn't, for example, the preserve of particular subject areas (such as chemistry or physics). Rather, *science* is a way of producing a particular *kind* of knowledge. As **Popper** (1934) classically puts it: 'Science is . . . a method of approaching and studying phenomena. It involves identifying a problem to study, collecting information about it and eventually offering an explanation for it. All this is done as systematically as possible.'

In this respect, therefore, we can think about science as a:

Methodology – a way of producing *reliable* and *valid* knowledge. Scientific knowledge has, in this respect, been *tested* against available evidence and not been *disproven*, something that, at the very least, gives such knowledge greater *plausibility* than non-scientific knowledge – ideas that are consolidated around the ability to make:

Predictive statements based on scientific knowledge: Predictive ability means the scientist is in a position to say with *complete certainty* that something *will* happen in the



'Science is best defined as a careful, disciplined, logical search for knowledge about any and all aspects of the universe, obtained by examination of the best available evidence and always subject to correction and improvement upon the discovery of better evidence. What's left is magic, and it doesn't work'
James Randi (1993), magician

future – perhaps the most powerful form of knowledge statement we can make.

Weeding the path

Although the power of science is bound up with its ability to make predictive statements, **Carpi** (2003) identifies a common misconception about science (that it somehow defines 'truth'): 'Science does not define truth; rather, it defines a way of thought. It is a process in which experiments are used to answer questions' – an important distinction because scientific knowledge (despite the claims of some postmodernists) doesn't claim to be 'true' in the sense that it can never be questioned.

Rather, it involves the idea that scientific knowledge, properly tested and evidenced, represents the *most plausible* explanation we currently have for something and it retains this status only until some other scientist produces a *more plausible* explanation.

✲ SYNOPTIC LINK

Religion/Power and politics: We can note that different definitions of 'truth' may apply in different contexts. For example, in terms of *religion* people may accept the truth of something (such as the existence of God) on the basis of *faith* (an unquestioning – and untestable – belief). Alternatively, *politicians* often ask their followers to accept the truth of something 'on *trust*' – which, unlike science, once again reflects an *unquestioning* attitude to truth.

If science is a methodology, it follows it must involve a set of *rules* applied by the scientist in the research process, and these, for our purpose, fall into two categories (*procedures* and *ethos*).

Procedures

Scientists must follow an agreed set of *methodological procedures* governing how data can be collected and analysed. One of the most influential examples here comes from **Popper's** (1934) notion of a:

Hypothetico-deductive model, involving a number of phases, starting with:

Phenomena: Scientists choose – and think about – 'a problem' requiring explanation. They then:

Generate ideas about how to study 'the problem'. This involves observations, both personal and of any work that may previously have been done in the area of interest. This eventually leads to the formation of a:

Testable hypothesis: To clarify 'the problem', a hypothesis is stated that must be capable of being tested through the collection and analysis of evidence. In **Popper's** formulation, a hypothesis must be *capable* of being disproven through:

Systematic observation: Hypothesis testing involves collecting data in a reliable way. In the natural sciences, for example, *experimentation* is widely used because the scientist can control the conditions under which data are generated and, in theory at least, maintain an objective position that avoids personal interference in the data-collection process. After collection, data are:

Systematically analysed – the data have to be objectively interpreted so that:

Conclusions can be drawn from them. On the basis of the evidence, the hypothesis is *either*:

- **Refuted** (shown to be false) – in which case the scientist might develop a new testable hypothesis – or
- **Confirmed** – shown to be 'not false', an important distinction because **Popper**

argues scientific knowledge can never be conclusively shown to be 'true'. A 'confirmed hypothesis' then becomes part of a:

- **Theory** – an explanatory statement (usually) consisting of a series of linked, confirmed hypotheses that allow the scientist to make *predictive statements* about the behaviour initially observed.

