A STUDY OF THE CONDITION OF SCIENCE EDUCATION IN THE HIGH SCHOOLS OF THE PILOT AREA OF NOVA SCOTIA

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Abstract

The Pilot Area, designated by the Government of Canada for economic assistance, comprises the Nova Scotia counties of Antigonish, Cape Breton, Colchester, Cumberland, Guysborough, Inverness, Pictou, Richmond and Victoria.

In the thesis, science education in the Pilot Area is compared with that in two other regions; namely, in the remainder of rural Nova Scotia (Area A), and in urban Halifax-Dartmouth (Area B).

The factors compared include: student enrolment in science subjects; time distributed between science subjects and other subjects in the curriculum; the laboratory facilities; the qualifications of teachers; and the pass rate in the sciences in provincial examinations.

The study reveals that, in the Pilot Area, a strong correlation exists between poverty and sub-standard science education.

A revised cost-sharing structure featuring increased subsidization to impoverished school boards, additional salary incentives to teachers in economically disadvantaged areas, and means to improve teacher qualifications in science are the recommendations of this study.

INTRODUCTION

The author will attempt to study the conditions of science education in the high schools of the Pilot Area of Nova Scotia. This examination has been confined to the Pilot Area because this area is one of many areas in Canada which has qualified for economic assistance under the terms of reference of the Area Development Program announced by the federal government on August 5, 1965.

The establishment of the Pilot Area of Nova Scotia as an economically depressed area prompted the author to consider the possibility that this area may also be disadvantaged in the field of education.

The diversity of the educational program today does not permit a complete examination of all the machinery which influences the state of education in the schools of the Pilot Area. A detailed examination of science education in the high schools of the Pilot Area will be undertaken in an attempt to provide a partial insight into the general conditions of education in this area.

The term "high school" will include the following grades: grade 10, grade 11 and grade 12.

The term "science education" can be interpreted to include a variety of subjects but for the purposes of this

study will be confined to the subjects, science and mathematics, in grade 10; physics, chemistry and mathematics in grade 11, and physics, chemistry, biology, geology and mathematics in grade 12. A surface analysis of the general science program in grades 10, 11 and 12 is also included in this study. The nine counties in Nova Scotia which have been categorized as the Pilot Area are: Antigonish, Cape Breton, Colchester, Cumberland, Guysborough, Inverness, Pictou, Richmond and Victoria.

An interpretation of the merits or defects in science education in the Pilot Area lacks significance unless a comparison is made with science education in the high schools of the remaining counties in Nova Scotia. The remainder of Nova Scotia has been divided into two areas for comparative purposes: Area A and Area B. It was the author's opinion that the inclusion of the cities of Halifax and Dartmouth as part of Area A would violate the principle of equivalence in comparative study. There are two reasons for this observation.

1. The cities of Halifax and Dartmouth salary their teachers above most other areas in the province, increasing the liklihood of more qualified teachers in their system.
2. Halifax and Dartmouth are the largest urban centers of population in the province enabling school boards to devote larger sums of money per student for capital expenditure.

An attempt was made to isolate specific factors which would strongly influence the general conditions of science education in the Pilot Area. The absence of relevant data in other important areas of science education limited the scope of this field to a consideration of the following factors:

1. The enrolment in science subjects.
2. The ratio of time allocated to science subjects in relationship to other courses in the curriculum.
3. The laboratory facilities available for the teaching of science.
4. The qualifications of science teachers.
5. The success of science students in provincial examinations.

The school year 1965-66 was used as the basis for this study, wherever possible, to ensure the most recent analysis.

CHAPTER I

A DISCUSSION OF THE SPECIFIC FACTORS WHICH WILL BE CONSIDERED IN THE EXAMINATION OF SCIENCE EDUCATION IN THE PILOT AREA

The state of science education in the nine designated counties which comprise the Pilot Area will be compared with the state of science education in the remaining geographic regions of Nova Scotia. The remainder of Nova Scotia has been divided into two Areas: Area A and Area B.

The following counties or cities comprise these areas:

1. Area A - The counties included in this area are: Annapolis, Digby, Hants, Kings, Lunenburg, Queens, Shelburne, Yarmouth, and Halifax County (excluding the cities of Halifax and Dartmouth).
2. Area B - This area includes the cities of Halifax and Dartmouth.

The five factor headings outlined in the introduction form the cornerstones of this study. The author will attempt to explain the reasons for the selection of these subject headings in science education and outline, briefly, the general content of these factors.

1. The Enrolment in Science Subjects in Grades 10-12

This subject heading was selected to obtain general information concerning student preferences for subjects offered in the general academic program at each of these grade levels. An examination of enrolment statistics must be confined to the elective subjects in the curriculum since the science subjects are classified in this category in the general academic program.

The age of technology, which the twentieth century epitomizes, has placed considerable pressure on employers to demand a general background in science subjects. This demand should be reflected in a high percentage enrolment of students in the science subjects. Students proceeding to university are required to have completed a course in mathematics and at least one other course in science for admittance to any faculty of studies.

2. The Ratio of Time Alloted to Science Courses in Relationship to Other Courses Within the Curriculum

The non-compulsory nature of science courses in grades 10-12 should not be sufficient reason to suggest that less time be devoted to these subjects than compulsory subjects in the curriculum. With the exception of mathematics, all science courses embody a laboratory program as an integral part of each course. The committment of one or two periods each week for laboratory work in science places science

subjects in a different perspective than other subjects in the curriculum.

A consideration of the time allocated to laboratory work should reflect to some degree the emphasis placed on the laboratory program in the schools of the Pilot Area.

The total time in minutes per week devoted to each science course will be related to the total time allocated to the other subjects in the curriculum in an effort to isolate the relative emphasis placed on science in the high school program. A more meaningful appraisal of the time allocations for science in relationship to other subjects will be undertaken by considering the suggested minimum time allotments of the Department of Education for each subject at the high school level.

3. Laboratory Facilities Available for the Teaching of Science in Grades 11 and 12

The major aim of any laboratory program is to develop the relationship between theoretical and experimental material. This task is accomplished by conducting investigations in the laboratory which involve ideas and concepts discussed in the classroom. In the experimental sciences, ideas, thought and experimentation are interrelated. The objective of a good laboratory program is to create a situation in which the student can experience the same interactions between the theoretical and the practical as the scientist.

An examination of the state of laboratory facilities in the high schools of the Pilot Area should provide some measure of the degree to which a laboratory program has achieved its major objectives. The laboratory program in grade 10 science will not be considered because the necessary equipment and facilities for the implementation of this program are provided by the senior science laboratories.

The laboratory facilities offered in geology were excluded from this study because very few schools in the Pilot Area, or in the province as a whole, offered this program.

An examination of the laboratory program in each science subject in Grades 11 and 12 which has been outlined in the syllabus issued by the Department of Education suggested the possibility of discussing laboratory facilities in the Pilot Area under the following general headings for all science subjects.

1. The Number of Students per Desk

Maximum student involvement in the laboratory would suggest that every student operate independently at his own desk. However, large classes and lack of equipment does not permit the operation of this ideal situation in the average high school laboratory. The most practical alternative is the use of each laboratory desk by two or more students depending upon the size of the class. It is advantageous to

have as few students as possible working at each desk to ensure maximum student participation in each experiment.

2. The Extent of Separate Laboratory Facilities for each Science Subject

The increase in scientific knowledge in the last fifty years has isolated specific fields of science for intensive study. Chemistry, physics, biology and geology have attained separate status within the high school curriculum. Each of these sciences has a list of equipment which is not easily convertible for use in other science subjects.

The use of one laboratory to conduct experimentation in all of the science subjects becomes impractical unless the school has a very small enrolment. The one and two room schools are gradually being replaced by consolidated schools which cater to a large school population. The need for separate laboratory facilities may be necessary to accomodate the laboratory requirements of all science subjects. An analysis of the ability of each high school in the Pilot Area to provide the needed laboratory facilities for their science students could furnish useful criteria to measure the effectiveness of their laboratory program.

3. The Adequacy of Laboratory Equipment

The Department of Education, in co-operation with the curriculum committees in each science subject, have suggested specific laboratory experiments in each of the sciences. Students in grade 11 and 12 are responsible for these

experiments for purposes of provincial examinations. The student will be handicapped if lack of equipment prevents the completion of the full laboratory program. Any assessment of the capability of a particular school to offer the required laboratory program would be dependent upon a complete list of equipment available in that school. Present research data limits a thorough examination of equipment facilities. However, based on the information available, a study will be made of the basic equipment which is required to conduct the laboratory experiments outlined by the Department of Education for each science subject. The adequacy of this equipment will be examined for chemistry, physics and biology using the following headings for each subject.

A. CHEMISTRY

1. Gas outlets to operate laboratory burners

The majority of experiments require the use of a constant source of heat.

2. Sinks for the disposal of liquids

A cold water outlet is constantly used for both the cleaning of glassware and the preparation of solutions.

3. A source of electricity

4. A fume hood

Many of the grade 12 experiments in chemistry involve

the preparation or use of chemicals which are toxic in nature. The escape of toxic vapors into the room could result in serious accidents or possible death. The lack of a fume hood would reduce the number of experiments which could be conducted under safety conditions.

5. Chemical stock room

A separate locked room preferably within the confines of the laboratory is necessary for the proper storage of chemicals. The storage of chemicals on open shelves in the laboratory can lead to serious accidents.

6. Adequate balances

The grade 11 and 12 laboratory program requires the constant use of balances to weigh given amounts of chemicals. Lack of adequate balances would increase the length of time required to complete a given experiment.

B. PHYSICS

1. Electrical outlets

Many experiments in physics require the extensive use of electrical appliances such as voltmeters and AC-DC power supplies.

2. Adequate balances

One-third of the required experiments in the grade 11 physics program require the use of triple beam balances. These balances are costly to purchase and the need will

probably arise to distribute the balances among groups of students.

3. Gas outlets

The grade 11 and 12 laboratory program requires the use of a heat source.

4. The adequacy of general equipment

The unit cost of equipment used in physics laboratories does not usually permit the use of this equipment by all students. The teacher must demonstrate many of the principles and theories in physics. Equipment, in many instances, must remain assembled for demonstration to other classes taking this subject. If other classes require the use of this equipment for other experiments, the continuity of the demonstration is destroyed. To facilitate this need, it is necessary to stock the laboratory with surplus equipment.

C. BIOLOGY

The Department of Education will replace the present grade 10 course in science with biology commencing in the academic school year 1966-67. The biology course at this level is laboratory orientated whereas the science program in grade 10 rarely uses laboratory facilities. The present offering of biology as an elective course in grade 12 in addition to the anticipated course in biology in grade 10

will place severe strains on any school which uses the biology laboratory for experimentation in physics or chemistry.

General equipment in biology

The microscope is continually used in the biology laboratory program to study details of cell tissue. The use of these instruments by a large number of students is not practical if each student is expected to make a drawing of the details observed in the microscope.

Any study of bacterial growth dictates the need for oil immersion lens, stereo-binocular microscopes, a temperature control oven and a refrigerator.

Vertebrate and invertebrate studies become more realistic if live specimens are used for demonstration purposes.

4. The Qualifications of Science Teachers

Brian T. Newbold of the Chemical Institute of Canada completed a survey in 1963 of the degrees held by chemistry teachers in Maritime high schools.

Table 1 indicates that in all the Maritime provinces with the exception of Nova Scotia, the largest percentage of teachers possess a degree in Arts and yet they are teaching a science subject. However these figures may not be entirely accurate, because some of these teachers may be teaching this subject to one or two classes only, spending the largest percentage of their time in the teaching of a subject or

TABLE 1[1]

Degrees held by Chemistry Teachers in Maritime High Schools in 1962

Province	Degrees (% distribution)							
	B.A.	B.Sc.	B.Ed.	B.Ped.	M.A.	M.Sc.	Ph.D.	No degree
Prince Edward Island	71.4	28.6	57.1	-	-	-	-	-
Newfoundland	66.6	16.7	16.7	-	-	16.7	-	-
New Brunswick	44.0	32.0	33.3	2.7	2.7	-	-	16.6
Nova Scotia	33.0	46.3	49.4	2.5	15.7	2.5	2.5	5.0

[1]Brian T. Newbold, A Study of the Qualifications of High School Chemistry Teachers in the Maritime Provinces, A Report to the Chemical Institute of Canada (Moncton, N.B.: University of Moncton, 1963), p. 4.

subjects other than a science. Furthermore, some of these teachers who graduated with a B.A. degree, may have taken chemistry as a minor field of study. The B.A. degree teachers may be equally qualified, in terms of the number of chemistry courses completed, as a teacher who graduated with a B.Sc. degree.

