SHORT TITLE

MODERN CURRICULUM DEVELOPMENT IN THE

PHYSICAL SCIENCES

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MODERN CURRICULUM DEVELOPMENT IN THE PHYSICAL SCIENCES WITH PARTICULAR REFERENCE TO THE PROVINCE OF QUEBEC

As the purpose and function of secondary education evolved, secondary school science, while still presented as a discipline has been influenced by external aims and objectives. Two persistent difficulties have been the wide range of student ability and interest, and external examinations. New types of curricula have not been widely adopted or entirely successful. In the present study the historical development of secondary education and its effect upon the science program is determined.

Recent theories of learning have proposed successive levels of mental development for all children and have suggested that successful learning is dependent upon the level at which the material is taught and the relation of the material to previous experiences encountered by the student. The requisites of a science program applicable to a subject-centered curriculum is presented. This is accomplished by grouping of students and the use of appropriate subject matter and learning experiences.

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by

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CHAPTER 1

INTRODUCTION

Within the last decade, one physics course and two chemistry courses have been prepared in North America for the Academically superior high school student. The courses were prepared by: the Physical Science Study Committee, the Chemical Bond Approach Committee and the Chemical Education Materials Study Committee.[1] Each course is a complete unit. The physics program consists of a textbook, a laboratory guide, a film program integrated with the course, a teacher's resource guide and a series of paperback monographs written expressly for high school students and providing supplementary reading on topics not covered in the textbook. New topics are covered in the laboratory with the laboratory guide manual indicating to the student the direction in which the investigation should proceed. The apparatus was designed to be simple and inexpensive in order to ensure that the student would not be diverted from the objectives of the experiment.[2]

These courses involve an intensive study of either physics or chemistry, a procedure not usually found at the high school level. It has been

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[1]Vide infra, pp. 80-83.

[2]Educational Services Incorporated, Quarterly Report (Watertown, Mass.; Educational Services Incorporated, Winter-Spring, 1964), pp. 5-16.

suggested, however, that learning is accelerated and improved when content is based on the logical development of subject matter.

The thesis which follows presents a review of the history and development of the physical sciences program in secondary education in the United States and in the Province of Quebec. Particular objectives have stimulated the growth of secondary education at different periods in time. Also, the type of general curriculum prevalent in the institutions reflected their current objectives and influenced the physical sciences program. Educational psychology as applied in experimental schools in the United States has resulted in several fundamentally different types of curricula. The process of learning, as it is presently understood, can suggest reasons why each of these curricula has had some success, and indicate the most promising direction for future curriculum development.[3] Learning theory can clearly be a useful guide in selecting suitable content for the curriculum.

Purpose of the Study

This study proposes to investigate the following topics the terms of which are defined in the next section:

(1) What factors have influenced the development of the physical sciences curriculum?

(2) Which of the major types of oriented curricula is most effective

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[3]Jerome S. Bruner, The Process of Education (Cambridge, Mass.: Harvard University Press, 1965), pp. 33-38.

for the physical sciences program?

(3) What are the implications of learning theory as related to the curriculum content and methods of instruction in the physical sciences?

Definitions

The following terms are used in this study:

Course of study: organized subject matter in which instruction is offered within a given period of time, and for which credit toward graduation or certification is usually given.

Advanced course: a course that presents material and concepts beyond the introductory or elementary level.

Program: all the courses in one field of study.

Curriculum: a group of courses and planned experiences which a student has under the guidance of the school.

Physical sciences: the courses of physics and chemistry.

Academy: an independent secondary school not under public control. This was the predominant type of secondary school in the middle-half of the nineteenth century.

High school: a secondary school under public control and supported from public funds.

Junior high school: grades 7, 8 and 9 in the United States and grades 8 and 9 in the Province of Quebec. The junior high school, particularly in the Province of Quebec, is not commonly a separate institution.

<u>Senior high school</u>: grades 10, 11 and 12 in the United States and grades 10 and 11 in the Province of Quebec. Both the junior high school and the senior high school, particularly in the Province of Quebec, are usually in the same building and together form the high school.

<u>Composite high school</u>: a term used to emphasize that several programs, such as college preparatory, academic, commercial, vocational or technical, are included in the curriculum. A number of programs is usually included in the curriculum of most high schools.

<u>Regional high school</u>: the union of several local high schools into one large high school.

<u>Junior college</u>: a post-high school educational institution offering a two-year program either of a terminal nature or as preparation for further training in college or university.

<u>P.S.S.C. physics course</u>: the Physical Science Study Committee physics course.

<u>C.B.A. chemistry course</u>: the Chemical Bond Approach chemistry course.

<u>CHEM Study Chemistry course:</u> the Chemical Education Materials Study chemistry course.

Delimitations

This study is restricted to the United States and Canada with particular reference to the Province of Quebec. Two independent systems of education developed in the Province of Quebec, one for Roman Catholics and one for Protestants, with the result that the growth of education in this province was quite different from that in other areas of North America. In considering education in the Province of Quebec, the study is primarily concerned with Protestant education.

The study is restricted to secondary education and the subjects of physics and chemistry. A number of influences, however, have affected the secondary school physical sciences curriculum, and these have been considered, when appropriate, throughout the study.

Assumptions

The major assumptions are as follows:

(1) that whatever type of curriculum is used, the students will be required to write some form of external examinations at the end of the high school period. This system is presently used in the Province of Quebec;

(2) that in a democracy, education is available to all children and that the mental and physical potential of each child should be developed to its fullest extent;

(3) that there is a wide range of student ability and interest in the high school.

Furthermore it is the belief of the author:

(1) that all students should be instructed in the objectives and methods of science as part of the high school curriculum, and that the course content should serve essentially to develop the mental abilities of the student;

(2) that curriculum development is essentially a continuous process, the direction of which is indicated by the objectives of education.

Major Educational Hypotheses

(1) It is postulated that the high school period could be a more meaningful experience to students by the use of a curriculum especially prepared for their stage of mental development.

(2) The structural logic of the science subjects and the psychological process of learning should be the criteria for the selection of curriculum content.

(3) The act of learning is a complex process which would appear to be influenced by environmental factors and which varies from one individual to another. It is suggested that the content of no one program could be effective for all students, therefore a system of grouping should be used with at least three major student groups, based upon the development of actual and potential mental abilities: superior, average, and below average.

(4) The use of grouping based on the level of mental development, and the use of suitably selected content, will produce a curriculum that will accommodate the individual student.

Significance

Many factors have contributed toward the inertia that has impeded curriculum development in the physical sciences. There has never been an excess of qualified science teachers or well equipped science laboratories. Thus there was little interest shown in, or funds made available for, the development of new curricula in science. The problems involved in putting the routine science program into operation have absorbed both staff and financial resources. Those changes which have been made in the physical sciences program usually represented only minor changes in the individual courses of study within the program.

This sort of curriculum development has little chance of providing an effective curriculum for most of the high school population. While experience would suggest that a limited number of students, namely those possessing above-average ability, thrive on concentrated academic courses,[4] a major curriculum revision is necessary to meet the needs of the remainder of the high-school population. This thesis will attempt to establish that factors other than subject matter content alone must be considered when constructing the sciences program for those students who are not academically gifted.

[4]The Winter-Spring, 1964, Quarterly Report of Educational Services Incorporated, loc. cit., states that by 1963, about 4,000 teachers were using the P.S.S.C. physics course and between 2,000 and 3,000 additional teachers were using part of the course. p. 4.

CHAPTER 2

TRENDS IN THE HISTORICAL DEVELOPMENT OF THE CURRICULUM AND THE EMERGENCE OF THE PHYSICAL SCIENCES PROGRAM

PART I: IN THE UNITED STATES

The physical sciences curriculum in the United States was strongly influenced by events that occurred before high schools were established. Physics, astronomy and chemistry were the first sciences included in the curriculum. Institutions for secondary education included programs other than a college preparatory program in their curriculum. In both the academy movement and the high school movement, the non-college preparatory programs did not retain their original objectives. The academy curriculum became predominantly college preparatory in nature. The high school non-college preparatory program developed primarily into a system of compulsory and elective courses. The educational psychology used in the selection of curriculum content was based on the mental disciplinary value of subject matter and the transfer of learning theory. During the first half of the twentieth century the curriculum became influenced by child-centered and society-centered objectives. The characteristics of the new types of curricula which were developed are examined in Chapter 4.[5]

The Influence of the Colleges on the High School Curriculum

The curriculum of American colonial colleges of the seventeenth and eighteenth century was predominantly classical and remained so until about 1840.[6] In examining the curricula of this period Brubacher and Rudy found them to be based on the concept that there was a fixed and known body of knowledge which was to be absorbed without question by every student. This view of education was also characteristic of the early high schools, but was gradually modified by introducing a number of elective courses during the late nineteenth and early twentieth century. Nor was there any evidence to suggest that the programs of the colonial colleges were concerned with the students' future vocations other than the ministry.[8]

By 1750, lectures in the natural sciences were included in the program of most colleges.[9] Lectures in the physical sciences appeared

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[5]<u>Vide infra,</u> p. 72

[6]Ellwood P. Cubberley, <u>Public Education in the United States</u> (Cambridge, Mass.: Houghton Mifflin Company, 1947), pp. 32-33.

[7]John S. Brubacher and Willis Rudy, <u>Higher Education in Transition; An American History: 1636-1956</u> (New York: Harper and Row, Publishers, 1958), p. 15.

[8]<u>Ibid.</u>

[9]<u>Ibid.</u>, p. 17.

on the program about the beginning of the nineteenth century,[10] and, by 1850, usually included demonstrations with apparatus to illustrate the experimental methods of physics and chemistry.[11] The number of separate courses on the college curriculum increased rapidly during the eighteenth century and, at the same time, subjects other than Latin and Greek became recognized for college entrance.

The new subjects used for college entrance were interpreted by Brubacher and Rudy as an effort by the colleges, to remove these subjects from the college to the secondary school curriculum, thus enabling the colleges to continue the subject at a higher level. A typical example illustrates how the curriculum and entrance standards changed at Yale College during this period. In 1720, Euclidean geometry was taught to the senior class; by 1743 it was studied in the sophomore year; in 1825 the subject was dropped to the third term of the freshman year; and in 1855 geometry was one of the subjects required for admission to the college.[13]

The order in which new subjects first appeared as college entrance requirements and the institutions at which they were first accepted is as follows:[14]

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[10]*Ibid.*, p. 15.

[11]*Ibid.*, p. 17.

[12]*Ibid.*, p. 13.

[13]*Ibid.*

[14]Cubberley, *Public Education in the United States*, p. 315.

College Entrance Requirements	Date	College
Old Subjects:		
Latin	1640	Harvard
Greek	1640	Harvard
Arithmetic	1802	Harvard
Geography	1807	Harvard
English Grammar	1819	Princeton
Algebra	1820	Harvard
Geometry	1844	Harvard
Ancient History	1847	Harvard and Michigan
New Subjects:		
Modern (U.S.) History	1869	Michigan
Physical Geography	1870	Michigan and Harvard
English Composition	1870	Princeton
Physical Science	1872	Harvard
English Literature	1874	Harvard
Modern Languages	1875	Harvard

Cubberley suggests that the decline of the Latin grammar schools and the inclusion of subjects other than classical subjects in the academies and high schools were instrumental in forming the new requirements for college entrance.[15] Regardless of the underlying causes of this trend, articulation between high school and college steadily deteriorated during the latter part of the nineteenth century as the new college entrance subjects became a contentious issue in the development of suitable curriculum for the expanding high school movement.

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[15] Ibid.

The Academy Movement

The academy movement, which evolved between 1750 and 1760, contributed a fresh approach to the content and presentation of curriculum subject matter.[16] Benjamin Franklin is usually credited as being the founder of the academy movement, although there were some private schools which had at that time developed a broad curriculum similar to that proposed by Franklin.[17] In describing his concept of the value and form of education, Franklin helped to clarify the aims of education by placing emphasis on the importance of functional studies and by stressing the desirability of an attractive educational environment, as well as the need for good educational equipment. The Philadelphia Public Academy, which he had proposed and helped to found, opened in 1751; however, the program was quite different from that which Franklin had proposed, and toward the end of the period of development of the academies, the curriculum became less functional and more classical and college preparatory in composition. Observing this trend, Franklin made several recommendations proposing the development of an entirely new curriculum; however, none of these recommendations

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[16]Karl R. Douglass (ed.), The High School Curriculum, (Douglass Series in Education, 2d. ed.; New York: The Ronald Press Co., 1956), p. 3.

[17]Newton Edwards and Herman G. Richey, The School in the American Social Order (2d. ed.; Boston: Houghton Mifflin Company, 1963), p. 163.

was carried out.[18]

The curriculum of the academies was not intended to be exclusively college preparatory, so a wide variety of courses was offered. The academies were usually organized into a Latin school, an English school, and a mathematics school. A number of new teaching methods were tested and developed in the courses which were not college preparatory in nature.[19] Practical and useful content was evident in these courses[20] and a new emphasis was given to the study of science.[21] Science was first emphasized in the academies. Astronomy and natural philosophy received most attention as these subjects were formulated during the eighteenth century. Nearly all academies taught geography and a large number taught chemistry.[22] In 1832, the academies of the State of New York reported the following science courses in their curriculum: astronomy, botany, chemistry and geology.[23]

The academy movement was widely accepted and developed rapidly, reaching its peak about 1850. At that time there were 6,085 academies

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[18]Thomas Woody, Educational Views of Benjamin Franklin (New York: McGraw-Hill Book Company, 1936), pp. 192-228.

[19]J. Minor Gwynn, Curriculum Principles and Social Trends (New York: The Macmillan Company, 1960), p.12.

[20]Cubberley, Public Education in the United States, p. 249.

[21]*Ibid.*

[22]Paul Monroe, A Brief Course in the History of Education (New York: The Macmillan Co., 1908), p. 365.

[23]J. Paul Leonard, Developing The Secondary School Curriculum (1st ed. rev.; New York: Rinehart and Company Inc., 1953), p.15.

with a total enrollment of 263,096 pupils, and a combined staff of 12,260 teachers. The combined annual reported income, at this time, was almost $6,000,000. Kandel suggests that this rapid growth was due to the failure of local authorities either to enforce or to support a system of public schools and to the inability of the Latin schools to adapt to changing conditions.[24] Leonard postulates that the academy movement would not have been so strong, or might not have even started, if the growth of free town grammar schools had begun earlier. He acknowledges, however, that the academies fostered the growth of secondary education and provided guidance in the development of the curriculum.[25]

As an increasing number of parents were beginning to want a college education for their children toward the end of the nineteenth century, the academies, being private and self-supporting, gradually changed their philosophy and began to emphasize Latin and classical studies.[26] In tracing the development of this movement, Atkinson and Maleska[27] found that most academies eventually came under the influence of various religious denominational interests thus the aims and quality of the courses of study varied

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[24]Kandel, History of Secondary Education: A Study in the Development of Liberal Education (Boston: Houghton Mifflin Company, 1930), p. 418.

[25]Leonard, op. cit., p. 13.

[26]Lester W. Anderson and Lauren A. Van Dyke, Secondary School Administration (Boston: Houghton Mifflin Company, 1963), p. 52.

[27]Carroll Atkinson and Eugene T. Maleska, The Story of Education (Philadelphia: Chilton Company, Book Division, 1962), p. 100.

widely between academies reflecting the sectarian views of the controlling body.

In summation, the academy had considerable influence on the secondary school curriculum in general and was the dominant influence for three-quarters of a century. Inglis[28] noted that many features of the modern high school had been developed by the academies, such as manual training, commercial education, vocational education and guidance. Eventually the academy curriculum became strongly formalized and tended toward a college preparatory curriculum. For about three decades after the establishment of free high schools the academy movement continued to grow; however from about 1890, after impeding free education for two decades, the academy movement ceased to be an important factor in the development of secondary education. Such institutions are now predominantly denominational and maintained by endowments and tuition fees. The program is almost exclusively college preparatory.[29]

The High School Movement

The high school movement began a few decades before the academy movement reached its peak. The founders were not dissatisfied with the

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[28]Alexander Inglis, Principles of Secondary Education (Boston: Houghton Mifflin Company, 1918), p. 184.

[29]Thomas Briggs, J. Paul Leonard and Joseph Justman, Secondary Education (New York: The Macmillan Company, 1950), p. 27.

work being done by the academies but wished to duplicate the success of the academies with public funds.[30] The demands of the middle class were probably the most powerful influence.[31]

The benefits of education beyond elementary school level, but not of a specifically college preparatory nature, became more evident and gained public approval. Opposition to the academy system appeared because the education provided there was not available to all since fees were charged. Tuition fees were not considered to be democratic. Therefore, the movement which demanded that secondary education should be provided for all children began to grow.[32]

The growth of the high school movement was not entirely unopposed during this period as the layman was frequently unfamiliar with, or unsympathetic towards, the new subjects which began to appear on the curriculum.[33] The taxation necessary to support public education was the most contentious issue. As the public elementary school movement grew there arose a demand for further education at public expense. The issue was settled in the decision of the Supreme Court of the State of Michigan in the Kalamazoo case

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[30]Atkinson and Maleska, op. cit., p. 118.

[31]Leonard, op. cit., p. 19.

[32]Nelson L. Bossing, Progressive Methods of Teaching in Secondary Schools (1st ed. rev.; Boston: Houghton Mifflin Company, 1942), p. 5.

[33]Ellwood P. Cubberley, Readings in the History of Education; A Collection of Sources and Readings to Illustrate the Development of Educational Practice, Theory and Organization (Boston: Houghton, Mifflin Company, 1920), p. 586.

of 1874 that legalized the right of local communities to establish high schools at public expense. Furthermore, the court stated that the high school authorities were not restricted by law in the branches of knowledge to be taught.[34] This decision set a precedent for a number of other cases of a similar nature. The first high school is considered to be the English Classical High School in Boston which opened in 1821. Three years later the name was changed to the English High School. Institutions of this kind were not considered to be college preparatory schools, although college preparatory departments were usually included.[35] As the high schools increased in number, the scope of the subjects in their programs became enlarged. Concurrently the colleges were revising their entrance requirements. Eventually, the heterogeneity of the high school population became more pronounced, and college entrance requirements became a problem in the selection of a suitable high school curriculum.[36]

Articulation Between Secondary Schools and Colleges

During the latter part of the nineteenth century modern subjects began to replace classical subjects at both levels of education. College entrance examinations were no longer based on only classical subjects. The changes resulted from two concurrent trends: both colleges and secondary schools

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[34] *Ibid.*, p. 588.

[35] Atkinson and Maleska, *op. cit.*, p. 104.

[36] Briggs, Leonard and Justman, *op. cit.*, p. 35.

were interested in the modern subjects and the curriculum of the new secondary schools, unlike the Latin grammar schools, was not limited to the classical subjects.

Curriculum development in the colleges progressed at different rates and in different directions. The order in which the new subjects first appeared as entrance requirements has been indicated;[37] however a further variable was the degree of competency required in the examination. While the secondary schools were not limited to preparing students for college entrance examinations, this objective was included in their program and became more difficult to achieve. Preparation for college became a source of increasing concern for the secondary schools as the subjects and degree of subject competence of the entrance requirements became more diverse. During the same period the number of students in the secondary schools increased steadily. The demands on the secondary schools and the range of ability in these schools made selection of curriculum content extremely difficult. As there was not one dominant philosophy for curriculum development, the curriculum developed more or less independently between schools and the resulting standards varied considerably from one school system to another.

In an effort to solve this dilemma a concerted effort was made to improve the articulation between secondary schools and colleges. The changes

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[37]See Table of College Entrance Requirements, <u>Vide supra</u>, p. 12.

could be grouped into the following major categories:[38]

1. Some colleges sent representatives to visit and examine the secondary schools. If they were satisfied with the standards, the diploma or certificate of the school was accepted for college entrance.

2. In a number of cities, committees were organized to prepare uniform college entrance examinations and courses of study which would enable students to write these examinations. The local colleges were either represented on such committees or they examined the standards and consented to accept the examination results for entrance. Once this was accomplished, the courses of study were absorbed into the curricula of the schools.

3. An effort was made to find a quantitative measurement to measure the amount of academic work required for admission to college. The most common were the point, credit, and unit systems. The system most widely accepted was the unit system adopted by the Carnegie Foundation for the Advancement of Teaching. A unit was defined as a course of five periods per week throughout the academic year.[39]

4. The National Education Association initiated a series of committees which reported between 1893 and 1918. These committees tried to introduce some uniformity into the subject matter demanded for admission to college.

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[38]Brubacher and Rudy, op. cit., pp. 238-245.

[39]Kandel, op. cit., p. 479.

Toward the end of the nineteenth century an effort was made to enrich and shorten the number of years spent in pre-college education. In 1888, President C.W. Eliot of Harvard University read a paper before the Department of Superintendence of the National Education Association entitled, "Can School Programs be Shortened and Enriched?" Eliot and others during the next two years were instrumental in having the National Education Association appoint the three committees listed below to study this question.[40]

	Appointed	Reported
Committee of Ten on Secondary School Studies	1891	1893
Committee of Fifteen on Elementary Education	1893	1895
Committee on College Entrance Requirements	1895	1899

An attempt to establish junior colleges and junior high schools was also made about this time.[41] The junior high school movement was an effort to extend secondary education downward, the junior college movement attempted to project secondary education upward. The proposal to move the first two years of college into the high school was made in 1852 by President Henry Tappin of Michigan University. In essence, however, the junior college did not develop until the twentieth century.[42] The proposed reorganization of the high school to include a junior high school was

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[40]Cubberley, Public Education in the United States, p. 542.