Ethos

Ethos refers to rules governing the general conditions 'science' must satisfy if it is to both attain and maintain scientific status. In other words, the process of 'doing science' is located in a *community* that specifies:

- **standards** for the overall conduct of scientists and scientific forms of research, and
- **policies** for scientific practice, to ensure rules of procedure, such as the ones we've just noted, are obeyed.

Merton (1942) identified four areas of *research ethics* that, in combination, make up what he termed a:

Scientific ethos – a set of *normative guidelines* related to the practice of science:

- **Universalism**: The scientific community must evaluate knowledge only on the basis of objective, universally agreed criteria. Personal values – either those of the scientific community or of society as a whole – play no part in the evaluation process and criticism of a scientist's work should focus on refuting ('falsifying') their conclusions, identifying weaknesses in the research process, and so forth. In technical terms, scientists must avoid what **Labossiere** (1995) calls the:

Ad hominem fallacy – a situation in which an argument is rejected ' . . . on the basis of some irrelevant fact about the author of or the person presenting the claim or argument' (whether this rejection is based on personal factors – their character, for example – or social factors such as gender, nationality, class, age and the like).

✻ SYNOPTIC LINK

Stratification and differentiation: Etzkowitz et al. (2000) argue that, despite this ethos of universalism, female scientists frequently find their work and careers hampered by the 'hidden barriers, subtle exclusions and unwritten rules of the scientific workplace'.

- **Communality**: Scientific knowledge is 'public knowledge' shared, initially, within the scientific community for a number of reasons:
  - **Progression**: Scientists must be able to build on the work done by other scientists. This not only saves time and effort (scientists are not continually 'reinventing the wheel'), but also encourages the 'leaps of faith' (where one scientist, for example, is inspired to develop new ideas by understanding the work of other scientists) through which scientific understanding advances on a *cumulative* basis.
  - **Evaluation**: If scientific knowledge cannot be accepted 'on trust', it follows that scientists must make their work, including details of research methodology, available for peer review and criticism.
  - **Replication**: An important aspect of

scholarly criticism is the ability to repeat ('replicate') a piece of research to see whether the same results are attained. Such replication is normally done by other scientists who, therefore, require detailed knowledge of the original research. In recent times one of the most famous examples of 'peer review' in the natural sciences is **Fleischmann** and **Pons'** (1989) claim to have created energy through a process called 'cold fusion' – subsequent attempts by other scientists to repeat the experiment failed to confirm **Fleischmann** and **Pons'** findings.

- **Disinterestedness** has two basic meanings here:
  - **Institutional**: The main responsibility of the scientist is the pursuit of knowledge. This is not to say scientists should not be recognised for their achievements (or rewarded for their efforts), but they should not have a stake in the 'success' of their research since this risks introducing personal bias into the research process.
  - **Detachment**: The use to which research is put is not the responsibility of the scientist who produced it. Scientists, in other words, cannot be held accountable for how others (such as politicians) use their research.
- **Organised scepticism**: One of the guiding principles of science is that nothing is beyond criticism, a significant idea for two main reasons:
  - **Critical reflection**: The scientific community must continually evaluate knowledge (rather than simply taking it for granted) since this 'process of questioning' contributes to the development of human understanding.

Growing it yourself: Functional science

The scientific ethos is rooted in Merton's Functionalist outlook on social behaviour – an ethos develops and is maintained because it's in the interests of both scientists and non-scientists to ensure its normative principles and procedures are obeyed.

In this respect, we could also note how such an ethos reflects Luhmann's ideas about autopoiesis – the scientific community resembles a self-reproducing organisation that exists independently of its individual members.

As a class, identify as many *functions* (both personal and organisational) as possible of a scientific ethos (we've given you some ideas to start you off).