A more accurate means of assessing teacher qualifications in science would be a classification system based upon the number of university courses completed in the high school science subject taught by the teacher.

The size of the high school and the diversity of the curriculum are two factors which affect qualifications in science teaching.

Many high schools are too small to permit specialized teaching in one subject field. High school science teachers are often required to instruct two or more science subjects. A teacher who is instructing grade 11 physics and chemistry cannot be expected to possess equal qualifications in each of these subjects. The structure of the university degree program does not support this contention. During their university tenure, an undergraduate pursues a major and minor field of study. The number of undergraduate courses which constitute a major and minor vary from university to university.

The wide range of selected topics which are incorporated

into the science courses offered at the high school level require a broad general background in science and the completion of a number of university courses in the subject field which the teacher is employed.

Science teachers, in this study, were categorized according to the grade level taught and the number of university courses completed in their major field of teaching. For example, the qualifications of a chemistry teacher in the Pilot Area was determined by recording the number of chemistry courses that the teacher successfully completed at university. A similar method was employed in determining the qualifications of mathematics, physics and biology teachers in grades 10-12.

The qualifications of grade 10 teachers of the science course were excluded from this study because this information was not available. Geology teachers were not included in this study because their small numbers would not provide any meaningful data.

5. The Success of Science Students in Provincial Examinations in Grade 11 and 12

All students in grade 11 and 12 who are enrolled in the academic or general program in Nova Scotia are required to write provincial examinations in the subjects they have taken during the academic year. The provincial examination system provides a common basis to assess the individual merits of any of the schools in a given locale.

However, any conclusions which are reached from a comparison of student success in these examinations in the areas under study cannot be definitive because certain factors are not measurable. The proportion of academically gifted, average and below average students cannot be assumed to be constant in every school in all areas. Variables such as the educational background of the student's parents, the social environment of the student and the family's financial position will affect the educational progress of any student.

The results of any comparative findings in student success in provincial examinations are meaningful and indicate certain general trends but must be carefully interpreted. The success of students in provincial examinations in grade 11 and 12 will be considered in terms of the percentage of students who made a pass mark of fifty percent or above. The general science students in grades 10 to 12 inclusive will not be considered in this analysis because the infancy of this program in the schools has resulted in a small student enrolment.

CHAPTER II

The Science Syllabus Suggested by the Department of Education for Grades 10 to 12

The various courses which are offered to senior high school students in grades 10, 11 and 12 in Nova Scotia can be categorized into three major divisions; namely, a university - preparatory program, a general program and a business education program. The latter program will not be considered in this discussion.

The university - preparatory program, designed for those students who intend to matriculate to university, includes English and history as compulsory subjects in grade 10, 11 and 12 respectively. Science and mathematic courses are offered as elective subjects. The minimum requirement for a full year's work for any pupil in these grades is English, history and any other three courses.

The courses which a college bound student selects will depend upon the university entrance requirements. A student who applied for university entrance at the termination of his grade 11 work must have an average of sixty in the following subjects; English, history, mathematics, science and one language. However certain universities have recently adopted the policy that grade 12 will be required for college entrance. Dalhousie University, for example, requires one

science in grade 12 if the student is pursuing a Bachelor of Arts program and two sciences for those students following a Bachelor of Science program. The grade 12 requirement for entrance to some universities has increased the high school enrolment in all subjects including science at this grade level.

The majority of universities have still retained their original policy of allowing credit for certain subjects in the grade 12 academic program. College credit is usually given for English, latin, french, history, mathematics and biology and in some cases geology providing marks in these subjects are above a required percentage.

Science and mathematics in grade 11 and mathematics in grade 12 are segmented. Science consists of chemistry and physics with each subject having a value of fifty percent. A full course in mathematics comprises algebra and geometry with each subject counting fifty percent of the mark. A similar percentage distribution occurs in grade 12 mathematics with trigonometry replacing geometry. It is the intention of the Department of Education in the academic year 1966-67 to offer grade 11 chemistry and physics as separate courses within the curriculum. These subjects will be given, in effect, the same status as any other full course in grade 11.

The Department of Education has suggested time allotments for each subject as a guide in determining the emphasis placed on the different courses in the program. Class time is computed

on the basis of three percent being equivalent to at least forty minutes per week. The allotment for each course includes all regular class time given to instruction and other learning activities.

The Table listed below has been compiled to indicate the time distribution for each subject in the university - preparatory program as suggested by the Department of Education.

TABLE 2[2]

The Distribution of Subject Time in Grades X-XII for the University - Preparatory Program in Nova Scotia, for the school year 1965-66

Grade level	Subject	Percentage time allotment/ wk.	% Equivalent no. of periods/wk.	Equivalent time in mins./wk. 1 period = 40 minutes (minimum)
X	English	15-21	5-7	200-280
	History	12-15	4-5	160-200
	Science	12	4	160
	Mathematics	18	6	240
	Geography	9-12	3-4	120-160
	Latin	12	4	160
	French	12	4	160
	German	12	4	160
	Greek	9	3	120
	Home Economics	12	4	160
	Industrial Arts	12	4	160
	Agriculture	12	4	160
XI	English	18-21	6-7	240-280
	History	12-15	4-5	160-200
	Science Physics & Chemistry	15-18	5-6	200-240
	Mathematics Algebra & Geometry	18	6	240

TABLE 2[2]--Continued

Grade Level	Subject	Percentage Time Allot. /wk.	% Equivalent No. of periods/wk.	Equivalent time in mins/wk 1 period = 40 minutes (minimum)
	Economics	9-12	3-4	120-160
	Latin	12	4	160
	French	12	4	160
	German	12	4	160
	Greek	9	3	120
	Home Economics	15-18	5-6	200-240
	Industrial Arts	12	4	160
XII	English	18-21	6-7	240-280
	History	12-15	4-5	160-200
	Physics	12	4	160
	Chemistry	12	4	160
	Biology	12	4	160
	Geology	9	3	120
	Mathematics Algebra & Trigonometry	18	6	180
	Latin	12	4	160
	French	12	4	160
	German	12	4	160
	Greek	9	3	120
	Modern World Problems	12-15	4-5	120-160

[2]Department of Education, Nova Scotia, Program of Studies in the Schools of Nova Scotia; Curriculum and Research Section (Halifax: Department of Education, 1965, Bulletin 8).

The General Program devised for senior high school pupils whose formal schooling will end with the completion of grade 12 was begun as a pilot project in four schools in 1962, twenty-three schools are now offering this program in 1965-66. A pupil commences this program in grade 10 and writes final examinations in each course after completion of the grade 12 program. Successful completion of these courses will qualify pupils for entrance to many forms of post-high-school training or occupations.

The table listed below indicates the subjects offered in this program and the recommended distribution of time in each subject as suggested by the Department of Education.

TABLE 3[3]

The Distribution of Subject Time in Grades X-XII for the General Program in Nova Scotia, for the School Year 1965-66

Grade level	Subject	Percentage time allotment/ wk.	% Equivalent no. of periods/wk.	Time in minutes	Compulsory or elective
X	English	15-21	5-7	200-280	Compulsory
	History	12-15	4-5	160-200	"
	Science	12-15	4-5	160-200	"
	Mathematics	12-15	4-5	160-200	"
	Geography	9-12	3-4	120-160	Elective
	Home Economics	12-24	4-8	160-320	"
	Industrial Arts	12-24	4-8	160-320	"
	Agriculture	12	4	160	"
XI	English	18-21	6-7	240-280	Compulsory
	History	12-15	4-5	160-200	"
	Science	15-18	5-6	200-240	"
	Mathematics	15-18	5-6	200-240	"
	Economics	9-12	3-4	120-160	Elective
	Home Economics	15-18	5-6	200-240	"
	Industrial Arts	12	4	160	"
XII	English	18-21	6-7	240-280	Compulsory
	History	12-15	4-5	160-200	"
	Science	15-18	5-6	200-240	"
	Mathematics	15-18	5-6	200-240	"
	World Problems	9-12	3-4	120-160	Elective
	Home Economics	15-18	5-6	200-240	"
	Industrial Arts	12	4	160	"

[3]Department of Education, Nova Scotia, Program of Studies in the Schools of Nova Scotia; Curriculum and Research Section (Halifax: Department of Education, 1965, Bulletin 8).

CHAPTER III

An Examination of Science Education in Grades 10-12 in the Pilot Area of Nova Scotia

(a) THE ENROLMENT IN SCIENCE SUBJECTS

The statistics given in Tables 4-6 were extracted from the records of the Department of Education for both the rural and urban school population. Since these figures were obtained at the commencement of the school year, no allowance has been made for those students who for one reason or another; were forced to retire from certain subjects during the school year. These statistics will become more meaningful upon examination of the number of candidates who wrote provincial examinations in each subject. However certain trends are evident in these enrolment statistics.

The majority of grade 10 students have chosen science and mathematics as two of their three elective choices. Science enjoys the same status as the compulsory subjects, English and history. These student selections are to be expected, however, as most occupational programs following high school training require a general science and mathematics background. This observation is further substantiated by

the enrolment figures in Tables 4-6 for subject choices in grade 11 and 12.

PART I

An Examination of Science Education in Grades 10-12 in the Selected Areas of Nova Scotia

TABLE 4

Enrolment Grade X Pilot Area - 1964-65

County	Eng.	Fr.	Ger.	Lat.	Greek	Geog.	Hist.	Sc.	Agric.	Gen. Math.	Alg.	Geom.
Antigonish	268	223	0	88	0	33	265	267	71	30	246	244
Cape Breton	2086	1809	18	879	0	1145	2120	2046	0	452	1846	1836
Colchester	657	397	39	43	0	397	621	665	0	180	523	521
Cumberland	524	364	16	24	0	329	523	526	0	95	429	429
Guysborough	184	163	0	27	0	125	184	174	0	0	181	181
Inverness	408	360	0	116	0	161	407	455	0	28	379	379
Pictou	639	541	113	120	0	277	638	633	0	24	593	591
Richmond	175	170	0	17	0	169	175	175	13	0	175	175
Victoria	116	110	0	46	0	68	115	115	0	0	112	112
TOTAL	5057	4137	186	1360	-	2704	5048	5056	84	809	4484	4468

TABLE 5

Enrolment Grade XI Pilot Area 1964-65

County	Eng.	Fr.	Ger.	Lat.	Greek	Econ.	Hist.	Gen. Sc.	Phys.	Chem.	Agric.	Gen. Math.	Alg.	Geom.
Antigonish	239	183	0	67	0	62	230	31	180	184	11	31	183	194
Cape Breton	1880	1461	10	514	0	910	1898	99	1545	1556	0	101	1549	1549
Colchester	519	301	14	34	0	354	469	46	334	341	0	73	392	381
Cumberland	477	331	16	13	0	445	481	92	347	362	0	92	371	370
Guysborough	135	106	0	5	0	137	139	0	133	135	0	0	112	110
Inverness	343	288	0	53	0	190	343	24	277	275	69	24	303	294
Pictou	535	418	48	80	0	393	531	0	523	536	6	0	526	524
Richmond	138	123	0	4	0	107	135	0	130	131	42	0	126	127
Victoria	98	88	0	21	0	74	98	0	97	101	0	0	100	99
TOTAL	4364	3299	88	791	0	2672	4324	292	3566	3621	138	321	3662	3648

TABLE 6

Enrolment Grade XII Pilot Area 1964-65

County	Eng.	Fr.	Ger.	Lat.	Mod. World Prob.	Hist.	Gen.	Bi.	Phys.	Chem.	Geol.	Agric.	Gen. Math.	Alg.	Trig.
Antigonish	56	28	0	14	27	58	0	18	33	55	0	4	0	49	51
Cape Breton	929	636	50	215	262	932	47	217	571	543	44	0	47	503	600
Colchester	224	141	3	19	82	219	0	99	101	164	7	2	0	178	182
Cumberland	249	132	9	8	158	252	29	106	135	168	8	7	25	191	198
Guysborough	39	20	0	2	30	24	0	18	27	25	0	0	0	27	28
Inverness	144	113	0	7	54	151	0	28	64	100	9	58	0	103	106
Pictou	293	178	13	53	130	293	0	113	189	234	2	0	0	213	231
Richmond	107	0	0	0	46	57	0	4	53	52	0	3	0	48	48
Victoria	44	22	0	6	33	43	0	0	31	40	0	0	12	35	22
TOTAL	2085	1270	75	324	822	2029	76	603	1204	1381	70	74	84	1347	1466

(b) THE RATIO OF TIME ALLOCATED TO SCIENCE SUBJECTS IN RELATIONSHIP TO OTHER COURSES IN THE CURRICULUM

A personal letter was circulated to the principals of all senior high schools in the province requesting subject time tables. Some schools could not provide complete time tables but did furnish information relating to the time allocated for science in their respective curriculums. Twenty-one schools in the Pilot Area or thirty-nine percent provided complete time tables and nine additional schools or six percent supplied information concerning only science. The discrepancies in the totals for science subjects in relationship to other subjects at each grade level can be attributed to this fact. Not all schools in the Pilot Area offer the academic program in grade 12; a fact which accounts for the reduction in the number of schools at this grade level.