[41]Junior college and junior high school defined, Vide supra, pp. 3-4.

[42]Adolph E. Meyer, The Development of Education in the Twentieth Century ("Prentice-Hall Education Series", 2nd. ed.; New York: Prentice-Hall Inc., 1951), p. 397.

suggested in 1881 by President Eliot of Harvard University.[43]

The Committee of Ten

Although the purpose of the National Education Association was to improve articulation between the schools and the colleges, the first few committees were more representative of the college point of view. Nevertheless, their recommendations had a marked effect upon the curriculum of the schools.

The first committee to report was the Committee of Ten, in 1893. It was composed of five college presidents, a college professor, three secondary school principals and the United States Commissioner of Education. Nine subcommittees were formed to examine and make recommendations on the nine major subject areas in the secondary school curriculum.[44]

The committee concluded that since an insignificant number of secondary school graduates proceeded to college, the secondary schools did not exist solely for the purpose of preparing students for college. The most important function of the secondary school, as suggested by the committee, was to prepare a small proportion of all the children in the nation for the duties of life. It was stipulated that this group

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[43] Ibid., p. 395.

[44] Lawrence A. Cremin, "The Revolution in American Secondary Education 1893-1918," Teachers College Record, LVI (March, 1955), p. 297.

would consist of students who could profit from an education extended to their eighteenth year and whose parents would be able to support them while they remained in school.[45]

With regard to secondary school programs which did not lead to college, the committee was concerned by the fact that the students enrolled in these programs would not be prepared to write college entrance examinations. The idea of recommending that noncollege preparatory courses should be recognized for college entrance was considered, but the committee decided against making this proposal in view of the number of inferior terminal programs in the secondary schools.[46] In order to improve the standards of the curriculum, it was proposed that all courses taught in the secondary school should be taught in the same way and to the same extent to all students, regardless of their probable destination or the point at which their education might cease.[47]

Therefore, at the end of the nineteenth century, the function of the high school was to present a curriculum that would give the student a mastery of subject matter content. It was conceded that not all students entered college; nevertheless it was assumed that the same curriculum would be equally beneficial to all students. Through the use of a common

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[45]Edgar W. Knight and Clifton L. Hall, Readings in American Educational History (New York: Appleton-Century-Crofts, Inc., 1951), p. 557, quoting from Report of the Committee of Ten on Secondary Studies (Washington, D.C.: United States Bureau of Education, 1893), pp. 46-47.

[46]Brubacher and Rudy, op. cit., p. 242.

[47]Knight and Hall, op. cit., p. 558.

curriculum no student would be unable to write college entrance examinations whether he was in a college preparatory program or not. This concept of secondary education deterred the development of curriculum in many school systems, particularly in school systems using a series of external examinations at the end of the secondary school year which were recognized for admission to college.

The subcommittee on physics, astronomy and chemistry in the secondary school was typical of the other eight subcommittees in the proposals they recommended. This report suggested that some of the simple facts and principles of the subject should be included in the elementary school curriculum, and indicated the terms, facts and principles used in college science which therefore should be included in the secondary school curriculum. The report was a statement of subject matter preparation and mental training from the college viewpoint. It did not consider the interests, ability, or future vocation of the individual student.[48]

Leonard claims that the Committee summarized, but did not build. The Report reflected the views of nineteenth-century education in that major attention was given to the college preparatory function of the high school. The suggestion that a large amount of the work done in the high school should be started in the elementary school was not consistent with

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[48]Leonard, op. cit., pp. 136-137.

other suggestions the Committee made with regard to preparing youth to participate in activities of other than a college nature.[49]

The Committee of Fifteen on the Correlation of Studies in Elementary Education and the Committee on College Entrance Requirements

The Committee of Fifteen on Elementary Education, formed in 1893, and the Committee on College Entrance Requirements, formed in 1895, concurred in that they did not propose any major change in the high school curriculum.[50] The first committee was mainly concerned with methods of teaching in the elementary school and the second committee was primarily interested in improving the quality of the high school curriculum.

The influence of the Herbartian philosophy of education was evident. In the report on elementary education, emphasis was on logical development of content, coordination of subjects, and correlation of subject matter with the environment. There appeared to be a strong desire to promote this method of teaching.[51]

The Committee of Fifteen recognized that the secondary school did not exist solely to prepare students for college; however they were disturbed by the rapid growth of the elective system. They suggested that the selection of a limited number of elective subjects should be permitted, but they proposed

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[49]Leonard, op. cit., p. 24.

[50]Ibid., p. 134.

[51]Gwynn, op. cit., p. 27.

that the curriculum should be composed of a number of courses which all students would be required to study in order to complete secondary school education. Individual student differences would be accommodated by a system of compulsory and elective courses. Courses of study illustrating subject matter content and methods of instruction were prepared for the secondary school curriculum.

The Committee of Fifteen also recommended the segregation of gifted students. Gifted students were to be encouraged to complete the college preparatory program in less than the commonly allotted time.[52] The unit system was proposed by this committee to evaluate academic work.[53] One unit was to represent a one-year study of a subject taught five periods per week.[54]

Since science courses were not compulsory in the secondary schools, the Committee recommended that the colleges should prepare science courses that would be sequential to secondary school science. A student who had studied a science subject in secondary school should not be placed in a beginners' class in this subject in college.

The work of both these committees reflect the theory of the disciplinary value of education. From this point of view, the subject is used to train the mind and this training could then be transferred to solve future problems. The emphasis on the disciplinary value of subject matter had

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[52]Gwynn, op. cit., p. 28.

[53]Vide supra, p. 20.

[54]Kandel, op. cit., p. 479.

the effect of enforcing the dichotomy between college preparatory courses and courses which were not college preparatory. This was particularly unfortunate, since educational psychologists were beginning to question the degree to which transfer of learning was effective.

In reviewing the science programs from 1860 to 1918, Stout grouped the aims under three headings: (1) the religious aim, (2) the knowledge aims which included the value of theoretical science and applied science and (3) the mental discipline aim.

Early courses of study stressed specific knowledge, and the importance of the methods of science did not appear until later. About 1905, a movement to promote general science appeared. There is no evidence that the general science course was meant to replace the separate sciences, nor is there any evidence of any agreement on the purpose of the course. The several aims of the general science course were (1) to give pupils an incentive for further study in science, (2) to provide an overview of of the scope of science, (3) to impart scientific knowledge and (4) to deal with applied applications of science in society.[55]

By the end of the first decade of the twentieth century, the high schools had evolved several programs to meet the needs of the students. In the larger schools, the curricula were divided into several programs such as college preparatory, general, commercial and vocational. In

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[55]John E. Stout, The Development of High School Curricula in the North Central States from 1860 to 1918 (University of Chicago: Supplementary Educational Monographs, No. 15, 1921), cited in Leonard, op. cit., pp. 36-38.

view of this, the number of elective subjects available to the student had increased. Most schools had also added vocational and industrial training to their curricula.

Commission on the Reorganization of Secondary Education

The changes which have been outlined did not represent a general change in attitude towards secondary education, but rather an evolution in spite of the traditional college preparatory aim expected from secondary schools. The Commission on the Reorganization of Secondary Education reported in 1918. Its recommendations were quite different from those of the preceding committees and from those of several committees which were to follow.[56] For the first time elementary and secondary school personnel were appointed to a commission.

The Commission postulated that the purpose of a democracy is to organize society so that each member may develop his own potential to its greatest advantage. Education in a democracy, therefore, should develop the individual so that he may contribute effectively to that democracy.[57] To accomplish this new aim, the Commission charged society to recognize the three environmental changes which had taken place: (1) in society, (2) in secondary school population, and (3) in educational theory. Several areas of educational theory, such as individual differences, formal discipline,

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[56] Ibid., p. 134.

[57] Kandel, op. cit., pp. 488-490.

application of knowledge and continuity of knowledge were studied by the Commission. Only formal discipline had been considered by former committees, and even in this area the Commission felt a re-examination was desirable.[58]

The seven cardinal principles of secondary education proposed were: health, command of the fundamental processes, worthy home membership, vocation, civic education, worthy use of leisure and ethical character.[59] Secondary education was not to be limited to the relatively few, but was to be extended to all. It was further proposed that education beyond the high school level should become more general. The colleges were advised to accept more students and to base their entrance requirements on the principle that the individual had a right to expect to further his education beyond the high school level.[60]

The concept of a comprehensive high school was endorsed,[61] and it was suggested that each course should be reorganized in terms of the new objectives of education. Subject studies would remain, but new criteria would be used to judge the content of each course, also the needs and interests of the individual were to be considered before the content of the subject.[62]

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[58]Leonard, op. cit., p. 146.

[59]Ibid.

[60]National Education Association, Report of the Commission on the Reorganization of Secondary Education, The Cardinal Principles of Secondary Education (Washington: National Education Association, 1918), p. 20, cited by Brubacher and Rudy, op. cit., p. 243.

[61]Briggs, Leonard, and Justman, op. cit., p. 40.

[62]Leonard, op. cit., p. 147.

The movement to organize the curriculum apart from subject lines came later.[63] Meyer[64] states that even though the makeup of the Commission had changed, the basic viewpoint was still subject-centered, linguistic and mathematical.

The Period from 1927 to 1957

During this period, the proponents of the child-and society-centered curriculum vied constantly with the proponents of the subject-centered curriculum and neither maintained ascendance for long. Professional curriculum specialists made their contributions in terms of emphasis on the structure of subject material and the importance of understanding basic principles and concepts. The curriculum continued to move from an encyclopaedic list of details to consideration of individual interests and vocations. The periods of prosperity just before the Depression, the Depression itself, the slow growth back to normalcy, World War II and the post-war period followed each other too quickly for any one philosophy to guide the development of the curriculum. Concurrently, the influence of tradition was still strong and innovations were usually introduced in modified form in deference to the traditional program.

In 1927, the Curriculum Committee of the National Society for the Study of Education published its Report, Foundations of Curriculum Theory.

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[63]Ibid., p. 150.

[64]Meyer, op. cit., p. 438.

This Committee was composed of twelve professors of educational philosophy, and it laid the foundation for the integration of the child-centered and society-centered curriculum.[65]

The Committee reported that the high schools were devoting a considerable amount of effort to reconstructing their programs. In a survey of 111 cities reporting for high schools, 72 reported at least one general revision since 1913.[66]

The Committee noted that, in a five year period, data from 90 high schools showed that, whereas 341 subjects were added, 130 were dropped. In the sciences, 37 courses were added and 29 were discontinued. The reason for this fluctuation, based upon criticisms reported, was that the former programs were not adequately adjusted to pupil needs.

In 1930 the Progressive Education Association appointed a Commission on the Relation of Secondary School and College. The project was to be an eight-year study with over two hundred colleges and universities and thirty secondary schools, selected at the start of the study. The colleges agreed to accept pupils without the restraints of the usual college entrance examinations for a five year period beginning in 1936. A second commission, the Commission on Secondary School Curriculum, was formed in May, 1932, to study the effects on the curriculum once the restraints of college

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[65]Meyer, op. cit., p. 439.

[66]National Society for the Study of Education, The Foundations of Curriculum Theory, 26th Yearbook, (Bloomington, Ill.; Public School Publishing Company, 1927), Vol. II, p. 136.

entrance examinations had been removed. This latter Commission was directed to (1) focus attention on the educational needs of all classes of adolescents, (2) suggest methods of studying curriculum problems, and (3) further experimentation in fundamental aspects of curriculum revision.[67] In the fall of 1933, the thirty secondary schools began the experiment; however the Directing Committee attempted to guard the independence and autonomy of each school by assisting, but not dictating, the development of curriculum within each school.[68]

Each of the schools made some changes in their programs. Two distinctive innovations initiated in the field of the sciences were correlated or fused science courses[69] and sequential science programs based on one particular theme of enquiry.[70]

At the end of the eight-year study the results showed that these students had achieved consistently better results in college. In fact, the greater the deviation of the experimental school program from the conventional program, the more noticeable was the superiority of its pupils in college.[71]

Leonard contends that the Report was similar to the work of the early committees inasmuch as each subject committee seemed to imply that its own subject, remaining unaltered but receiving attention from the

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[67] Leonard, op. cit., p. 162.

[68] Wilford H. Aiken, The Story of the Eight Year Study, Vol. I of Adventure in American Education (5 vols.; New York: Harper and Brothers, 1942), pp. 12-16.

[69] Ibid., pp. 52-53.

[70] Ibid., pp. 145-146.

[71] Ibid., pp. 112-113.

other subject teachers, was best suited to serve youth.[72] He suggests that the major achievements are found in the reports on the experiments made with the curriculum in individual schools.[73]

By 1930, Stout found that courses in chemistry and physics still stressed the acquisition of specific details. A change had occurred in that these details were usually grouped into principles and generalizations.[74]

A survey made by the National Society for the Study of Education indicated that since 1930, the textbook was the factor in determining the curriculum in thirty per cent of the schools surveyed.[75] The authors noted that although there appears to be agreement that education should be a continuous process, this principle has not been recognized in the selection of materials for the teaching of science.[76] They recommended that each grade level should present an increasingly mature development of objectives.[77] Lastly, the aim of the program should be to have the individuals acquire (1) an ability to utilize those findings of science which have applications in their own experiences, (2) an ability to interpret the natural phenomena of their environment, and (3) an understanding of, and

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[72]Leonard, op. cit., p. 169.

[73]Ibid., p. 170.

[74]Stout, op. cit., cited by Leonard, op. cit., p. 40.

[75]National Society for the Study of Education, A Program for Teaching Science, 31st Yearbook, (Chicago: University of Chicago Press, 1932), Part I Ch. 2.

[76]Ibid., Part I, p. IX.

[77]Ibid., p. 44.

ability to use, some of the methods of study which have been used by creative workers in the field of science.[78]

Kandel states that, since 1930, a great variety of curricula is offered; however all courses in all subjects, provided that they are of equal length, are still considered as equivalent.[79] He adds that the ultimate end of this trend cannot be anticipated.

In the 1930's the Cooperative Study of Secondary School Studies undertook a three directional study of the secondary schools. They attempted to determine (1) the characteristics of an effective secondary school, (2) a method by which to measure effectiveness and (3) the means by which a school could become more effective. Their conclusions, as far as they affected the curriculum, stressed the importance of adjusting the school program to the social and economic needs of the people.[80] Several other committees reported during the 1930's, but no new techniques of curriculum organization were offered.[81]

In the thirties and the forties the effect of social factors on the curriculum was noticeable. In the mid-thirties the Society for Curriculum Study was organized. The public, too, considered itself capable of constructing and altering the curriculum. This trend was so strong, that the National Education Association observed that if the curriculum revision program should fail to have the support of the press, civic leaders and

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[78] Ibid., p. 50.

[79] Kandel, op. cit., p. 493.

[80] Edgar W. Knight, Fifty Years of American Education: 1900-1950 (New York: The Ronald Press, 1952), p. 115.

[81] Leonard, op. cit., p. 171.

other vocal laymen, it would encounter active opposition, or, at best, only lukewarm support.[82]

Bossing notes that prior to World War II, yearly enrollments in science subjects did not match the growth in total school population; moreover, there was a substantial lack of technicians and scientific personnel at the beginning of the War. The science programs in the high schools were poorly organized and largely abstract. Laboratory work had deteriorated and had in many schools been discontinued in favour of classroom demonstrations. The original vitality and challenge had been lost in the effort to liberalize the overall program as demanded by the new goals in education.[83]

In 1945, the Harvard Committee attempted to find the common principles of education which would appeal to different ages, abilities and outlooks, and yet remain in objective and essential teaching the same for all.[84] They felt that special education or competition and general education or common good both have a place in education, but they could not find a mean between the defenders of heritage and the defenders of experiment.[85]

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[82]Meyer, op. cit., p. 440-1.

[83]Nelson L. Bossing, Principles of Secondary Education (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1955), p. 372.

[84]Harvard Committee, General Education in a Free Society (Cambridge: Harvard University Press, 1945), p. 93.

[85]Ibid., p. 97.

In 1947, in its forty-sixth yearbook, the National Society for the Study of Education again considered the science curriculum. They proposed that science materials should be organized for understanding around a limited number of generalizations, and that the acquisition of scientific skills and attitudes should be a valid concomitant outcome of mastering the subject matter.[86]

As to the method of achieving these goals, they suggested that a basic textbook should be selected that would provide a good outline of the course and the primary text material. This foundation material should then be supplemented from a variety of other sources, such as textbooks, periodicals and reference works.[87]

The Committee suggested the emphasis of the science program should be on (1) unification about a central theme, (2) the social implications of the material, (3) material of immediate personal interest and value to the students, (4) reduction in the number of separate topics, (5) organization partly or entirely around problems, (6) the students' role in organizing the program and (7) rejection for the most part of the college preparatory function.[88]

In 1955, Bossing identified three major patterns which had developed

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[86]National Society for the Study of Education, Science Education in American Schools, 46th Yearbook, (Chicago: University of Chicago Press, 1947), Part I, p. 150.

[87]Ibid., p. 48.

[88]Ibid., pp. 208-211.

within the framework of the subject curriculum concept during the previous quarter century. These patterns were: (1) correlation between two or more subjects at several convenient points during the school year, (2) fusion of two or more subjects and (3) broad-fields study which attempted to eliminate subject divisions in favour of broader areas of knowledge. In his view there must be a further evolution to include life experiences in the school program. The views of the curriculum specialist, the experienced teacher and the community must be included in the curriculum. Finally, to be successful, the student must be brought into active participation in the program in order that he may be helped by an environment that will ensure the right kind of learning experiences.[89]

The 34th Yearbook of the American Association of School Administrators, published in 1956, is concerned with the dual nature of the high school. In preparing the school program, the vocational career of the individual must be balanced against his life as a member of society. It suggests that, since there is a tendency to cling to the traditional elements of the curricula, innovations should be introduced through the regular subjects. Specific examples of subject matter which should be included are speech training, world history and consumer education. The implication is made that the program is too traditional and very likely to remain so. The report appeared to be predominantly concerned with the basic needs of the

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[89] Bossing, Principles of Secondary Education, p. 398.

student as an individual and as a member of modern society.[90]

During the twentieth century the study of chemistry and physics became more than simply a course based on the materials of the field of science. The factors which caused this change were in reaction to the concept of the early secondary schools and the restricted portion of the population that could benefit from such education. By the time the proponents of change had succeeded, it was evident that their victory was merely a beginning.

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[90]American Association of School Administrators, School Board Superintendent Relationships, 34th Yearbook, (Washington, D. C.: American Association of School Administrators, 1956), Ch. 9.

CHAPTER 3

TRENDS IN THE HISTORICAL DEVELOPMENT OF THE CURRICULUM AND THE EMERGENCE OF THE PHYSICAL SCIENCES PROGRAM

PART II: IN THE PROVINCE OF QUEBEC - THE EFFECT OF THE DUAL SYSTEM

The aims and objectives of education have evolved in the Province of Quebec to accommodate the various religious, political, economic and social factors which have been operative therein at different times.[91] In the initial period there was little evidence of education directed to practical purposes.[92] The rights of the few where education was concerned were slowly extended to include a larger segment of the population. In an examination of provincial school grants in Canada, Crawford found that the evolution of education in each province could be identified with three periods of fiscal policy. What money was available was given to private institutions during the period in which education was the prerogative of the privileged few; later, small local groups began to petition for financial aid to build schools in their own areas; and finally, a system of school grants was

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[91]Charles E. Phillips, Public Secondary School Education in Canada ("Quance Lectures in Canadian Education"; Toronto: W. J. Gage and Co. Ltd., 1955), p. 21.

[92]J. Bascom St.John, Spotlight on Canadian Education (Toronto: W.J. Gage and Co. Ltd., 1957), p. 16.

developed in that period in which education was extended to all levels of society.[93]

Denominational interests, which were evident in the early development of all countries of the western world, were dominant in Quebec.[94] This was inevitable since the trappers and traders had little time for, and less interest in, the development of education. From the outset, the meaning and content of education was decided by those who provided it, namely the Roman Catholic Church. For many years the Church in Quebec struggled to gain its objectives against opposing external forces.[95]

There were other factors that influenced both French and English Canadians to accept the role of the church in education. In the period following the founding of Quebec, Cardinals Richelieu and Mazarin dominated the politics of France, and from the time of Henry VIII in the previous century, England had had a state church with the sovereign as its titular head.[96]

Education was not limited to one particular social class in French

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[93]K. Grant Crawford, Provincial School Grants (Toronto: Canadian Tax Foundation, 1962), p. 6.

[94]Charles E. Phillips, The Development of Education in Canada (Toronto: W.J. Gage and Co. Ltd., 1957), p. 4.

