



8 | THE SCIENTIFIC METHOD: TEACHING THE HOW OF SCIENCE AND NOT JUST THE WHAT

The scientific method, in its pared down form, follows the approximate order: an observation is made of a phenomenon; information is gathered; a hypothesis is put forward; an experimental strategy is devised and carried out; results are collected and analysed; a conclusion is drawn about the validity of the hypotheses, or whether more experiments are needed to make a determination.

In university science classes however, much of the lab work is of a cookbook variety, where the students are told exactly what to do, how to do it and – much of the time – they are even told the results they should get and the conclusions they should draw. While this way of teaching science is valuable, showing students the importance of precision in following protocols and illustrating facts from lectures, such an approach should be complemented by laboratory classes where the students are provided with a more realistic experience of the scientific process. In a recent survey we carried out in a first year biology class (Shearer and Smith, in preparation) students showed a desire to understand the scientific process itself and for freedom to explore different avenues:

“more explanation as to how the tutor came up with the given method for each experiment”

“more creative element would be great, to introduce a skill and then allow the students to go away and explore the use of the skill/technique in their own way/own experiment without the concern that if they make a mistake they will lose lots of marks”

However, a free-for-all is not a good educational tool either. To make sure that students do not simply go wildly off on the wrong path (nor cause damage to themselves, or to the labs!), one method we have found works well in a first year class of biologists (based on White, 1999) is for the students to be shown a simple biological observation and asked the question, ‘why?’. They are provided with a set of tools to approach the problem, and the class is split into small groups of

3 or 4 and left to develop hypotheses and experimental strategies. The class then reconvenes and the various hypotheses and strategies are shared and discussed, and in some cases, rejected. Each group then decides on their experiments, carries them out and observes the results. Another class discussion takes place (teaching the importance of interaction in the scientific arena), the students plan another round of experiments and so on. This approach more closely mirrors the process of science as carried out in research laboratories, underscores the dynamic nature of science (replete with all its contradictions and controversies) and creates a collaborative learning community, encouraging intellectual debate. But further, this strategy of active inquiry-based learning challenges and engages the students; two key factors necessary for effective learning.

Teaching the process of science – hypothesis formulation, problem solving, experimentation and data analysis (Handelsman, Houser and Kriegel, 2002) enhances the student experience on a number of levels and better trains future scientists. Providing such experience early in the first year allows students to bring the understanding of the scientific process to material they are taught throughout their degree. With such a perspective on the body of their scientific knowledge, they are well-prepared to continue into the realm of scientific research themselves. However, there is an additional and equally important benefit of such an approach.

Not all science undergraduates will eventually become research scientists, but will instead contribute to many other sectors of our society. Teaching the process of science in practical classes equips all students with the skills and understanding required to make them scientifically literate. And in today’s society scientific literacy is essential. The media and popular press inundate us daily with headlines, breakthroughs, findings and statistics and if our students are not practised in the understanding and analytical skills essential for delineating fact

from fiction (and are content rather to believe everything they hear or read without question) then we find ourselves in a precarious situation.

However, by experiencing first-hand the process of science – not just the what but the how – “students will see the allure of science and feel the thrill of discovery ... [T]he benefits will be an invigorated research enterprise fueled by a scientifically literate society.” (Handelsman *et al.*, 2004).

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STUDENT ESSAY WINNER

Congratulations to the winner of our third annual student essay competition, Aneeqa Meedin, a third year Biomedical Sciences student from the University of Sheffield, wins £250 for her essay “What advice would you give to students starting your course?”. Aneeqa’s essay, the runners-up and shortlisted essays, are available through the Centre for Bioscience website at:
<http://www.bioscience.heacademy.ac.uk/publications/essay07.htm>