The following tables represent the distribution of subject time for all schools who replied to the personal letter.

TABLE 7

Distribution of Subject Time Grade X Pilot Area
(1965-66)

Time (Min.)	Eng.	Hist.	Fr.	Geog. Econ.	Acad. Sci.	Gen. Sci.	Acad. Math.	Gen. Math.
75-100	0	0	0	2	0	0	0	0
101-125	0	0	1	5	3	1	0	0
126-150	0	0	2	1	2	0	0	0
151-175	0	7	9	6	11	1	0	0
176-200	0	10	7	1	11	2	0	0
201-225	4	3	0	0	1	2	0	1
226-250	7	1	2	0	1	2	7	1
251-275	2	0	0	0	0	0	3	1
276-300	4	0	0	0	0	0	6	0
301-325	3	0	0	0	0	0	1	1
326-350	0	0	0	0	0	0	2	0
351-375	0	0	0	0	0	0	1	0
376-400	1	0	0	0	0	0	1	0
Total No. of Schools	21	21	21	15	29	8	21	5
Avg. Time in Mins. in each Subject	265	190	175	142	170	200	283	260

TABLE 8

Distribution of Subject Time Grade XI Pilot Area
(1965-66)

Time (Min.)	Eng.	Hist.	Fr.	Econ.	Acad. Sci.	Gen. Sci.	Acad. Math.	Gen. Math.
75-100	0	0	0	2	0	-	-	-
101-125	0	0	0	3	0	-	-	-
126-150	0	1	0	2	0	-	-	-
151-175	0	5	10	8	0	-	-	-
176-200	-	11	6	4	0	-	-	-
201-225	2	1	1	0	1	1	-	-
226-250	5	3	3	0	2	1	8	-
251-275	5	0	1	0	5	3	2	1
276-300	5	0	0	0	4	-	6	3
301-325	1	0	0	0	9	-	2	1
326-350	2	0	0	0	3	-	2	-
351-375	1	0	0	0	3	-	1	-
376-400	0	0	0	0	2	-	-	-
Total No. of Schools	21	21	21	19	29	5	21	5
Avg. Time in Mins. in each Subject	273	193	189	150	310	252	279	293

TABLE 9

Distribution of Subject Time Grade XII Pilot Area
(1965-66)

Time (Min.)	Eng.	Hist.	Fr.	World Prob.	Phys.	Chem.	Biol.	Geol.	Acad. Math.	Gen. Math.	Gen. Sci.
75-100	0	-	-	-	-	-	-	-	-	-	-
101-125	0	-	-	-	-	-	1	-	-	-	-
126-150	0	-	-	-	-	-	-	-	-	-	-
151-175	0	2	7	9	6	8	7	-	-	-	-
176-200	0	10	6	3	9	8	4	-	-	-	-
201-225	1	1	1	-	3	3	1	-	-	-	1
226-250	7	1	-	-	-	-	-	-	8	-	1
251-275	1	-	-	-	1	1	-	-	2	2	1
276-300	4	-	-	-	-	-	-	-	2	-	1
301-325	1	-	-	-	-	-	-	-	2	2	-
326-350	-	-	-	-	-	-	-	-	-	-	-
356-375	-	-	-	-	-	-	-	-	-	-	-
376-400	-	-	-	-	-	-	-	-	-	-	-
Total No. of Schools	14	14	14	12	19	20	13	-	14	4	4
Avg. time in Mins. in each Subject	260	195	179	169	191	188	170	-	262	293	258

Six of the twenty-one schools reporting from the Pilot Area did not offer geography in grade 10 and two schools did not list economics in their regular academic program. All schools in grade 12 provided elective courses in chemistry, physics and mathematics. Only one school did not offer biology to their students. Geology does not form an integral part of the academic program in any of the reporting schools in this area. All subjects at each grade level in this area are within the time allocations suggested by the Department of Education. Science and mathematics subjects exceed the suggested time allocation in all instances. The same pattern is not evident for other subjects within the curriculum of each grade level.

(c) THE LABORATORY FACILITIES AVAILABLE FOR THE TEACHING OF SCIENCE

The curriculum and research section of the Department of Education circulated a questionaire to the high schools in the province requesting information on the laboratory facilities available for the teaching of chemistry, physics and biology. A tabular compilation of the data extracted from this survey was processed by subject for each county under study. The content of the questionaire has been included in this chapter to facilitate examination of this data.

DEPARTMENT OF EDUCATION

CURRICULUM AND RESEARCH SECTION

SURVEY OF HIGH SCHOOL LABORATORY FACILITIES

Name of School	Address of School

Principal Reporting

PLEASE MARK ALL ANSWERS IN BOXES AT RIGHT OF PAGE.

CHEMISTRY LABORATORY FACILITIES

1. Number of laboratory rooms available for teaching Chemistry
2. Number of student stations
   (a) Total pupil stations available in laboratory(ies)
   (b) Number of students who work together on an experiment
   Grade XII
   Grade XI
   (c) Total number of students registered in Grade XII Chemistry
   (d) Total number of students registered in Grade XI Chemistry
3. Number of minutes per week for individual student in laboratory for A. Grade XII
   B. Grade XI
4. The same facilities are also used by: Yes No
   (a) Physics laboratory classes
   (b) Biology laboratory
   (c) Regular home room or other classes
5. Equipment
   (a) Is there sufficient equipment in the student stations?

(b) Are desks supplied with

A. running water?

B. burner gas?

C. electricity?

(c) Is the laboratory equipped with a fume cabinet?

(d) Is there a chemical stockroom?

(e) Is the supply of student balances adequate?

(f) Is there an adequate supply of other apparatus such as electrolysis, atom models, charts, etc.?

PHYSICS LABORATORY FACILITIES

1. Number of laboratory rooms available for teaching Physics
2. Number of student stations
   (a) Total pupil stations available in laboratory(ies)
   (b) Number of students who work together on a laboratory experiment

   Grade XII

   Grade XI
   (c) Total number of students registered in Grade XII Physics

(d) Total number of students registered in Grade XI Physics

3. Number of minutes per week for individual student in laboratory for A. Grade XII

B. Grade XI

		Yes	No
4.	The same facilities are also used by:		
	(a) Chemistry laboratory classes		
	(b) Biology laboratory classes		
	(c) Regular home room or other classes		
5.	(a) How many experiments do you run concurrently in Physics?	Yes	No
	(b) Is it possible to leave equipment assembled in the laboratory when the experiment runs over to a succeeding session?		
6.	Is the stock of apparatus and equipment adequate for the present course?	Yes	No
	(a) Number of AC Voltmeters		
	(b) Number of linear expansion apparatus		
	(c) Number of vernier calipers		
	(d) Number of Hooke's Law apparatus		
	(e) Number of beam balances		

BIOLOGY LABORATORY FACILITIES

1. Number of laboratory rooms available for teaching Biology

2. Number of student stations

   (a) Total pupil stations available in laboratory(ies)

   (b) Number of students who work together on a laboratory experiment in Grade XII

   (c) If Biology is introduced in Grade X as a laboratory oriented course, will present facilities accommodate your anticipated enrolment in Grade X? Yes No

3. Number of minutes per week for individual student in laboratory for Grade XII

4. Equipment

   (a) How many student microscopes do you have in your school?

   (b) How many stereo binocular microscopes do you have in your school?

   (c) Do you have an oil immersion lens for bacteria study? Yes No

   (d) Is your Biology laboratory equipped with a constant temperature oven?

   (e) Do you have a refrigerator in the Biology laboratory?

   (f) Do you have small animal cages and a stock of animals?

(g) Do you have aquaria and terraria?

GENERAL

1. What additional facilities do you foresee as needed in your school?

   (a) Additional laboratories?

      (a) Chemistry (give number of rooms)

      (b) Physics (give number of rooms)

      (c) Biology (give number of rooms)

2. COMMENTS

The total number of pupil stations available in the laboratory was excluded from the tables because the information required was misinterpreted by many teachers who completed the questionaire.

The number of rooms for laboratory work was deleted from the following tables because in practically every instance there was only one room allocated for laboratory work in each subject.

TABLE 10

Chemistry Laboratory Facilities in
(1965-66)

County	No. of Schools	Avg. No. of Students working together		Total No. of Students in Chemistry		Avg. No. of Minutes per Week		The same Facilities are used by						Equipme Adequat
								Physics		Biology		Regular		
		XII	XI	XII	XI	XII	XI	Yes	No	Yes	No	Yes	No	Yes
Antigonish	2	2	2.5	50	184	90	90	1	1	-	2	1	1	2
Cape Breton	14	2.3-2.8	2.6-3.1	510	1246	69.5	62	9	5	2	12	5	9	11
Colchester	5	2	2	173	366	105	75.0	4	1	1	4	3	2	5
Cumberland	7	3-3.7	2.6-3	112	265	71.4	71.5	6	1	4	3	2	5	3
Guysborough	2	2	3	6	64	80	80	2	-	2	-	2	-	1
Inverness	8	2.3	3.1	105	298	69.2	53.1	8	-	3	5	4	4	6
Pictou	6	2	2	214	394	75	61.3	5	1	1	5	0	6	5
Richmond	4	2	2.7	57	123	55	50	2	2	1	3	13	3	1
Victoria	3	10.5	6.3	54	84	55	50	3	-	1	2	2	1	3
Totals	51	3.19	3.03	1281	3024	74.5	65.9	40	11	15	36	20	31	37
Percent Yes								78.4		29.4		39.2		72.5

n the Pilot Area

oment uate No	Desks supplied with Running Water Yes	No	Burner Gas Yes	No	Electricity Yes	No	Lab. is Equipped with Fume Cabinet Yes	No	Chemical Stock Room Yes	No	Adequate Balances Yes	No	Other Equipment Adequate Yes	No
-	2	-	2	-	1	1	2	-	1	1	2	-	1	1
3	14	-	13	1	10	4	6	8	13	1	9	5	6	8
-	5	-	5	-	3	2	3	2	5	0	5	0	4	1
4	7	-	7	-	5	2	2	5	6	1	3	4	2	5
1	2	-	2	-	1	1	1	1	2	-	1	1	1	1
2	8	-	8	-	8	-	1	7	6	2	5	3	5	3
1	6	-	5	1	2	4	4	2	1	5	3	3	1	5
3	4	-	4	-	4	-	2	2	2	2	2	2	1	3
-	3	-	2	1	2	1	2	1	3	-	1	2	-	3
14	51	-	48	3	36	15	23	28	39	12	31	20	21	30
	100		94.1		70.6		45.1		76.5		60.8		41.2	

TABLE 12

Biology Laboratory Facilities in the Pilot
(1965-66)

County	No. of Schools Reporting	No. of Students working together XII	Ques. 2C Yes	No	Min./Wk.	Micro-scopes /School	Stereo Bino-cular Micro-scopes/ School	Laboratory Equ: Oil Immersion Lens Yes	No	Temp. Control Oven Yes	No	Refrige Yes
Antigonish	2	2	-	2	80-100	7	0	1	1	0	2	0
Cape Breton	12	2.4	1	11	62	5.8	0.083	-	12	-	12	0
Colchester	5	2	2	3	74	8.6	0.6	2	3	-	5	-
Cumberland	6	2.5-4	2	4	85	8.6	.333	1	5	-	6	-
Guysborough	3	2.5	-	3	80	1.7	0	1	2	-	3	-
Inverness	6	2	3	3	85	3.3	.5	1	5	1	5	1
Pictou	6	1.8	2	4	52-56	7.3	0	-	6	-	6	1
Richmond	3	1	1	2	50	4	0	-	3	1	2	-
Victoria	2	6	-	2	80	2	0	-	2	-	2	-
Totals or Average	45	3.1	11	34	73.3	5.4	0.168	6	39	2	43	2
Percent Yes			24.4					13.3		4.44		4.44

TABLE 12

y Facilities in the Pilot Area
(1965-66)

Laboratory Equipment												
Oil mmersion Lens es		Temp. Control Oven		Refrigerator		Small Animal Cages			Aquaria and Tenaria		Need Additional, Facilities, Rooms		
	No	Yes	No	Yes	No	Yes		No	Yes	No	Chemistry	Physics	Biology
	1	0	2	0	2	0		2	0	2	-	-	-
	12	-	12	0	12	-		12	1	11	5	6	6
	3	-	5	-	5	-		5	3	2	4	5	5
	5	-	6	-	6	-		6	1	5	5	4	4
	2	-	3	-	3	1		2	-	3	1	2	3
	5	1	5	1	5	-		6	2	4	1	3	3
	6	-	6	1	5	-		6	2	4	1	2	4
	3	1	2	-	3	-		3	1	2	-	-	-
	2	-	2	-	2	-		2	-	2	-	1	1
	39	2	43	2	43	1		44	10	35	17	23	26
3		4.44		4.44		2.22			22.2		37.7	51.1	57.7

A separate discussion of the laboratory facilities offered in each science subject reveals the following general information.

