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Earth Sciences and the National Curriculum

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WILSON, R.C.L. (1990). Earth Sciences and the National Curriculum. *Proceedings of the Shropshire Geological Society*, **9**, 10–12. Summary of a talk describing development of earth science within the National Curriculum. The exploration of science is largely content free, as is the nature of science which depends on concepts rather content. Earth science is a good vehicle for carrying these ideas forwards, referring to how science has progressed, how it relates to society, how scientific ideas have changed through time, and the perception of science in other cultures.

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BACKGROUND

The author contends that Earth Science must be taught from a science base, in an investigational way. Its relationship with geography was still debated, e.g. who covers atmosphere? Weather and climate are in both the geography and the science national curricula. Earth science introduces the new dimension of time. Climatic belts were different 10,000 years ago; 100,000 years they were very different! Earth science also emphases the global aspect. Earth science processes cross subject boundaries - landforms are in geography; the movement and behaviour of ice/water are in science. Earth science should have an input into both.

Geology in the past had often tended to be taught from a geographical standpoint and in catalogue form rather than understanding processes, e.g. why volcanoes are different shapes and erupt in different ways. This could be approached in a scientific way with children investigating properties like viscosity and gaseous content.

THE GEOLOGIST'S APPROACH

Geologists look at granite as a coarse grained rock which cooled slowly. Another scientist might look at the rounded shape of a granite body and relate it to other things, e.g. animals which live in cold climates have compact shapes. Dykes are sheets and cool more quickly (compare with thin floppy ears of elephants which are efficient at loosing heat!).

Pattern recognition, citing the Pacific ring of fire of explosive volcanoes contrasted with the distribution of quiet oceanic eruptions. This pattern, with that of earthquake distribution, can be recognised and later related to plate tectonics.

Earth Science looks back in time and includes the changes in ideas. Fossils also give insight into the significance of time. The science part of the National Curriculum (NC) should be introducing children to ideas concerning the processes involved in forming different rocks and to appreciating their influence on landscape and economic development and, to a certain extent, on present day distribution of rocks. They should also begin to interpret geological maps which combine many of these aspects. This offers opportunities for geographers and scientists to work together, e.g. with map work. The teaching of geology has changed considerably and is much more science-orientated though often left to the geographers to deliver. The advent of GCSE has accelerated this change.

THE NATIONAL SCIENCE CURRICULUM

Earth Science fits into the national science curriculum in three of the attainment targets in the double award science GCSE, in particular in sections on earth and atmosphere, human influences on the earth, and earth in space. Less obviously the geologists' input had resulted in fossils being included in sections on the variety of life, genetics and evolution. Also earth science has input into types and uses of materials and how they behave. In addition, the earth's magnetic field now comes into magnetism. Thus earth science input into the science NC is scattered and varied and within a number of Attainment Targets. Exploration of science covers the active, practical work of science though schools are free to devise their own methods of doing this.

For the benefit of non-teachers, the author considers the main points of the Education Act of 1989 which established the National Curriculum with three core subjects: English, Maths and Science and other foundation subjects which would be compulsory education for everyone up to 16 years. Working Parties were set up and have agreed the content of the Core Subjects which are defined in Parliamentary Orders and are law. Work is in progress on the foundation subjects. Design and Technology is complete. The time scale reveals the amazing rate of production demanded by the government, with reports being produced in months, including adequate consultation phases. The Parliamentary Orders which most be followed are heavy for secondary teachers who mostly teach one subject but must be aware of cross-curricular aspects, but the load on primary teachers who must absorb the implications in every subject while teaching all week must be even greater.

The programmes of study are divided into four Key Stages which describe the curriculum and skills which must be taught. In addition, Attainment Targets, numbering 1 to 10, express what children have learnt and can do, i.e. they reflect skills and content. These are not related to age as people develop at different rates. Primary teachers especially have to cover a very wide spread of Attainment Targets. The system is designed to meet a wide range of ability so that at 16 even a very low performer will have achieved something positive, which is the philosophy involved. GCSE has already moved in this direction and will continue to do so.

