CHAPTER 4: THE ‘EXPLANATORY STORIES’ APPROACH TO A CURRICULUM FOR GLOBAL SCIENCE LITERACY

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1. INTRODUCTION

In the current debate about future revision of the science curriculum in England and Wales, a document central to the discussions is Beyond 2000: Science education for the future (Millar and Osborne, 1998). This argues for an education for all pupils in scientific literacy. Such an education would be based on a series of carefully chosen 'explanatory stories' that take key 'big ideas' in science and explain these in a rounded, relevant and interesting way that highlights their importance in current scientific understandings and developments. Such an approach mirrors many of the aims and objectives of Global Science Literacy (GSL) and can be developed to further these aims even more effectively.

Breadth, balance, even more relevance, and more scope for the development of GSL objectives, would be added to the Beyond 2000 proposals by adding Earth science-related stories to the list of 'explanatory stories' provided as examples in the document. This chapter provides an exemplar of how such a story entitled, 'The dynamic Earth's crust' might be developed. The story is written in an accessible, relevant and interesting way that draws together the threads of the processes that have affected our planet's evolution and will have ramifications for the future of the Earth. It is dissected to emphasize the scope for developing GSL approaches and links with other areas of science. A variety of teaching and learning activities is suggested to illustrate the range of skills and perspectives that can be taught in this way. Such a story could provide a powerful vehicle for the development of scientific understanding in young people, beyond the narrow confines of science as it is currently taught in many classrooms and laboratories. It would illustrate the key role that science can play in the safeguarding of our planet for the future.

2. REVISITING THE NATIONAL CURRICULUM FOR SCIENCE

The National Curriculum (NC) is the central focus of all government schools in England and Wales for children between the ages of 5 and 16 and has now been in place for ten years. It includes the three core subjects of mathematics, English and science, and a number of foundation subjects including geography, technology, languages, physical education, etc. There were a large number of changes to the detail of the NC in the early years, such that, in science, seven different versions of the National Curriculum for Science (NCS) appeared at different times of which three were actually implemented. Since all this change caused significant problems

to the successful implementation of the National Curriculum in schools, in 1995 a five-year moratorium to changes was called. This gave five ‘change-free’ years for schools, as far as NC detail was concerned and five years to prepare for the changes due in September 2000. In the event, only a limited revision was carried out in 2000, with a more comprehensive review being envisaged for 2005.

In the build up to the September 2000 changes in the National Science Curriculum, a series of debates took place. The most influential of these were:

- those generated by the Association for Science Education (ASE) that resulted in the document Science education for the year 2000 and beyond (ASE, 1999);
- those that formed part of a seminar series funded by the Nuffield Foundation. The document produced as a result of the Nuffield seminar discussions was called Beyond 2000: science education for the future (Millar and Osborne, 1998).

3. THE GLOBAL SCIENCE LITERACY PERSPECTIVE

The global science literacy approach (GSL) as described in the first section of this book, focuses on:

A conceptual rather than disciplinary organization of curricula. Instead of arranging science curricula according to units or courses organized around the contributions of each of the traditional disciplines of science, GSL recommends a unified, conceptual organization of curricula. The organizational concept is the Earth as a System and its involvement in larger systems. This concept or set of concepts, after all, is the subject of all science investigations.

A broader encompassing of the spectrum of scientific methodology beyond the reductionism characteristics of current curricula. GSL includes a significant treatment of the systems methodologies of the ecologists and Earth scientists.

An inclusion of aesthetic aspects of science and its subject, the Earth System. This inclusion recognizes the incentives of many scientists in their study of Earth and brings science close to its students and their diverse cultures. It recognizes the aesthetic feelings and reactions to Earth system phenomena that are often expressed in the arts, literature and music of their nation or culture.

A recognition of the unique qualities of science and its ability to develop procedures and languages that bridge cultural and linguistic boundaries. As a component of curricula, knowledge of the culture and procedures of science can therefore help to achieve the objectives of Global Education (a Social Studies curriculum construct) thereby assisting international and inter-cultural understanding.

Science as a way of understanding ourselves as an interacting component of the Earth system that we all share and inhabit. This concept of humanity as a part of nature is consistent with many elements of Eastern
thought and contrasts with the western conception of man as created separately and therefore apart from nature.

The uses of appropriate technology to assist our understanding of Earth and to conserve Earth resources. GSL does not view science as a basis for the development of technologies for defense or economic competition; a view of science that seems implicit in most of the world pre-college science curricula today.

4. THE DEBATE ON THE FUTURE FOR SCIENCE EDUCATION – AND ITS LINKS WITH GLOBAL SCIENCE LITERACY

4.1. ‘Science education for the year 2000 and beyond’ and Global Science Literacy

The ASE document Science education for the year 2000 and beyond (ASE, 1999) was produced as the result of a wide-ranging debate across the science educational community. A constructive contribution to the debate was provided by the Earth Science Teachers’ Association (Thompson, 1996). The document, produced as a result of the debate, lists a series of aims, as follows. The first two are considered important at all ages.

☐ The development of curiosity, sensitivity, social responsibility, motivation and independence in learning, when dealing with living things, the environment and the applications of science.

☐ The development of investigative observational and manipulative skills.

The following aims are considered to show increasing emphasis as learners get older.

☐ The development of scientific terminology and an understanding of key scientific ideas.

☐ Understanding of the generation, evaluation and use of evidence in making decisions, solving problems and considering scientific, personal, social and environmental issues and ethical implications.

☐ Understanding of the tentative nature of scientific knowledge and the use of theories and models in explanation.

