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Introduction

There are many similarities in the type of science education provided in Australia and in the United States. Teaching methods, for example, range from the traditional textbook-oriented approach to a laboratory, inquiry-oriented one. Also similar issues related to science education are being debated. Two areas of concern are the preservice education of science teachers and curriculum development. It is in this last mentioned area that the greatest innovation has occurred.

Tisher

Three phases can be identified in science curriculum development in Australia. I like to designate them as the "go-it-alone," the "adoption-adaption," and national curriculum phases. The go-it-alone one—the first of the three phases—was characterized by small groups of subject-oriented teacher experts listing topics to be included in a state science program. From time to time the experts added, or removed, topics depending upon the particular likes and dislikes of the experts. One significant addition, I believe, was an emphasis on laboratory work. At first teachers had to supply their own laboratory equipment and supplies, but in the early 1900s it became mandatory for all secondary schools to provide laboratory facilities. Since that time laboratory work has continued to play an important role in Australian science education. However, the nature of laboratory work changed over the years from a "cook-book" approach to an "inquiry-discovery" one.

It is appropriate to note that Australia and the United States are not yet out of the "go-it-alone" phase of curriculum development. Nor has every teacher adopted a discovery approach in the laboratory. It is salutory to realize that in both countries "cook-book" laboratory work still exists.

Overlapping the first phase is the second, or adoption-adaption, phase of curriculum development. This phase could be designated a naturally occurring one since Australian science educators tend to watch overseas developments. Many school teachers and university lecturers belong to European and American professional organizations as well as local ones. Consequently, there is a group of well-informed educators who can speak about recent develop-

ments in science education from a world perspective. Knowledge of major curriculum developments was one of the factors which led to the adoption and adaption of some overseas courses. For example, CHEM Study and PSSC have been adopted *in toto* in several Australian states (and that means all secondary schools in the state follow the curriculum) and an adapted, Australian version of BSCS is used. This BSCS version was developed in a National Project under the sponsorship of the Australian Academy of Sciences. During 1970 and 1971 Western Australia is to try out ISCS with a view to adopting it in future years.

The third phase—the National curriculum one—began in 1968 and it overlaps phases one and two. More details relating to this recent phase appear below, but before the details are given it is appropriate to provide some descriptions of Australian education so that recent developments can be set in context.

Responsibilities for Education

Under the Commonwealth Constitution each state has retained a sovereign right for education. Thus each state government sets its criteria for the nature of the education it provides. Consequently, there are variations in the quality of education throughout Australia. However, in recent years, educators have stressed that the quality of education in the country has National significance and Australia cannot afford to have uneven provision in education. The Commonwealth government appears to have accepted this argument and is increasingly taking a greater interest in all aspects of education. The Commonwealth government has also attempted, by various means, to influence the quality of education provided. In the area of science education several fillips have been provided, e.g., grants for secondary science laboratories and scholarships for senior secondary pupils.

The state governments maintain a state department of education with a permanent head, the director-general, who has a staff of directors, inspectors, research officers, and clerical officers in a central office. The director-general and his officers administer all the state schools and employ, and train, the majority of the teachers in the state. Local government is not strong and there is no local control of education as in the United States or in England. The state education department is, therefore, a very powerful body and exerts a considerable influence on the nature and quality of education. The department, too, has a major say in any curriculum innovation, since it controls the majority of the schools. This is not meant to imply that other groups, such as private schools, universities and colleges of advanced education, are of no account. On the contrary, these groups, through their representatives, can exert a tremendous influence on any of the many curriculum subcommittees which have been established. In fact, in recent years these representatives have been responsible for major curriculum changes.