[95]Ibid., p. X1

[96]John E. Cheal, Investment in Canadian Youth (Toronto: The Macmillan Co. of Canada Ltd., 1963), p. 15.

Canada, since boys from all classes were educated to enter the priesthood.[97] Self-determination, either individually or collectively, was neither a recognized right or goal, nor even an issue.[98] What assistance there was from the temporal powers was chiefly financial.[99]

The extent to which the religious influence operates at the present time is difficult to assess; however that such an influence still exists is evidenced by recommendations of the Parent Report that the clergy should yield to the laity and should withdraw entirely from technical education and also from certain branches of higher education.[100] In 1959, Joseph R. Pagé,[101] Catholic Secretary of the Quebec Department of Public Instruction, wrote that French Canada firmly believes that religion is a part of true education; that the Church has the right to supervise the religious education of Roman Catholic children in public schools and that Roman Catholic schools should contribute to the preservation and enhancement of French culture. In 1959, Arthur Tremblay[102]

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[97] Phillips, Public Secondary Education in Canada, p. 43.

[98] Phillips, The Development of Education in Canada, p. 26.

[99] Report of the Royal Commission of Inquiry on Education in the Province of Quebec (Quebec: Government of the Province of Quebec, 1963), Vol.I, p. 3.

[100] Ibid., p. 20.

[101] Joseph L. Pagé, "Quebec on the Move", Part 1, Education: A Collection of Essays on Canadian Education (Toronto: W.J. Gage and Co. Ltd., 1960), Vol. 3, 1958 - 1960, p. 1.

[102] Arthur Tremblay, "Contemporary Educational Thoughts in French-speaking Quebec", Fifth Annual Conference of the Canadian Association of Professors of Education: 1959 (Toronto: The Macmillan Co. of Canada, 1960), p. 11.

of the Ecole de Pédagogie, Université de Laval, in a paper delivered at the fifth annual conference of the Canadian Association of Professors of Education, stated that almost none of the traditional French characteristics is being taken for granted. He added that even the denominational characteristic has been molded into an issue, the more so since it had been tacitly assumed that it had been definitely settled. Also in 1959, C.B. Sissons,[103] Professor Emeritus, Victoria College, University of Toronto, wrote that the emphasis on science at McGill University might be attributed to the fact that it was an institution that was originally privately endowed and without church affiliation. A number of prominent writers have a tendency to allude to the influence of religion on education in Quebec, but avoid any discussion of it when considering Canadian education as a whole.[104]

The physical sciences program in the Protestant high schools developed rather slowly until about 1930. After 1930 an effort was made to shift the emphasis from a descriptive approach to an experimental approach to science. Laboratories were installed in a number of large high schools. Interest in the science program did not last. In 1939, the science requirement was dropped as a compulsory subject for the High School Leaving Certificate. Only minor changes have been made in the science program

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[103]C. B. Sissons, Church and State in Canadian Education (Toronto: The Ryerson Press, 1959), p. 158.

[104]Ewart H. Morgan, "Secondary Education", Canadian Education Today: A Symposium, ed. Joseph Katz (Toronto: McGraw-Hill Co. of Canada Ltd., 1956), p. 115.

since then. About 1960, the Physical Science Study Committee physics course and the Chemical Bond Approach chemistry course were introduced on an experimental basis in a limited number of schools of the Protestant School Board of Greater Montreal. This will be discussed in Chapter 4.

The French Regime: 1608 to 1763

In 1608 Champlain founded the city of Quebec, and in the years that followed members of various religious orders came to evangelize the Indians and, where possible, to educate them in the traditional system of France. The first organized endeavour was in 1615 when a number of priests from France landed at Tadoussac with the primary intention of teaching the Indians.[105] In 1616, a school was established at Three Rivers solely to instruct the Indians in reading, writing and the catechism.[106]

The first formal elementary school for pupils other than Indians was the Petit Ecole of the Jesuits at Quebec in 1635. A college for higher education was established in 1655. In 1636, Latin was introduced into the elementary school.[107] Madame Marie Madeleine de la Peltrie of the Ursuline Convent founded the first girls school at Quebec in 1639, and

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[105] Walter P. Percival, Across the Years, A Century of Education in the Province of Quebec (Montreal: The Gazette Printing Co. Ltd., 1946), p. 1.

[106] Ibid.

[107] Phillips, The Development of Education in Canada, p. 16

later, a second girls' school in Montreal in 1657.[108] The first important elementary boys' school in Montreal was the School of the Sulpicians founded in 1666.[109] The Grand Séminaire of Quebec was founded by Monseigneur de Laval in 1663, and the Petit Séminaire for boys destined for the priesthood, in 1668.[110] In 1694, the Trade School at St. Joachim in Montreal was established to train boys in practical arts and trades.[111]

In A History of Chemistry in Canada, Warrington and Nicholls conclude from the records available, that the first public instruction in chemistry was offered at the Grand Séminaire de Quebec from about 1720 onwards. How extensive the course was is not known; however they postulate that it was probably purely descriptive, forming part of a philosophy course. By 1720 the library had a number of printed books in French on chemical topics, one as early as 1643, and a number of bound manuscripts in Latin by 1754.[112]

The courses were almost wholly academic, the discipline strict, and the lectures in the secondary schools or colleges were delivered in Latin as a general rule.[113] Since the schools of the religious orders usually served the whole population of the town, secondary education was a continuation of elementary education and not a separate and distinct

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[108] Percival, Across the Years, p. 3.

[109] Phillips, The Development of Education in Canada, p. 16

[110] Percival, Across the Years, p. 3.

[111] Phillips, The Development of Education in Canada, p. 16.

[112] C.J.S. Warrington and R.V.V. Nicholls, A History of Chemistry in Canada (Toronto: Sir Isaac Pitman and Sons, Canada, Ltd., 1949), p. 411.

[113] Phillips, The Development of Education in Canada, p. 21.

type of education.[114] The absence of coeducation represented an attitude prevalent in France during the period of colonization.[115] Under these circumstances the pupils' academic development was, in essence, training for the priesthood.

There is no evidence of new methodology or controversial topics in education at this time. Not a single printing press was set up for the dissemination of knowledge, news, or ideas in this period of about one hundred and fifty years, whereas in the colony of Massachussets there was a printing press within a decade of its founding.[116] The French colony was relatively poor from the start, being chiefly an agrarian society, and one in which the average inhabitant received little training in agronomy. Commerce developed slowly, being hampered by lack of roads and markets.[117] Nevertheless, based on spiritual and moral objectives, education in the colony was successful and resulted in a unique development not found elsewhere in the western world.[118]

The Failure of Central Control: 1763 to 1846

The Quebec colony and territory to the west came under British rule in 1763; however no attempt was made to interfere with existing

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[114] Ibid., p. 20.

[115] Ibid., p. 23.

[116] Ibid., p. 25.

[117] Ibid.

[118] Ibid., p. 22.

French Canadian institutions.[119] After 1763, the French nobility and priests, as distinct from their French Canadian counterparts, returned to France.[120] The Petit Séminaire for example, was forced to rely upon its Canadian staff for instruction and immediately succeeded in organizing a five year classical course which included some physics and chemistry.[121] Sissons cites the difficulties the Jesuits encountered during this period which culminated in 1773 when the Jesuit Order was suppressed by the Pope and its members expelled from Rome.[122]

By the Quebec Act of 1774 the state recognized the separate rights of the Roman Catholic and Protestant systems of education.[123] After the initial period of disruption and confusion, the French Canadian schools continued their development and, eventually, their facilities for secondary school education were superior to the equivalent English speaking facilities.[124] By a constitutional act in 1791, an assembly was introduced in Lower Canada. This institution was neither welcomed nor trusted by the French Canadians who preferred their traditional attitudes and manner of life, and who clung tenaciously to their religion, language and agricultural economy.[125]

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[119] Ibid., p. 76.

[120] Ibid.

[121] Ibid., p. 86.

[122] Sissons, op. cit., p. 132.

[123] Cheal, op. cit., p. 17.

[124] Phillips, The Development of Education in Canada, p. 86.

[125] Ibid., p. 76.

Several attempts were made about this time to establish schools under a central control and linked to civil authority. In 1789, a committee of the council recommended the establishment of a system of free elementary or parish schools, superior schools and nondenominational or secular collegiates for the teaching of the liberal arts and sciences. The system was to be under the control of a central department and financed by local assessments.[126] There was very little enthusiasm for, or cooperation in, such schemes. The French community interpreted such undertakings as an effort to undermine the Roman Catholic religion and the French language; the English community resented the proposed taxation; and both communities opposed the concept of governmental control of education.[127]

In 1801, an act was passed by the assembly to establish such a system of schools and to promote the cause of education. The Royal Institution only partially obtained its objectives; as it appeared to be authoritarian, its sponsorship was suspect and it was poorly represented by the foreign teachers it had engaged who were unable to adjust to the environment.[128] The local inhabitants did not accept the concept and were further annoyed by the central appointment of teachers, control of the course of study and selection of textbooks.[129]

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[126] Ibid., p. 79.

[127] Ibid.

[128] Sissons, op. cit., p. 133.

[129] Phillips, The Development of Education in Canada, p. 79.

In retrospect, it now appears that the Royal Institution did not deserve the opposition it received. Establishment of any school could only be made at the request of the community and instruction was to be given in the language of the pupils.[130] Further evidence of the ideals and adaptability of the Royal Institution was offered by Audet.[131] The maximum number of schools established was 84. By 1822, financial troubles were encountered. A revised system of financial grants in 1829, devised in response to an increasing demand for local control of schools, marked the decline of central control.[132]

The Act also provided for the creation of a "Royal Institution for the Advancement of Learning" which is perpetuated today through McGill University.[133] McGill College was chartered in 1821, and appointed a Faculty of Medicine. Two rooms of chemical apparatus were included in the original plans, but it is not known whether the teaching of chemistry was begun then or at a later date.[134]

There were private institutes as early as 1776, modeled on the public schools of England. Such schools did not restrict their curriculum

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[130] Ibid., p. 38.

[131] Louis - Phillipe Audet, Le Système Scholaire de la Province de Quebec, Vols, I - IV, (Les Presses Universitaires Laval, 1951-52), cited by Phillips, Ibid., p. 381, and Sissons, loc. cit., p. 131.

[132] Phillips, The Development of Education in Canada, p. 80.

[133] Percival, Across the Years, p. 5.

[134] Warrington and Nicholls, op. cit., p. 416.

rigidly to the classics but also offered natural philosophy or science.[135] Presbyterian, Methodist, Quaker and Anglican academies were founded and were supported by private subscriptions. Historically, they were the transition between the early Latin grammar schools and later high schools. They were middle-class schools, offering both classical and non-classical subjects, and accepted pupils from the common schools.[136] Latin grammar schools, controlled by the Church of England, were established in Quebec and Montreal in 1816. These Royal Grammar Schools taught natural philosophy and demonstrations of scientific experiments were included in these courses.[137]

In Protestant public education, the High School of Montreal was founded in 1799. This school was the result of the amalgamation of an institution also called the High School of Montreal, which had flourished for a short time, and an early Royal Grammar School. The six-year program was divided into a preparatory division and five classes or grades. The last class or grade covered a two year period since it was divided into an upper and lower division.[138]

Adult morning and evening classes were common in the new commercial society. From the first the English population had exhibited an interest in higher education. The majority were literate, but anything beyond the basic elements of education had the appeal of an exceptional opportunity.

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[135] Phillips, The Development of Education in Canada, p. 92.

[136] Ibid., pp. 37-37.

[137] Ibid., pp. 91-92.

[138] Percival, Across the Years, pp. 45-46.

Phillips states that instruction of a practical nature was available on all subjects except science "about which most teachers knew nothing", and history "which anyone could read for himself".[139]

Since it was apparent that the common schools of the Royal Institution were not acceptable, the assembly, in 1824, passed legislation permitting each Roman Catholic parish to establish a Fabrique or church council school.[140] Such schools were completely autonomous and were financed by the local parish; however this failed to stem the increasing French Canadian illiteracy rate. The Parent Report claims that public apathy was too great and that the parishes had insufficient revenue to undertake such a project.[141] From 1824 to 1829, between fifty and sixty Fabrique schools were built.[142] The lack of sufficient revenue was somewhat alleviated by the 1829 Act, "For the Encouragement of Elementary Education". This Act permitted the government to grant subsidies to both Roman Catholic and Protestant school boards and thus encouraged the growth of autonomous boards.[143] This Act also provided for a committee on education and permitted the election of trustees to form local school boards. School grants continued and increased in number and amount. Eventually there were fifteen hundred schools in the province. These grants were abruptly stopped after the 1837 Rebellion.[144]

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[139] Phillips, The Development of Education in Canada, pp. 93-94.

[140] Percival, Across the Years, p. 8.

[141] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol.I, p. 4.

[142] Phillips, The Development of Education in Canada, p. 83.

[143] Percival, Across the Years, p. 9.

[144] Phillips, The Development of Education in Canada, p. 84.

Science instruction increased during this period with chemistry being the science subject most frequently taught. French colleges which were already established followed the traditional classical curriculum, but the sciences were usually included. During the 1830's the College of St. Hyacinthe received a grant to build a chemistry laboratory.[145] Dr. J.B. Meilleur was the first Canadian author of a textbook on chemistry. The textbook was called, Cours abrégé de leçons de Chymie, and was printed in Montreal in 1833.[146]

By 1835, the authorities of the Grand Séminaire of Quebec decided that chemistry was to be taught independently of philosophy. A year later one of the faculty members went to England to purchase apparatus for both physics and chemistry. The inventories and invoices of these purchases are preserved in the archives.[147]

The teaching of the sciences did not continue to develop further despite the initiative shown in this early period. The sciences were never discontinued, but there was a distinct preference shown towards retention of a predominantly classical curriculum.[148]

The minutes of the meetings of the Roman Catholic Committee of the Quebec Council of Education reveal that as far back as 1868, chemistry was a subject of examination for candidates applying for a teaching diploma.

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[145] Ibid., p. 87.

[146] Warrington and Nicholls, op. cit., p. 413.

[147] Ibid., p. 413.

[148] Ibid., p. 414.

By inference, therefore, it may be postulated that chemistry had been taught in the academies prior to this date.[149]

In the Protestant schools it would appear that chemistry was not taught extensively until the 1880's. In 1881 Roscoe's Chemistry was the prescribed text, and was replaced in 1886 by Remsen's Elements of Chemistry. The latter text was a more developed study of the subject.[150]

From 1829 on, two dominant trends developed: decentralization, and state intervention limited to financial subsidies fixed in amount by legislation. In an attempt to avoid the uniformity of the Royal Institution schools, great diversification of school authority resulted. A system of provincial examinations was introduced to achieve a minimal standard of education. The Royal Institution, in 1826, proposed that a Roman Catholic and a Protestant Committee should be constituted to settle the problems that concerned either group separately. Such a bill was passed in the Legislature but failed to pass in the Assembly.[151]

The 1839 Durham Report praised higher education in Lower Canada but lamented the high illiteracy there prevalent.[152] Church and state worked at cross-purposes.[153] It was proposed that Upper and Lower Canada should be unified and this unification was accomplished in 1841. In the same year,

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[149] Ibid., p. 484.

[150] Ibid., p. 485.

[151] Cheal, op. cit., p. 20.

[152] Phillips, The Development of Education in Canada, p. 86.

[153] Sissons, op. cit., p. 134.

an education act was passed which provided two separate school systems for Lower Canada. Embodied in this act were the appointment of a Superintendent of Education, provision for the election of school commissioners and authorization for the minority to dissent.[154] Once again the state was relegated to the position of sharing financial costs with only supervisory powers. Since the school grants were usually fixed by law and could not be controlled, the first superintendent, Dr. J.B. Meilleur, encountered a difficult situation.[155]

Formation of the Dual System: 1846 to 1876

The Education Act of 1846 repealed all previous acts and selected certain features from each. It was said to be the great charter of education in that the control of education was now shared by the people, the clergy and the government. The right of dissent and the principle of taxation were confirmed. The dual system of education was now recognized. School boards were empowered to engage teachers, regulate the courses of study, levy taxes, fix fees and generally manage the schools. The only textbooks to be used were those authorized by the Board of Examiners.[156]

The Boards of Examiners were authorized to certify prospective teachers. In 1857, three teacher training institutions were opened: the

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[154] Percival, Across the Years, p. 17.

[155] John K. Jobling, "The Contribution of Jean Baptiste Meilleur to Education in Lower Canada" (unpublished Master's Thesis, McGill University, 1963), Chap. 3.

[156] Percival, Across the Years, p. 20.

Jacques Cartier and the McGill Normal Schools in Montreal, and the Laval Normal School in Quebec. The two schools in Montreal had been previously established but were closed during the riots of 1837.[157]

In 1851, an Act authorizing the appointment of school inspectors was passed.[158] The Journal of Education for Upper Canada had been established in 1848, and in 1857 a French and an English Journal of Education began to appear in Quebec.[159] The Council of Education was established in 1859, and in 1869 a further Act enlarged the membership and formed two separate committees to increase the efficiency of each system and reduce the number of Council meetings.[160] Canon Carter claims that the creation of the Council of Education and its two committees limited the powers of intervention on the part of the government to a level far below that of other provincial governments.[161]

The Parent Report[162] postulates that the state might have repossessed a greater control of education through the British North America Act of 1867, had it not been for the fears of the English-speaking minority in Lower Canada. The insertion of provisions to protect the established rights of religious minorities was made to protect this group. These provisions ensure that legislation

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[157] Percival, Across the Years, pp. 21-22.

[158] Ibid., p. 22.

[159] Ibid., p. 23.

[160] Ibid., pp. 23-24.

[161] G. E. Carter, The Catholic Public Schools of Quebec (Toronto: W.J. Gage and Co. Ltd., 1957), p. 22, cited by Woodrow S. Lloyd, The Role of Government in Canadian Education (Toronto: W.J. Gage and Co. Ltd., 1959), p. 29.

[162] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. I, p. 13.

may not infringe upon the rights and privileges of denominational schools, and that the rights, provisions and duties inferred and imposed in Upper Canada on the separate schools should be extended to the Protestant and Roman Catholic schools in Lower Canada.[163] The forces behind Confederation were political and economic and there was, therefore, little desire to blend the two cultures in Lower Canada.[164]

In 1875, the law was altered to return control of the Department of Education to a Superintendent instead of to a Minister. The Minister had had the Department under his jurisdiction since Confederation.[165] The Superintendent was to be assisted by a French secretary and an English secretary. This was to facilitate matters of language rather than segregate the two systems.[166] Roman Catholic bishops were entitled to sit in on the Council of Education, and although this was merely an attempt to remove education from political influence, it nonetheless reasserted the religious role in education.[167]

With the passage of this Act, Protestant education was officially recognized. The Protestant Committee received full jurisdiction over all matters pertaining to Protestant education.[168] Government grants were

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[163]Walter P. Percival, Life in School (Montreal: The Herald Press, 1940), p. 10.

[164]Woodrow S. Lloyd, The Rôle of Government in Canadian Education (Toronto: W.J. Gage and Co. Ltd., 1959), p. 19.

[165]Percival, Across the Years, p. 24.

[166]Percival, Life in School, p. 11.

[167]Percival, Across the Years, p. 24.

[168]Ibid., pp. 24-25.

made to both Committees on the basis of pupil enrollments and community requirements.[169]

The Protestants now had a central system, but this system had no organized course of study nor any statistical records to use as guidelines.[170] Further difficulties were encountered since the Committee had no effective means of enforcing its decisions, especially in the elementary schools, as school grants were almost automatic, based solely on population.[171] In 1881, the Educational Record, which contains the minutes of the Protestant Committee, began publication, and in 1886, a Central Board of Examiners was established.[172]

Growth under the Dual System: 1876 to the Present

During this period the central bodies consolidated their position and experimented with the course of study which had to be altered and adjusted to the changing conditions of society. Phillips characterized this period in Canadian education as being one of organized efficiency. Provincial departments supervised the training of teachers, issued courses of study, authorized textbooks, sent out qualified inspectors and conducted examinations. Elementary and secondary schools became known as public and high schools respectively. Elementary education became free and was made virtually compulsory,

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[169]Percival, Life in School, p. 12.

[170]Percival, Across the Years, p. 25.

[171]Ibid.

[172]Ibid., p. 26.

while secondary education was cheap if not free. Originally, secondary edu- had overlapped elementary education, but when secondary education became a continuation of elementary education, a split occurred in secondary education and a system of programs or courses of study was devised. Willingness to be guided by what proved workable in practice was a partial solution to the problems which arose as education was extended to more pupils and as the time spent in school increased.[173]

According to Lloyd's concept of the role of government in education the provincial government acted in a positive manner during this period and ensured that the rights of the people under its jurisdiction were fully enjoyed and developed.[174] This, of course, had to be accomplished through suggestion and persuasion of the local boards of education. Percival states that the Protestant Schools of Montreal have had an organized program since the beginning of this period and the rural Protestant schools for a somewhat shorter period of time.[175] However, Morgan indicates the abnormally high incidence of rural and small town communities in which the academic program is the only one available.[176] In an effort to organize a system of education, the purpose of education has not been sufficiently clarified and the college preparatory function has received the most attention. There has been an uncertainty in the development of education because of the lack of a

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[173]Phillips, The Development of Education in Canada, p. 180.