The document notes that the science curriculum should focus on ‘the place of science in our lives’ in a way that encompass a holistic view of science education and enables learners:

☐ to participate fully in a technological society as informed citizens who understand the nature of scientific ideas and activity and the basis for scientific claims, and

☐ to develop intellectually and morally through experiencing the richness and excitement of exploring the natural and physical world.

This holistic view could be provided by the GSL focus on Earth as a system that would particularly offer the richness and excitement of exploring the natural and physical world and would effectively deal with living things, the environment and the applications of science. GSL emphasis on appropriate technology would form a key aspect of the pupil’s view of a technological society. Both the ASE and GSL documents emphasize that pupils should see science as a way of understanding ourselves in the scientific context of the Earth environment.
Part of the ASE document (p. 4) focuses on the selection of key scientific ideas that should be included in the science curriculum. It stresses that these should:

- enable learners to make sense of science;
- have global significance (not a list of facts);
- have personal significance to the learners;
- be supported by practical activities and have applications; and
- map progression in a core of knowledge and understanding that enables children to understand how ideas develop.

The document adds: ‘A number of the key scientific ideas benefit from being developed through a storyline approach’. The ‘storyline approach’ is explained in more detail below. All the points listed could be addressed effectively through a GSL perspective.

4.2. ‘Beyond 2000’ and Global Science Literacy

The Nuffield document _Beyond 2000: science education for the future_ (Millar and Osborne, 1998) concludes with ten recommendations to guide future revisions of the NCS. Some were intended for the limited revision of the NCS in 2000 and some for a more comprehensive revision in 2005. The two main Nuffield recommendations relating to 2000 have now been incorporated into the revised version of the NSC. Thus, it is likely that a number of the recommendations relating to 2005 will also be incorporated at that time. Key recommendations of the Nuffield document, that relate to Global Science Literacy (GSL) but have yet to be implemented include:

- **Recommendation 1:** The science curriculum from ages 5 to 16 should be seen primarily as a course to enhance general ‘scientific literacy’.

- **Recommendation two:** At Key Stage 4 (14 - 16 year olds), the structure of the science curriculum needs to differentiate more explicitly between those elements designed to enhance ‘scientific literacy’ and those designed as the early stages of a specialist training in science, so that the requirement for the latter does not come to distort the former.

- **Recommendation 4:** The curriculum needs to be presented clearly and simply, and its content needs to be seen to follow from the statement of aims (above). Scientific knowledge can best be presented in the curriculum as a number of key ‘explanatory stories’. In addition, the curriculum should introduce young people to a number of important ideas about science.

- **Recommendation six:** The science curriculum should provide young people with an understanding of some key ideas-about-science, that is, ideas about the ways in which reliable knowledge has been, and is being, obtained.

- **Recommendation 7:** The science curriculum should encourage the use of a wide variety of teaching methods and approaches. There should be variation in the pace at which new ideas are introduced. In particular, case studies of historical and current issues should be used to consolidate understanding of the ‘explanatory stories’ and of key ideas-about-science, and to make it easier for teachers to match work to the needs and interests of learners.
In the light of these recommendations and those of the ASE document (ASE, 1999), it is likely that an NCS for the 'scientific literacy' of all children will be considered that may be based on some key 'explanatory stories', which include case studies of historical and current issues.

5. THE 'EXPLANATORY STORIES' APPROACH

The document Beyond 2000 (Millar and Osborne, 1998) recommends that the science curriculum be presented, at least in part, through a series of 'explanatory stories'. The authors (p. 13) describe these as accounts that have broad features which interest and engage pupils and are able to communicate ideas in a way that makes them coherent, memorable and meaningful. The 'explanatory stories' are not fiction, but use the narrative form to present the ideas as a rounded whole. The stories (p. 13–14):

- emphasize that understanding is not of single propositions or concepts, but of inter-related sets of ideas that provide a framework for understanding;
- help to ensure that the central ideas of the curriculum are not obscured by the weight of detail so that both teachers and pupils can see clearly where the ideas are leading;
- portray the sort of understanding that one would wish young people to develop through studying the science curriculum.

The authors developed the 'explanatory stories' approach recommended in the 'Beyond 2000' document over several years. An initial impetus came from a report published by Ogborn, Brosnan and Hann (1992) that was based on a paper produced by Ogborn in 1991 (Ogborn, 1991). In these publications, the authors explored the use of explanation in science and used the term 'history' or 'explanatory history'. A 'history' is the account of a scientific situation (or 'world') from which an explanation for a scientific phenomenon is derived. This idea was built upon by Arnold and Millar (1996) in a paper containing the phrase 'Learning the scientific “story”' in the title. The authors (p. 250) state that 'Our use of the term (story) is intended to convey the complex and interrelated set of ideas which constitutes the accepted scientific explanatory framework for a particular domain of science education' before going on to discuss the 'story' of elementary thermodynamics.

This approach was further discussed by Millar (1996, p. 13) in arguing that there are a number of 'powerful models' at the heart of science that provide explanations for natural phenomena. He described these explanations as a 'story' or 'mental model' that provides a means of thinking about what is going on. He went on to 'nominate' a range of suitable models, including: the atomic model of matter; models of the solar system; a model of radiation transmission; 'field' models (gravity, magnetism, electricity); the germ theory of disease; the gene model of inheritance; Darwin's evolutionary theory; and models of the evolution of the Earth's surface (rock formation, plate tectonics). Millar felt that these models would address a number of key ideas, including those of size, scale, distance, time, cycling
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