Who appoints the members of a curriculum subcommittee? In the state of

Queensland (area, 670,000 square miles; population, one and three-quarter million) this is done by a state board of senior secondary or junior secondary school studies. Thus, the physics curriculum subcommittee is elected by the state board of senior secondary school studies. This last mentioned board is appointed by the state government. The physics curriculum committee has representatives from government and private schools, the universities and the science teachers' association of Queensland. As a matter of fact, the science teachers' association is represented on all science curriculum committees. What is the role of the physics curriculum subcommittee? Essentially it serves in an advisory capacity only. It makes recommendations to the board of senior secondary school studies and the recommendations may be adopted, modified, or rejected. Most of the recommendations are concerned with the nature of a curriculum and the appointment of examiners for the matriculation examination. This examination is an external one (i.e., it is not set by a school for pupils in that school but is set by someone outside the school system) which is taken by all students in grade 12. On the basis of his performance on the examination a student is awarded matriculation status which entitles him to enter any Australian university.

Curriculum Committee Influence

The influence of a curriculum committee can be far-reaching as the following description will show. This description also illustrates some of the procedures which operate in the adoption-adaption phase in science education in Australia.

In 1966 when the senior physics course for grades 11 and 12 came under review in Queensland, the physics syllabus subcommittee agreed that a major change was needed in the nature of the physics curriculum. The committee members reviewed the Nuffield course, Project Physics and PSSC, and visited schools in Victoria, Australia, where PSSC was being taught. After careful study, it was decided to recommend the adoption, *in toto,* of PSSC. The specific recommendations of the subcommittee included the following:

1. From January, 1969 PSSC should be the physics course for grades 11 and 12.
2. Selected pilot schools should begin teaching PSSC in 1968 and the pilot teachers should be used in inservice education courses in 1968 and 1969.
3. Inservice courses should be arranged in 1967 for the pilot teachers and these teachers should be released from school, on full pay, to attend these courses.
4. A subcommittee should be established to investigate appropriate methods for testing course outcomes and this committee should prepare the news physics matriculation examination.
5. Science teachers should be represented on the examination subcommittee.
6. A special matriculation examination should be prepared in 1969 for the physics students in the pilot schools, and
7. All schools, that is private state-controlled ones, should be encouraged to begin planning for PSSC immediately, and that the schools be given advice relating to laboratory equipment, library materials, ancillary reading, PSSC

films, laboratory manuals, PSSC textbooks and the Australian Council for Educational Research Diagnostic Tests for PSSC.

It was indeed fortunate that the board of senior school studies accepted all the recommendations. Of course, a rationale was presented for each one. Also, before the final recommendations were passed on to the board three subcommittee members prepared a detailed report on PSSC and the success of the course in other Australian schools. This report was presented to the director-general, members of the board of senior secondary school studies, and the head of the physics department in the university. (He was a member of the syllabus subcommittee and the board.)

During the planning period, 1967-68, members of the syllabus subcommittee, the university physics department, the science teachers association, visiting teachers, and officials of the state education department cooperated to disseminate literature about PSSC and arrange meetings and inservice courses. The science teachers association also arranged regular meetings for the pilot school teachers and the Australian Council for Educational Research produced twenty diagnostic multiple-choice-type tests for use in Queensland classrooms. During the period laboratory equipment was tested, remodeled and redesigned, and the state government stores branch contracted with tenders to supply all laboratory materials. Private schools were allowed to purchase from the store at cost.

When PSSC became the official matriculation physics course in 1969, regular regional meetings were set up by the state education department so that the new PSSC teachers and the pilot teachers could share ideas. The dissemination and sharing of ideas was a key feature during the planning period and it was argued that this communication among the teachers should be fostered during the early years of implementation of the course.

CHEM Study and BSCS, too, were adopted in Queensland on the basis of recommendations from the chemistry and biology subcommittees. These courses, like PSSC, are taught over a two-year period and the courses terminate in an external examination.

Other Comparisons and Contrasts

It is appropriate here to qualify some of the points made with respect to external examinations and to compare and contrast one other characteristic of Australian and American education in order to place Australian developments in science education in clearer perspective.