I. CHEMISTRY LABORATORY FACILITIES

(a) The majority of the schools (78.4%) use the facilities of the Chemistry laboratory for instruction in Physics. These facilities are also used by 29.4% of the schools for Biology and 39.2% for regular academic classes.

(b) Each laboratory desk is shared by an average of three students in both grade 11 and 12.

(c) Three in every four schools, on an average basis, have reported that present equipment is adequate to conduct experimentation but only two of every five schools have an adequate supply of other equipment needed in the normal academic program.

(d) There is a serious shortage of fume hood facilities with 55% of the schools lacking an adequate ventilation system.

(e) Separate storage facilities for chemicals is not a serious problem; 25% of the schools lack storage capacity.

(f) Each desk is well-equipped with running water and burners in practically all schools but lack of electrical outlets exists in 30% of the schools.

Balances are urgently required in two of every five schools which reported.

II. PHYSICS LABORATORY FACILITIES

(a) Physics laboratories are shared by Chemistry classes in 71.2% of the schools. 27% of the schools use these facilities for Biology and 40.4% of the regular classes also use the Physics laboratory.

(b) Three students share each laboratory desk in grade 11 while approximately 3-1/2 students work at each laboratory bench in grade 12.

(c) There is a serious shortage of laboratory equipment in seventy percent of the schools in this area. An examination of the average number of balances, voltmeters and vernier calibers would appear to support the generally poor level of equipment present in these schools.

(d) The fact that only 43.1% of the schools can leave equipment assembled for incoming classes is not unrealistic in view of the sharing of the Physics facilities by other science and regular classes.

III. BIOLOGY LABORATORY FACILITIES

(a) The general laboratory program in Biology in 70% of the schools utilizes the facilities of laboratories other than Physics and Chemistry.

These statistics do not indicate the nature of these facilities. However present facilities in 75% of the schools would be inadequate if a laboratory orientated Biology course was introduced in grade 10.

(b) An average of three students are working at each laboratory desk in the grade 12 laboratory program.

(c) 14% of the schools which replied to the questionaire did not offer biology as an elective science subject in grade 12.

(d) A very serious shortage of the basic biology equipment which was listed in the questionaire existed in more than three-quarters of the schools in this area. The average number of microscopes (5.4) suggests that these instruments must be shared by numerous students at each lab desk.

The extent of the laboratory facilities in grade 11 and 12 science in the Pilot Area can be summarized.

1. Each science subject does not have separate laboratory facilities. The chemistry laboratory is used for experiments in physics in more than seventy percent of the schools. To a lesser extent these facilities are also used for biology and regular classes.

2. The equipment is inadequate in the physics and biology laboratories. The chemistry laboratories have adequate equipment in most schools but additional equipment is required in more than 50 percent of the schools. Additional fume hood facilities are urgently needed in most chemistry laboratories.
3. Additional biology and physics facilities are required in more than fifty percent of the schools in this area. The need is not as acute in the field of chemistry.
4. There are approximately three students at each laboratory desk performing the required experiments in each science subject.

(d) THE QUALIFICATION OF SCIENCE TEACHERS

The Department of Education required each teacher in the province to complete a report on their qualifications, salary and experience at the commencement of the academic school year 1965-66. A sample of this form is included in this section of the chapter.

The Dominion Bureau of Statistics computerized this information on separate punch cards for each teacher in Nova Scotia. At the time of writing of this thesis the Department of Education had not extracted, in tabular form, the information located on each card. Duplicate cards were processed on all teachers of science in grades 10-12 in Nova Scotia. Information pertinent to the qualifications of science teachers was extracted from each card using the facilities of a data processing center. The tables listed below including tables found in succeeding chapters are the products of this analysis.

The tables constructed for each area under study contain the number of university credits obtained by each teacher in the specific science subject taught and the number of years teaching experience in that subject. Each teacher is classified in a specific grade level according to the following code:

1. grade Level one - Grades 11 and/or 12
2. grade Level two - Grades 9 and/or 10
3. grade Level three - Grades 9/10 to 11/12

The average number of credits was computed for all teachers in each subject area to obtain a more accurate assessment of teacher qualifications. The qualifications of science teachers will be examined for each subject.

I. The Qualifications of Mathematics Teachers

(a) Teachers of grade level one are the most qualified with an average of 3.1 credits per teacher. In this category, one-half of the teachers have obtained three or more university credits in mathematics.

(b) The teachers in grade level two, which constitutes the majority of mathematics teachers, are the least qualified with 1.5 credits per teacher.

(c) Consideration of teacher qualifications at all levels combined produces an average of 2.2 credits per teacher. 79 teachers, or thirty percent, in this general grouping have obtained more than three university credits in mathematics.

(d) The majority of teachers (over 60%) have been teaching for less than ten years.

II. The Qualifications of Physics Teachers

Seventy one teachers were involved with instruction in Physics courses in the Pilot Area. The Qualifications of these teachers reveals the following general data.

(a) Teachers in grade level three had the greatest number of average credits, 2.7. 53% of these teachers had failed to obtain more than two university credits in Physics.

(b) No significant difference was evident statistically in the average number of credits for teachers in grade level one and two. However the differences in the averages of the least qualified (grade level two) and the most qualified represented a difference of one full university credit.

(c) Teachers in all grade levels possessed an average of 1.9 credits. Generally, this average signified that twenty-eight percent of all teachers obtained three or more university credits in Physics.

(d) Seventy-two percent of the teachers in grade level one and all teachers in the remaining grade levels have been teaching for a period less than ten years.

III. The Qualifications of Chemistry Teachers

The majority of the seventy-two Chemistry Teachers in the Pilot Area were located in grade level one. The following information was extracted using the data provided in Table 15.

(a) Teachers of grade level one appeared to be the most qualified with an average of 3.4 credits

for each teacher. This average reflected the fact that approximately seventy-nine percent of the teachers possessed three or more university credits in Chemistry.

(b) Teachers in grade level two were least qualified averaging 2 university credits per teacher.

(c) The average number of credits for all grade levels, 3.2, indicated that fifty percent of all chemistry teachers in this area had obtained at least three university credits in this subject.

(d) The vast majority of teachers instructing this subject had been employed in this profession for periods ranging from one to ten years.

IV. The Qualifications of Biology Teachers

Biology teachers represent the smallest group of science teachers in this area because this course is only offered in grade 12. The following observations have been recorded from the data in Table 16.

(a) Grade level one teachers had obtained the largest number of university credits in biology, averaging 3.8 credits per teacher. Eighty-six percent of the teachers at this level had successfully completed a minimum of three university courses in biology.

(b) The teachers in the other grade levels possessed considerably fewer credits with grade level three teachers, the least qualified.

(c) The average number of credits of teachers in all grade levels was 2.7. Approximately forty percent of these teachers obtained three or more university credits in biology.

(d) Eighty percent or more of all teachers had been teaching for less than ten years.

Certain general trends are evident after completing this subject examination of teacher qualifications.

Considering all grade levels combined, chemistry teachers are the most qualified in all fields which were examined and these teachers were the only group who, on average basis, had successfully completed a minimum of three university courses in the subject they were teaching. Physics teachers, on the other hand, possessed the least number of university credits in their subject field. An examination of the average number of years teaching experience relative to the number of university credits produces a similar trend in all subjects; namely, the teachers with the greatest teaching experience are the least qualified in their subject field. The majority of science teachers in the Pilot Area have been teaching for less than ten years.

TABLE 13

Qualifications of Mathematics Teachers in the Pilo
(1965-66)

No. of Credits	Grade Level 1			Grade Level 2				
	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Te /Nc Cre
8	1	1.85	20	2	1.43	7.5	4	5
7	3	5.56	16.3	1	0.71	14	4	5
6	6	11.11	13.1	0	0	0	3	4
5	4	7.41	10.8	6	4.28	10.7	2	2
4	5	9.26	13	6	4.28	8.2	4	5
1	8	14.81	9.1	10	7.14	7.1	10	14
2	15	27.78	8.3	27	19.28	6.5	19	26
1	9	16.67	7.9	54	38.56	5.9	17	23
0	3	5.55	8	34	24.28	6.5	8	11
Avg. No. Credits	3.1			1.5			2.7	
Total No. Teachers	54			140			71	

Teaching Exp. in Yrs.	% Teachers per No. of Years Teaching	Teaching Exp. in Yrs.	% Teachers per No. of Years Teaching	Teaching Exp. in Yrs.	% Te per Ye Tea
1-5	38.9	1-5	60.7	1-5	
6-10	25.9	6-10	16.4	6-10	
11-15	11.1	11-15	9.3	11-15	
16-20	11.1	16-20	8.6	16-20	
21-25	5.6	21-25	3.6	21-25	
26-30	3.7	26-30	0.7	26-30	
31+	3.7	31+	0.7	31+	

TABLE 28

ications of Mathematics Teachers in the Pilot Area
(1965-66)

Grade Level 2					Combined Grade Levels
% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	
1.43	7.5	4	5.63	20.3	7
0.71	14	4	5.63	16	8
0	0	3	4.22	3	9
4.28	10.7	2	2.82	0	12
4.28	8.2	4	5.63	8	15
7.14	7.1	10	14.08	10.7	28
19.28	6.5	19	26.75	7.4	61
38.56	5.9	17	23.94	11.5	80
24.28	6.5	8	11.26	12	45
		2.7			2.2
		71			

% Teachers per No. of Years Teaching	Teaching Exp. in Yrs.	% Teachers per No. of Years Teaching
60.7	1-5	36.6
16.4	6-10	23.9
9.3	11-15	15.5
8.6	16-20	9.9
3.6	21-25	8.5
0.7	26-30	2.8
0.7	31+	2.8

TABLE 14

Qualifications of Physics Teachers in the Pilot Area
(1965-66)

	Grade Level 1			Grade Level 2				Grade Le
No. of Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Tea /No. Cred
8	0	0	0	6	0	0	7	0.
7	1	1.72	8	0	0	0	0	0
6	0	0	0	0	0	0	1	14.
5	2	3.45	4.5	0	0	0	0	0
4	5	8.62	8.6	0	0	0	0	0
3	6	10.34	10.1	2	33.33	4.5	1	14.
2	13	22.41	14.6	1	16.67	2	2	28.
1	26	44.82	7.3	2	33.33	2.5	0	0
0	5	8.62	1	1	16.67	3	2	28.
							1	14.
Avg. No. Credits	1.9			1.7			2.7	
Total No. Teachers	58							

Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Te /No. Tea
1-5	48.3	1-5	83.3	1-5	7
6-10	24.14	6-10	16.7	6-10	2
11-15	13.79	11-15	0	11-15	
16-20	1.72	16-20	0	16-20	
21-25	3.45	21-25	0	21-25	
26-30	3.45	26-30	0	26-30	
31+	5.17	31+	0	31+	

TABLE 14

s of Physics Teachers in the Pilot Area
(1965-66)

e Level 2			Grade Level 3		Combined Gr. Levels
Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit
0	0	7	0	0	71
0	0	0	0	0	0
0	0	1	14.29	5	2
0	0	0	0	0	0
0	0	0	0	0	2
33.33	4.5	1	14.29	8	6
16.67	2	2	28.58	1	10
33.33	2.5	0	0	0	14
16.67	3	2	28.58	3.5	30
		1	14.29	8	7
		2.7			1.9

Teachers No. of Yrs. Teaching	Teaching Exp.	% Teachers /No. of Yrs. Teaching
83.3	1-5	71.4
16.7	6-10	28.6
0	11-15	0
0	16-20	0
0	21-25	0
0	26-30	0
0	31+	0

TABLE 15

Qualifications of Chemistry Teachers in the Pilot Area (1965-66)

	Grade Level 1			Grade Level 2			Grade Leve	
No. of Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teach /No. o Credit
8	3	5.45	26	0	0	0	0	0
7	5	9.09	17	0	0	0	1	8.33
6	1	1.82	7	0	0	0	0	0
5	5	9.09	6	0	0	0	0	0
4	8	14.54	5.5	0	0	0	3	24.99
3	11	20.00	6.2	2	40.00	8.5	2	16.66
2	9	16.36	10.5	1	20.00	10	3	24.99
1	12	21.82	10.7	2	40.00	5.5	3	24.99
0	1	1.82	0	0	0	0	0	0
Avg. No. Credits	3.4			2.0			2.8	
Total No. Teachers	55			5			12	

Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teach /No. of Teachi
1-5	49.09	1-5	40	1-5	58.3
6-10	16.36	6-10	40	6-10	33.3
11-15	10.91	11-15	20	11-15	0
16-20	3.64	16-20	0	16-20	8.1
21-25	0	21-25	0	21-25	0
26-30	3.64	26-30	0	26-30	0
31+	9.09	31+	0	31+	0

TABLE 15

ns of Chemistry Teachers in the Pilot Area
(1965-66)

ade Level 2			Grade Level 3		Combined Gr. Levels
% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit
0	0	0	0	0	3
0	0	1	8.33	1	6
0	0	0	0	0	1
0	0	0	0	0	5
0	0	3	24.99	4	11
40.00	8.5	2	16.66	0	15
20.00	10	3	24.99	10	13
40.00	5.5	3	24.99	5.3	17
0	0	0	0	0	1
		2.8			3.2
		12			72

% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teachers /No. of Yrs. Teaching
40	1-5	58.3
40	6-10	33.3
20	11-15	0
0	16-20	8.4
0	21-25	0
0	26-30	0
0	31+	0

TABLE 16

Qualifications of Biology Teachers in the Pilot Area

No. of Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. of Years Teaching /Credits	No. of Teachers /Credit	% Teache /No. of Credits
8	2	10.00	1.5	2	15.38	1	0	0
7	2	10.00	8	0	0	0	0	0
6	2	10.00	3	0	0	0	0	0
5	1	5.00	13	0	0	0	0	0
4	2	10.00	8	0	0	0	0	0
3	5	25.00	2	0	0	0	0	0
2	2	10.00	10	1	7.69	1	0	0
1	2	10.00	2.5	5	38.45	3	2	40.00
0	2	10.00	1	5	38.48	4	3	60.00
Avg. No. Credits	3.8			1.8			0.4	
Total No. Teachers	20			13			5	

Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teachers /No. of Yrs. Teaching	Teaching Exp.	% Teache /No. of Teachin
1-5	65.00	1-5	100	1-5	80
6-10	20.00	6-10	0	6-10	0
11-15	15.00	11-15	0	11-15	0
16-20	0	16-20	0	16-20	0
21-25	0	21-25	0	21-25	0
26-30	0	26-30	0	26-30	20
31+	0	31+	0	31+	0

TABLE 16

cations of Biology Teachers in the Pilot Area

rs t	% Teachers /No. of Credits	Avg. No. of Years Teaching /Credits	No. of Teachers /Credit	% Teachers /No. of Credits	Avg. No. Yrs. Teaching /Credits	Combined Gr. Levels No. of Teachers /Credit
	15.38	1	0	0	0	4
	0	0	0	0	0	2
	0	0	0	0	0	2
	0	0	0	0	0	1
	0	0	0	0	0	2
	0	0	0	0	0	5
	7.69	1	0	0	0	3
	38.45	3	2	40.00	2.5	9
	38.48	4	3	60.00	11	10
			0.4			2.7
			5			38

ing	% Teachers /No. of Yrs. Teaching	Teachin Exp.	Teachers No. of Yrs. Teaching
	100	1-5	80
0	0	6-10	0
5	0	11-15	0
0	0	16-20	0
5	0	21-25	0
0	0	26-30	20
	0	31+	0

(e) THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATIONS IN GRADES 11 AND 12

The Department of Education does not maintain a statistical record of the number of students in each county who were successful in each subject in the provincial examinations. Using coded minute sheets provided by the Registrar's Division of the Department of Education, a statistical tabulation was made of the number of students who were successful in science subjects in each county with a mark of fifty percent constituting a pass. A student's laboratory book in physics, chemistry and biology, if certified constitutes twenty percent of the final provincial mark. The mark that a student obtains in one of these three exams is the sole mark in schools where no laboratory mark is submitted to the Department of Education.

Tables showing the results of this research were constructed for each area under study. Each county was designated by a letter in accordance with stipulations established by the Department of Education for the release of this information.

The results of the provincial examinations indicate that mathematics has created the most difficulty in grade 11. It is interesting to note that physics students were more successful than chemistry students at this grade level although the former were handicapped by less adequate

facilities and less qualified teachers. Chemistry and mathematics students improved their standing in these subjects in the grade 12 examinations. The percentage pass rate in biology is unusually high in relationship to other science subjects at this grade level.

TABLE 17

The Success of Science Students in Provincial Exam

Grade XI — the Academic Year 1964-65 Pilot Area

County	Chemistry		Physics		Algebra		Geometry		Chemistry		Physics	
	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. Pass
A	275	219	176	141	182	125	179	110	49	39	33	24
B	325	275	313	269	390	286	363	234	159	138	85	67
C	314	219	307	255	373	276	371	267	153	121	125	92
D	1285	852	1277	1012	1361	1037	1411	753	475	355	512	378
E	65	33	77	42	89	45	79	21	31	17	21	15
F	233	127	232	171	284	175	262	134	90	58	69	53
G	475	341	472	407	472	355	455	308	205	169	157	131
H	114	72	99	72	111	77	108	73	46	41	49	44
I	96	64	91	76	100	79	98	68	41	26	32	20
Totals	3182	2202	3044	2445	3362	2455	3326	1968	1249	964	1083	824
Percentage Pass	69.1		80.3		73.0		59.1		77.2		76.0	

al Examinations in
Area

Grade XII

ysics		Biology		Geology		Algebra		Geom.-Trig.	
f	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes
	24	22	18	5	5	50	33	48	42
	67	103	98	7	4	159	108	160	115
	92	94	91	9	7	192	130	154	108
	378	184	172	28	17	524	382	512	371
	15	15	14	1	1	20	13	22	13
	53	31	23	10	8	87	67	90	65
	131	101	96	10	6	212	141	186	145
	44	4	4	0	0	49	38	49	41
	20	7	7	2	0	35	26	35	31
	824	561	523	72	48	1328	938	1256	931
6.0		93.2		66.6		70.6		74.1	

CHAPTER IV

An Examination of Science Education in Grades 10-12 in Area A

(a) THE ENROLMENT IN SCIENCE SUBJECTS

Table 18 reveals that over ninety percent of all grade 10 students are selecting science and mathematics as elective courses. In grade 11 approximately eight out of every ten students have selected both mathematics and science (physics and chemistry) as their elective choices. Economics is the third elective choice of over eighty percent of the students. In grade 12 the science subjects are full credit courses; each having the same value as the other subjects in the curriculum. The separation of science into the various subject headings provides some difficulty in the interpretation of the more students selecting one or more sciences than other academic subjects in the elective field.

TABLE 18

Subject Enrolment in Grade X in Area A (1964-65)

County	Eng.	Fr.	Ger.	Latin	Greek	Geog.	Hist.	Sci.	Agric.	Gen. Math.	Alg.	Geom.
Annapolis	282	181	0	33	0	163	282	278	0	31	241	241
Digby	205	152	0	31	0	117	246	205	0	24	180	180
Hants	421	291	0	29	0	346	421	415	0	0	410	410
Kings	566	425	94	29	0	372	566	548	0	45	511	511
Lunenburg	500	301	59	18	0	301	471	470	0	0	465	465
Queens	187	124	0	14	0	177	187	186	0	33	154	154
Shelburne	211	144	38	12	0	155	211	211	0	0	202	202
Yarmouth	365	356	0	55	0	221	365	365	0	0	353	352
TOTAL	2737	1974	191	221	0	1852	2749	2678	0	133	2516	2515

TABLE 19

Subject Enrolment in Grade XI in Area A (1964-65)

County	Eng.	Fr.	Ger.	Latin	Greek	Econ.	Hist.	Gen. Sci.	Phys.	Chem.	Agric.	Gen. Math.	Alg.	Geom.
Annapolis	308	135	0	36	0	186	267	42	200	204	0	42	209	208
Digby	141	99	0	19	0	127	171	0	116	111	0	32	117	114
Hants	314	211	0	18	0	308	316	0	217	224	1	0	286	283
Kings	473	320	81	17	0	295	461	29	321	397	0	30	401	401
Lunenburg	351	209	26	15	0	321	307	0	322	333	22	0	326	322
Queens	155	101	0	10	0	152	158	40	107	107	1	43	117	117
Shelburne	179	119	1	11	0	163	175	0	144	145	0	0	160	160
Yarmouth	301	233	0	37	0	259	309	0	267	269	5	0	277	271
TOTAL A	2222	1427	108	158	0	1811	2164	111	1694	1790	29	147	1893	1876

TABLE 20

Subject Enrolment in Grade XII in Area A (1964-65)

County	Eng.	Fr.	Ger.	Latin	Modern World Prob.	Hist.	Sci.	Bi.	Phys.	Chem.	Geol.	Agric.	Math.	Alg.	Trig.
napolis	112	72	0	15	25	110	7	36	68	75	0	0	7	59	93
gby	65	34	0	8	14	60	32	6	22	42	0	0	0	48	49
nts	137	85	0	5	64	138	0	44	84	103	0	0	0	110	110
ngs	254	120	20	0	119	250	31	65	142	164	0	0	7	194	194
nenburg	113	55	0	1	27	90	0	38	71	60	20	3	25	76	69
eens	75	41	0	2	37	76	5	26	49	59	0	2	5	59	59
elburne	57	38	0	3	20	60	0	35	28	38	8	0	0	39	39
rmouth	159	119	1	26	56	156	0	104	75	126	0	1	0	100	100
TAL	972	564	21	60	362	940	75	354	539	667	28	6	44	685	713

(b) THE RATIO OF TIME ALLOCATED TO SCIENCE SUBJECTS IN RELATIONSHIP TO OTHER COURSES IN THE CURRICULUM

Letters were forwarded to the principals of the forty-three senior high schools in Area A. Thirty percent of these schools forwarded complete time tables and an additional 19.5 percent provided information on the amount of time allocated to science subjects. The average time in minutes each week devoted to science subjects exceeds the time allocation suggested by the Department of Education for the three grade levels. The same situation does not exist for the other subjects included in these tables although no subject falls below the specified time allocations. A similar pattern was evident in the schools of the Pilot Area. Wide discrepancies are visible in the subject time allotments for each school in Area A.