At the end of each Key Stage there will be Standard Assessment Tests at 7, 11, 14 and 16, but these are still awaited, except the last which is GCSE. These tests will be yet another burden to teachers. The establishment of the NC enables progression to be universal from any school to any school.

PROGRESSION

The idea of progression can be illustrated by considering the definition of a mineral. This was "A naturally occurring chemical element that possesses a definite crystalline structure based on an ordered internal arrangement of the constituent atoms, and with a chemical composition that may be expressed in terms of a chemical formula".

All the concepts in this definition would be met in the science national curriculum, though only the more able sixteen year olds would be able to express this in their own words. Academics would tend to start from the definition as a base whereas teachers start with the direct observation at infant level and progress through the concepts until eventually there is sufficient knowledge and understanding to appreciate the definition.

Two attainment targets have no content. Of these, AT1 is the most important as it develops the children's skills and includes plan, hypothesis and predict: design and carry out investigations. This can vary from simple sorting exercises at the infant level to sophisticated experiments at GCSE level. It includes being able to draw conclusions and investigate findings. Many of these skills are found in other parts of the curriculum: geography, English, mathematics.

These skills are valuable to employers – much more so than content, which quickly becomes out of date though obviously a balance is needed.

Earth science input into the National Curriculum may be as much as 15-20%, depending on how it is taught. There are problems with delivery as most secondary schools have physicists, chemists and biologists but virtually none have earth scientists. Geographers who have come via physical geography will have the knowledge but are not used to teaching it from the science viewpoint, i.e. from AT1, the exploration of science. This is the way it must be taught and how it will be assessed.

Much has been invested in the development of the traditional sciences but little in earth science. Materials both for pupils and for in-service training for teachers is required but funding is difficult. The exploration of science is largely content free, as is the nature of science which depends on concepts rather content. It refers to how science has progressed, how it relates to society, how scientific ideas have changed through time and the perception of science in other cultures. Earth science is a good vehicle for carrying these ideas.

Plate tectonics can be used as an example. Tracing the development of Wegner's ideas through those of Holmes to modern methods of measurement it can be shown how the history of scientific ideas and a particular subject could be taught at the same time. This can also include social attitudes and scientific funding. Other areas of science can be treated in the same way.

CONCLUDING REMARKS

Questions were varied and numerous. Did earth scientists realise that geographers had already moved a long way with emphasis on processes and skills, e.g. fieldwork skills and investigation? The integrating role of the NC, with less emphasis on pigeon holing into 'science' or 'geography' and more on cooperation across the subjects can address this, rather than arguing what goes into each. Unfortunately the reports do not reflect this cross curriculum attitude.

Shropshire has a Working Party on cooperation between geography and science but old attitudes are slow to change. Primary teachers have the opportunity to work in a cross-curricular way but are hampered by the extreme range of ability. There are arguments for scientists to do some arts and *vice versa*, i.e. total integration in education. This aspect has been addressed by the NC in primary and secondary education but not yet in sixth form and higher education. Universities and polytechnics accept A and AS levels at institutional level but at departmental level it is still A levels which are required. However, the demographic decline is going to force places of higher education to adapt to attract enough students to survive.

The question may be asked as to how far within the earth science course would one include economic and social factors? For earth science, on resources, one would teach how certain elements are concentrated in the earth's crust and why distribution is inequitable – linking with geography and politics. It is also important to know how natural resources are found – into physics. The consensus is that the social relevance of science is important. This leads into design and technology, and geography. There are problems ensuring that everything is covered somewhere and at an appropriate level – particularly difficult with mixed ability classes.

Are classes likely to be built on Attainment Targets and thus be of mixed ages? This idea is fraught with problems. The current emphasis was on stressing what pupils had achieved, though it would take time not to just mentally transfer GCSE back to 'O' level.

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