FINDING OUT WHAT IS UNDERSTOOD

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Introduction

In *Science in Schools: Which Way Now?*, Ingle and Jennings have voiced much concern over the teaching of science in schools. Science teaching has become a formal exposition of definitions and laws – to be memorized for examinations – and of methods of solving artificial problems. The practical work in a laboratory merely requires the student to follow carefully detailed instructions and then write a formal record. Such teaching does not do justice to the spirit of science; and that knowledge of science does not last very long after the course nor is a delight in science the usual product.

Psychologists warn us that what they call "transfer of learning" is much more difficult to achieve and therefore much more rare than had been thought in the past. The question is a vital one in education: can students transfer the training given in some course to other fields of study and to life in general? Can training in science make students scientific all their lives? Can it at least train them in scientific methods for use in other activities? Can it, at the very least, give them an equipment of scientific knowledge that they will use both immediately and much later? Educators trust that the answer will be "yes" to all these questions but experienced psychologists say the answer is very often "no".

Teaching for Understanding

If we accept that warning we should not be surprised at the failure of formal science teaching to provide long-term benefits, except for a few students who continue as research scientists. If we hope for such benefits, we should think about the attitudes our students will develop in learning science. If they enjoy doing experiments, an experimental attitude may stay with them. If they are pleased with an argument and have a sense of success in mastering it, that may last. If they understand so well that they feel "This knowledge is my own proud possession", then that knowledge of science – concepts, ideas, methods and perhaps the whole structure – may well take a valuable place in their lifelong outlook.

If we aim at such benefits, our teaching may need to change towards encouraging *understanding* of what is learnt. Many of us have perhaps commented at some time or other – "I never understood that topic in science until I came to teach it". We turn that to our present use: when a student "understands" a topic we expect him to know it well enough to teach it to others.

We claim that we teach for understanding; yet, when we examine our own teaching in practice, we are disappointed. A crowded syllabus hurries us too much; a tradition of memorizing among students spoils our hopes; and tests or examinations reinforce both these problems by insisting on widespread coverage of topics and by encouraging memorizing. What then can we do as science teachers?

How to Find Out What is Understood

Examinations or tests play an important role in determining the real aim of the course. Consider the following question.

> Draw a fully labelled diagram of a distillation apparatus and explain how it works.

A pupil scoring a high mark on such a question does not necessarily tell the teacher that his pupil understood the concepts involved in distillation. It merely tells the teacher how good his pupil is at recalling information from the textbook or from his notebook. Consider another way of setting the same question.

> Suppose that during an expedition to a remote mountainous area you discover that a supply of distilled water is required urgently. You have a kettle, a camping stove and a few bottles. Draw a diagram to show how you would use them to obtain some distilled water. Explain how your method works.

This second way requires the pupil to apply knowledge of the principles of distillation in an actual situation and is more likely to tell the teacher which points are well understood and which points are not. It involves higher cognitive skills by compelling pupils to express their thoughts in their own words. It is this type of question that will produce a thinking child and not a walking robot. Even robots of today can be programmed to think.

Another Example

Here is another example of a question found in almost every chemistry textbook.

> What is (a) an element, (b) a mixture, and (c) a compound? Give two examples of each.
>
> Describe an experiment in which copper reacts with sulphur.

This same question can be rephrased in a way that will tell the teacher what is understood.

> Several boys heated copper with sulphur. Noting the colour change, they recorded thus:
>
> 1st Boy: Copper and sulphur are both elements.
>
> 2nd Boy: The black substance formed is a compound of copper and sulphur.
>
> 3rd Boy: When copper and sulphur are heated together, the black substance is a mixture of copper and sulphur.
>
> Which is the best conclusion? State why you did not choose the other two.

Conclusion

The way a question is posed will determine whether they are useful predictors of pupil comprehension of a topic. This will mean that the teacher will have to sieve the immense bank of question books in the market or past years' examination papers. They may even have to rewrite some of the questions, if they are to be of any use to the teacher.

References

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