[174]Lloyd, op. cit., p. 21.

[175]Percival, Life in School, pp. 40-41.

[176]Morgan, op. cit., p. 121.

consistent philosophy. Alternatively, the philosophies that were developed were either not accepted or were not successful in guiding the development of the curriculum.[177]

In the last quarter of the nineteenth century the provincial systems of written examinations were developed. Although intended for the purpose of raising the educational standards to certain minimal levels, they functioned more as a device that would eliminate some pupils and select others. Commercial courses were introduced; however such courses did not always meet with public approval. A compromise was reached when the universities agreed to increase the number of courses they would accept as suitable for university entrance.[178]

In 1870, the Protestant Board of School Commissioners assumed control of the High School of Montreal. At that time there were three divisions in the school: the Preparatory Department, the Classical Department and the Commercial Department. In 1877, the Protestant Board made the following changes: Latin was to be a compulsory subject, the Commercial Department was dissolved, and science was permitted as an alternative to Latin in the higher grades. By 1891, however, classical, science, and once again, commercial options were available.[179]

During the latter part of the nineteenth century the Protestant

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[177] Andrew F. Skinner, "Philosophy in Education in Canada", Canadian Education and Research Digest, III (December, 1963), 254.

[178] Phillips, Secondary School Education in Canada, p. 50.

[179] Percival, Across the Years, pp. 49-50.

school curriculum was based on an academic program which led from the elementary school to the high school, and finally to college.[180] Percival states that in the 1880's the objectives outlined for pupils fifteen years of age were: to read and spell, to write neatly and legibly, to speak and write correct English, to have an elementary knowledge of world geography, and to work accurately simple business arithmetic.[181]

In 1897, ten subjects were offered in the last year of high school. Prior to 1901, Protestant education was spread over ten years or grades. In that year the Grade 8 work was distributed over a two-year period, thus adding an extra year, Grade 11, to the system. At the same time physics was made a compulsory subject in Grade 9, and one science was made compulsory in both Grades 10 and 11.[182] The high school curriculum has remained to the present time predominantly academic in that pupils are prepared for High School Leaving Examinations in the subjects that are needed to meet the requirements for university entrance.[183]

Warrington and Nicholls claim that the appearance of science in the high school curriculum was delayed until nearly the beginning of the twentieth century because Canada was still a pioneer country.[184] It is more likely that the teachers' lack of scientific knowledge, suggested by Phillips, was

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[180]Phillips, Secondary Education in Canada, p. 60.

[181]Percival, Life in School, p. 39.

[182]Percival, Across the Years, p. 155.

[183]Ibid., p. 157.

[184]Warrington and Nicholls, op. cit., p. 480.

the dominant factor.[185] Textbooks and methods were available for only the standard subjects, and Percival states that textbooks in the schools of Lower Canada were in short supply.[186] At the beginning of the twentieth century, the curriculum still favoured Latin and the academic subjects; however courses in the sciences were now being developed.[187] Science courses began to receive favourable attention by the turn of the century, and pupil enrollment in the science courses increased steadily.[188]

The Parent Report states that a new approach to technical education was introduced in 1907 when technical and vocational schools were established in Montreal and Quebec. Similar institutions were gradually provided at other centers in the province.[189] Before the First World War, practical or vocational subjects were added to the school curriculum. The presence of the new courses may be taken as recognition of pupil interests and abilities as motivating forces in learning.[190]

According to Percival, it was not until the 1930's that a marked shift appeared in favour of the science subjects.[191] Laboratories were

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[185] Phillips, Public Secondary Education in Canada, p. 48.

[186] Percival, Across the Years, p. 159.

[187] Ibid., p. 155.

[188] Phillips, Public Secondary Education in Canada, p. 54.

[189] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. I, p. 17.

[190] Morgan, op. cit., p. 116.

[191] Percival, Across the Years, p. 155.

installed in the larger high schools and a revision of the physics and chemistry courses of study was begun.[192] Phillips agrees with this statement, but adds that it was not until after 1930 that the students were allowed to perform experiments.[193] In contrast, the science program began to develop in Ontario in the late 1880's and early 1890's.[194] In 1931, biology was added to the curriculum.[195] Percival states that in 1931, a comparison of the Quebec Protestant course of study with that of other Provinces and English-speaking countries indicated that the Protestant schools of Quebec compared most favourably.[196] The criticisms of the Hepburn Report and the Parent Report would lead one to suspect the terms of comparison.

In 1937, a Survey Committee was appointed to enquire into, and report to the Protestant Committee of the Council of Education on, all matters affecting Protestant education in the Province of Quebec.[197] The following year the Hepburn Report was submitted. The report stated that inadequate accommodation and equipment for the teaching of science to high school pupils was often encountered. Furthermore, the Committee found that science instruction in the elementary and high schools was often less liberal than

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[192] _Ibid._

[193] Phillips, _The Development of Education in Canada,_ p. 491.

[194] _Ibid._

[195] Percival, _Across the Years,_ p. 155.

[196] Percival, _Life in School_, p. 44.

[197] _Report of the Quebec Protestant Education Survey,_ W.A.F. Hepburn, Chairman, (n.p.) 1938, p.vi.

the course of study indicated.[198] The Parent Report of 1963 states that science education assumes the availability of sufficiently large and well equipped laboratories to enable all students to perform experiments and execute practical assignments;[199] however these facilities are still frequently unavailable.[200]

To ensure practicality, the cost of such a scheme must be indicated. Each pupil does not represent an equal cost. The instruction of a technical school pupil may be twice or even three times as much as that of an academic pupil, and that of a high school pupil may be just over one and a half times as much as that of an elementary school pupil. Furthermore, the elementary school, high school and special school rooms are not equally costly to build and operate.[201] Based on these values it was estimated in 1959, that in order to provide shops and laboratories to allow fifty per cent of the pupils in junior and senior high schools to spend fifty per cent of their time on practical subjects, education in Canada would cost $85 million per year rather than the present amount of $18 million.[202]

The need for additional expenditure is due to the ever increasing number of pupils, as well as to their wide range of interests and abilities.

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[198] Ibid., p. 109.

[199] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol.II, p. 143.

[200] Ibid., Vol.II, p. 95.

[201] M. E. LaZerte, School Finance in Canada, Report of the Canadian School Trustees' Association, School Finance Research Committee (Edmonton, Alberta: The Hamly Press Ltd., 1955), p. 215.

[202] Ibid., p. 59.

School attendance between the ages of six and fourteen became compulsory by law in 1943. The legislature did not readily accept this concept, as it had rejected compulsory attendance bills in 1892, 1901, 1912 and 1919.[203] During this period the Hepburn Report found that school authorities were forced to acknowledge the increasing heterogeneity of their school populations. Two main courses were common to all high schools, an academic course and a general one. A few high schools had organized a science course, and several had included a commercial course as well.[204]

The remission of school fees and the provision for free textbooks made by the Act offered greater opportunity and promoted regularity of attendance.[205] Secondary school enrollment had increased from about five per cent of the school enrollment in 1900 to more than twenty-three per cent in 1950.[206] The average length of a pupil's school career was eight years in 1911 and ten years in 1941.[207]

Concurrent with an increase in the number of pupils being educated there has been an increasing growth in the rate of drop-outs. Bancroft illustrates that in a sample of 10,000 children, 3,200 drop out before

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[203] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. II, p. 20.

[204] Report of the Quebec Protestant Education Survey, pp. 116-117.

[205] Percival, Across the Years, p. 194.

[206] George W. Bancroft, "Some Sociological Considerations on Education in Canada", Canadian Education and Research Digest, IV (March, 1964), 25. (No date reported for survey.)

[207] Ibid.

Grade 8; 1,500 fail to reach Grade 9; less than half of the remainder, or 5,300, receive a junior high school leaving certificate; and only a little over 1,000 enter university.[208] He has noted a self-perpetuating trend in this situation. The percentage of pupils leaving school early in their academic career is forty-nine per cent for those students whose fathers are in non-professional careers, but only six per cent for pupils whose fathers are in professional careers. A similar trend was noted regarding pupils who remain but do not finish high school. Of pupils who do not complete their high school education, eighty per cent have fathers who are in non-professional occupations, while twenty-three per cent have fathers who are in professional occupations.[209]

Since 1930, there has been a change in the types of occupations available for high school drop-outs. Unskilled and semi-skilled jobs are usually the only occupations available to such pupils, and rapid technological advances are now eliminating many such jobs.[210] Rivers states that education must consider the two influences caused by technological progress: as machines take over the work formerly done by human labour, a semi-skilled worker will probably be forced to change occupations two or three times during his working lifetime; and as the number of working hours will decrease, a student should be trained in the constructive use of increased

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[208] Ibid.

[209] Ibid., p. 27.

[210] F. S. Rivers, "Education, 1930 - 1980 : Fifty Years of Crisis", Canadian Education and Research Digest, IV (September, 1964), 172.

leisure time.[211]

The Parent Report states that the general course in secondary education which was to have absorbed the mass of students has not been successful.[212] It recommends that elementary school must not be considered as terminal.[213] Secondary education, by means of electives, must be diverse enough to accept all pupils from the elementary school and help the students discover and develop their aptitudes before leaving school.[214]

The Hepburn Report stated that the textbook was the main source of instruction in science subjects.[215] This was attributed to the course of study which was based on authorized texts and which indicated the sections of the text to be covered.[216] This method of teaching science did little to form habits of accurate observation, or to develop the scientific method, both of which had been indicated as desirable objectives in the philosophy outlined by the Department of Education.[217] MacKinnon criticizes the tyranny of uniformity because of its effect upon intellectual initiative.[218] He also indicates

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[211] Ibid.

[212] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. II, p. 129.

[213] Ibid., Vol. II, p. 90.

[214] Ibid., Vol. II, p. 131.

[215] Report of the Quebec Protestant Education Survey, p. 118.

[216] Ibid.

[217] Ibid., p. 121.

[218] Frank MacKinnon, The Politics of Education (Toronto: University of Toronto Press, 1960), p. 129.

the problem of the teacher who is not fully qualified to teach a course but who, nonetheless, is assigned to teach it.[219]

Article 30 of the Quebec Education Act authorizes each Committee of the Education Council to adopt and withdraw all textbooks, maps, globes, models, or other articles for use in the schools under their jurisdiction.[220] Article 222 states that authorized textbooks may be made available without charge to the students; that is, school boards may purchase textbooks, but such authorization is denied in the case of exercise textbooks or manuals in which the pupils are required to write or draw. Workbooks are not considered to be textbooks, and school boards are not permitted to purchase them.[221] This attitude has proscribed the use of programmed textbooks in science and laboratory manuals in which the pupil is required to complete certain statements and thus by a series of simple steps arrive at a desired conclusion.

The problem of textbooks and particularly the cost of textbooks has been a topic of considerable debate in the province. Percival devotes a full chapter in his book on Protestant education to answering the charge that textbooks are changed too frequently.[222] The Hepburn Report is more concerned with the role of textbooks in education and recommended that district boards

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[219] Ibid., p. 124.

[220] The Education Act of the Province of Quebec, compiled by W. P. Percival (Quebec: Department of Education, 1951), p. 15.

[221] The Education Act of the Province, p. 94.

[222] Percival, Life in School, p. 81.

should be empowered to select their own textbooks and that no objection should be raised against books not specifically written for the Province of Quebec.[223] In this instance, centralized control has shifted attention from the needs of the teacher to the curriculum.[224] In the matter of textbooks and laboratory manuals the curriculum has been over-influenced by governmental control.[225]

According to MacKinnon, the final expression of state control is the examination system. It cannot be tacitly assumed that examination systems will always operate to promote good teaching and effective learning.[226] The inherent disadvantage is that the pupil, responsible for certain allotted pages in an authorized text, becomes nothing more than a candidate whom the teacher prepares for examinations.[227] Lloyd states that the demand for additional and more stringent examinations appears to be increasing to the point where the other areas and aims of education are being detrimentally affected.[228]

Educational authorities in the Province of Quebec have been aware of this problem. In an effort to make the high school autonomous with respect to the university, the final examinations were renamed High School

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[223]Hepburn, op. cit., pp. 134-135.

[224]MacKinnon, op. cit., p. 123.

[225]Ibid., p. 107.

[226]Ibid., p. 125.

[227]Ibid., pp. 125-126.

[228]Lloyd, op. cit., p. 47.

Leaving Examinations in 1910; however, the former term, Matriculation Examinations, is still in current use.[229]

Prior to 1931, each student was required to write at least one science examination to achieve his High School Leaving Certificate. In 1939, however, the science requirement was dropped and the only compulsory examinations were English and French.[230]

The value of the science subject was held in high regard, at least during that period around 1930, and it was suggested at that time, that science offered an intellectual training second to no other subject.[231] The stated objectives were patience, deliberateness of purpose and clarity of thought.[232] It was specifically stated that these would only be achieved through understanding, not memorization, and the use of the laboratory approach to science.[233] Fletcher also agrees with this philosophy and cites biology as a subject that may be used both as a liberal and as a vocational study.[234] He stipulates that excessive reliance on the textbook by an unqualified science teacher could effectively stifle all interest in the natural sciences.[235]

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[229]Percival, Life in School, p. 110.

[230]Percival, Across the Years, p. 162.

[231]Percival, Life in School, p. 152.

[232]Ibid.

[233]Ibid.

[234]B. A. Fletcher, The Next Step in Canadian Education, Studies of the Institute of Public Affairs at Dalhousie University (Toronto: The Macmillan Co. of Canada Ltd., 1939), p. 29.

[235]Ibid.

Phillips asserts that the reliance on the textbook was due to the shortage of science specialists.[236] In 1850, there were few teachers with a knowledge of science, and one hundred years later the increased complexity of science had outpaced the number of teachers who were qualified to teach science subjects. This is particularly true in schools where a teacher is required to teach a number of subjects.[237] Cognizance of this was apparent in the Parent Report, which stated that specialization should not be discouraged.[238] Teachers require specialized knowledge and training in methods and techniques no less than doctors, lawyers and ministers.[239] The numerical size of the classes alone demands that the teacher be given the best possible preparation. The Dominion Bureau of Statistics in "Teachers' Salaries and Qualifications in Nine Provinces, 1952 - 1953", lists the following statistics concerning the number of pupils per class across Canada.

SIZE OF CLASSES

BASED ON 27,623 CLASSES REPORTED BY 8 CANADIAN PROVINCES[240]

Number of Pupils per Class	Number of Classes	Per cent of Total
25 or more	17,617	64
30 or more	13,485	49
35 or more	8,136	29
40 or more	3,503	13

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236 Phillips, The Development of Education in Canada, p. 488.

237 Ibid.

238 Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. II, p. 12.

239 St. John, op. cit., p. 20.

240 LaZerte, op. cit., p. 214.

In a sociological study of education, Bancroft postulates that education, particularly higher education at the college level, is one of the principal modes of self-improvement in an industrial society, and that there is at least some indication that such an education is not equally available to all Canadian youth.[241] In a statistical study Cheal reports several items which should dispel any complacency about the present system. A significant negative correlation was reported between educational output and the degree of denominationalism in the provincial systems.[242] A similar negative correlation was reported between educational output and the percentage of Roman Catholic population in provincial systems.[243] Several provinces higher in denominational divisions achieved a lower output even though they showed a high effort relative to ability to support educational institutions.[244]

The future development of the physical sciences program and of education in general in the Province of Quebec appears promising in terms of the proposals of the Parent Report. The recommended appointment of a Minister of Education was made in 1965. It is too early to report on the results achieved by the new Superior Council of Education, now meeting as a unified body as recommended.[245] Increasing competence of teachers is recognized, and there is a movement to reduce the importance of examinations in the lower grade levels, and to limit external examinations to the last year of high school. The Report recommended the activist

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[241] Bancroft, op. cit., p. 31.

[242] Cheal, op. cit., p. 31.

[243] Ibid., p. 119.

[244] Ibid.

[245] Report of the Royal Commission of Inquiry on Education in the Province of Quebec, Vol. I, p. 88.

school approach and also that the first two years of secondary education should be devoted to general education.[246] The Hepburn Report recommended that the first three years, of a six year period, should be general in content.[247] Both committees recommended that specialization should not begin until the last three years of high school, provided that the high school period is extended from Grade 7 to Grade 11. The consolidation of smaller administrative units was also proposed. This had already been accomplished in other parts of Canada by 1950.[248] The large resources of the province would be able to support this consolidation.[249] The history of the province gives numerous instances of its claim to be unique even to the refusal to accept federal grants from the Canadian Council in 1957.[250] Progress has not been ignored, but the pace is slower when a concurrent effort is made to retain traditions and customs.[251] At the present time a new philosophy concerning education and its relation to Church and State is emerging which should provide considerable guidance and assistance for curriculum development.[252] At the same time, the reduced emphasis on external examinations recommended by the Parent Report should provide more freedom for the experimental development of the curriculum.

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[246] Ibid., Vol. II, p. 90.

[247] Report of the Quebec Protestant Education Survey, p. 125.

[248] Lloyd, op. cit., p. 33.

[249] Fletcher, op. cit., p. 16.

[250] Sissons, op. cit., p. 180.

[251] Page, op. cit., Part 2, p. 9.

[252] Skinner, op. cit., p. 260.

CHAPTER 4

RECENT CURRICULUM DEVELOPMENTS IN NORTH AMERICAN HIGH SCHOOLS AND IMPLICATIONS OF CURRENT LEARNING THEORY

The previous chapters have indicated the general growth and development of education in North America and their influence on the physical sciences program in the first half of the twentieth century. Later influences on the science curriculum will now be considered along with the adaptations made in response to them.

As the high school movement grew, its role in society evolved from an exclusive and selective institution to one that was inclusive and democratic.[253] Concurrently, the trend towards mass secondary education forced the establishment of technical or vocational programs.[254] In the absence of suitable and varied content in the composite high school academic standards tended to revert to the norm or average of the whole group.[255] Campbell illustrated the magnitude of the problem by reference to a hypothetical course in

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[253] Will French, "The Role of the American High School," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Company, 1959), p. 109.

[254] H. L. Campbell, Curriculum Trends in Canadian Education, Lectures delivered under the Quance Lectures in Canadian Education (Toronto: W.J. Gage and Co. Ltd., 1952), p. 41.

[255] Ibid., p. 45.

English Literature at the Grade 9 level adequate enough to challenge students whose I.Q. varied from 80 to 140 and whose reading level varied from Grade 7 to Grade 11.[256] There was outspoken criticism of the fact that the academic program was poorly adapted to the majority of students.[257] The deficiencies of general education became a matter of American and Canadian concern during World War II. Testing programs indicated that a large number of high school graduates were inadequately prepared in basic science and mathematics,[258] and that their preparation in the cultural subjects was not at a much higher level. Other studies during and after the war confirmed these results and not infrequently indicated that a majority of students was not achieving as well as the students of preceding generations. A study which compared the competence of students in algebra in 1938 and 1959 indicated that, although the latter generation of students had a higher mean I.Q., better school attendance and a lower pupil to teacher ratio, their proficiency in algebra was decidedly lower.[259]

Beauchamp suggested that education had developed as a technology rather than a science in that courses were added to, or taken from, the

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[256] Ibid., p. 68.

[257] Harold B. Alberty and Elsie J. Alberty, Reorganization of the High School Curriculum (3d. ed; New York: The Macmillan Co., 1962), p. 68.

[258] John E. Goodlad, School Curriculum Reform in the United States (New York: The Fund for the Advancement of Education, 1964), p. 9.

[259] Norman D. Muir, "A Comparison of the Competence in Algebra of the Grade IX Students of the Edmonton Public Schools in 1938 and 1959," Alberta Journal of Educational Research, VII (December 1961), 182-183.

high school program on an empirical basis.[260] By 1950, the concept of education as human growth and development became widely accepted.[261] Benjamin Franklin's contributions to education have been previously discussed: (1) clarification of the aims of education, (2) emphasis on functional studies and (3) stress on environment and equipment.[262] The composite high school of the twentieth century represented considerable progress towards achieving such ideals.[263]

Adaptations Made to Improve the Curriculum

In 1959, the National Education Association appointed a committee to study and make recommendations for the improvement of the whole instructional program. This committee used three sources of data: (1) the academic disciplines, (2) social forces and trends and (3) research in intellectual growth, levels of development and the psychology of learning. In the development of learning theory, direct experience in learning, individual differences and relation of maturation to readiness suggested that factors other than the logical sequence of content should be considered in curriculum planning.[264] Existing programs which were premised on the above were

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[260]George A. Beauchamp, Curriculum Theory (Illinois: The Kagg Press, 1961), p. 1.

[261]Harl. R. Douglass (ed.), The High School Curriculum (2d. ed., New York: The Ronald Press Co., 1956), p. 3.

[262]Vide infra., p. 13.

[263]Ibid., "The School Program as a Heritage," p. 25.