For scientists	For society
Preserves the personal and institutional credibility of science and scientists	Trust – we know research has been checked and rechecked

- **Inherency**: Knowledge is never 'inherently true' (an article of faith). This 'sceptical attitude' represented, for **Merton**, the main way scientific knowledge differed from other forms of knowledge (such as religious faith); the former is 'true' only because it has not, *as yet*, been disproved. The latter, however, is considered by its adherents to be *self-evidently true* (it cannot be refuted).

The idea of a scientific ethos, to which all scientists – by choice, peer pressure or institutional imperative – are forced to subscribe, enables us to understand the way scientific research is both organised and validated according to a set of institutionalised norms and values concerning what does and does not constitute science.

Weeding the path

Prelli (1989) notes that four types of 'oppositional counter norms' have been suggested to set against **Merton's** moral norms:

- **Particularism**, whereby the personal status, ability and experience of a scientist leads others to uncritically accept their arguments and findings.
- **Solitariness**: Scientists are increasingly claiming 'property rights' to the commercial exploitation of their work, thereby preventing scientific scrutiny under the guise of 'commercial confidentiality'.
- **Interestedness**: With commercial employment and exploitation scientists are under increasing pressure to ensure their work 'produces the desired results'.
- **Organised dogmatism** involving scientists fervently defending their research and findings against external criticism, while 'doubting the findings of others'.

Digging deeper: The nature of science

Prelli's identification of 'oppositional norms' suggests we need to look more critically at both the theory and practice of science, not only in terms of a *scientific ethos* but also in terms of the logic and procedures of a scientific methodology (such as the hypothetico-deductive model proposed by **Popper**).

In thinking about the conduct of science, therefore, we can begin by noting **Kaplan's** (1964) distinction between two types of logic:

- **Logics-in-use**: **Solomon** (2000) describes this as 'what people actually do' – and how they go about doing it – when they carry out research.
- **Reconstructed logics** refer to how a piece of research is presented to the world, for both peer review within the scientific community and public consumption.

Ideally, the two logics should be the same since the scientist is simply recording and presenting a description of their research, but research 'in the real world' is rarely, if ever, the smooth, uncluttered process described by **Popper's** (idealised) research procedure.

Weeding the path

Although these two ideas express possible differences between what scientists 'say they do' (a *reconstructed logic* that presents a polished narrative for peer and public consumption) and what they 'actually do' (*logic-in-use*), this is not to say scientists deliberately cheat or falsify their procedures and results. As **Medawar** (1963) argues, scientific papers describing the research process are 'fraudulent' only in the sense that they ' . . . give a totally misleading narrative of the processes of thought that go into the making of scientific discoveries'.

However, it does suggest that if reconstructions are the norm, it is difficult for scientific research to be reliably and validly *replicated* since what is being retested is a *narrative* that *describes* a research process, not the actual process itself – something **Kaplan** (1964) calls an 'idealisation of scientific practice' rather than an objective description of such practice. This distinction raises an important question for the sociology of science (and, by extension, the question of whether or not sociology can be considered scientific), namely the extent to which the ability of natural scientists to produce highly reliable and valid knowledge is based on a:

- **Scientific methodology** that guarantees the production of such knowledge or a:
- **Subject matter** that, because it does not have *consciousness*, allows the natural scientist to produce reliable and valid knowledge 'regardless' of the exact form of methodology used to generate it.

These questions are crucial to both an understanding of science and, by implication, the question of whether or not sociology can be a science in the same way that physics, for example, is a science. If 'scientific knowledge' is the product of a *methodology*, it's theoretically possible for social scientists to use a similar methodology to study human behaviour. If, however, such knowledge is a quality of the *subject matter* of natural science (inanimate objects rather than thinking subjects), it will be impossible to reliably and validly use such a methodology in the social sciences.

Systems

We can develop these ideas further by thinking about the difference between two types of system:

- **Closed systems** allow researchers to tightly control variables that potentially affect the behaviour being studied (as in a laboratory, for example). Such systems are 'closed' because they can be isolated from wider environments (the 'outside world').
- **Open systems** involve the opposite idea – they represent situations where the possible range of influences on behaviour cannot be completely controlled by the researcher. In the social world, 'society' is the ultimate *open system*, but open systems are also found in the natural world – in the study of global weather systems, for example – and this makes for an interesting observation.

