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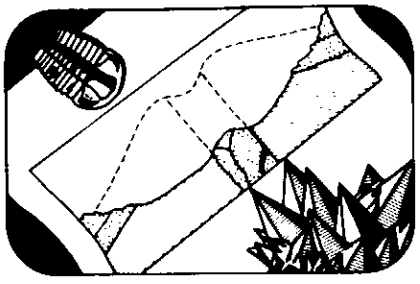

Education Feature

Earth Science 11 – a New Course For British Columbia's Students

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Introduction

In response to a strong demand from *teachers* for more earth sciences in the curriculum of British Columbia's high schools, the Ministry of Education authorized the development of two new science courses, Earth Science 11 and Geology 12. The purpose of the Earth Science 11 course as outlined in its curriculum guide (Armstrong *et al.*, 1977) is as follows: "Earth Science 11 is intended to provide secondary school students with the background and the desire to investigate their earth, its materials, and its processes. Thus the course should provide young people with the knowledge to understand and make decisions in a rapidly changing and resource-oriented world." The Earth Science 11 course was taught experimentally for several years before it was officially introduced into the curriculum of B.C's high schools in 1976. Thus, the course has been a part of the science programme for almost three years and now it is appropriate to evaluate its pros and cons. Another paper will consider the new Geology 12 course.

This paper will only highlight the content and development problems of Earth Science 11. For a detailed treatment of its content, learning outcomes, activities and investigations, books, supplies and equipment, films, filmstrips, and slides, one should write the Curriculum Development Branch of the Ministry of Education for copies of the 85 page course guide. The guide was written by a Course Development Committee appointed by the Ministry (Armstrong *et al.*, 1977).

Themes and Content

The four major themes of the course are: 1) inquiry and prediction, 2) universality of change, 3) uniformity of process, and 4) the conservation of mass energy. The course has been divided into four sections: 1) astronomical sciences, 2) geological sciences, 3) oceanographic and atmospheric sciences, and 4) resource sciences. The organization of the course is shown in the outline below.

Section A: Astronomical Sciences
Unit 1 – Stellar Systems
Unit 2 – Solar Systems
Unit 3 – The Third Planet

Section B: Geological Sciences
Unit 1 – The Dynamic Crust
1. Earth Materials
2. Igneous Activity
3. Rocks Flow Bend and Break
4. Continental Drift-Plate Tectonics

Unit 2 – A Changing Planet
1. The Earth Below
2. The Time Scale
3. Gradational Forces

Unit 3 – The Earth's Biography/Geologic Time
1. Geologic Time
2. Fossils and Earth History

Section C: Oceanographic and Atmospheric Sciences
Unit 1 – The Oceans
1. Ocean Waters
2. Ocean Basins

Unit 2 – Atmospheric Science

Section D: Earth Resources
Unit 1 – Renewable
Unit 2 – Non-renewable

Each section has a series of units and a set of learning outcomes (objectives). Activities and investigations are suggested for each unit, but the choice of which of these to use, if any, and the method of attack or teaching strategy is determined by the teacher. For example, there are 30 learning outcomes and 18 activities and investigations listed under the heading of The Dynamic Crust (Armstrong *et al.*, 1977). Lectures are to be kept to a minimum. Instead, the following approaches can be used to focus individual or group studies: a hands-on laboratory or field activity; an investigation using the resource material of the high school; research into geologic oceanographic and/or meteorological aspects of the local physical environment; and interviews and presentations by earth science professionals within the community.

Therefore, all aspects of the earth sciences are included in this course, but teachers tend to enlarge those sections in which they have particularly good training or expertise. This is one of the appeals of the course to the classroom teacher, and teachers are allowed considerable leeway in designing their courses. The end result should be an up-to-date and broad understanding of the earth, its history, and its environment in space.

The course is taught for one academic year or 110 class sessions, just as are Physics 11, Chemistry 11, Biology 11, and Math 11. The number of hours devoted to each section of earth Science 11 is more difficult to determine, because some teachers, for example, have never taught the oceanography section. Some of its content may be taught in other courses, such as Geography 12, and is therefore omitted from Earth Science 11. Some geography teachers have objected to the introduction of Earth Science 11 claiming that "This material will be taught in Geography 12". This problem will be considered later.