TABLE 21

Distribution of Subject Time in Grade X
in Area A (1965-66)

Time	Eng.	Hist.	Fr.	Geog. Econ.	Acad. Sci.	Gen. Sci.	Acad. Math.	Gen. Math.
75-100	-	-	-	-	-	-	-	-
101-125	1	1	1	1	-	-	-	-
126-150	-	-	2	2	1	-	-	-
151-175	0	5	4	4	6	1	-	-
176-200	1	6	3	3	7	4	-	-
201-225	1	-	1	1	3	1	1	-
226-250	1	-	-	-	-	-	3	3
251-275	8	-	1	-	-	-	5	3
276-300	-	-	-	-	-	-	1	-
301-325	-	-	-	-	-	-	2	1
326-350	-	-	-	-	-	-	-	-
351-375	-	-	-	-	-	-	-	-
376-400	-	-	-	-	-	-	-	-
TOTAL	12	12	12	11	17	6	12	7
Avg. in Min.	242	169	185	162	184	204	266	268

TABLE 22

Distribution of Subject Time in Grade XI
in Area A (1965-66)

Time	Eng.	Hist.	Fr.	Econ.	Acad. Sci.	Gen. Sci.	Math.	Gen. Math.
75-100	-	-	-	-	-	-	-	-
101-125	-	-	-	-	-	-	-	-
126-150	-	-	1	2	-	-	-	-
151-175	-	4	5	7	-	-	-	-
176-200	1	4	2	4	-	2	-	1
201-225	-	4	4	-	-	-	1	-
226-250	4	-	1	-	-	1	2	-
251-275	4	1	-	-	2	-	6	1
276-300	2	-	-	-	3	-	2	1
301-325	2	-	-	-	6	-	2	-
326-350	-	-	-	-	2	-	-	-
351-375	-	-	-	-	5	-	-	-
376-400	-	-	-	-	-	-	-	-
TOTAL	13	13	13	13	18	3	13	3
Avg. in Min.	263	195	199	163	322	215	266	258

TABLE 23

Distribution of Subject Time in Grade XII in Area A (1965-66)

Time	Eng.	Hist.	Fr.	World Problems	Phys.	Chem.	Biol.	Geol.	Math.	Gen. Sci.	Gen. Math.
75-100	-	-	-	-	-	-	-	-	-	-	-
101-125	-	-	-	-	-	-	-	-	-	-	-
126-150	-	-	1	-	-	-	-	-	-	-	-
151-175	-	2	4	3	3	3	1	-	-	-	-
176-200	-	5	-	3	7	7	5	-	-	1	1
201-225	-	3	3	1	3	4	4	1	-	-	-
226-250	4	-	2	-	-	-	-	-	3	-	-
251-275	2	-	-	-	1	-	1	-	4	-	-
276-300	2	-	-	-	-	-	-	-	1	-	-
301-325	2	-	-	-	-	-	-	-	2	-	-
326-350	-	-	-	-	-	-	-	-	-	-	-
351-375	-	-	-	-	-	-	-	-	-	-	-
376-400	-	-	-	-	-	-	-	-	-	-	-
TOTALS	10	10	10	7	14	14	11	1	10	1	1
Avg. in Min.	270	193	188	182	198	192	204	225	268	200	200

(c) THE LABORATORY FACILITIES AVAILABLE FOR THE TEACHING OF SCIENCE

The information contained in Tables 24-26 was extracted from the same questionaire which was forwarded to the schools in the Pilot Area.

A separate examination of the facilities in each science subject included in Tables 24-26 will be undertaken.

I. Chemistry Laboratory Facilities

(a) 68.2% of the schools use the facilities of one laboratory to conduct experimentation in physics as well as chemistry. 38.6% of the schools use the laboratory facilities in chemistry for instruction in biology and 27.3% use these facilities for regular classes.

(b) Laboratory desks are being used by an average of 2.7 students for grade 11 chemistry and 2.3 students for the grade 12 course.

(c) Fume hood facilities are installed in three quarters of the schools teaching chemistry in this area.

(d) Stock room facilities for the storage of chemicals is satisfactory in the majority of schools with approximately 7 out of 10 laboratories possessing this facility.

(e) Running water and gas outlets are supplied at each desk in practically all schools in this area. A lack of electrical outlets at each desk was reported by 31.8% of the schools. The most serious deficiency at individual

desks is the inadequacy of present balances. 52.3% of the schools specified an urgent need for more balances.

II. Physics Laboratory Facilities

(a) The majority of schools (63.6%) use one laboratory for instruction in physics and chemistry. Biology classes use the physics laboratory to a lesser degree (38.6%) while regular class sessions are held in the physics laboratory in 36.4% of the schools.

(b) The larger student enrolment in grade 11 is reflected in the average number of students using each laboratory desk. An average of 3.2 students are working together in grade 11 while 2.8 students operate at each desk in grade 12.

(c) There is a serious shortage of laboratory equipment in the schools in Area A. Examination of the statistics reveals that 72.7% of the schools reported that the stock of equipment and apparatus was inadequate. The majority of schools, for example, reported possessing fewer than three voltmeters and four balances.

(d) The shortage of equipment is related to the fact that only 34.1% of the schools were able to leave equipment assembled for demonstration to future classes.

III. Biology Laboratory Facilities

(a) 14% of the schools in this area did not offer a biology program in grade 12.

(b) Biology laboratory facilities were separate from physics and chemistry in the majority of schools. In these schools the biology laboratory could be used as a general science laboratory for grade 10 students. Present biology facilities would not be adequate to absorb a laboratory orientated course in biology at the grade 10 level. 28.6% of the schools are capable of making this adjustment.

(c) 2.2 students, on an average basis, are employed at each laboratory desk in grade 12.

(d) The general equipment level is inadequate in most schools. Approximately one-half of the schools have their own refrigerator and possess some aquaria and terraria. The average number of microscopes for each county exceeds six in number with the schools in Kings county affecting this figure averaging 13 microscopes per school.

The laboratory facilities in Area A can be briefly summarized.

1. There is an average of less than three students conducting experimentation at each laboratory desk.
2. Between sixty and seventy percent of the chemistry laboratories in this area are utilized by physics students and less than one-third are used for biology and regular classes. Most schools in this area do not provide separate facilities for each science subject.

3. The majority of laboratories in each of the sciences are inadequately equipped to conduct the prescribed laboratory program. Chemistry laboratories appears to suffer least in this regard.
4. Additional chemistry facilities are required in one-third of the schools and forty-two percent of the schools require additional physics laboratories. The need is most critical in biology where two-thirds of the schools require laboratory space.

TABLE 24

Chemistry Laboratory Facilities in Area

County	No. of Schools Reporting	Avg. No. of Students Working Together		Total No. of Students in Chem.		Avg. No. of Minutes per Week for Individual		The same Facilities are used by						Equipm Adequa
		XII	XI	XII	XI	XII	XI	Biology XII	Biology XI	Physics XII	Physics XI	Regular XII	Regular XI	Yes
Annapolis	4	2	2	79	189	103	95	-	4	2	2	1	3	4
Digby	4	2.33 2.66	2.75 3.25	75	180	75	59	2	2	4	-	2	2	1
Halifax	8	2.5 3.0	3.5 4.0	258	797	78	59	2	6	3	5	-	8	2
Hants	6	1.8	2.2	107	265	81	74	1	5	4	2	1	5	6
Kings	7	1.8	2	217	378	90	84	2	5	5	2	2	5	3
Lunenburg	8	3.1 4.50	4.25 4.50	142	353	88	73	5	3	7	1	3	5	5
Queens	2	2	2	52	100	90	90	-	2	1	1	-	2	2
Shelburne	3	2	3.3	38	139	85	98	3	-	3	-	1	2	-
Yarmouth	2	2.5	2	90	214	80	80	2	-	1	1	2	-	2
Totals or Avg. No.	44 4.9	2.23 2.31	2.66 2.80	1058 117	2615 290.6			17	27	30	14	12	32	25
Percent Yes						85.6	79.1	38.6		68.2		27.3		56

A (1965-66)

nt e No	Desks supplied with						Lab. is Equipped with Fume Hood		Chemical Stock Room		Adequate Balances		Other Equipment	
	Running Water		Burner Gas		Electricity									
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
-	4	-	4	-	2	2	4	-	3	1	4	-	3	1
	3	1	4	-	1	3	2	2	2	2	1	3	1	3
	8	-	8	-	5	3	4	4	5	3	3	5	1	7
	6	-	6	-	6	-	6	-	6	-	4	2	3	3
	7	-	7	-	5	2	5	2	5	2	3	4	2	5
	8	-	8	-	8	-	7	1	4	4	3	5	1	7
	2	-	2	-	0	2	2	-	2	-	1	1	-	2
	3	-	2	1	2	1	2	1	3	-	1	2	1	2
	2	-	2	-	1	1	1	1	2	-	1	1	1	1
9	43	1	43	1	30	14	33	11	32	12	21	23	13	31
	97.7		97.7		68.2		75.0		72.7		47.7		29.5	

TABLE 25

Physics Laboratory Facilities in Are

County	No. of Schools Reporting	Avg. No. of Students Working Together		Total No. of Students in Physics		Avg. No. of Minutes per Week for Individual		The same Facilities are used by						Ques.	
								Chemistry		Biology		Regular		Yes	No
		XII	XI	XII	XI	XII	XI	Yes	No	Yes	No	Yes	No		
Annapolis	4	3	3.3	69	187	103	95	1	3	2	2	2	2	1	3
Digby	4	2.3-2.7	3-3.3	54	174	75	58.8	4	-	2	2	3	1	1	3
Hants	6	2.4	2.3-2.5	64	235	81.2	74.3	4	2	2	4	1	5	4	2
Kings	7	2-2.4	2-2.3	131	352	90	64.3	5	2		7	2	5	2	5
Lunenburg	8	3.1-3.3	3-3.6	118	337	88-91	59.4-63	7	1	5	3	3	5	2	6
Queens	2	2-2.5	2-3	123	97	90	90	1	1	-	2	1	1	1	1
Shelburne	3	3.5	4	28	139	75	97	2	1	2	1	2	1	1	2
Yarmouth	2	3.5	4	56	214	80	80	1	1	1	1	2	8		2
Hfx. Co. Excl. Hfx.-Dart.	8	2.7-3	3.9-4.8	213	792	73.1	56.1	3	5	3	5		8	3	5
TOTALS	44	2.72-2.92	3.06-3.42	856	2527	83.9	75.0	28	16	17	27	16	28	15	29
				95.1	280.7										
Percent Yes								63.6		38.6		36.4		34.1	

Avg. No. of Experiments Run Con-Currently in Physics	Equipment Adequate		Average Number of				
	Yes	No	AC Volt Meters	Linear Expansion Apparatus	Vernier Calibers	Hooke's Law Appar.	Beam Balances
1.3-1.5		4	0.25	2.7	5.3	0.5	4.3
1	1	3	1.3	1	6.5	0.25	3.3
1.6	2	4	2.2	0.83	4.5	2.2	5.1
2.5	5	2	2.1	2.4	4.3	1.9	12
2.1	2	6	0.75	1.3	2	0.63	2.4
3	1	1	0.5	1	1	0.5	4
2		3	2.3	1.3	6.3	0.67	6.5
1		2	2.5	1.5	1	1	3.5
2.1	1	7	1.6	1.8	3.3	0.75	3.7
1.86	12	32	1.5	1.54	3.8	0.93	3.76
	27.3						

TABLE 26

Biology Laboratory Facilities in Ar

County	No. of Schools Reporting	No. of Rooms	No. of Students Working Together XII	Ques. 2C Yes	Ques. 2C No	Min./Wk. XII	Stereo Binocular Micro-scopes /School	Oil Immersion Lens Yes	Oil Immersion Lens No	Temp. Control Oven Yes	Temp. Control Oven No	Ref Yes
Annapolis	3	1	2	-	2	87	0.33	1	2	-	3	-
Digby	2	1	2.5	-	2	42.5	1.5	1	1	1	1	-
Hants	5	1	2	3	2	84	0.40	2	3	-	5	-
Lunenburg	7	1	2.4-2.6	2	5	78.3	0.14	1	6	-	7	-
Kings	7	1	2	4	3	84	0.29	1	6	-	1	-
Queens	1	1		-	-	84	0.29	-	-	-	3	-
Shelburne	3	1	1.7-2.7	-	3	88	-	-	3	1	1	-
Yarmouth	2	1	2	-	2	80	-	-	2	2	5	2
Hfx. Co. excl. Hfx.-Dart.	8	1	2.3-2.8	1	6	69	-	-	8	-	8	-
TOTALS	38	1	2.2	10	25	76.6	0.129	6	31	4	34	2
% Yes				28.6				16.2		10.5		52.

igerator	Small Animal Cages		Aquaria and Terraria		Micro-scopes /School	Need additional Facilities		
						Chemistry	Physics	Biology
No	Yes	No	Yes	No				
3		3	2	1	7	-	-	2
2	1	1	1	1	5	2	3	2
5	1	4	3	2	5.2	-	1	2
7	1	6	3	4	4.6	3	6	5
1	-	1	-	1	3	-	-	-
3	-	3	2	1	4.3	-	-	2
2	-	2	-	2	7.5	2	2	2
5	1	6	6	1	13	3	2	3
8	-	8	2	6	8.4	3	2	7
36	4	34	19	19	6.4	13	16	25
6	10.5		50			34.2	42.1	65.9

(d) THE QUALIFICATIONS OF SCIENCE TEACHERS

An examination of teacher qualifications in science will be undertaken for Area A using Tables 27-30 as sources of data.