For both types of system:

Laws of cause and effect operate, making it theoretically possible to predict how something will behave. However, the inability to fully control all possible variables in *open systems* makes *predictions* about observed behaviour difficult – if not impossible. In this respect:

Growing it yourself: Open and closed systems

Using the following table as a template, we can relate ideas about open and closed systems to research methods by identifying the advantages and disadvantages of studying people's behaviour in a laboratory as opposed to their natural environment (society).

Laboratory (closed system)		In society (open system)	
Advantages	*Disadvantages*	*Advantages*	*Disadvantages*
Control of variables	Unnatural environment	Natural environment	Difficult to control variables

Chaos theory provides an example of how open systems work and the problems they hold for scientific research methodology in that it argues that small variations in behaviour can produce very large differences in outcome, sometimes referred to as the:

Butterfly effect: Lorenz (1972) posed the question 'Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?' to demonstrate the idea of *random variation* – something illustrated quite neatly in the film *Jurassic Park*, where the 'chaos mathematician' Ian Malcolm argues that the plan to cage dinosaurs in a *closed system* (an isolated theme park) is doomed to failure because 'nature always finds a way'. In other words, although open systems are relatively stable and in some measure predictable, there are times when minute changes lead to random (or unpredictable) outcomes – and since we have no way of knowing what change will produce what outcome, the ability to predict behaviour in open systems with any certainty is impossible.

Weeding the path

Both *chaos theory* and the nature of *open systems* suggest two things:

- **Science** is a methodology sensitive to the subject matter it is designed to study.
- **Societies** – and the behaviour of people within them – are open, chaotic systems that cannot necessarily be studied in the same way we study behaviour in closed systems.

In addition, thus far we've failed to question the idea of a 'single scientific methodology' (that proposed, for example, by **Popper**). However, we can correct this by suggesting there may be different ways of 'doing science' both *within* natural sciences such as chemistry and biology and *between* different areas of science (such as biology and sociology). **Feyerabend** (1975), for example, contributes a couple of interesting ideas here:

- **Complexity**: The natural world is a *complex space* that cannot be easily contained within simple categories of thought; developments in *chaos theory* (and *quantum physics*), for example, call into question a 'one size fits all' methodology based around *falsification* (the hypothetico-deductive model). For **Feyerabend** this methodological straightjacket of a 'single prescriptive scientific method' was too restrictive and led to a:

- **Rigidity of thinking**: Natural scientists become locked into the need to defend '*the* scientific method' against both internal and external attack and, by so doing, close themselves off to alternative arguments and methodologies.

Weeding the path

Feyerabend's arguments are sometimes interpreted as an 'attack on science' (he has been accused of being 'antiscience' and the advocate of an 'anything goes' view of scientific methodology). However, **Feyerabend** can also be seen as contributing to a debate about the nature of science designed to *strengthen* science by making it more responsive to new ideas.

More recently, the question of objective forms of knowledge and practice has been attacked by postmodernists in two related ways.

Theoretical critiques

Theoretical critiques focus on the idea that science is simply another:

Discourse that explains something about the world and, as such, it competes against other discourses (religion, mysticism, magic, and so forth). Science has no special claim to truth because, from this viewpoint, concepts like 'truth' are, as we've suggested, inherently subjective. The argument, for example, that 'scientific explanations' are *superior* to religious explanations (because scientific knowledge is based on objective testing and proof while religious knowledge is based on faith) is rejected by postmodernists because tests of 'superiority' are inherently based on *subjective criteria*; certain groups (such as scientists or priests), for example, have the *power* to define the criteria against which something is judged. In this way, therefore, science (like religion) represents a:

Metanarrative – just another grand narrative that seeks, by whatever means, to establish its *hegemony* over all other possible narratives. Postmodernist theoretical critiques tend, in this respect, to focus around ideas like:

- **Objectivity**: Taking a lead from **Polyani's** (1958) observation that 'all observation is theory-dependent' (to understand what we are seeing we must, by definition, already know what it is – we must have already formulated a *theory* that describes what we're seeing *before* we see it), postmodernists have argued that the concept of 'objectivity' (the ability to observe something dispassionately without influencing the behaviour being observed) is not possible.
- **Midwifery**: Natural science argues that 'reality' (and by extension *knowledge*) is something that 'exists to be discovered' (*heurism*). The scientist, therefore, is like a midwife – someone charged with the delivery of knowledge rather than its actual creation (which is how scientists are able to claim objectivity). For postmodernists this involves what

Polyani (1967) termed '*tacit knowledge*', a fundamental conviction about the nature of things in the natural world – in this case, the *subjective belief* (one based on the cultural values of the scientist) that reality and knowledge take the form they claim.

Weeding the path

Craig (2005) notes: 'Science bases its pursuit of and claim to truth on *objective* enquiry. Denials of the possibility of objectivity therefore attack science 'at its root' and, as you might expect, scientists have responded to the criticisms put forward by postmodernists in a variety of ways:

- **Reality**: The natural world really is different to the social world and the two should not be confused. *Causal relationships* between inanimate objects are *real* – they occur whatever the political and ideological outlook of the observer. Partly this is the result of the *heuristic* nature of the natural world (things exist and can be discovered), but it is also due to the skill and knowledge of the scientist. **Feyerabend** (1992) – although, as we've suggested, sometimes seen as a critic of modern science – makes a significant supporting point when he notes: 'Movements that view quantum mechanics as a turning point in thought – and that includes fly-by-night mystics, prophets of a New Age, and relativists of all sorts – get aroused by the cultural component and forget predictions and technology'.
- **Misinformation**: Critics of postmodernism, such as **Sokal** (1994), have argued that a great deal of postmodern writing on science is generally misinformed, lacking in depth and misunderstands what scientists attempt to do. An example here is the concept of:
  - **Truth** – scientists, according to **Sokal**, are well aware that any claim to 'truth' must, as **Popper** (1934) argues, '. . . remain tentative for ever'.

Practical critiques

Practical critiques, meanwhile, focus on the uses to which scientific knowledge is put, an idea bound up in the concept of:

Progress: Postmodernists have been critical of the association between scientific knowledge and 'progress' – the idea that science has practical uses in terms of *improving* our lives. **Campbell** (1996) captures the general flavour of this criticism when he notes: 'Science is viewed as the vanguard of European exploitation, a discipline run amok, the instigators of nuclear and other weapons systems, the handmaiden of big business and as the defilers of nature.'

The charge here, in effect, is that science is not necessarily the 'dispassionate, objective 'search for truth' that scientists would like us to believe, and **Malik** (1998) articulates this general situation quite neatly: 'Whereas once science stood as a metaphor for human advancement, today it stands more as a metaphor for human debasement. That is why with every technological advance – from cloning to genetically modified food – there is a tendency for people to stress the *problems* it may cause rather than the promise that it holds. *Fear of science* has become the vehicle through which wider social insecurities are given vent.'

Discussion point: What have scientists ever done for us?

Whether or not you see this type of criticism as valid, it's clear that people no longer (if indeed they ever did) view science and scientists as necessarily being beneficial bringers of progress.

To explore this idea as a class, identify some positive and negative aspects of science and scientific knowledge.

Use these ideas to discuss the extent to which you see science as a broadly beneficial or broadly harmful enterprise.