[264]National Education Association, Project on the Instructional Program of the Public Schools, Deciding What to Teach (Washington, D.C.: National Education Association, 1963), p. 8.

found to be more flexible in selection of content and methods of instruction.[265] There was no indication of a disregard of content, but rather a change in the criteria used to select content. Determination of the role of academic disciplines in the school program was identified as the central issue.[266]

The traditional approach tended to regard the individual as passive, and learning as being specific. Topics or elements were taught separately and then associated, the process being predicated on the stimulus and response theory of psychology. Later, the individual came to be regarded as a complex organism and his personal interpretation of his activities was postulated as being inseparably bound up with the learning process and learning results. Based on this assumption, the physical stimulus could not be separated from the emotional and intellectual stimuli, and therefore the context of the learning act was significantly important.[267]

There was general agreement concerning the factors which contributed to dissatisfaction with the high school program. Tyler[268] cited three: (1) rapid technological development and social upheaval, (2) increased number of youth in school and (3) decreased influence of other educational

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[265] Ibid., p. 10.

[266] Ibid., p. 16.

[267] Alberty and Alberty, op. cit., pp. 68-69.

[268] Ralph W. Tyler, "The Curriculum - Then and Now," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Co., 1959), p. 191.

institutions, such as the home and the church. Goslin[269] suggested that two reasons for the lack of agreement on the content of the curriculum were that, historically, this was a period of rapid change, and that environmentally there was a wide range of political, economic, social and religious beliefs.

The solutions to these problems devised by various school systems were generally quite similar. Koos,[270] in an examination of the report of a national survey of secondary education for the fifteen-year period prior to 1930, summarized the main trends as follows: (1) a rapid increase in the number of vocational and technical courses, (2) an increase in the number of elective courses and (3) a decrease in the number of required courses.

The 1959 National Education Association Committee[271] reported that balance in the high school program was commonly achieved by adjusting the nature and number of required courses, providing a wide range of electives and including a broad extracurricular program. In the same report the committee referred to a survey conducted by the United States Office of Education in which high school principals and education department officials reported that their curriculum was still strongly influenced by college admission standards.[272] Even in the area of textbooks, similarities between high school

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[269]Willard E. Goslin, "What Shall We Teach?" Ibid., p. 83.

[270]Leonard V. Koos, and others, Administering the Secondary School (New York: American Book Co., 1940), p. 14.

[271]National Education Association, Deciding What to Teach, p106.

[272]Ibid., p. 200.

and college textbooks were noted.[273] It was clear that the relationship between high school and university had not been resolved.[274]

General dissatisfaction with the content and organization of the individual courses was widely indicated. Science and mathematics courses were criticized because of their failure to convey either the scope or the practical function of the subject matter to the students.[275] The division of subject fields into courses accented the compartamentalization of knowledge and in itself tended to destroy the unity of the subject.[276]

Numerous proposals were made to remedy the situation. New programs were devised in which the curriculum was not organized around traditional subjects; however attention was primarily focused on evolving schemes to make the subject-centered curriculum more effective. Since the publication of the "Seven Cardinal Principles of Education" in 1917,[277] teachers accepted the postulation that the student who developed the bulletin board, exhibit or working model, or who gave the demonstration, potentially learned more

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[273]Clarence M. Pruitt, An Analysis, Evaluation and Synthesis of Subject Matter Concepts and Generalizations on Chemistry, Doctoral Dissertation, Teachers' College, Columbia University (New York: By the Author, 1935), p. 50.

[274]William M. Alexander and Galen J. Saylor, Modern Secondary Education: Basic Principles and Practices (New York: Rinehart and Company Inc., 1959), p. 386.

[275]A.W. Hurd, "Present Inadequacies and Suggested Remedies in the Teaching of High School Science," School Science and Mathematics, XXVII (June, 1928), 638.

[276]John C. Hogg, "The Physical Sciences Course - Its Justification and Sequence," School Science and Mathematics, XXXIX (February, 1939), 175.

[277]Vide Infra., p.28.

than the student who merely watched.[278] It was suggested that, periodically, the lesson should be centered on a scientific problem independent of the text-book, in which each member of the class could conduct research and make a report of the results.[279] Supplementary reading was provided to stimulate interest and to broaden the course of study.[280] Experiments were conducted in which the school timetable was arranged so that a number of classes and their teachers could periodically meet as one group and then return to their individual classrooms.[282]

Science clubs were organized to develop the interests of certain students.[283] Enrichment of the curriculum was achieved in these programs by lectures from subject teachers or guest lecturers.[284] Other clubs were in seminar form at a considerably advanced level as compared with the course of study.[285]

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[278] Paul de H. Hurd, "Mid-Century Trends in Science Teaching," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Company, 1959), p. 157.

[279] Leonard Boone, "Scientific Problem Solving and 'Water Witching'," Science Education, XLIX (February, 1965), 93 - 96.

[280] Norman Gillespie, "The School Library and Mathematics and Science", The Bulletin, O.S.S.T.F., XLIV (March, 1964), 86.

[281] E. L. Goldsmith, "Independent Study in the Junior High School," Educational Digest, XXX (February, 1965), 40.

[282] R.W. Joly, "Flexible Scheduling," Hi Points, XLVII (February, 1965), 36.

[283] J. E. Kruger and R.S. MacArthur, "The Systematic Development of a Program of Extracurricular Activities in Science," Alberta Journal of Educational Research, VI (March, 1960), 218-28.

[284] D. E. Keller, "Fairleigh Dickinson Program for Enriching the Curriculum of Gifted Secondary School Students in the Fields of the Philosophy of Science and Natural Science," Science Education, XLIX (March, 1965), 100-7.

[285] Murl B. Salisbury, "Mathematics-Science Seminars for Talented Secondary School Students," Science Teacher, XXVI (April, 1959), 150-4.

Within the school program enriched courses were devised.[286] Some enriched programs included courses not commonly taught in the high school.[287] In a study of twenty-three programs for gifted students, Fox noted the following common characteristics with regard to science education: laboratory work in each science course, graduation requirements in mathematics and science and advanced courses in science and laboratory research opportunities.[288] With regard to the schools, the following data was noted: generally the schools were large and crowded, some form of special grouping was used and the schools having larger populations were usually able to form more efficient student groups.[289]

After a survey of science programs in the United States the National Science Foundation, in 1955, identified several problem areas: a lack of qualified science and mathematics teachers, insufficient identification, motivation and counselling of superior students and the need for improvement of high school science courses.[290]

In the same period McGrath[291] summarized six measures introduced

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[286]Donald B. Summers, "College Level Chemistry for Gifted High School Students," Science Teacher, XXVI (April, 1959), 176-7.

[287]H. N. Cairns, "On the Care and Feeding of Science Teachers," The B. C. Teacher, XXXVIII (April, 1959), 345.

[288]Robert P. Fox, "A Study and Analysis of Twenty-Three Programs for Gifted High School Science Students in the United States" (unpublished D.Ed. thesis, Boston University, 1960), p. 155.

[289]Ibid., p. 151.

[290]National Science Foundation, Scientific Personnel Resources (Washington, D.C., U.S. Government Printing Office, 1955), p. 1.

[291]G. D. McGrath, "The Natural Sciences," The High School Curriculum, ed. Harl R. Douglass (2d. ed; New York: The Ronald Press Co., 1956), pp. 414-20.

to improve science instruction: (1) fusion of two or more courses, (2) vocational science courses, (3) consumer science courses, (4) science courses based on life problems and activities, (5) grouping or streaming of pupils and (6) introduction of supplementary reading.

In a study of the aims of science in Canadian high schools, Bessai noted the influence of the agricultural economy.[292] The descriptive aim and the practical aim predominated in the early decades of the twentieth century[293] and he concluded that there was a lack of modern educational theory in both the preparation of, and instruction in, science courses.[294]

In the United States, the concern for the physical sciences program resulted in the creation of three major courses for academically talented science students: (1) the Physical Science Study Committee physics course, referred to as the P.S.S.C. physics course, (2) the Chemical Education Materials Study course in chemistry, referred to as the CHEM Study course, and (3) the Chemical Bond Approach chemistry course, referred to as the C.B.A. chemistry course.

In surveying the characteristics of both the enriched courses and new chemistry courses, the National Science Teachers' Association noted at least four common trends:[295] (1) a greater amount of time given to the

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[292]Frederick Bessai, "The Aims of Science Teaching in Canadian Secondary Schools" (unpublished Master's thesis, University of Saskatchewan, 1962) p. 43.

[293]Ibid.

[294]Ibid., p. 109.

[295]National Science Teachers' Association, New Developments in High School Science Teaching (Washington, D.C.: The Association, 1960), p. 64.

subject, (2) elimination of purely descriptive material, (3) increased dependence on mathematics and (4) quantitative measurements and "open-ended" experiments stressed in laboratory programs.

Canadian courses in physics and chemistry seldom reflected these characteristics. Physical science courses rarely included modern topics,[296] or permitted the teacher a sufficient amount of time to develop them;[297] the material was not presented as a unified body of knowledge, and the textbook was often a revised edition containing a few appended chapters to cover the newer aspects of the subject.[298]

The two general aims of the P.S.S.C. physics course as stated in the first annual report of the Committee were to build a good scientific background in a segment of the population and to develop a physics course that emphasized the essential intellectual, aesthetic and historic background of physical science.[299] In a survey of the objectives of traditional physics courses compared with the P.S.S.C. physics course, Trowbridge reported the unique and common objectives of each. Five of the objectives emphasized in traditional physics were: (1) consumer knowledge, (2) scientific method, (3) technology of physics, (4) approximately ten major topic areas

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[296] James H. McLachlan, "Twentieth Century Science and The High School Courses," The Bulletin, O.S.S.T.F., XLI (May 31, 1961), 157.

[297] Ibid., 158.

[298] Ibid.

[299] Physical Science Study Committee, First Annual Report of the Physical Science Study Committee (U.S.A.: Recording and Statistical Corporation, 1957), p. 20.

and (5) verification of principles and development of instrumental skills in the laboratory program.[300] Five objectives of the P.S.S.C. physics course were to present: (1) a unified course, (2) physics as a pure rather than as an applied science, (3) a smaller number of topics, (4) an integrated film program and (5) the laboratory program as a focal point for learning.[301] Four objectives common to both traditional physics and P.S.S.C. physics courses were: (1) a major effort to develop appreciation and interest, (2) use of varied teaching techniques, (3) skill and concept development and (4) the development of several subject matter topics.[302]

The new physics course was often contrasted with the older physics courses. Traditional physics courses were criticized because the content was not representative of current topics of interest, physics was presented to the student as a system of established facts and the laboratory program was primarily a matter of confirming known answers and therefore was not an integral part of the learning process.[303] Alternatively, the P.S.S.C. approach was approved because topics were introduced in the laboratory program, descriptive material was minimized and an emphasis was placed

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[300]Leslie W. Trowbridge, "A Comparison of Traditional High School Physics with the Objectives of the Physical Science Study Committee Course, and an Analysis of the Instructional Materials of the Physical Science Study Course" (unpublished Doctoral thesis, University of Michigan, 1960), p. 179.

[301]Ibid.

[302]Ibid.

[303]A. B. Van Cleave, "New Ideas on Science Teaching," Quest, I (September, 1963), 14.

upon critical analysis.[304] Not all comments were favourable. Calandra contended that for high school students, the P.S.S.C. physics course was too long and too difficult, and that the C.B.A. chemistry course was too abstract.[305]

In the summer of 1958, the Protestant School Board of Greater Montreal selected five teachers of physics to attend a P.S.S.C. Summer Institute at Bowdoin College, Brunswick, Maine. This group, of which the present author was a member, was to consider the feasibility of making the P.S.S.C. physics course available to superior students in the Montreal school system. At the end of the Institute program, the teachers unanimously recommended that the P.S.S.C. physics course should be included along with the regular physics course, and an experimental group of selected students was organized at the High School of Montreal and at Lachine, West Hill and Monklands High Schools.

In a study of concepts taught in high school chemistry courses, Routh noted at least four characteristics common to all Canadian provinces. Essential criticisms were: (1) little evidence of a unifying theme, (2) too much time devoted to the less complex topics, (3) the course of study usually based on one textbook and not very detailed[306] and (4) strong evidence

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[304]D. L. Livesey, "A New Way to Teach Physics," School Progress, XI (November, 1962), 34.

[305]Alexander Calandra, "The New Science Curricula," School Management, VIII (November, 1964), 75-88.

[306]Ibid., p. 413

of the college preparatory aim and little concern with the intrinsic value of the subject.[307] In considering the American high schools, Routh listed the three prime objectives of chemistry courses in the following order: (1) to understand the physical environment, (2) to enable the student to succeed in college courses, gain entrance to college, or pass specific examinations and (3) to appreciate chemistry for its own sake.[308]

By 1962, Madras[309] found that all Canadian provinces had chemistry committees engaged in course revision. Several provinces reported their intention to use some of the methods of C.B.A. and CHEM study. In a comparative study of high school physical science programs in 1935 and 1959, Radomsky[310] reported that the revisions were usually based on university requirements and were effected by deleting certain topics and adding others.

A number of courses were prepared by individuals or local committees seeking to restore unity to the sciences by the use of a limited number of concepts or principles. Pierce[311] prepared such a course in chemistry using five concepts: (1) energy, (2) atomic structure, (3) equilibrium, (4) periodic table and (5) chemical bonds.

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[307] Ibid., p. 446.

[308] Ibid., p. 447.

[309] Samuel Madras, "Changes Loom in High School Chemistry," Chemistry in Canada, XIV (December, 1962), 49.

[310] Steve W. Radomsky, "A Comparative Study of the High School Physical Science Programs for Two School Years 1935-6 and 1959-60" (unpublished Master's thesis, University of Alberta, 1961), p. 52.

[311] Edward F. Pierce, "Modernized Course of Study in High School Chemistry" (unpublished D.Ed. thesis, Teachers' College, Columbia University, 1959), p. 6.

In 1963, the present author was authorized by the Protestant School Board of Greater Montreal to select a group of students in Monklands High School to study the C.B.A. chemistry course on an experimental basis. Admittance into either the C.B.A. or the previously mentioned P.S.S.C. course was contingent on prior academic achievement, particularly in mathematical subjects. A student was permitted to select only one advanced course. The interest of these students and their examination results were above average, which was commendable in view of the fact that a number of these students were studying Latin, which had excluded them from general science in junior high school.

It has been stated that in this period most curriculum changes were merely modifications in the course of study designed to raise academic standards. There was little doubt that a need existed for both the new and enriched courses. In a survey of 32,750 selected high school seniors, Cole[312] found that one-quarter of the boys and one-half of the girls who were graduated in the top third of their classes and who did not go to college indicated that they had no definite goals or interests.

The schools were encouraged to include the new courses in their programs[313] and the colleges and universities were encouraged to acknowledge the new courses in their admittance requirements.[314] The several

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[312] Charles Cole, "Current Loss of Talent from High School to College," Higher Education, XII (November, 1955), 38.

[313] Edwin E. Moise, "The S.M.S.G. (School Mathematics Study Group) Geometry Program," The Mathematics Teacher, LIII (October, 1960), 442.

[314] Richard S. Pieters and E.P. Vance, "The Advanced Placement Program in Mathematics," The Mathematics Teacher, LIV (April, 1961), 175.

approaches provided academic challenge to gifted pupils in at least one of three ways: (1) an increase in breadth or depth, (2) an increase in pace or (3) a change in content of the course of study.[315]

Several studies confirmed the success of this method of stimulating academically superior students. Smith[316] reported that a majority of 1459 replies to 3500 questionnaires sent to selected individuals favoured high standards of achievement in a program of preselected subjects. By means of a questionnaire sent to 100 superior students and their parents, Hays[317] determined that 75 per cent favoured ability grouping and an enriched program. In a questionnaire sent to 2804 Merit Winners who represented the top two per cent of high school students in competitive national examinations, Applbaum[318] reported that 67 per cent favoured an enriched program.

In a study to determine the effectiveness of enriched high school programs upon achievement in university, Macfarlane[319] reported a nil

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[315]Harry A. Passow, "Enrichment of Education for the Gifted," Fifty-Seventh Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1958), p. 197.

[316]Gjertrud H. Smith, "Professional and Lay Attitudes Toward the Education of the Intellectually Gifted High School Student," Dissertation Abstracts, XX (September, 1959), 939.

[317]Donald G. Hays, "Educational Decision-Making by Superior Secondary School Students and their Parents," Dissertation Abstracts, XXI (September, 1960), 547.

[318]Morris L. Applbaum, "A Survey of Special Provisions for the Education of Academically Superior Students," The National Association of Secondary School Principals' Bulletin, XLIII (October, 1959), 26.

[319]John D. Macfarlane, "A Follow-up Study to Determine the Effect of Enrichment Programs in a High School Upon Achievement in University" (unpublished M.Ed. thesis, University of Manitoba, 1961), p. 65.

result. Approximately 100 students who had followed one of three programs in high school were in the study. The students selected were all academically gifted and about one-third were in each program. One group had taken an extra course, a second group was given enriched courses in each subject and a third group followed the regular program and was used as a control group. While the degree of enrichment given to the enriched group was questionable, the study established that the control group had a larger drop-out rate at the university level and never produced superior results relative to the two other groups.[320] Such studies were significant in that they substantiated the claim that enriched courses in high school contributed benefits in addition to the acquisition of academic knowledge.

The success of the new courses for superior students emphasized the deficiencies of the regular courses.[321] If the essential characteristics of the new courses could not be applied to science courses for regular students, it became apparent that science might become a subject to be studied by only the academically elite.[322] The new approach, however, improved articulation between the high school and the college.[323] Academically, the

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[320]Ibid., p. 66.

[321]J.D. Barnard, M. Gardner and C. Johnson, "Sciences: Issues, Developments, A Principal's Views," National Association of Secondary School Principals' Bulletin, XLVII (November, 1963), 132.

[322]Ibid., p. 123.

[323]R.W. Heath (ed), New Curricula (New York: Harper and Row, Publishers, 1964), p. 8.

various projects presented an organized course in which principles appeared throughout in order that concepts might be developed in depth.[324] Unfortunately, each project also formulated its own objectives and further increased the existing objectives of secondary education.[325]

The Inclusion of Social Objectives

In an effort to establish guidelines for curriculum development a joint committee was formed in the United States in 1937, representing the Department of Supervisors and Directors of Instruction, and the Society for Curriculum Study. At the conclusion of their deliberations the chairman reported that they had proposed little more than had been proposed by a committee of the National Society for the Study of Education in 1926.[326] Alberty and Alberty[327] acknowledged that there were proponents of the view that educational objectives were a matter of individual concern; however they rejected such negative philosophy as a basis on which to build an effective

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[324]Goodlad, op. cit., p. 56.

[325]Ibid., p. 11 and p. 55.

[326]Henry Harap (Chairman), The Joint Committee on Curriculum, The Changing Curriculum (New York: D. Appleton - Century Co., 1937), quoting the National Society for the Study of Education, The Foundations of Curriculum Making, Twenty-sixth Yearbook, Part II (Bloomington, Ind.,: Public School Publishing Co., 1927), p. 92.

[327]Alberty and Alberty, op. cit., p. 41.

curriculum.

Romine[328] cited Hopkins' criteria of an educational philosophy: (1) clarity, (2) consistency in facts, experience, and other beliefs verified by experience and (3) utility and simplicity. Wells[329] listed realism, idealism and pragmatism as philosophical predicative factors. To give meaning and direction to curriculum development, modern education philosophy needed to include the principles of a democratic society, individualism of the student, and the process of learning.[330] It was recognized that the desired use of any philosophy was dependent upon the extent to which it was accepted and valued.[331]

Bobbitt calculated that in a total of 175,000 hours, or the first twenty years of life, the school provided 15,000 hours of contributory education and the home provided 145,000 hours of basic education.[332] In his theory of curriculum, he proposed a chain of learning. A need must be understood or felt, which, through valuation or attitude, may be transferred into a desire, and by purpose or will, may be activated into effort.[333] He expressed a strong reaction against prepared subject matter and suggested

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[328]Stephen A. Romine, Building the High School Curriculum, (New York: The Ronald Press Co., 1954), p. 165, quoting Thomas L. Hopkins, Interaction, The Democratic Process (New York: D.C. Heath and Co., 1941), p. 191.

[329]Harrington Wells, Secondary Science Education (McGraw-Hill Series in Education; New York: McGraw-Hill Book Co., Inc., 1952), pp. 26-29.

[330]Romine, op. cit., pp. 158-163.

[331]Ibid., p. 164.

[332]Franklin Bobbitt, The Curriculum of Modern Education (New York: McGraw-Hill Book Co. Inc., 1941), p. 23.

[333]Ibid., p. 227.

that the curriculum should be centered on the child and reflect the needs of the developing individual.[334]

In an analysis of developing trends in the curriculum for the period 1925 to 1958, Congleton[335] stated that change in the curriculum reflected change in the existing social order. According to Beauchamp,[336] modification of the subject-centered curriculum was inevitable if only for the sake of practicality. Douglass[337] listed three factors that should be considered in curriculum construction: (1) changes in the structure of society, (2) increased knowledge of human nature, learning and adolescents, and (3) changes in the composition of the high school population. Anderson indicated the effect of community attitudes and values on the young[338] and suggested that social and cultural values should be used as guides in selecting the content of the curriculum.[339] Smith, Stanley and Shores[340] asserted that it was no longer a matter of debate that curriculum principles and procedures should be grounded in social reality.