Each table will be examined separately to isolate the qualifications of teachers in specific science subjects in grades 9-12.

I. The Qualifications of Mathematics Teachers

Table 27 reveals that there are 171 Mathematics teachers employed in Area A. Analysis of grade level qualifications suggests the following general conditions exists in the area of mathematics.

(a) The teachers in grade level one, comprise the fewest number of teachers but possess the largest number of university credits, 4.2, of any grade level in this area.

(b) Grade level two, which includes the largest number of teachers, is the least qualified level of teacher classification with an average of 2.1 credits for each teacher.

(c) The average number of credits for all mathematics teachers in Area A is 3 which suggests that fifty percent of these teachers have obtained credit for three or more university courses in this subject.

(d) Fifty-five percent of the mathematics teachers in grade level one have been teaching for a period

which does not exceed ten years. This percentage approximates eighty-five in grade level two.

II. The Qualifications of Physics Teachers

There are sixty physics teachers in Area A with eighty percent of these teachers classified in grade level one. A breakdown of these grade levels reveals the following summary of facts.

(a) Teachers in grade level one are the most qualified in mathematics with 2.9 credits per teacher while grade level two teachers are the least qualified with 1.2 credits per teacher. Forty-eight percent of all teachers in grade level one have completed at least three physics courses at university.

(b) Consideration of teacher qualifications at all grade levels reveals that on an average basis each teacher possesses 2.6 credits in university physics.

(c) Two-thirds or more of all teachers in this area have been employed in the teaching profession for a maximum of ten years.

III. The Qualifications of Chemistry Teachers

Three quarters of all chemistry teachers in Area A are located in grade level one. Teachers of this subject have the following qualifications in accordance with Table 29.

(a) Teachers in grade level one are the most qualified

with an average of 3.3 credits for each teacher.

The least qualified teachers in chemistry are located in grade level two.

(b) The fifty-five chemistry teachers in Area A have successfully completed an average of 2.9 credits in university courses pertaining to chemistry.

(c) The majority of teachers have been teaching less than ten years.

IV. The Qualifications of Biology Teachers

Sixty percent of all biology teachers in Area A are classified in grade level one in Table 30. The statistics in this table suggest the following generalizations.

(a) Teachers in grade level three are the most qualified with an average of six credits but these teachers represent only twelve percent of all biology teachers in this area.

The twenty-five teachers in grade level one average 4.2 credits per teacher with the twelve teachers in grade level two least qualified with 1.3 credits per teacher.

(b) The average number of credits for all teachers for all biology teachers is 3.6.

(c) Practically all biology teachers in this area have been employed in their profession for a period of time which does not exceed ten years.

The qualifications of science teachers in Area B can

be briefly summarized.

1. Physics teachers possess the lowest qualifications of science teachers in this area. Biology teachers in this area appear to possess the highest qualifications of any science category which was examined.
2. Noticeable differences occur in the average number of credits in each grade level. Teachers in grade level two are the least qualified in all science subjects which were studied.
3. The majority of teachers in this area have been teaching for less than ten years. The teaching experience, calculated on a percentage basis, suggests that the greatest percentage of teachers in any one category are located in the range which includes one to five teaching years.

TABLE 27

Qualifications of Mathematics Teachers in Area A (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	5	10	11	3	3.53	11	1	2.17
7	6	15	8.2	4	4.71	1	9	19.57
6	1	2.5	11	2	2.35	10	4	8.70
5	3	7.5	1.6	0	-	-	3	6.52
4	8	20	13.2	9	10.59	3.4	5	10.87
3	9	22.5	11.4	8	9.41	3.5	7	15.22
2	6	15	5	17	20.00	3.4	3	6.52
1	2	5	18.5	22	25.88	6	9	19.57
0	1	2.5	29	20	23.53	8.5	5	10.87
TOTAL Teachers	40			85			46	
Avg. No. Credits /Teacher	4.2			2.1			3.6	
Teaching Exp.	% Teachers			Teaching Exp.	% Teachers		Teaching Exp.	%
1-5	37.5			1-5	75.26		1-5	
6-10	17.5			6-10	9.40		6-10	
11-15	15.0			11-15	7.06		11-15	
16-20	12.5			16-20	5.88		16-20	
21-25	12.5			21-25	1.18		21-25	
26-30	5.0			26-30	1.18		26-30	
31+				31+			31+	

TABLE 27

of Mathematics Teachers in Area A (1965-66)

Grade Level 2			Grade Level 3			
No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
3	3.53	11	1	2.17	1	5
4	4.71	1	9	19.57	10.6	13
2	2.35	10	4	8.70	6	7
0	-	-	3	6.52	2.3	6
9	10.59	3.4	5	10.87	14	22
8	9.41	3.5	7	15.22	11.4	24
17	20.00	3.4	3	6.52	7.3	26
22	25.88	6	9	19.57	8.1	33
20	23.53	8.5	5	10.87	19	26
85			46			171
2.1			3.6			3.0

eaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	75.26	1-5	43.48
6-10	9.40	6-10	13.04
11-15	7.06	11-15	26.09
16-20	5.88	16-20	8.70
21-25	1.18	21-25	2.17
26-30	1.18	26-30	2.17
31+		31+	

TABLE 28

Qualifications of Physics Teachers in Area A (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	1	2.08	6	0	0	0	0	0
7	5	10.42	10.8	0	0	0	0	0
6	2	4.17	2.5	0	0	0	0	0
5	1	2.08	0	0	0	0	0	0
4	4	8.32	5.7	0	0	0	0	0
3	11	22.88	5.8	2	22.22	8	2	66.67
2	12	24.96	6	1	11.11	0	0	0
1	7	14.56	9.4	3	33.33	2.6	0	0
0	6	12.48	7	3	33.33	4	1	33.33
Total Teachers	48			9			3	
Avg. No. Credits /Teacher	2.9			1.2			2.0	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	64.48	1-5	66.6	1-5	33.3
6-10	10.40	6-10	22.2	6-10	33.3
11-15	10.40	11-15	11.2	11-15	33.3
16-20	10.40	16-20	0	16-20	0
21-25	4.24	21-25	0	21-25	0

TABLE 28

of Physics Teachers in Area A (1965-66)

Grade Level 2		Grade Level 3			
% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
0	0	0	0	0	1
0	0	0	0	0	5
0	0	0	0	0	2
0	0	0	0	0	1
0	0	0	0	0	4
22.22	8	2	66.67	9	15
11.11	0	0	0	0	13
33.33	2.6	0	0	0	10
33.33	4	1	33.33	6	10
		3			60
		2.0			2.6

Exp.	% Teachers	Teaching Exp.	% Teachers
	66.6	1-5	33.3
	22.2	6-10	33.3
	11.2	11-15	33.3
	0	16-20	0
	0	21-25	0
	0	26-30	0

TABLE 29

Qualifications of Chemistry Teachers in Area A (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	4	9.52	13.2	0	0	0	0	0
7	4	9.52	2.7	0	0	0	0	0
6	0	0	0	0	0	0	1	20.00
5	6	14.29	8	0	0	0	0	0
4	2	4.76	6.5	0	0	0	0	0
3	7	16.67	5.6	0	0	0	2	40.00
2	7	16.67	4.7	1	12.50	7	0	0
1	6	14.29	6.5	6	75.0	2.2	1	20
0	6	14.29	6.8	1	12.50	3	1	20
Total Teachers	42			8			5	
Avg. No. Credits /Teacher	3.3			1.0			2.6	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	66.67	1-5	87.5	1-5	20
6-10	7.14	6-10	13.5	6-10	40
11-15	11.90	11-15	0	11-15	40
16-20	7.14	16-20	0	16-20	0
21-25	4.76	21-25	0	21-25	0
26-30	0	26-30	0	26-30	0
31+	2.38	31+	0	31+	0

TABLE 29

of Chemistry Teachers in Area A (1965-66)

Grade Level 2			Grade Level 3			
No. of eachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	1	20.00	14	1
0	0	0	0	0	0	6
0	0	0	0	0	0	2
0	0	0	2	40.00	9	9
1	12.50	7	0	0	0	8
6	75.0	2.2	1	20	14	13
1	12.50	3	1	20	6	8
8			5			55
1.0			2.6			2.9

eaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	87.5	1-5	20
6-10	13.5	6-10	40
11-15	0	11-15	40
16-20	0	16-20	0
21-25	0	21-25	0
26-30	0	26-30	0
31+	0	31+	0

TABLE 30

Qualifications of Biology Teachers in Area A (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	3	12.00	2	0	0	0	2	40.00
7	4	16.00	2	0	0	0	1	20.00
6	1	4.00	2	0	0	0	0	0
5	4	16.00	2.7	1	8.33	2	0	0
4	3	12.00	1	0	0	0	1	20.00
3	3	12.00	2.3	1	8.33	9	1	20.00
2	3	12.00	6	2	16.66	2	0	0
1	0	16.00	5	4	33.32	3.5	0	0
0	4	16.00	5	4	33.32	7	0	0
Total Teachers	25			12			5	
Avg. No. Credits /Teacher	4.2			1.3			6.0	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	88.00	1-5	58.3	1-5	40
6-10	4.00	6-10	33.3	6-10	60
11-15	8.00	11-15	8.4	11-15	0
16-20	-	16-20	0	16-20	0
21-25	-	21-25	0	21-25	0
26-30	-	26-30	0	26-30	0
31+	-	31+	0	31+	0

TABLE 30

of Biology Teachers in Area A (1965-66)

Grade Level 2			Grade Level 3			
No. of eachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
0	0	0	2	40.00	8	5
0	0	0	1	20.00	7	5
0	0	0	0	0	0	1
1	8.33	2	0	0	0	5
0	0	0	1	20.00	2	4
1	8.33	9	1	20.00	4	5
2	16.66	2	0	0	0	5
4	33.32	3.5	0	0	0	4
4	33.32	7	0	0	0	8
12			5			42
1.3			6.0			3.6

eaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	58.3	1-5	40
6-10	33.3	6-10	60
.1-15	8.4	11-15	0
.6-20	0	16-20	0
!1-25	0	21-25	0
!6-30	0	26-30	0
31+	0	31+	0

(e) THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATION IN GRADE 11 AND 12

The data in Table 31 can be summarized with the following observations.

1. Algebra and geometry are the science subjects in grade 11 which appear to provide the most difficulty to students. The pass rate in grade 12 chemistry, physics and biology is significantly higher than the combined mathematics subjects.

2. The pass rate in biology is fifteen percent higher than its nearest competitive subject.

3. Consideration of the pass rate for the combined science subjects suggests that grade 12 students have a higher level of achievement.

TABLE 31

The Success of Science Students in Area A in provincial examinations in 1964-6

County	Chemistry		Physics		Algebra		Geometry		Chemistry		Phys
	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.
A	174	143	174	158	201	159	201	150	70	61	65
B	101	86	91	81	113	88	109	71	85	78	21
C	284	204	285	231	297	195	285	177	114	92	129
D	186	143	169	122	252	191	232	169	91	58	73
E	349	270	339	280	424	248	413	284	171	159	120
F	102	86	103	91	120	100	117	100	57	53	50
G	118	75	116	87	153	67	152	63	38	28	24
H	250	176	266	226	272	189	268	181	78	58	38
I	658	377	653	525	699	447	647	441	179	125	189
TOTALS	2222	1560	2196	1801	2531	1684	2424	1636	883	712	709
Percent Pass	70.3		82.2		66.6		67.4		80.7		82.