Further questions develop, with a practical focus, from the idea of **Prelli's** (1989) 'oppositional norms' which we noted earlier, and the extent to which scientists actually conform to a 'community of values' represented by a *scientific ethos*. We could, for example, note the problem of:

Scientific fraud: Although both **Martin** (1992) and **Jones** (2002), among others, have documented examples of scientific fraud, the fact that it is routinely detected tells us that either the policing of science is relatively successful or, as with other forms of deception, 'revealed deviance' is merely the tip of a very large iceberg. Although we can't know with any certainty the extent of fraud within various branches of science, **Martinson et al.** (2005) discovered 33% of 3200 US scientists 'confessed to various kinds of misconduct – such as claiming credit for someone else's work, or changing results because of pressure from a study's sponsor'. They suggest, however, that the real area of concern is the ' . . . wider range of questionable research practices', such as:

Misrepresentations: **Martin** (1992) suggests: 'In the routine practice of scientific research, there are many types of misrepresentation and bias which could be considered dubious. However, only a few narrowly defined behaviours are singled out and castigated as scientific fraud.' This characterisation has two major consequences:

- **Routinisation**: A variety of 'dubious practices', **Martin** (1992) suggests, permeate the research process. These 'routine deviations' are technically misrepresentations but are rarely, if ever, punished. Included in this general category are behaviours such as:
  - **Reconstructed logics** – as we've seen, publications detailing a research process may bear only a passing resemblance to the *actual* process.
  - **Referencing**: A failure to adequately reference all sources. **Simkin** and **Roychowdhury** (2002) found 80% of citations in research papers were simply copied – spelling mistakes included – from other reference lists.
  - **Intellectual exploitation**: Making use of the work of others without giving them the credit/recognition they deserve.
  - **Unrealistic assessments** of the research's importance (in order to achieve higher levels of funding).
- **Function**: **Martin** argues: 'A narrow

definition of scientific fraud is convenient to the groups in society – scientific elites and powerful government and corporate interests – that have the dominant influence on priorities in science.' He notes that one function of 'the denunciation of fraud' is that it 'helps to paint the rest of scientific behaviour as blameless'.

Preparing the ground: Is sociology scientific?

When we start to consider the question of whether sociology can – or cannot – be considered scientific, an initial problem we face is one of:

Definition: The extent to which anything can be considered scientific depends on how science is defined; however, for the sake of argument, we can think of science in the way we've outlined it at the start of this section and focus our efforts on the question of the extent to which sociology is scientific in the way something like physics is considered scientific. We can do this by examining a number of theoretical and practical ideas surrounding the theory and practice of science and the extent to which sociology meets these scientific criteria.

Principles

We can, therefore, examine the general methodological principles of science, starting with the idea that it is:

Theoretical: This idea works on two levels. First, science, as we've suggested, operates on the principle of testable hypotheses. Second, it represents a body of reliable and valid theoretical knowledge that can be used to inform our judgements about – and interpretations of – future behaviour. In the natural sciences both these levels are attainable; within sociology, however, although the first is achievable, the second is more questionable ('*problematic*').

Weeding the path

Predicting individual behaviour is, for reasons we'll explore in a moment, either methodologically unattainable (the social world does not conform to *simple* cause-and-effect relationships, for example) or unattainable given our present levels of technology (the development of computerised mathematical modelling, for example, may change this). We need to remember, however, that not all forms of behaviour in the natural world are 'individually predictable' – weather systems being a case in point (scientists have never been able to *precisely predict* weather patterns).

At the level of social groups it's possible, in some ways, to make theoretical sociological statements that have 'law-like' qualities. **Parsons'** concept of *functional imperative* might be a case in point and, on a more general level, we could note the fact that all social groups involve roles, socialisation, values, beliefs and norms (although we can't, unlike with natural science, necessarily predict with any certainty their precise content).

SYNOPTIC LINK

Crime and deviance: Durkheim's analysis and explanation for different types of suicide could fit this category of theoretical statements with law-like qualities.

Empiricism involves specifying what constitutes an acceptable form of data. In a