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Adrian Day

The Structure of Scientific Examination Questions

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Adrian Day
London Institute of Education
London
UK
pcosher@lineone.net
adrian.day77@yahoo.com

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Introduction

A definition is the enclosing a wilderness of idea within a wall of words
Samuel Butler 1835–1902

Samuel Butler, though famous for his novels and works on moral philosophy, also wrote about the scientific ideas that were developing in his time. His interests also extended to scientific language and on this topic he was particularly pugnacious, describing scientific terminology as a *'Scylla's cave which men of science are preparing for themselves to be able to pounce out upon us from it, and into which we cannot penetrate'*. Perhaps to compare the men of science with Scylla, a many headed sea monster, was a little extreme although his ire is easy to understand. The lexis of scientific language can be complex and confusing. Yet it arises from necessity rather than a desire to ambush the ingenuous. Its purpose is to prevent rather than create confusion. As Robert Boyle pointed out, the fallacies of Alchemy had been perpetuated for centuries by the lack of a systematic language.

> As I have told you once before, qualities sleight enough may serve to denominate a chemical principle. For when they (alchemists) anatomise a body by the fire, if they get a substance inflammable, and that will not mingle with water, that they presently call sulphur. What is sapid and dissoluble in water, that must passe for salt; whatsoever is fixed, and indissoluble in water, that they name Earth. And I was going to add, that whatsoever volatile substance they know not what to make of, not to say whatsoever they please, that they call mercury.

Perhaps, despite his misgivings, Butler might have accepted scientific terminology as the lesser of two evils. Nevertheless, scientific writing is difficult to master and, as it developed from the time of Robert Boyle to the present day, its terminology has increased in complexity and new forms of notation and a distinct grammar have arisen. Students must learn this language for if they cannot do so then they will never learn the ideas that it expresses. Such ideas are indeed enclosed within a wall of words and in this respect Butler's views seem quite reasonable.

Of course, when it comes to examinations and assessments, it is not just ideas that are enclosed but also the hopes and aspirations of the candidates. After all, a scientific examination must make use of scientific language and its candidates must make use of it in their answers. If success or failure depends on mastery of this language then so too will their future lives. Such mastery will also determine the success or failure of any education system that wishes to monitor its own performance, for it is trammelled by these same walls. If there are a large number of

incorrect answers to particular question then how can anyone know why these candidates failed? Was it because they did not understand the concept or because they did not understand the language in which the question was asked? If an examination board wishes to ensure that the level of linguistic difficulty is commensurate with the level of the test then how are they to ensure this parity? Surely the language that is used in scientific examinations must itself be examined.

In the last century there have been remarkable advances in the understanding of the way in which languages work; their structures and the resources by which meaning is created. There has also developed a small but valuable canon of works on scientific language and the challenges that it poses to educators and students. Analytical techniques have arisen from these linguistic disciplines and have been in regular, or even routine, use for many years. Their utility has been established in many areas and it is reasonable to expect that they should prove just as useful in the inspection of examination texts. The purpose of this book is to demonstrate how such analyses might be done; to explain how the theory that underpins these analyses pertains to examinations, and to show some of the issues that these analyses can reveal.

Chapter 1
Systemic Functional Analysis and Science Examinations

Abstract The challenges that are presented by a science examination question may be a true test of knowledge and ability or they may arise from the structure of the question itself. In the second case candidates may fail a question simply because they do not understand what they are being asked to do. Often it is difficult to determine why an incorrect or inappropriate answer is given. Is it because the candidate does not comprehend the science or is it because the candidate does not comprehend the question? Cognitive analyses of science examination questions show that many incorrect answers can be attributed to the expectations of the candidates. This being said, one should also consider the linguistic structures that are involved. Proficiency in a scientific subject requires a proficiency in the language by which this subject is communicated. Yet there are different levels of proficiency, and if the level of language does not match that of the subject then comprehension failure is inevitable. It follows that linguistic analysis should play a part in the evaluation of examination questions. Although there are many forms of linguistic analysis, one of the most effective is systemic functional analysis.

Keywords Examinations • Assessment • Systemic Functional Analysis • Scientific Register • Schema Theory

1.1 Comprehension Failure

1.1.1 Unfair and Unhelpful Questions

This book owes its conception to some animated in-service training sessions that I gave to science teachers. These sessions were in response to the expansion of the English National Literacy Strategy and their purpose in part was to persuade science teachers to take a greater role in the development of reading and writing skills. As a way of kindling interest I displayed several questions from the English National Curriculum Tests. These questions had been answered

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incorrectly by many children because they had not properly understood the text of the questions. My intention was to show that, by improving literacy, it should be possible to improve examination performance and, for this reason, the development of literacy strategies should be seen as a worthwhile undertaking. However, instead of inspiring the audience, the overhead images provoked considerable resentment and even anger. Many of the teachers argued that the questions were badly written and unfair to their pupils and no one felt that it was necessary to adapt their teaching in order to address the problems created by 'pointless' assessments. Although their antipathy was alarming, their comments were not entirely unreasonable for, very often, the structure of the questions did seem to influence the quality of the answers. In the following three years I analysed a number of examination papers from the English National Curriculum Tests and from the General Certificate of Secondary Education (G.C.S.E.) examination boards. Later, I presented some of my findings to examiners in a series of seminars. Their response was no less vociferous than that of the teachers and no less reasonable. Their principal objections were, first, that it was impossible to write a perfect question and, second, that many of my examples exposed weaknesses in teaching rather than any structural problem with the questions. Hence both teachers and examiners agreed that there were problems but disagreed about the resolution, both parties maintaining that this was the responsibility of the other. So what lies at the heart of these concerns? Is it that teachers consistently fail to convey the skills necessary for pupils to succeed in examinations or is it that examiners contrive meretricious obstacles to the progress of their candidates? Probably neither explanation is realistic since the first would require an implausible degree of incompetence and the second an implausible degree of malevolence. Of course, examination questions can indicate areas of teaching that require attention and teachers themselves will use examination results as a way of assessing their own practice. On the other hand, examination questions can create challenges that have little to do with the science that is being tested and in such cases there is little that a teacher can do to circumvent the difficulties created. The validity of questions like this might be challenged but, as has been pointed out, flawless questions probably do not exist. Accepting the peculiarities of the examination process, however, there are still instances that demand attention. Very often, perfectly straightforward questions seem to engender inappropriate answers from knowledgeable and intelligent candidates; answers which seem to defy reason. Naturally, this is a source of consternation for pupils and teachers and of perplexity for examiners. Yet, despite the best efforts of everyone concerned the causes of these peculiar answers defy any explanation. What is required is a systematic means of analysing questions that can shed light on the way in which candidates read, interpret and respond to the assessments before them; a way of explaining what makes a particular question difficult. Such an analysis could better inform teachers about the abilities of their pupils and inform the authors of questions about their effectiveness. Yet, an undertaking of this kind could not usefully be carried out in a spirit of censure. Rather, it must be done to determine what the question and its corresponding answer really tell about the knowledge of the candidate.