Unique Features

There are several unique features about this course. One is the emphasis, indeed insistence, on the incorporation of studies of local geology. This always helps make an earth science course more relevant to both students and teachers. To this end, the Department of Geological Sciences at U.B.C. has developed a series of field

guides to the geology found around most of the major cities in the province. These guides, published under the series title as "Adventures in Earth Science", suggest field activities and consider the geology in terms that teachers and students can understand.

The course content lends itself to field trips, including evening sky watches, sailing and boating, trips to a mine, dam, or power plant, field work at local rock outcrops or in glacial sediment sequences. The most successful teachers are those that have incorporated interesting field trips involving more than "show and tell", and including field projects and investigations of geology, atmospheric and celestial conditions.

Another unusual aspect of this course is the multiple text approach, which allows both teachers and students to select a series of texts rather than a classroom set of just one book. For example, a class may order 10 of each of 3 books, or 5 of each of 6 books, etc. Further extensive reference materials are provided on a one-for-each-class basis. In 1976 the committee selected the following texts for adoption.

Krynowsky *et al.*, 1970, Foundations of Space Science: Holt, Rinehart and Winston (out of print in 1978-79).

Wolfe, C.W. *et al*., 1971, Earth and Space Science, 2nd edition: D.C. Heath.

American Geological Institute, 1979, Investigating the Earth, revised edition Houghton-Mifflin.

Goldthwait, R., 1975, Earth Science. Ginn

Jackson, J.H., and E.D. Evans, 1973, Spaceship Earth / Earth Science: Houghton-Mifflin

Heller, R. *et al.*, 1976, Challenges to Science, Earth Science: McGraw-Hill.

Bishop *et al.*, 1975, Focus on Earth Science, 2nd edition: Merrill:(out of print in 1978-79)

A reference package was also supplied to each high school. It includes among many other items the following:

Ordway, R.J., 1973, Earth Science, 2nd edition Van Nostrand Reinhold

Intermediate Science Curriculum Study, 1972, Crusty Problems (plus Record Book). Silver Burdett / General Learning Corporation.

Intermediate Science Curriculum Study, 1972, Winds and Weather (plus record book): Silver Burdett / General Learning Corporation.

Scientific American, 1976, Continents Adrift and Continents Aground. W.H. Freeman and Company.

Scientific American, 1977, Ocean Science. W.H. Freeman and Company.

Nuffield Secondary Science Eight, 1973, The Earth and Its Place in the Universe. Longman.

U.S. Geological Survey, 1971, Atlas of Volcanic Phenomena: Washington, D.C.

Although not unique so far as the traditional sciences are concerned, the inclusion of laboratory investigations in Earth Science 11 serves to clearly distinguish its content from Geography 12, a more lecture-oriented course However, the development of *successful* hands-on activities is one of the more challenging parts of the course so far as the teacher is concerned Many of the investigations suggested by the Course Development Committee are unique and have not been tested for teaching effectiveness.

Neither is the use of films a truly unique feature of the course, but the recommendations of the committee were enthusiastically received by the media resource centres throughout the province and an extraordinary number of the films were purchased for this course. Fifteen films are deemed especially important and have been emphasized as essential for successful implementation of the course in the curriculum guide (Armstrong *et al.*, 1977). This virtually assures that district media centres will either purchase them or make them available for purchase in video tape format Further, more than 22 films are already available in video tape format and 37 films on earth science are available as free loans from the Provincial Educational Media Centre for this course.