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[334]Ibid., pp. 296-298.

[335]Joseph W. Congleton, "An Analysis of Developing Trends in the Public Secondary School Curriculum: 1925 - 1958" (unpublished Ph.D. thesis, University of North Carolina, 1964), p. 458.

[336]George W. Beauchamp, Planning the Elementary School Curriculum (New York: Allyn and Bacon, Inc., 1956), p. 28.

[337]Harl R. Douglass (ed), The High School Curriculum (2d ed.; New York: The Ronald Press Co., 1956), p. 4.

[338]Vernon E. Anderson, Principles and Procedures of Curriculum Development ("Douglass Series in Education;" New York: The Ronald Press Co., 1956), pp. 125-142.

[339]Ibid., Chap. 5.

[340]B. Othanel Smith, William D. Stanley and J. Harlan Shores, Fundamentals of Curriculum Development (rev.ed.; New York: Harcourt, Brace and World, Inc., 1957), p. 2.

Saylor and Alexander noted that pupil needs and interests were not constant; therefore the program should be flexible enough to allow for such changes.[341] They premised their approach to the curriculum on the assumption that pupils remember and use learning that is functional for them.[342] Furthermore, the design of the curriculum should encourage teachers to take cognizance of learning experiences outside the school and relate them to activities within the school.[343]

Smith, Stanley and Shores defined a culture in terms of the activities, values and enjoyments of society.[344] A change in the way a society exploits the material world to ensure the necessities of existence will affect its culture and social development.[345] They concluded that the curriculum should reflect the following social factors: (1) change in the culture, (2) changes in community patterns and values and (3) the trend toward a social state.[346]

Mort and Cornell selected the Pennsylvania school system as representative of a school system that had successfully responded to changing demands in public education and consequently conducted a study there to

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[341]Galen J. Saylor and William M. Alexander, Curriculum Planning for Better Teaching and Learning (New York: Rinehart and Company, Inc., 1954), p. 298.

[342]Ibid., p. 287.

[343]Ibid., p. 250.

[344]Smith, Stanley and Shores, op. cit., p. 4.

[345]Ibid., p. 13.

[346]Ibid., pp. 1-95.

determine the factors which influenced its adaptability.[347] They concluded that the part played by teacher training institutions[348] and school boards[349] was rather small, and attributed this to the tendency of organizational systems to become rigidly prudent.[350] A further conclusion was that sufficient flexibility should be maintained so that changes could be introduced before enthusiasm for change began to wane.[351] The study indicated that schools which had modified their programs in an effort to meet the needs and interests of their pupils had hired teachers who were more progressive in their outlook. The characteristic of progressiveness did not appear to have resulted from the institutions from which the teachers came, nor from the training which they had received.[352] There was also little evidence to substantiate two familiar assumptions: that older teachers are uninformed and unprogressive in their ideas; and that, younger teachers are more informed and more receptive to educational change.[352] The adaptability of the school was discovered to be closely related to the ability of its teachers to be absorbed within the community.[354] It may be inferred that whatever

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[347]Paul R. Mort and Francis G. Cornell, American Schools in Transition, A Study Prepared Under the Auspices of Columbia University Council for Research in Social Studies (New York: Bureau of Publications, Columbia University, 1941), p. XXI.

[348]Ibid., p. 341.

[349]Ibid., p. 377.

[350]Ibid.

[351]Ibid., p. 390.

[352]Ibid., p. 341.

[353]Ibid., p. 390.

[354]Ibid., p. 380.

environmental objectives are built into the curriculum, success in achieving these objectives depends more upon the teacher than upon the curriculum.

Although the importance of the environmental influence was recognized, there was a need for further research to determine how it could successfully be integrated into the science curriculum.[355] Barlow noted (1) little agreement on what secondary education should emphasize, (2) a lack of appreciation of the evolution of secondary education and (3) an inevitable lag between educational theory and educational practice.[356] Leonard[357] suggested that the content should be a function of the individual, of time and of social customs.

There was some agreement on what the science program should achieve in the area of environmental objectives. A student should attain minimal literacy in the physical sciences in order to understand the scientific base and complex technology of modern society.[358] An awareness of the principles of physics was considered necessary, since these concepts are basic both to science and technology.[359] Through the study of science the

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[355]J. S. Richardson, "Social Science in its Social Setting," Theory Into Practice, I (December, 1962), 238.

[356]Melvin Barlow, "Modern Secondary Education from the Standpoint of a Vocational Educator," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Company, 1959), p. 84.

[357]J. Paul Leonard, Developing the Secondary Curriculum, p. 102.

[358]National Education Association, Deciding What to Teach, p. 109.

[359]Ralph C. Collins, "An Investigation of the Relative Significance and Use of Principles of Physics in High School Science Survey Courses Offered in Grades Ten, Eleven, and Twelve" (unpublished D. Ed. thesis, University of Colorado, 1951), p. 11.

student should learn to understand and adapt to his environment.[360]

Other environmental objectives were also suggested for the science curriculum. Drummond[361] recommended that reference should be made to the history of science in order to indicate the role of the scientist. Other groups, typified by Moe,[362] felt that science teachers in their classes should include the topic of human survival in the nuclear age. To build a society in which scientists could work effectively, Collins[363] suggested that a general appreciation of science was a desirable objective.

Noll asserted that, for a majority of students, science instruction which was not functional was wasted effort,[364] and he attributed the failure of science courses to interest students primarily to the manner in which the subject was organized and presented in most textbooks.[365] Radomsky[366] proposed that social and economic objectives were not achieved because modern topics were not given adequate treatment.

At the beginning of the present chapter reference was made to the difficulty of constructing courses because of the wide range of abilities and

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[360] Committee on Curriculum Planning and Development, "The Imperative Needs of Youth of Secondary School Age," The Bulletin of the National Association of Secondary School Principals, XXXI (March, 1947), p. 78.

[361] C. A. Drummond, "Science and the Cultural Matrix," Clearing House, XXXIX (December, 1964), 241.

[362] D. Moe, "On the Social Responsibility of Science Teachers," Science Education, XLIX (February, 1965), 90.

[363] Collins, op. cit., p. 9.

[364] G. W. Noll, The Teaching of Science in Elementary and Secondary Schools (New York: Longmans, Green and Co., 1942), p. 247.

[365] Ibid., p. 137.

[366] Radomsky, loc. cit., p. 66.

interests of any age group in the high school. Conant proposed grouping by ability within the major subjects[367] and including one course within the program designed to promote understanding and respect between students.[368] There would be no grouping in the latter course. Alberty and Alberty claimed that such expectations for a single course in the total curriculum were unrealistic.[369] The evidence would favour this conclusion, since the demands on the curriculum are too varied. The next section will examine other arrangements of curriculum and subject matter through which the objectives of education may be accomplished.

Relation of Subject Curriculum to Other Types of Curricula

As new theories of curricula were developed, educational terminology grew rapidly. Different interpretations of common terms clearly indicated the advisability of delimitation, but in practice this was not always followed. Except in cases where reference was made to a specific author, Good's[370] definition of the following terms was satisfactory: (1) course: an organized body of knowledge in which instruction is offered within a given period of time; (2) program: all the courses in one field of study; and

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[367] James B. Conant, The American High School Today (New York: McGraw-Hill Book Co. Inc., 1959), p. 49, quoted in Alberty and Alberty, op. cit., pp. 226-228.

[368] Ibid., pp. 75-76.

[369] Alberty and Alberty, op. cit., pp. 226-228.

[370] Carter V. Good (ed.), Dictionary of Education (2d. ed.; New York: McGraw-Hill Book Co., Inc., 1959), pp. 140, 416, 149.

(3) curriculum: a group of courses and planned experiences which a student undertakes with the guidance of the school. In using the last term to its fullest sense, it has become quite common to include all experiences and interacting forces of the student's environment.[371]

The determinants of curriculum as indicated by Leonard[372] were: (1) industrial and political characteristics of society, (2) growth of internationalism and (3) development of school organization and control. Gwynn[373] analyzed the following stages of curriculum activity which occurred during four decades: (1) aims and objectives stage, (2) survey movement, (3) development of unit techniques, (4) system-wide curriculum revision and (5) core curriculum and large unit procedures including the fusion movement. Draper[374] identified six major trends in curriculum development: (1) emphasis of subject matter, (2) extracurricular activities, (3) child-centered approach, (4) stress on social adjustment, (5) synthesis of the above four and (6) integrated curriculum and integrated learning experiences.

Since the subject-centered curriculum was most common, particularly in schools in the Province of Quebec, this type is used as the basis of comparison. The characteristics of this curriculum as defined by Anderson[375]

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[371] Anderson, op. cit., p. 9.

[372] Leonard, op. cit., pp. 44-63.

[373] J. Minor Gwynn, op. cit., pp. 141-245.

[374] Edgar M. Draper, "Major Trends in Curriculum Development," The High School Curriculum, ed. Harl R. Douglass (2d ed.; New York: The Ronald Press Co., 1956), p. 196.

[375] Ibid., p. 226.

are: (1) the learning of subject matter as an end in itself, (2) acquiring of information for future use, (3) progress dependent on the information acquired and based on a pre-determined standard of knowledge, (4) emphasis on periods of drill and practice in skills, (5) each subject as a distinct entity and (6) content determined by adults in advance to the extent that teachers controlled all experiences, activities and conduct.

The distinctive characteristics of the subject-centered curriculum outlined by Smith, Stanley and Shores were: material classified and organized in accordance with the topic organization used in research, and emphasis on expository discourse and techniques in exposition.[376] Experiences, therefore, occurred only within the boundaries of conventional fields of knowledge.[377] Three characteristics were essential but not distinctive. These consisted of: (1) a system of required and elective courses, (2) required subjects constituting the major part of general education and (3) possibility of varied learning experiences for individuals in a class or groups in a streamed program.[378]

Beauchamp stated that a subject curriculum was based on the transfer of cultural skills and skills of communication and expression divided into grades and embodied in a series of textbooks. Among the school systems

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[376]Smith, Stanley and Shores, op. cit., pp. 230-231.

[377]Ibid., p. 226.

[378]Ibid., pp. 234-236.

there was a striking consistency in content of a preselected and highly organized nature. Communication with parents, however, was facilitated, since they were familiar with this type of curriculum.[379]

The first attempts at modification resulted in correlated and broad-fields curricula.[380] For example, general science courses emerged in the early 1900's with four basic objectives: (1) to furnish fundamental information and training in scientific methods, (2) to provide an attractive view of the content of the sciences, (3) to free the teacher from the limitations of a college preparatory course and (4) to eliminate the restrictions of compartmentalization.[381]

Since these courses invariably consisted of poorly related topics drawn from the separate sciences, they were seldom successful in achieving their goals, nor were they truly representative of broad-fields curriculum. To overcome this lack of unity, later courses were sometimes organized around the principles of the sciences or the history of science.[382]

The core curriculum represented a new concept of curriculum approach. Smith, Stanley and Shores listed two distinctive characteristics: emphasis on social values, and structure determined by broad social problems or by themes of social living.[383]

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[379]George A. Beauchamp, Planning the Elementary School Curriculum, pp. 18-19.

[380]Smith, Stanley and Shores, op. cit., pp. 252-254.

[381]Ibid., p. 257, quoting from G. R. Twiss, A Textbook in the Principles of Science Teaching (New York: The Macmillan Company, 1917), pp. 415-417.

[382]Ibid., p. 258.

[383]Ibid., pp. 314-319.

Four essential but not exclusive characteristics were: (1) certain core subjects required of all students, (2) activities co-operatively planned, (3) provision for special needs and interests made as they arose and (4) skills taught only when needed.[384]

The activity or experience curriculum was the most radical of all, since it was diametrically opposed to the subject curriculum. Between these two extremes were the core and a number of other curricula.

Anderson described the nature of the activity curriculum as follows: (1) a change toward socially desirable behaviour was the main objective; (2) subject matter was used as a means to an end; (3) content was a series of meaningful experiences and emphasis was placed on solving problems in the student's environment; (4) pupils participated in planning, in that subject matter was selected co-operatively; (5) teaching skills were related to practical use; (6) emphasis was on individual development and the continuous process of growth and creativity.[385]

In this type of curriculum, attitudes and emotional development were considered to be just as important as skills and academic learning.[386] Since growth was regarded as a continuous process on an individual basis, minimum standards of grade placement had no meaning in this type of curriculum.[387]

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[384] Ibid., pp. 319-324.

[385] Anderson, op. cit., pp. 74-81.

[386] Ibid., p. 75.

[387] Ibid., p. 81.

The experience curriculum was described by Beauchamp as being structured on psychological, rather than logical, concepts.[388] The basic assumption was that education was a process of reconstruction of experiences.[389] Vicarious experiences arising from the performance of laboratory experiments in the subject curriculum were not in the same category and the two curricula could not be reconciled.[390] A caveat against a personal experience curriculum was raised by Alberty and Alberty. To be effective, the following conditions were required: (1) the existence of methods by which experiences could be intellectualized; (2) the presence of teachers prepared or trained to manipulate the program; (3) a public persuaded to accept the validity of the process; (4) reorganized and enlarged school facilities; (5) a frame of reference designed to yield principles in order to determine scope and sequence.[391] This type of curriculum has been most successful in backward or deprived communities.[392]

Smith, Stanley and Shores described three distinct characteristics of the activity program as follows: (1) interests and purposes of children determine the curriculum; (2) pursuit of common interests constitute the common learnings; (3) program is not prepared in advance.[393] They included the following as essential: that activities should be planned by teacher and

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[388] George A. Beauchamp, Planning the Elementary School Curriculum, p. 22.

[389] Ibid., p. 21.

[390] Ibid., p. 26.

[391] Alberty and Alberty, op. cit., pp. 167-171

[392] Ibid., p. 170.

[393] Smith, Stanley and Shores, op. cit., pp. 270 - 275.

students; that problem solving should be dominant; that interests and needs should be met within the program, since special subjects provided for special interests.[394]

The activity curriculum required greater flexibility in administrative arrangements, such as grouping and scheduling, and the replacement of grade sequence with interest grouping.[395] This type of program had not been incorporated in as many high schools as elementary schools, probably due to the fact that the subject curriculum enjoyed a greater degree of tacit approval and therefore had been bolstered by the development of teaching aids and improved methodology.[396]

Criticisms of the Subject Curriculum

Smith, Stanley and Shores[397] proposed that the failure of a large number of subject courses was due to the fact that the courses were compartmentalized and fragmentary; that they ignored the interests and activities of the learner; that content was inefficiently arranged for learning and use; that the courses were divorced from current and persistent social problems;

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[394] Ibid., pp. 275-281.

[395] Ibid., pp. 287-288.

[396] Ibid., p. 270.

[397] Ibid., pp. 244-249.

finally, that they failed to develop habits of effective thinking.

Invariably, students who studied only general science and one other science had meagre knowledge of the scope of science.[398] Since the content was chiefly expository in form, repetition and memorization were unavoidable and emphasis appeared to be on the conclusion rather than on the process by which the conclusion was reached.[399] Similarly, the attention of both learner and teacher was mainly centered on the subject, and the subject became an end in itself.[400]

The textbook should function as an aid in achieving the predetermined objectives of the course,[401] but if the objectives were not clearly understood or accepted, the objectives of the textbook became the objectives of the course. Heath[402] noted that textbooks of the progressive school of the 1920's were written by groups of specialists from several fields and were physically more attractive and more readable, but they demanded less from the student and provided less understanding of the subject as a discipline. In one survey, high school principals rated the textbook as the most important single factor in determining content.[403] Significantly, committees engaged

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[398]Saylor and Alexander, op. cit., p. 264.

[399]Smith, Stanley and Shores, op. cit., p. 249.

[400]Saylor and Alexander, op. cit., p. 260.

[401]Ibid., p. 88.

[402]Heath, op. cit., p. 4.

[403]National Educational Association, Deciding What to Teach, pp. 200-201.

in the preparation of new courses, such as the P.S.S.C. physics and the C.B.A. chemistry courses, used a considerable proportion of their budget in the preparation of texts to implement their proposed program.[404] In 1941, a study of 85,000 courses of study indicated that a majority of physics and chemistry courses followed the logical development of subject matter as found in most textbooks.[405] Trowbridge reported that a high degree of standardization with regard to subject matter had always been characteristic of high school physics.[406]

A study by Justman on college teaching involved an examination of the subject curriculum in an environment where an optimum level of academic ability could be presupposed. Because of the broad scope of higher education, only part could be fully mastered. The variety of courses was not an outcome of design, but of evolutionary development. Nevertheless, there existed a disparity in depth and range between courses. Several remedial systems existed which attempted to identify and assemble the elements of a common core for all students, or which, by means of placement and exemption examinations, bypassed prerequisite courses.[407]

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[404] Ibid.

[405] Anderson, op. cit., p. 268, quoting from Herbert A. Bruner and others, What Our Schools are Teaching (New York: Bureau of Publications, Teachers' College, Columbia University, 1941), p. 22.

[406] Trowbridge, op. cit., p. 5.

[407] Joseph Justman, College Teaching: Its Practice and Its Potential (New York: Harper and Brothers, Publishers, 1956), pp. 131-135.

The elective system recognized intellectual freedom and permitted a student to develop his individual interests. Within the curriculum, the program of available courses was not static, which indicated a willingness to change, experiment and appraise.[408]

The weaknesses appeared to be inevitably bound with the subject curriculum. A lack of clear aims made it difficult to organize a balanced, unified and coherent program of studies. Electives were often narrow and overspecialized, which made the problem of interrelating the disciplines and maintaining lateral coherence more difficult. Assumptions regarding a student's real knowledge, based upon credit standing or the number of courses taken, were extremely hazardous.[409]

In summation of this examination of the various curricula by which the objectives of the physical science courses may best be attained, the following points were established: parents were inclined towards subject curriculum; alternative curricula were not widely adopted nor, when adopted, did they entirely remedy the faults attributed to the subject curriculum; there were few systematic theories of subject reorganization.[410] Within the subject curriculum, the degree to which the child learned to think was influenced, at least to some extent, by the effectiveness of the teacher. The interests of the children were not entirely ignored since

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[408] Ibid., pp. 135-137.

[409] Ibid., pp. 137-141.

[410] Smith, Stanley and Shores, op. cit., p. 250.

they undoubtedly asked questions. The charge that content was fragmentary was not entirely justified, as some selection was unavoidable.[411]

Foshay related the dissatisfaction with subject curriculum to the gap between the subject as it was taught in the high school and as it was known to the subject specialist.[412] High school courses appeared to be based on the tacit assumption that the subject was to be presented to an unwilling child. Bate and Speed[413] reported that teachers in England had greater control of the curriculum, choice of textbooks and methods of instruction, and that these facts tended to present a more balanced approach to curriculum planning. Campbell[414] commented on the benefits of supplements to the curriculum, such as projects and activities aimed at the growth and development of pupil insight. A wider interpretation may be taken from the full implications of Woonton's statement concerning high school mathematics courses: "since mathematicians had refrained from influencing the content ... the task fell to those who were less qualified to do so."[415]

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[411] Ibid.

[412] Arthur W. Foshay, "Discipline-Centered Curriculum," Curriculum Crossroads, ed. Harry A. Passow (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), pp. 66-67.

[413] C.D.S. Bate and F.M.S. Speed, "Science In Ontario and English Schools," The Bulletin, O.S.S.T.F., XL (March, 1960), 82.

[414] Campbell, op. cit., p. 64.

[415] William Woonton, "The History and Status of the School Mathematics Study Group," New Curricula, ed. Robert W. Heath (New York: Harper and Row, Publishers, 1964), p. 36.

Criteria for Selection

Broad objectives of education emerged during the past quarter century. While no new curricula were successful in eclipsing the subject curriculum, the essential objectives of each were applied to the subject curriculum. Increasing demands upon education predicated a clarification of the criteria to be used for selecting the means by which these objectives were to be achieved.

Anderson[416] outlined five purposes of curriculum study: (1) to change the curriculum, (2) to meet cultural demands, (3) to solve pupil problems, (4) to improve experiences provided for pupils and (5) to change behaviour patterns and social relations. Some sources of confusion that had arisen in the course of curriculum development arose from conflicts in philosophical and psychological theories, pluralism of values and use of a single criterion as the basis of curriculum development. There was also lack of methodology to promote experimentation with new ideas and translation of new programs into practice.[417] The Association for Supervision and Curriculum Development recommended that objectives should be consistent with the central values of culture, namely, society, human growth

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[416] Anderson, op. cit., pp. 4-7.

[417] Hilda Taba, Curriculum Development: Theory and Practice (New York: Harcourt, Brace and World, Inc., 1962), pp. 7-9.

and development, and the disciplines.[418] Similar objectives were detailed by Romine as life, behavioural and educational problems.[419]

Leonard[420] indicated the dichotomy of educational values. The values to be sought in a program could be instrumental or consummatory, immediate or deferred, personal or social, cultural or vocational, and finally, child or adult.