The "external examination" plays an important role in secondary education in Australia. All students who continue their education to grade 12 must face the "external" hurdle if they wish to receive a school graduation, leaving, or senior certificate and if they wish to matriculate. As the majority of the senior students are seeking entry to one of the fourteen Australian universities or to one of the Colleges of Advanced Education, Agricultural Colleges and Conservatoria of Music, grade 11 and 12 courses and teaching methods

are influenced by the nature of the external examination. Teachers are free to use whatever type of evaluation procedures they wish during the teaching of a course but, as may be expected, they tend to model these procedures on the final external examination. Because of this, the Queensland physics subcommittee recommended a change in the nature of the senior physics examination and followed up the recommendation with the suggestion that examiners should study evaluation procedures. An outcome of these moves is that Queensland and Victoria now cooperate in the design of physics tests for PSSC students. Also, test-construction workshops have been held where teachers work side by side with the external examiners.

In contrast to American secondary education, Australian education is highly selective. Only 28 per cent of the students who enter grade 7 progress through to grade 12 to sit for the matriculation examination and half of those who sit the examination enter a university. Seventy per cent of an entering (grade 7) population leave school at, or before, the statutory school leaving age of 15-16. This group constitutes a high "wastage" from secondary education. In America the wastage occurs at college. Here, 65 per cent of an entering secondary group (grade 7) go on to college but only 50 per cent of the group entering college graduate. In Australia, 85 to 90 per cent of the students entering university graduate. Not all of these graduate in the minimum time.

National Curriculum Development

During the last two years a new phase, the National curriculum one, began in Australia. This phase would not have started if the Commonwealth government had withheld funds, and if states had refused to cooperate with each other. It may sound odd to state the facts in this manner, but funding and cooperation were the two key issues, and these issues are not peculiar to the Australian scene. They exist here, too. Education is such a big enterprise that state governments or local governments are finding they can no longer provide the type of education that is considered desirable or adequate. Increasingly, federal, or Commonwealth, governments are being called in to assist. Furthermore, educators (and scientists, too) realize that in a big enterprise it is more efficient for many groups to cooperate. Unfortunately, parochialism exists and it is sometimes difficult for states to relinquish some of their identity in national interests. This has been one of the problems in Australia. Some states still want to "go-it-alone" on educational matters but want commonwealth funds to do this. Several years ago the Commonwealth government indicated that it would be willing to support education projects in which two or more states cooperated. When three governments indicated that they would do so, $1.25 million ($US 1.4 million) was made available for a Junior Secondary Science Project (JSSP). Actually, this project had begun in a small way before Commonwealth funds were available and the initiators, those with a vision, "sold" the project to several states.

Now there is a permanent JSSP project team consisting of a director and

three curriculum developers. In addition, each cooperating state releases several teachers on full pay for curriculum writing and also provides facilities, e.g., classes for the tryout of materials. Printed curriculum materials are made available to all the research branches of all state departments of education and teachers, in states not involved directly in the project, are encouraged to try out materials in their own classes.

The JSSP is a self-pacing, general science, branching type program for grades 7, 8, and 9. In some respects the program is similar to an SRA Reading Laboratory. The materials for grades 7 and 8, for example, appear in units on cards, and pupils select cards and work through a unit at their own pace. The units are organized to provide branching sequences or enrichment sequences. Slow learners thus follow a different sequence to other pupils. Special evaluation and remedial units form an integral part of some of the branches. Furthermore, JSSP is laboratory oriented, and includes an emphasis on inquiry and individual learning. The interested reader may obtain complete details by writing to the Director, JSSP, c/-Australian Council for Educational Research, Frederick Street, Hawthorne, Melbourne, Victoria, Australia.

Australian educators are always critical of local developments and JSSP is not without its critics, or its limitations. Nevertheless, the project heralds a new and exciting era in science education in Australia. The project has provided a fillip to educational practice and, hopefully, is the precursor of more innovation in science education.