Finally, the cost of implementing the course is shared between the Province and the district, and a $2,500 matching grant is available to each school that applies for support

Geological Sciences Section

This section includes two major sections; The Dynamic Crust, and A Changing Earth, each further subdivided as indicated in the course outline. The approach is traditional, but the activities and investigations proposed are, in many cases, new and designed to be relevant to students of British Columbia. The unit entitled 'The Dynamic Crust' focuses on earth materials 'from a close inspection of rocks and minerals to the formation and composition of rock units " More academically, this section also includes "a study of the formation of oceans and mountains, integrated in terms of theories of global plate tectonics" This unit and the one dealing with earth resources had substantial input from university geologists and science education people. The other units were written primarily by experienced and well trained high school teachers. It is interesting to note that these teachers had also taught, at one time or another, geography 12, physics 12, chemistry 12, or biology 12. This was useful in order to develop a bridge between this science course and the others.

Implementation

The course was a long time in coming. It took almost five years of lobbying on the part of teachers, university geologists, and friends to convince the Ministry of the desirability of instituting Earth Science 11 and Geology 12. This in spite of the fact that the mineral industry ranks second behind forestry in B.C.'s economy

The course development committee consisted of eight persons and included a curriculum consultant from the Ministry of Education, two university professors one from the Faculty of Science (Geology), and one from the Faculty of Education (Science Education), as well as five high school teachers. The committee met once a month for a period of almost two years. A dearth in texts with Canadian content was a particularly vexing problem. However, supplementary reference texts such as the Alberta Society of Petroleum Geologists' *The Face of Time* and the Geological Survey of Canada's *Geology and Economic Minerals of Canada* helped fill the gaps. Neither is entirely satisfactory, and Canada is still lacking a geology text for both high school and first year university students Discussions of course content, investigations, teaching strategies were held and texts and teaching materials were thoroughly reviewed.

Course Acceptance

Whether or not a school opts to teach this course is dependent on many factors, including: 1) the availability of teaching personnel with adequate backgrounds in the four areas included within Earth Science, 2) financial resources within the school district, 3) attitude of the science department head towards geology science or social study? 4) number of potential enrollees and the effect of that on the numbers in the more traditional science courses and in Geography 12, and 5) the strength and political influence of the head of the social studies department and whether or not he can convince the administration and/or school board that "I'm already teaching it," or "We can handle it ", thus excluding the possibility of hiring a teacher, for example a geology teacher, with an adequate background in geological and geophysical sciences, oceanography, astronomy, and atmospheric science. Unfortunately, several high school department heads still feel that geology is not a 'basic' science and continue to exclude it to the advantage of chemistry, physics, and biology.

In spite of initial setbacks, Earth Science 11 is being taught in 45 of British Columbia's 75 school districts. Moreover, 2,187 students enrolled in the course in the 1978-79 school year The future seems bright with respect to anticipated acceptance, because more than 90 per cent of British Columbia's 125 high schools have asked for the texts and materials for this course so

Table I. *Enrolment in Earth Science 11 Compared to Other Science Courses*

Course	Enrolment	Teachers	% Teaching Time/School Week
Earth Science 11	2,187	81	11.8
Biology 11	17,662	324	12.4
Chemistry 11	13,336	276	12.3
Mathematics 11	1,608	63	12.6
Algebra 11	23,380*	474	12.5
Physics 11	9,740	224	12.2
Geography 12	8,833	205	12.5

* Prescribed course
Source of data is Educational Data Services, Ministry of Education, Victoria, B.C. Figures are for the 1978-79 school year.

that they can consider it for adoption. At the present time it is still far behind the traditional sciences in enrolment, but we anticipate that within a five to ten year period it will have more than 5,000 students enrolled per year. Table I compares enrolments in the traditional sciences with the new Earth Science 11.

Problems

Many problems beset this new course. There is the traditional one of the lack of well-trained teachers in the area of astronomy-oceanography-geology. Atmospheric science and geomorphology areas tend to be reasonably well covered because of the preference of education students in B.C. universities to elect geography rather than geology. Moreover, only one university (U.B.C.) offers basic courses in geology, geophysics, and oceanography. Ironically, many regional colleges do offer a first year geology course, but they feed few students into the Faculties of Education of B.C.'s three universities. Nevertheless, a number of outstanding teachers are teaching it, having been trained as geologists or having come in from other science teaching areas as "retreads". Most of these people have had at least one university course in geology, a background judged sufficiently good enough to handle the geology content at this level. Several have received valuable training at the Shell Earth Science Workshop conducted each summer in London, Ontario under the tutelage of Dr. Gordon Winder and his associates.