Brinck[421] suggested two criteria for content as recognition of the learning process and satisfaction of youth needs. Content should be valid, significant and should relate to objectives. Studies in educational psychology suggest that the program should stimulate interest, provide continuity and sequence, recognize the multiple character of outcomes and be adaptable to individual learners. The achievement of success in meeting the needs of youth required identification of all needs, those of youth, life and universe.

Smith, Stanley and Shores[422] suggested that the criteria which should be used in the validation of objectives should be social adequacy, basic human

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[418]Association for Supervision and Curriculum Development, Criteria for Curriculum Decisions in Teacher Education, A report, G.W. Denemark (ed.) (Washington, D.C.: The Association, 1963), p. 11.

[419]Romine, op. cit., pp. 166-171.

[420]Leonard, op. cit., p. 104.

[421]William G. Brinck, "Criteria for the Selection of Curriculum" Tho High School Curriculum, ed. Harl R. Douglass (2d. ed.; New York: The Ronald Press Co., 1956), p. 225.

[422]Smith, Stanley and Shores, op. cit., pp. 107-122.

needs, democratic ideals, consistency and noncontradiction and behavioristic interpretation. Beauchamp's four categories for judging the suitability of material for elementary school curriculum, which might well be applied to high school physical sciences curriculum, consisted of purpose and function, selection of subject matter, child behaviour and organization of teaching.[423]

The Science Committee of the Ontario Curriculum Institute suggested as the aims of total education the development of the individual personality of the child and the fulfilment of the needs of the society in which the child is going to live as a mature person.[424] Also proposed by the same Committee were objectives for the physical sciences program. These objectives were defined as enabling the student to adjust to his environment, developing a scientific attitude and training students who will eventually make a career in science and technology.[425]

The following standards for the selection of subject matter were suggested by Smith, Stanley and Shores:[426] relation to an organized field of knowledge, usefulness and interest, and contribution to growth and

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[423]Beauchamp, Building the Elementary School Curriculum, p. 230.

[424]Ontario Curriculum Institute, The Science Committee, Science: An Interim Report of the Science Committee (Ontario: Ontario Curriculum Institute, 1963), p. 2.

[425]Ibid., pp. 5-9.

[426]Smith, Stanley and Shores, op. cit., p. 132.

development. Caswell[427] suggested that there was general agreement that facts, concepts and methods of the disciplines are essential to education, that material to be included must be valid and current and that organization of knowledge is desirable and perhaps essential.

The characteristics of an effective curriculum suggested by several authorities were generally quite uniform in description. Fischer[428] stated that the curriculum should indicate awareness of current forces and their impact, reflect values and higher purposes of society and employ all appropriate and available means of education. Blair[429] suggested that a successful curriculum would provide for varying maturity and experience levels, adapt learning activities to needs and goals of pupils, provide experiences that have meaning and structure and select and appraise pupil activities.

Educational objectives were designed to influence the interpretation and use of curriculum content, and the extent to which they were successful varied considerably between schools. Studies clearly indicated, however, that understanding and application of curriculum objectives could not be

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[427] Hollis L. Caswell, "Difficulties in Defending the Structure of the Curriculum," Curriculum Crossroads ed. Harry A. Passow, (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), pp. 110-111.

[428] John H. Fischer, "Curriculum Crossroads?" Curriculum Crossroads ed. Harry A. Passow, (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), p. 5.

[429] G.M. Blair, "How Learning Theory is Related to Curriculum Organization," Journal of Educational Psychology, XXX (March, 1948), 166.

tacitly assumed. A study conducted by Littrell concluded that over fifty per cent of a group of forty-six teachers did not have clear ideas of the objectives of their school system.[430] The difficulty of maintaining internal communication in the school system between administrators and teachers was clearly evident. In the field of science instruction it was strongly implied that both teacher and pupil should be aware of the objectives of the program,[431] and that the teacher should understand the true nature of the material taught at each level of science instruction and its relation within the field of science.[432]

Contribution of Learning Theory to Curriculum Development

Learning may be described as that process by which an activity originates or is changed through reacting to an encountered situation, provided that the characteristics in the change in activity cannot be explained on the basis of native response tendencies, maturation, or temporary states in the organism.[433]

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[430] J.H. Littrell, "When Teachers Evaluate Curriculum Study," Educational Leadership, XX (December, 1964), 174.

[431] James Savage, "Some Objectives in Science Teaching," The Bulletin, O.S.S.T.F., XLV (December, 1965), 522-523.

[432] G.D. Blough, "Improving the Science Program," Educational Leadership, XIX (January, 1962), 221.

[433] Ernest R. Hilgard, Theories of Learning (2d. ed.; New York: Appleton-Century-Crofts, Inc., 1956), p. 3. quoted in Alberty and Alberty, op. cit., p. 84.

In determining what experiences should be provided, Leonard[434] listed three basic views from which the student might be considered: (1) as an individual with a system of faculties, each of which must be disciplined, (2) as the embodiment of intellectual, emotional and social potentialities which are to be developed and (3) as a biological unit within the environment to be developed by personal experiences. The curriculum proposed as best suited to each of the above categories was: intellectualized subject matter for the first, functional subject matter for the second and experience or activity for the third.

A number of factors, operating singly and collectively in influencing the learning process, were listed as: background and meaning, readiness, activity, association and transfer, whole versus part learning, interest and effort, and satisfaction versus annoyance.[435] Leonard divided learning experiences to be included, into: (1) the acquisition of knowledge through the use of mental capacities and (2) the development of understanding through personal experiences.[436] The psychological predicative factors were considered by Wells[437] to be environment and socio-economic status, mental

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[434]Leonard, op. cit., p. 232.

[435]Romine, op. cit., p. 138.

[436]Leonard, op. cit., p. 94.

[437]Wells, op. cit., pp. 11-18.

and physical maturity, learning theory and classroom atmosphere.

Davis[438] proposed that the function of psychology in education was threefold: to determine readiness for learning, to select and organize the material and to devise methods for progress evaluation. Anderson[439] identified the four steps in the learning process as motivation or stimulation, problem recognition, proposed activities to solve the problem and selection of a method to solve the problem.

The concept of mental discipline as the basis for curriculum selection has been discredited; however a tendence to relate mental exercise to physical exercise persisted as a major impediment to curriculum improvement.[440] Practices predicated on formal discipline were still evident[441] regardless of experimental evidence which questioned the validity of transfer of learning, one of the basic assumptions of the concept. Experiments on this topic were published in 1893 by James and in 1901 by Thorndyke and Woodworth.[442] Alternative modes of curriculum structure, however, were not nearly so successful in gaining recognition.[443]

More recent views on transfer of learning related effectiveness to

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[438]Robert A. Davis, "Psychological Basis of Curriculum Planning," The High School Curriculum, ed. Harl R. Douglass (2d. ed.; New York: The Ronald Press Co., 1956), pp. 52-69.

[439]Anderson, op. cit., pp. 103-105.

[440]Romine, op. cit., p. 136.

[441]Alberty and Alberty, op. cit., pp. 87-88.

[442]Beauchamp, Planning the Elementary School Curriculum, p. 27.

[443]Ibid., p. 17.

the extent to which principles and structure of the subject were clear to the learner.[444] Successful application of the principle was limited to subjects which were closely related and the degree to which the student was trained to associate one subject with another.[445]

Evolution of the principles of learning indicated the importance of organization or structure for meaningful learning.[446] It was also recognized that the learning process was more successful when motivation was based on a series of successful experiences within a conceptual frame in which the structure was clear to both student and teacher.[447]

Application of these ideas suggested a psychological rather than a logical basis to organization of curriculum. Davis[448] suggested that as the child matured he would graduate from the former to the latter. Bruner defined discovery as essentially a matter of rearranging or transforming evidence to provide additional insight.[449] He believed that the benefits to learning through the discovery method were an increase in intellectual potency, a shift from extrinsic to intrinsic rewards, an appreciation of the

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[444]National Education Association, Deciding What to Teach, p. 35.

[445]Robert A. Davis, "Psychological Basis of Curriculum Planning," The High School Curriculum, ed. Harl R. Douglass, (2d. ed.; New York: The Ronald Press Co., 1956), pp. 66-67.

[446]National Education Association, Deciding What to Teach, p. 25.

[447]Ibid., p. 33.

[448]Robert A. Davis, "Psychological Basis of Curriculum Planning," The High School Curriculum, ed. Harl R. Douglass, (2d. ed.; New York: The Ronald Press Co., 1956), p. 63.

[449]Jerome S. Bruner, "The Act of Discovery," Harvard Educational Review, XXXI (Winter, 1961), 22.

heuristics of discovery and an aid to memory processing.[450] Anderson[451] proposed that sequence should depend on pupil continuity since sequence was a function of background and knowledge. Saylor and Alexander[452] summarized the process in the following manner: learning results from experiences, the school provides experiences and experiences outside the school can be related to those which occur within the school.

Responsibility for the implementation of these ideas seemed to be directed primarily to school administrators,[453] although the importance of the role of heads of the science departments and science teachers was stressed.[454] The teacher was required to do more than dispense information[455] and several methods for improving the effectiveness of teachers were suggested.[456]

With regard to the curriculum there appeared to be a return to the subject curriculum with emphasis on pupil activities in a course structured on selected principles and generalizations.[457] The difficulties of building

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[450] Ibid., pp. 23-32.

[451] Anderson, op. cit., pp. 271-272.

[452] Saylor and Alexander, op. cit., p. 4.

[453] American Association of School Administrators, American School Curriculum (Washington, D.C.: National Education Association, 1953), p. 82.

[454] G.M. Hipps, "Supervision: A Basic Responsibility of the Department Heads," Clearing House, XXXIX (April, 1965), 489.

[455] E.D. Heiss, E.S. Obourn and C.W. Hoffmann, Modern Science Teaching (New York: The Macmillan Co., 1950), p. v.

[456] N.H. Cairns, op. cit., p. 345.

[457] Paul de H. Hurd, "Mid-Century Trends in Science Teaching," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Company, 1959), p. 153.

such courses were reccgnized. Caswell[458] indicated that the CHEM Study program and the C.B.A. study had been successfully established on one concept, but that the P.S.S.C. had used three.

Nevertheless, the proponents maintained that the students must be active in the laboratory program and in reading. They proposed that the role of the teacher, particularly in the laboratory, should be that of a guide.[459] Emphasis on individual experience was one of the chief characteristics of this type of program.[460] Recommendations were made suggesting that laboratory experiences should begin in elementary school.[461]

There was overt criticism of science courses lacking structure and logical development.[462] Bruner[463] stated that a curriculum can be constructed so that a pupil may achieve a sense of mastery of ideas and concepts. He

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458 Hollis L. Caswell, "Difficulties in Defining the Structure of the Curriculum," Curriculum Crossroads, ed. Harry A. Passow (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), p. 108.

459 U. Haber-Schaim, "Scratching the Surface of Science Education," Canadian School Journal, XLIII (May-June, 1965), 43.

460 Livesey, op. cit., p. 35.

461 Ontario Curriculum Institute, The Science Committee, Science: An Interim Report of the Science Committee, p. 36.

462 Ibid., p. 41.

463 Jerome S. Bruner, "On Learning Mathematics," Mathematics Teacher, LIII (December, 1960), 619.

suggested that the essence of the activity movement was not in the product discovered but in the process of working.[464] Phenix proposed that all curriculum content should be drawn from the disciplines.[465]

This new trend did not ignore the wide range of abilities and interests among students. Suggested criteria were: content of interest to students, flexibility of material and methods, sources of information used objectively and critically, and constant use of scientific or exact methods.[466] The basic assumption was that a large number of students was potentially capable of greater achievement than had previously been expected,[467] and the aim was to reorganize subject matter along lines that would produce increased learning.[468] Methods used in activity curriculum appeared to be well suited as they implied physical manipulation of material prior to the more sophisticated process of verbalization.[469]

The stimulus-response theories were gradually modified to account for events that might occur between the input of a stimulus and the emission of a response. Interest was focused on this interval or process of cognition

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[464]Ibid., p. 612.

[465]Philip H. Phenix, "The Disciplines as Curriculum Content," Curriculum Crossroads, ed. Harry A. Passow (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), p. 57.

[466]Alexander and Saylor, op. cit., p. 422.

[467]Heath, op. cit., p. 43.

[468]Max Beberman, "An Emergency Program of Secondary School Mathematics," New Curricula, ed. Robert W. Heath, (New York: Harper and Row Publishers, 1964), p. 34.

[469]Ibid., p. 25.

in which children achieve, retain and transform information. The work of two psychologists is of particular interest: Piaget, who performed most of his research on very young children, and Bruner, who had directed a program of research into concept-formation and problem-solving by adults and who has recently applied the results of his research to children of secondary-school age.

Piaget[470] suggested that the growth of intelligent or logical thought processes developed in a similar manner in all children, but at different ages. Bruner[471] identified the learning act as a process of categorizing various stimuli in order to discriminate between them. This would confirm the idea that the use of experiences which are meaningful to the student improve the extent to which new topics are understood. The determining factor is not the topic, but rather the knowledge of what educational experiences correspond with the student's maturation.[472] For the same reason, transfer of learning is frequently incomplete, since a student can learn to perform certain operations, but not understand the concepts upon which the operations are based.

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[470] Jean Piaget and Barbel Inhelder, The Child's Conception of Space, translated from the French by F.J. Langdon and J.L. Lunzer (London: Routledge and Kegan Paul, 1956), p. 40.

[471] Jerome S. Bruner and others, A Study of Thinking, Harvard Cognition Project (New York: John Wiley and Sons, 1956), pp. 21-22.

[472] D.H. Crawford, "The Work of Piaget as it Relates to School Mathematics," Alberta Journal of Educational Research, VI (March, 1960), 133.

A most important aspect was the emphasis on testing and evaluation; however the problem of evaluating general growth and testing specific knowledge remained unresolved. Certain practices, such as the use of booklets of previous examinations in the teaching process, has a decidedly adverse effect on all the wider objectives of education.[473] Guidance procedures seemed to provide the most reliable method for placing students in courses where they were most likely to succeed and for counselling those students who were not functioning satisfactorily.[474]

There was a clear indication that testing procedures must include a definition of desired outcomes and the selection of valid testing instruments.[475] One study had limited success in preparing practical laboratory examinations for the science subjects.[476] The trend in written examinations was inclined to questions designed to test a student's ability to utilize his science knowledge and understanding.[477]

A number of different types of curricula have appeared during the twentieth century, each of which has merit; however no one curriculum has

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[473]Anderson, op. cit., p. 436.

[474]Alexander and Saylor, op. cit., p. 383.

[475]Wells, op. cit., p.261.

[476]A. A. Abouseif and D. M. Lee, "Evaluation of Certain Science Practical Tests at the Secondary School Level," British Journal of Educational Psychology, XXXV (February, 1965), 49.

[477]Paul de H. Hurd, "Mid-Century Trends in Science Teaching," Issues in Curriculum Development: A Book of Readings, ed. Marvin D. Alcorn and James M. Linley (New York: World Book Company, 1959), p. 159.

been successful in establishing itself to the exclusion of all others. New theories of learning have concurrently contributed to the psychology of education. The disciplinary value of subject matter content would justify the claims of the subject-centered curriculum. It may develop that no one curriculum is entirely satisfactory and that the techniques of each can be effectively used at different times throughout the curriculum of the composite high school.

CHAPTER 5

RECOMMENDATIONS

A Subject Curriculum for the Science Program

Relative to the other types of curricula in the high school, a subject curriculum would appear to be the most advantageous at the present time. A considerable amount of research on methodology has contributed a number of teaching aids which may assist in effective presentation of subject matter content. The learning process, as it is presently understood, is more effective when the experiences used have a definite sequence in an organized scheme. A subject curriculum is proposed because a subject is a body of organized knowledge verified by experience and is furthermore the ultimate source of content for all curricula.

Beauchamp[478] has referred to the tacit approval given to the subject curriculum and to the failure of other types of curricula to gain public approval. This factor alone is not sufficient to warrant the continuance of any curriculum no matter how well established; however Alberty and Alberty[479] also noted the extensive retraining and modifications necessary completely to

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[478] Vide infra., pp. 97-98.

[479] Vide infra., p. 100.

adopt the activity or core curriculum. While a conversion may nonetheless be attempted, as is being done in the elementary schools of the Province of Quebec, it does not appear to be warranted or desirable at the high school level at the present time. Individual development and social adjustment are certainly recognized as important, but perhaps to a lesser degree than in elementary education. Consequently, the high school curriculum must be flexible enough to provide for individual interests and rates of development within the program. Both teachers and administrators in the Province of Quebec are familiar with the subject curriculum from their own education and training so that their approval and active support, fundamental requisites for proposed changes, will be more readily obtained within the existing framework of the subject curriculum.

The concept of levels of mental development is considered fundamental and is to be accommodated through carefully selected homogeneous grouping within the science program. Continued surveillance of the individuals within each group is necessary; since the individual rate of development within each group will vary, provision must be available to transfer pupils from one group to another. The methods used should be drawn from the activity and core curriculum according to their effect upon each group. Since individual standards are to be nurtured, the experiences selected cannot be rigidly determined in advance, but must be strategically selected and replaced as content changes. In general, it may be postulated that the principles of the activity program would predominate at the junior high school level. This would ease the transfer from elementary school and would be particularly valuable for students from those elementary schools which have instituted an activist program. Concurrently, the concepts of the core curriculum with accent on societal objectives and experiences should be gradually introduced since their appeal is greatest to students of the early high school age group. It is evident from the Parent Report that a strong desire to transmit cultural standards to students of this province exists, and the experience of core curriculum high schools indicates that this is the optimum point at which to undertake this objective. The benefits accrued from these methods diminish for mature students; as they are identified, they should be given a program that is centered on the disciplines.

The subject of science is in itself problem-centered, and progresses through the assimilation of data, the formation of hypotheses, experimentation and evaluation. Within the boundaries of physics and chemistry there are sufficient experiences to prime the interest of young pupils and through the selection of appropriate material, problems and experiences simultaneously permit the testing of postulations. By programmed increments the intellectual capacity of the pupil may be nurtured, which is essential if intellectual achievement is to be taken as an index of achievement. Foshay[480] has suggested

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[480]Arthur W. Foshay, "Discipline-Centered Curriculum," Curriculum Crossroads, ed. Harry A. Passow (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), p. 70.

that an approach through the intellectual appeal of the disciplines would bridge the dichotomy of an activist curriculum versus a subject curriculum.

A further requirement is increased evaluation and experimentation to promote continued development of the curriculum. Dewey has compared the development of the physical sciences with that of curriculum development. Progress in the physical sciences was made because of intentional experiment on the basis of ideas and hypotheses, with observed phenomena. Action on imperfect and even wrong hypotheses indicated significant phenomena which produced improved ideas and made later experiments more significant.[481]

The suggestion of a modified subject curriculum is recognition that the present curriculum system in the high schools in the Province of Quebec is not equally suited to all pupils. A modified subject curriculum is a step towards improving articulation between the logical and psychological organization of content. The process of improved articulation will benefit all pupils, especially those who labour under the present system because they have not learned to recognize the principles and the structure of subject matter and have increasingly relied on memory processes.

Relation of the Pupil to the Program

The program should permit and encourage expression of individual

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[481]John Dewey, "Social Science and Social Control," The New Republic, LXV (July 29, 1931), 276.

interests. New science courses and enriched courses have done much for the university-bound student; however the courses available for the average pupil still reflect many of the undesirable characteristics of the subject curriculum.

It is proposed that general grouping of students should be on the basis of interests and understanding at the junior high school level, and knowledge and ability at the senior high school level. Within each course homogeneity may be achieved by placing the student in one of three groups, each presenting basically the same topics, but emphasizing them from different viewpoints. In one group, environmental and practical applications of science would be stressed throughout junior and senior high school. In the second, the activities would gradually shift from sensory to conceptual material. The third group would be composed of advanced students who would need less time to develop the ability required to deal with symbolic manipulations and would therefore be ready to undertake the enriched or new science courses in senior high school.

The greatest hazard likely to affect the first group is that it may develop into a repository for undesirable students. A study by Johnson[481] of 234 schools in cities having a population of 75,000 or more, has indicated that such a misuse of the grouping system has had a detrimental effect upon science courses not leading to university entrance. The content used for

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[481] Harold E. Johnson, "The Nature and Content of Science Courses in Selected Public Senior High Schools in the United States in the School Year 1953-54" (unpublished D. Ed. Thesis, Temple University, 1960), p. 148.

this group of students would not eliminate the possibility of their moving to a more advanced group, or of spending an additional year in high school to attain university entrance requirements. It would, however, permit normal development and achieve the desired objectives of science instruction, both of which are held as being more essential than subject preparation alone.

The second group would encompass a majority of students. It would include students who at the present time rely heavily on memory processes, since they have failed to appreciate the logical structure of subject matter. To break this pattern it is necessary to present experiences which will develop the learning process even though this may not be the most logical presentation for the development of the subject. Piaget[482] suggests that the stage of formal operations, the time at which the ability to work with hypothetical propositions is developed, is reached by most children between their tenth and fourteenth year. Other investigators have suggested that stage level should be determined by mental rather than chronological age.[483] Therefore, in planning the program for this group, the correct identification of developmental stages is critical and will vary within the group and between groups from different social backgrounds.

