Is Science 'True'?

The purpose of this lesson is to develop the students' understanding of how science works by presenting it in terms of a game. As the game relies on a 'rule', which plays the role of a law of nature, and which will most often be numerical (not exclusively, the rule could be based on suit or colour for example), this is perhaps most easily seen as a model for the working of physics. However, the process of testing, sifting and evaluating evidence and making educated guesses to be confirmed or refuted by trial, is common to all branches of science.

Exercise: *Eleusis*

We suggest that no more than 20-25 minutes is devoted to the game itself, in order to allow time for discussion.

In order to save time in lessons, it is worth giving out information about the game in the lesson before it is due to be played, so that the students have a chance of familiarising themselves with the idea and to think up a rule to use. The game is best played in groups of three or four, so that there is one rule maker and two or three other players.

Students will tend to pick a rule that is too easy or one that is very hard to apply and to guess. Sometimes they do not fully think through the consequences of the rule until an example forces them to figure something out, or to amend the rule (what to do with picture cards or what happens if a total goes over 10, for example). It would be worth having a few rules in your own mind to give hints to students who are struggling to come up with a rule.

There may not be time to allow all the members of the group to be the rule maker.

While you are observing play, making comments about the nature of the process can help students relate their experience to science. Especially important is the information that they can gain from the cards that do not fit the pattern. Sometimes in science it is the things that you think ought to happen, but do not, which can give vital clues as to what is going on.

Encourage the groups to discuss the questions raised in the list on their sheets and duplicated below (with additional comments):

Things to consider

- Science uses theories and experiments – how do they relate to aspects of this game? *(The fundamental analogy at work here is between the rule invented for the game and a law of nature. Like the players, scientists do not know the laws of nature ahead of time. They may have suspicions based on experience and similar circumstances [the players might know enough about the rule maker to* *make educated guesses], but must set out to uncover the laws at work through experimentation and theorising. Initially, there is not enough of a pattern to the cards to make the rule plain. The first moves must be educated guesses. In modern science, experiments tend not to be done out of context; they are designed for a particular purpose. However, there is always the possibility of discovering something new. Once enough experimental evidence has accumulated, scientists attempt to explain the data via theories, just as the players start to gain an inkling into the rule at work in the game. It is then vitally important to test this theory by conducting new experiments. As the game progresses, so the players test their ideas by having more reasoned suggestions for the cards that they play. If they turn out to be correct, so the idea they are working with gains credence. In science, the theory is used to suggest new experimental results, which can then be tested. In a sense, a theory is never proven correct [unlike a guess as to the rule in the game], just sufficient to the circumstances where it has been tested so far. This simple account of how science works glosses over much of the detail to do with hypotheses and modelling, never mind the complex relationship between experimental fact and theoretical context; however ,it is a sound starting point for students to develop an understanding of the scope and nature of science.)*

- The evidence about what does not fit a pattern is just as important as the evidence about what does fit. *(For example, if we consider hardness as a defining characteristic of a metal, then the example of Mercury being a liquid at room temperature forces us to reconsider and expand our thinking as to what a metal is.)*
- Patterns in nature can be very simple, or they can be very complicated.
- Sometimes what looks like a simple pattern is actually the result of a complicated effect in a restricted circumstance. *(Some planetary orbits are so nearly circular, it is quite hard to tell that they are actually elliptical; a circular path is actually a specific case of a more general rule that orbits are elliptical.)*
- Does learning about science give you a good idea how science is done in real life? *(The science that is covered at school tends to be well-established. Often, the story about how the knowledge came to be is not covered. Indeed, trying to do this can obscure the important ideas that need to be absorbed. This gives a false impression of how science is done. Many students will appreciate science more and be inspired by the human stories behind discovery. The important skill of scientific imagination, which is an aspect of seeing patterns in, e.g. the cards, is often missed out. For many students, seeing the role of imagination will make science more appealing than the apparent sifting of data in a mechanical manner.)*

Wider discussion

The key point in the wider discussion is that science is good with quantifiable and objective knowledge. Other subjects can involve personal, aesthetic, philosophical and qualitative knowledge. Scientism becomes dangerous when it is used to pronounce judgement on issues to do with these other aspects of knowledge, or to dismiss them as not 'true knowledge'.