The lack of 'tried and true' hands-on activities that can make geology and oceanography interesting to students as a laboratory science is a severe problem. Atmospheric science and astronomy stand in better stead. One of the biggest jobs ahead is the testing and selection of good laboratory exercises for grade 11 students. This may take another three to five years to develop. The activities developed in the Earth Science Curriculum Project were meant for grade 8 students, but many were too rigorous for this age group. Some of these activities are quite suitable for Earth Science 11 students. We are trying to avoid the types of problems that beset the ESCP programme, which was probably too structured.

A lack of texts with Canadian content has already been noted. Several Canadian authors are contemplating the writing of a first year university text. Such a book would have wide appeal as a reference text for high school students. The content of a high school text viewed by the author in 1977 was disappointing.

Another problem is the development of 'spheres of influence' in high school departments. One sphere of influence typically centres around the social studies department, where Geography 12 is carefully nourished. This course is commonly taught in Canada but may have no equivalent in the United States. It tends to emphasize what used to be called physical geography, physiography or geomorphology in Europe. This course typically includes many lectures on plate tectonics, a subject dear to the heart of most geological and geophysical scientists. of course, it makes the geography course more interesting, and some students enter our universities and head for the Department of Geography, enrolling in the first year physical geography course rather than a first year geology course. And, if a school can avoid hiring an earth science or geology teacher in lieu of using its present social studies teacher to teach both Earth Science 11 and Geography 12, it will do so. That school is never likely to offer Geology 12, because a better geology background is required to teach it than most geography teachers have. A science department cannot justify hiring a geology teacher specifically for one course, Geology 12, because only one section may be offered in that school. So if you really want to teach Geology 12, you must be equally well prepared to teach one or more of the traditional sciences for the rest of the day. Jack-of-all-science teachers are difficult to find. Finally, there is a tendency to go with the status quo, so that course enrolments don't suddenly drop in other science or social studies courses. Courses such as Biology 11 and 12, Chemistry 12, and Geography 12 might lose students if Earth Science 11 or Geology 12 are taught. We, of course, do not want to see our new courses replace those of the traditional sciences, especially if students are thinking about careers in the geological sciences. On the other hand, students must be properly counselled so that they do not fear rejection by the registrar of The University of British Columbia, thinking that if they take Earth Science 11 they will lack one of the prerequisites for admission to the Faculty of Science. It should be noted that at the present time, admission to the Faculty of Science at U.B.C. requires the high school graduate to have satisfactorily completed Chemistry 11, Algebra 11 and 12, Physics 11, and *at least one other Science course of Grade 11 or Grade 12*. Unfortunately, some counsellor tell high school students that they *must* take Chemistry 11 and 12 as well as Physics 11 and 12. Moreover, there is a natural tendency for grade 12 students to elect Biology 12 because this course is so firmly entrenched in the curriculum and its teachers occupy positions of influence in science departments all over the province.

Conclusion

We have traced the development of Earth Science 11 and have noted that this course, although facing stiff competition from Geography 12 and other traditional sciences, has made good headway in less than three years. The success of the new Geology 12 course will depend on how well Earth Science 11 is taught and the future economic climate of B.C. Further, the recreational attraction of B.C.'s mountains and shorelines has always made geology and earth science a viable alternative to the somewhat more stodgy but more firmly entrenched chemistry and physics course. We do not expect that these two courses, Earth Science 11 and Geology 12, will stream a monumental number of students into our Geological and Geophysical Science Department at U.B.C., but, rather, we hope that they will make more students knowledgeable with regard to the nation's resources and the future role that Canada is likely to play in a world increasingly dependent on mineral wealth. Nevertheless, if these courses are well taught, and it's a big 'if', we certainly will increase our chances of attracting more bright students into geology and geophysics.

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