Bruner's contribution is of major importance for this large body of

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[482] Bruner, The Process of Education, p. 37.

[483] Crawford, The Work of Piaget as it Relates to School Mathematics, p. 133.

students. On the premise that intellectual activity is the same wherever it occurs, it is important that when the student studies physics, for example, he should formulate his thought processes along lines similar to those of the trained physicist. The function of any curriculum is to develop within the individual the ability to formulate assumptions and postulates in order that a variety of problems may be solved. The science course must provide a sufficient number of simple problems which, through a series of successful experiences in solving them, will lead the student to the next stage of development. Once intuitive understanding has been developed and a sense of structure of the subject has been established, the more conceptual modes of thought may be developed. Subsequent learning will then proceed more rapidly and the content will be retained for a longer period of time.

The third group presents problems of a different nature since it would contain academically gifted students. Such students are not always willing to undertake an advanced program; however the combined efforts of the teacher, guidance counsellor and the parents should be used to encourage such children to develop their potential. Within this group sensory activities would also be used, but not as frequently as in the other two groups.

To place emphasis on the individual is only possible in a large high school. In an era of widespread industrial expansion it is necessary for growing communities to provide complete educational facilities comparable to those of the composite city high school. Small high schools are almost as expensive to build, staff and maintain as are city high schools, but do not, however, have the number of pupils necessary to facilitate efficient grouping. Since it is felt that grouping is an integral requirement for the development of the student as an individual, the trend in this province, as elsewhere, to consolidate small local high schools into large regional high schools is considered to be a contributing factor in solving this problem.

Content of the Science Program

Present learning theory indicates that all experiences affect the learner, although it is often difficult to know precisely what interpretation will be made by the learner. In view of such uncertainty, it is suggested that appropriate learning activities from the sciences, selected to match the levels of development, would have a greater chance of producing the desired effect. In proper sequence and at the correct maturity level such activities reflect the structure of the discipline itself.

Subject structure should not become the only determinant. Bruner objected to any content that lacked structure and developed this theme to include growth from sensual to conceptual perception. There is little evidence, however, to support the assumption that the broad topics of plants and animals found in many elementary science textbooks are easier to understand than a fundamental study of inanimate objects much less complex in design.[484] The design of the course should present content that the child can easily master and should return to the same topic at succeeding stages to develop full meaning and understanding.

The syllabus of the course should present a number of topics and suggestions for their development, from which the most adequate and useful may be chosen. The syllabus by itself has no intrinsic value, but should encourage the selection of the most suitable learning experiences. Such experiences should assist the junior high school student to develop his approach, techniques and modes of expression. In the senior high school, the syllabus needs to be concerned with a narrower field which can be investigated in some depth.

Phenix[485] has described a discipline as being capable of contributing to the curriculum in three ways. Through analytic simplification, complexities may be reduced to fundamentals which the learner is capable of understanding. Conversely, a discipline is a community of concepts, and through synthetic coordination, generalizations may be developed between a number of separate topics. Finally, science is a dynamic study, and through the media

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[484]Northrop Frye (ed.), Design for Learning, Reports Submitted to the Joint Committee of the Toronto Board of Education and the University of Toronto (Toronto: University of Toronto Press, 1962), p. 123.

[485]Philip H. Phenix, "The Disciplines as Curriculum Content," Curriculum Crossroads, ed. Harry A. Passow (New York: Bureau of Publications, Teachers' College, Columbia University, 1962), p. 59.

of television, radio and the printed word, content may be drawn to help the pupil relate to and understand his environment.

Characteristics of Course Content

The topics and skills which are selected to form the content of the science program should have either wide application or be required for immediate use. Too much detail or excess material is likely to produce an undesirable reversion to memory processes. The subject should not be viewed by either the student or teacher as an immutable body of knowledge. The processes of science are enhanced if both teacher and pupil accept the course content as a practical arrangement of material subject to modification or revision at a later date. Through the use of inherent elementary principles, present knowledge will be more securely based, and future revisions will serve to enhance and broaden the scope of the elementary principles.

The syllabus should include a sufficient number of topics and an ample range of activities so that selection is possible, and the choice should be made jointly by the pupils and the teacher. Neither the syllabus nor the teacher should attempt to impose uniformity; however the teacher must actively participate in the role of a guide in order to achieve the objectives of the course. The result will be successful if the course is presented as a coherent body of knowledge and experiences. To do so requires that all material be of a nature that may be understood by the student.

Audio-visual and other teaching aids should be available and should be used periodically. Special interests or activities can be further developed by the use of films, television, projects and supplementary reading. Wherever a choice is available, local resource material should be used as such material promotes the environmental objectives of the program. Contact with the community will indicate the practical value of the subject and this may be accomplished through class visits or, where this is not possible, through guest lecturers. An adequate syllabus cannot be based on a single textbook. It should be clear that the textbook is only a reference source and not the source of all content.

The Laboratory Program

While it is theoretically possible to teach science without including a laboratory program, the benefits which accrue from laboratory experiences indicate that it should be included. Courses such as P.S.S.C. physics, C.B.A. chemistry and CHEM Study chemistry introduce all topics through the laboratory program.[486] This technique appears to be well suited for the student capable of concept formation. It appears to be successful when used with groups that can formulate their own simple problems. A recent series of summer programs conducted by the Ontario Curriculum Institute with

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[486] *Vide infra*, pp. 80-83.

children of pre-high school age reported that the children were able to formulate their own problems and later test their hypotheses in the laboratory.[487] Many students now reaching high school, however, are unable to formulate problems, and until the student reaches the stage of formal operations, the problem and laboratory procedure will have to be introduced in the classroom. Portable laboratory desks should be used when the proper facilities are either unavailable or inadequate. Demonstrations performed by the teacher or individual students should be used to introduce classes to laboratory techniques.

While all programs examined used a laboratory report for recording the results, a wide variety of forms was used. Since it is desirable that the student participate in these experiences on an individual basis, the essential experimental data should be recorded in the laboratory. Furthermore, it is suggested that the report should be completed by the student in the laboratory where the apparatus is available and to do this it is recommended that a double class period should be available for laboratory work. It is essential that both the experiment and the equipment used in the experiment should be simpler than the topic being illustrated. The student must be capable of understanding the activity if the experience is to be significant. In the event that the use of simple equipment is not feasible or possible, a successful technique is to refer to such complex equipment

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[487] Ontario Curriculum Institute. The Science Committee. Science: Interim Report No. 2 (Ontario: Ontario Curriculum Institute, 1964), p. 18.

as a "black box", which has the effect of detracting from its apparent importance. Laboratory experiences should be correlated with the topics presented in the classroom in order that the one may reinforce the other.

Science Teachers and Science Instruction

The minimum requirements for a teacher of science should be a science major at the university level. Furthermore, all science teachers should be encouraged to maintain competence in the field of science by attending summer or winter courses at least once every four or five years. The retraining of teachers, to enable them to teach the new science courses effectively, must be built into the program from the very outset. Through a series of staff seminars the new objectives and techniques should be presented and discussed so that all teachers may become involved to the fullest extent in the development of an improved program.

From the practical difficulties experienced by the teachers instituting the new science courses it became evident that many aids other than textbooks must be available.[488] Reference textbooks, manuals, teaching aids and equipment must be in ample supply and stored where readily available. Failure to supply the necessary material will result in a tendency to avoid difficult subject areas involving group activities. The development of individual capacities, leading up to the stage of formal operations, is best

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[488] Vide infra., p. 103.

served by the techniques of the activity program which requires a variety of teaching aids.

Since the proper grouping of students is considered essential, particularly in activity experiences, both teacher and guidance counsellor should be involved to the fullest extent in the selection and classification of students. During the program, science teachers should be prepared to identify students who develop and mature more quickly than anticipated, or fail to achieve as expected, in order that they may be reclassified or receive remedial counselling.

Since each group should be relatively homogeneous, uniform standards of achievement must be avoided. The differences will become more pronounced as each group will vary in the rate at which it progresses through the sequences of mental development. During the initial period all students will have the opportunity to determine the role of science in their future vocation. Before the end of high school it is anticipated that each student will be enrolled in at least one science course to be characterized primarily by one of the following three objectives: (1) environmental and applied objectives, (2) technical and practical objectives and (3) theoretical and disciplinary objectives.

The Junior High School Program

There is considerable evidence to indicate that a course in general science at the junior high school level should be compulsory. The content should be basic, lie within the limits of student interests and favour material which requires a minimum of conceptual understanding. Instructional techniques should be orientated toward the need for individual and group experiences and activities.

Fundamental topics are selected so that basic principles will emerge and be clear to the student. The degree to which any one topic is developed should be determined by group interest in the classroom or in the laboratory. The major aims are to stimulate an interest in learning and to develop the ability to make valid generalizations; the minor aims are to impart specific information and to study applications of scientific principles.

Content that promotes memorization rather than understanding should be excluded or minimized; the degree of success depends upon the method used to introduce the topic to the class. If the topic is introduced as an experiment or a group discussion, individual hypotheses may be developed. Since the class level should be similar in mental development and background experience, the explanations offered will be relatively uniform in both degree of sophistication and validity. The important factor is that the teacher, in the role of guide, should then direct attention toward other topics in succeeding periods which will refute, modify or substantiate the earlier hypotheses. By such methods, science is presented as a process of constructing bodies of tentative knowledge and discovering different ways of making data coherent.

Sharp subject matter distinctions should be avoided and the basic unity of all scientific knowledge should be stressed. The skills to be developed should be meaningful and should have immediate applicability for the pupil. The extent to which skills are to be developed should not be determined in advance, but rather predicated on the interest, ability and background of the pupil. Verbalization, use of symbols and mathematical treatment should be used moderately in the science course at this level.

Suggested Topics for the Junior High School Program

The course should be based on a limited number of concepts selected for their familiar application in daily living and their frequent use in common situations readily recognized by students. Such concepts will help organize present knowledge and serve as a foundation for future learning. Some concepts which may be used are: (1) length, mass and time; (2) force and pressure; (3) the molecule; (4) the atom; (5) fields; (6) energy.

Some topics which may be selected to develop these concepts are illustrated in the following tables:

Topics marked * are suggested for a group of average students who are, in mental development, entering the stage of formal operations.

TABLE I

Length, Mass and Time

1. *Use of significant figures
2. Power - of - ten notation
3. *Metric and English systems of measurement
4. Density and specific gravity
5. Difference between quantity of heat and temperature
6. *Construction of a thermometer
7. *Fahrenheit, Centigrade and Absolute temperature scales
8. Specific heat and latent heat
9. Variation
10. Inverse square law
11. *Graphs: distance versus time, velocity versus time

TABLE II

Force and Pressure

1. *The difference between mass and weight
2. *Force, work and power
3. *Vectors
4. Equilibrium of forces
5. *Acceleration: ratio of force to mass
6. Newton's laws of motion
7. Friction
8. *Newton's Law of Universal Gravitation
9. Kepler's Laws of Planetary Motion
10. Air pressure
11. Pressure in liquids

TABLE III

Molecules

1. *Elements and compounds
2. *Mixtures, solutions and alloys
3. *Kinetic Molecular Theory
4. *Three states of matter
5. *Physical properties
6. Crystalline structure of solids
7. Charles' Law and Boyle's Law

TABLE IV

Atoms

1. *Protons, electrons and neutrons
2. *Chemical properties
3. *Arrangement of electrons around the nucleus
4. *Atomic number and atomic weight
5. Law of Conservation of Mass
6. Law of Definite Composition
7. Law of Multiple Proportions
8. *Radioactivity

TABLE V

Fields

1. *Gravitational
2. *Electrostatic
3. *Electric
4. *Magnetic
5. Electromagnetic
6. *Application of Ohm's Law in simple circuits
7. Coulomb's Law

TABLE VI

Energy

1. Potential and Kinetic
2. Mechanical
3. *Chemical
4. *Heat
5. *Magnetic
6. *Electrical
7. Light
8. Sound
9. Nuclear
10. *Transformation of Energy
11. *Conservation of Energy
12. Inertia

These topics may be used to indicate the role of science in society, utilizing a number of laboratory and classroom experiments which are available to provide manual activities. These activities would be founded on basic concepts which would develop understanding and promote the growth of formal mental operations. As the child's intellectual activity increases, it will not be necessary to restrict the course to topics which the child can experience through manual operations.

The Senior High School Program

At least one further course in science should be compulsory for all students at the senior high school level. A choice between advanced general science and one of the subject sciences should be available. These electives should in their presentation be in the nature of a discipline. The content of the advanced general science course might be based on the practical application of scientific knowledge, the technology of science or science in engineering. Maximum flexibility must be permitted in selecting content and objectives. In large regional schools having more than one general science course, it may be desirable to structure one course on industrial science or agronomy. The content of physics and chemistry courses should be primarily theoretical and mathematical.

The standard of achievement must be consistent with individual abilities within the class. Reserves of additional material, either more elementary or more advanced, should be available in the syllabus. Conceptual and mathematical ability will vary between individuals; therefore the emphasis in the subject courses should not be the same in all groups.

Recognition of generalizations and identification of principles are also important objectives at the senior high school level. The effect of environmental and social forces is recognized; however it is felt that the school should not depend to the same extent on these factors to construct the sciences program for students at the senior high school level.

A majority of students of this age group will have progressed from analogical learning towards an appreciation of digital or sequential and classical methods of learning. Bruner[489] identifies the process as

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[489]Bruner and others, A Study of Thinking, p. 246.

concept attainment and suggests that all mental growth involves, and is dependent upon, the process of categorizing and is in this sense a psychological phenomenon. The categorizing process should also influence the selection of content. Whatever activities are provided should suggest successive regrouping of data in order that the student may learn to apply his knowledge to new problems and unfamiliar topics.

On the basis of this line of reasoning, the function of grouping may be seen in proper perspective. Even at the senior high school level, grouping does not serve to segregate the university-directed student from any other student. The experiences and activities which are valid for one student are also valid for the other, and while the issue can not be determined in absolute terms, it is urged that the differences should be in degree and not in kind. The program constructed for each group should be motivated by the theory of continuous growth and development. Within each group short-term objectives may be used to accommodate the individual pupils.

Topics for the Senior High School Program

It is anticipated that specialization would begin at this level. The advanced general science program should include a number of elective courses, each based on the topics developed in the general science course, but having vocational or technical objectives. The subject courses should also repeat the topics of the general science course, but this time in greater depth. The degree to which concepts are developed, and the extent to which mathematics is used, should be determined by the mental development level of the group.

Testing and Promotional Policies

There must be a clear statement of the desired objectives of each group. Successful teaching methods for each group should be formulated and recorded. From this data, a process of hypothesis formation to determine the most effective instructional methods may be included as a permanent policy of science departments. Periodic testing and revision of objectives and methods should be planned.

All tests must reflect the objectives of each group. Tests which measure the student's ability to categorize data and formulate problem-solving strategies may be used to modify further the program and teaching process. The student will also learn from the testing process if the difficulty of the material presented is related to his maturity level and if the questions presented reflect the logical structure of the subject.

All these factors will have to be considered in the promotional policy. At the junior high school level, uniform standards must be replaced by individual development and achievement levels. Later on in high school, promotional policy should require evidence of subject matter learning and promotion in subject courses should be based solely upon achievement in the academic discipline.

Separate standards in the science program recognize the wide range of student interests and abilities. During the period in which the student is in the school the use of such standards will present that type of activities and content which will be most effective in promoting both his mental growth and development and which will further his knowledge and enrich his understanding of science.

CHAPTER 6

CONCLUSIONS

Courses in science were included in the curriculum of the academies. Later, when high schools were established to provide secondary education, they too included instruction in science as part of the curriculum. This may be accepted as evidence of the desire to include science as one of the subjects in the curriculum at the secondary school level.

The objectives of science instruction were not constant but reflected the objectives of secondary education. Secondary education was first conceived as education beyond grammar or elementary school, but not necessarily college-preparatory in nature. This concept was perceptibly influenced by college entrance requirements as both the number of students attending secondary schools and the number of students requiring college preparatory courses increased.

Methods of instruction in the physical sciences usually included the use of practical demonstrations. Laboratories, in which the students performed their own experiments, appeared at a later date depending upon the size and wealth of the school system. In general the science program was retarded by a lack of science teachers and the courses were based on, and taught from, the textbook.

Towards the end of the nineteenth century the range of abilities of the students in the high schools became more representative of the general population and the curriculum became increasingly influenced by college entrance requirements. The solution most commonly adopted appeared to be the inclusion of courses of a non-academic nature and the use of the elective system. At the turn of the twentieth century the lack of suitable curriculum threatened the overall academic standards of the high schools.

The work of the National Education Association in the United States may be correctly interpreted as an effort to reaffirm the academic integrity of the secondary schools and to recognize at the same time that the high schools did not exist exclusively for the college-bound student.

During the twentieth century a number of laboratory schools was started by the universities in which new teaching methods could be developed and child behaviour studied. The position of the child and of society as the focal points of the curriculum was established in the Seven Cardinal Principles of Education. The Eight Year Study provided a further stimulus to the development of new curricula. The three major types of curricula which were developed were activity, core and subject.

During the 1950's the academic quality of the courses in the curriculum once again became a topic of investigation. Course revision rather than curriculum revision resulted during this period. This was the case particularly in the science and mathematics programs. The subject matter in these fields had increased to such an extent that the traditional high school courses were considered to be incapable of modification and several new courses were prepared. These courses, being based on the subject itself, were more difficult than the courses they were designed to replace. They were therefore usually reserved for superior students and have achieved their purpose. This is particularly true in the case of school systems using external examinations in the last year of high school.

Courses for the less talented students have not been developed to nearly the same extent. This large group of students has in general been assigned to the regular physics or chemistry courses or has been excluded from taking any science course. Such a procedure is not considered satisfactory. This group of students needs a knowledge of the fundamentals of science, but a course is needed that will present the material in such a way that the topics of science have meaning and application in the environment of the student. The students in this latter group are not likely to be impressed with the objectives of theoretical science; in fact, it is more probable that they have never appreciated the role of science in their environment.

The development of subject material must be deferred until the student's interest is stimulated. At the junior high school level a variety of instructional techniques may be used to cultivate interest and develop latent ability. To accomplish these objectives a degree of flexibility must be built into the course topics and limits. It is desirable that the course content draw heavily from concrete learning experiences and gradually introduce material of a conceptual nature.

The exact point at which the student can transfer from the concrete to the conceptual is not known, nor is the minimum intelligence required to effect this transfer known. It is a fact that learning which is not predicated on the growth of reasoning becomes increasingly dependent upon memory processes. Memory alone is not a desirable foundation for continuous mental growth and development.

To structure the science course in such a way as to afford the student more time and a variety of experiences will contribute toward the development of mental processes. There are sufficient topics of a suitable nature and methods of instruction for this to be accomplished within the subject-centered curriculum.

The first requisite for this type of science program is the identification and grouping of students entering high school according to their stage of mental development. Preliminary grouping could be accomplished by using elementary school records. Errors made in this initial classification of students could be easily rectified: the topics and methodology used in the science course would be relatively similar in all groups during the first few months and students could be transferred from one group to another during this period without placing the individual student at a disadvantage or disturbing the development of the group.

The content of the general science course at the junior high school level would be selected primarily from phenomena which the students have experienced and topics which could be studied through manual operations. Since homogeneous grouping is desired, a uniform rate of development for all groups should not be expected. Neither should rigid standards of achievement for each group be determined in advance. The program should be sufficiently flexible so as to allow the teacher and the students a degree of choice in determining the amount of time to be spent on, and the methods of developing, each topic.

It is anticipated that as the student matures, the instructional methods and the treatment of subject matter will recognize the student's increased maturity. The first objective throughout the general science course is, however, to present basic principles and concepts of science in a variety of modes in order that the student may be led to a fuller appreciation and understanding of them. In time, the students should be expected to propose problems to be investigated which would involve a degree of abstract concept-formation. In these instances, too, excessive verbalization should be avoided, since the essential point is the methods by which problems are solved and not the final conclusions.

In science courses at the senior high school level, the proper grouping of students is essential. Courses should be available to suit the abilities and promote the mental development of the student. A science program should include advanced, regular and applied science courses. The objectives at this level should be mainly disciplinary in nature. Through the experiences provided at the junior high school level it is to be supposed the student will already have developed his mental abilities and that a majority will have achieved the psychological stage of concept formation. The science courses at the senior high school level are conceived as providing the means by which the student may apply his abilities toward acquiring specific knowledge or preparing for a vocation.

The successful execution of this type of science program is dependent upon three mutually inclusive factors. The school administration must be willing to accept the flexibility of a curriculum modified to suit the needs of the individual student and prepared to supply the leadership in implementing the program. Qualified and energetic science teachers are needed who would be ready to modify established courses and programs in order to rebuild them on the basis of a child-centered curriculum. A final requisite is the development of effective testing and evaluating programs. If these conditions can be met, a modified subject-centered curriculum is proposed as representing the most efficient method of achieving the objectives of the modern composite high school.

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