964-6

Physics		Biology		Geology		Algebra		Geom.-Trig.	
. of nd.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes
	59	35	35	1	0	107	92	104	92
	19	31	31	0	0	41	31	43	34
	100	108	105	24	17	159	95	157	115
	59	54	47	2	1	109	71	109	81
	107	77	73	2	2	176	121	162	123
	43	25	23	0	0	51	38	51	40
	18	28	28	7	6	35	27	35	26
	31	51	50	1	1	100	77	100	77
	149	143	140	6	3	291	193	286	202
	585	552	532	43	30	1069	745	1047	790
82.6		96.4		69.8		69.7		75.6	

TABLE 32

Subject Enrolment in Grade X in Halifax-Dartmouth (1964-65)

City	Eng.	Fr.	Ger.	Latin	Greek	Geog.	Hist.	Sci.	Agric.	Gen. Math.	Alg.	Geom.
Dartmouth	627	419	126	80	0	249	626	599	0	76	503	503
Halifax	1231	1023	53	502	6	543	1231	1187	0	0	1169	1169
TOTAL Halifax-Dartmouth	1858	1442	179	582	6	792	1857	1786	0	76	1672	1672
Area A	2737	1974	191	221	0	1852	2749	2678	0	133	2516	2515
Pilot	5057	4137	186	1360	0	2704	5048	5056	84	809	4484	4468
TOTAL	9652	7553	556	2163	6	5348	9654	9520	84	1018	8672	8655

TABLE 33

Subject Enrolment in Grade XI in Halifax-Dartmouth (1964-65)

City	Eng.	Fr.	Ger.	Latin	Greek	Econ.	Hist.	Gen. Sci.	Phys.	Chem.	Agric.	Gen. Math.	Alg.	Geom.
Halifax	1052	887	74	361	2	622	1045	0	939	938	0	0	1001	998
Dartmouth	506	394	66	84	0	308	507	58	414	417	0	58	447	449
TOTAL Halifax-Dartmouth	1558	1281	140	445	2	930	1552	58	1353	1355	0	58	1448	1447
TOTAL A	2222	1427	108	158	0	1811	2164	111	1694	1790	29	147	1893	1876
Pilot Area	4364	3299	88	791	0	2672	4324	292	3566	3621	138	321	3662	3648
GRAND TOTAL	8144	6007	336	1399	2	5413	8040	461	6613	6766	167	526	7003	6971

TABLE 34

Subject Enrolment in Grade XII in Halifax-Dartmouth (1964-65)

City	Eng.	Fr.	Ger.	Latin	Modern World Prob.	Hist.	Gen. Sci.	Bi.	Phys.	Chem.	Geol.	Agric.	Gen. Math.	Alg.	Trig
Halifax	572	451	22	181	51	580	0	186	212	209	72	0	0	504	474
Dartmouth	278	195	6	19	73	281	0	127	149	166	0	0	0	240	240
TOTAL Halifax-Dartmouth	850	646	28	200	124	861	0	313	361	375	72	0	0	744	714
Pilot Area	2085	1270	75	324	822	2029	76	603	1204	1381	70	74	84	1347	1461
Area A	972	564	21	60	362	940	75	354	539	667	28	6	44	685	713
TOTAL	3907	2480	124	584	1308	3830	151	1270	2104	2423	170	80	128	2776	2893

(b) THE RATIO OF TIME ALLOCATED TO SCIENCE SUBJECTS

The four senior high schools in the cities of Halifax and Dartmouth forwarded complete time tables.

Examination of tables 35-37 furnishes the following information.

1. All schools offered the complete academic program suggested for each grade level by the Department of Education.

2. All subjects at each grade level satisfied the suggested time allocations.

3. Mathematics and science subjects exceeded the maximum time suggested for these subjects in each grade.

4. French and social studies were the only other subjects in these tables that exceeded the maximum suggested time.

5. One school in this area did not allocate sufficient time to physics, chemistry and biology in grade 12 and mathematics in grade 11.

TABLE 35

Distribution of Subject Time in Grade X in Area B (1965-66)

Time	Eng.	Hist.	Fr.	Geog. Econ.	Acad. Sci.	Gen. Sci.	Acad. Math.	Gen. Math.
75-100	-	-	-	-	-	-	-	-
101-125	-	-	-	1	-	-	-	-
126-150	-	-	-	-	1	-	-	-
151-175	-	1	1	-	1	-	-	-
176-200	-	2	2	2	1	1	1	-
201-225	2	1	1	1	1	-	-	1
226-250	-	-	-	-	-	-	1	-
251-275	2	-	-	-	-	-	1	-
276-300	-	-	-	-	-	-	1	-
301-325	-	-	-	-	-	-	-	-
326-350	-	-	-	-	-	-	-	-
351-375	-	-	-	-	-	-	-	-
376-400	-	-	-	-	-	-	-	-
TOTAL	4	4	4	4	41	1	4	1
Avg. in Min.	240	184	184	174	172	180	250	225

TABLE 36

Distribution of Subject Time in Grade XI in Area B (1965-66)

Time in Minutes	Eng.	Hist.	Fr.	Econ.	Acad. Sci.	Gen. Sci.	Acad. Math.	Gen. Math.
75-100	-	-	-	-	-	-	-	-
101-125	-	-	-	1	-	-	-	-
126-150	-	-	-	-	-	-	-	-
151-175	-	-	1	-	-	-	-	-
176-200	-	2	2	2	-	-	-	-
201-225	1	2	1	-	-	1	1	-
226-250	1	-	-	1	-	-	2	-
251-275	2	-	-	-	1	-	1	-
276-300	-	-	-	-	-	-	-	-
301-325	-	-	-	-	-	-	-	1
326-350	-	-	-	-	1	-	-	-
351-375	-	-	-	-	1	-	-	-
376-400	-	-	-	-	1	-	-	-
TOTAL	4	4	4	4	4	1	4	1
Avg. in Min.	249	194	184	184	340	225	248	315

TABLE 37

Distribution of Subject Time in Grade XII in Area B (1965-66)

Time in Minutes	Eng.	Hist.	Fr.	World Prob.	Phys.	Chem.	Biol.	Geol.	Acad. Math.	Gen. Sci.	Gen. Math.
75-100	-	-	-	-	-	-	-	-	-	-	-
101-125	-	-	-	-	-	-	-	-	-	-	-
126-150	-	-	-	-	1	1	1	-	-	-	-
151-175	-	1	1	1	-	-	-	-	-	-	-
176-200	-	2	2	2	-	-	-	-	-	-	-
201-225	-	1	1	1	3	3	3	1	1	1	-
226-250	1	-	-	-	-	-	-	-	1	-	-
251-275	3	-	-	-	-	-	-	-	1	-	1
276-300	-	-	-	-	-	-	-	-	1	-	-
301-325	-	-	-	-	-	-	-	-	-	-	-
326-350	-	-	-	-	-	-	-	-	-	-	-
351-375	-	-	-	-	-	-	-	-	-	-	-
376-400	-	-	-	-	-	-	-	-	-	-	-
TOTAL	4	4	4	4	4	4	4	1	4	1	1
Avg. in Min.	259	184	184	184	194	194	194	210	260	225	270

(c) THE LABORATORY FACILITIES AVAILABLE FOR THE TEACHING OF SCIENCE

The four senior high schools in the cities of Halifax and Dartmouth provided laboratory facilities in biology, chemistry and physics.

Tables 38-40 list information obtained from the laboratory questionaire for each of the sciences.

Each subject heading in these tables will be discussed under separate headings.

I. Chemistry Laboratory Facilities

(a) All four schools in this area had separate laboratory facilities which were not used by any other science classes. One school in this area used the chemistry laboratory for regular academic classes.

(b) Two students performed the required experiments at each laboratory desk in grades 11 and 12.

(c) The equipment was deemed to be adequate in all of the schools and other equipment was present in adequate quantity in three of the four schools.

(d) Fume hood and stock room facilities were available in all schools in this area.

(e) Each desk in the four schools was equipped with running water and burner gas while 75% of the schools had electrical outlets at each desk. Each school had a sufficient number of balances to conduct group experimentation.

II. Physics Laboratory Facilities

(a) No school in this area used the physics laboratory facilities for instruction in chemistry. However, 25% of the schools used this laboratory for biology and regular classes.

(b) The laboratory desks were occupied by an average of 2.2 students in grade 11 and 2.8 students in grade 12.

(c) Physics equipment was adequate in 75% of the schools in this area. The number of balances per school (15.3), vernier calipers (11.8) and linear expansion apparatus (9.3) would attest to this fact. However the number of voltmeters, 2 per school, is inadequate.

(d) 25% of the schools could leave equipment assembled for succeeding classes.

III. Biology Laboratory Facilities

(a) The four schools in this area offered the biology program in grade 12. No school in this area, was capable of offering a laboratory orientated course in grade 10 with the present facilities available. One school was unable to offer separate laboratory facilities to grade 12 students.

(b) Each laboratory desk was shared by an average of 2.6 students.

(c) The level of equipment was satisfactory in the majority of schools. There were approximately seventeen

microscopes in each school in addition to some aquaria and terraria. 75% of the schools possessed oil immersion lens, 50% ovens and 25% animal cages. No school had adequate refrigeration facilities.

The following main points summarize the general laboratory conditions in this area.

1. An average of less than three students are employed at each laboratory desk in each of the sciences. Optimum conditions existed in chemistry laboratories with only two students sharing each laboratory desk.

2. Approximately eighty-five minutes each week were devoted to grade 12 experiments in the sciences. The time allocation was reduced in grade 11 physics and chemistry with approximately sixty-five minutes each week devoted to these subjects.

3. All schools in this area have separate laboratory facilities for experimentation in physics and chemistry. Seventy-five percent of the schools have a laboratory used exclusively for biology. Large student enrolment in some schools has necessitated the use of laboratory space for regular classes during periods in which the laboratory is not being used for experimentation.

4. The equipment necessary to conduct experiments in chemistry is adequate in all schools in Area B. Inadequate

equipment in physics provides difficulties in only one school. Biology laboratories suffer from an inadequate supply of refrigerators, animal cages and temperature control ovens. Consequently, these laboratories are the most poorly equipped.

5. Additional laboratory space in chemistry, physics and biology is urgently needed in seventy-five percent or more of the schools in this area.

TABLE 3

Chemistry Laboratory Facilities

School	Total No. of Stations	Avg. No. of Students Working Together XII	XI	Total No. of Students in Chem. XII	XI	Avg. No. of Minutes per Week for Individual XII	XI	The same facilities are used by Physics Yes	No	Biology Yes	No	Regular Yes	No	Equipment Adequate Yes	No
Halifax															
St. Pats.	40	2	2	105	418	80-90	40-45	0	1	0	1	0	1	1	0
Queen Eliz. High	40	2	2	56	435	90	45	0	1	0	1	0	1	1	0
Dartmouth															
Dart. H.S.	36	2	2	120	236	80	80	0	1	0	1	0	1	1	0
Prince Andrew H.S.	18	2	2	86	167	90	90	0	1	0	1	0	1	1	0
Hfx.-Dart. Avg.	33.8	2	2	91.7	314	85-87.5	63.7-65.0								
								0	4	0	4	1	4	4	0
								0%		0%		25%		100%	

in Area B (1965-66)

Running Water		Burner Gas		Electricity		Lab. is Equipped with Fume Hoods		Chemical Stock Room		Adequate Balances		Other Equipment Adequate		No. of Rooms
Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
1	0	1	0	0	1	1	0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0	1	0	1	0	0	1	2
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
														1.25
4	0	4	0	3	1	4	0	4	0	4	0	3	1	
100%		100%		75%		100%		100%		100%		75%		

TABLE 39

Physics Laboratory Facilities in

School	Total No. of Stations	Avg. No. of Students Working Together		Total No. of Students in Physics		Avg. No. of Minutes per Week for Individual		The same facilities are used by						Avg. No. of Experiments Run Concurrently in Physics
		XII	XI	XII	XI	XII	XI	Chemistry Yes	Chemistry No	Biology Yes	Biology No	Regular Yes	Regular No	
Halifax														
St. Pats.	40	3 or 4	2	115	413	80-90	40-45	0	1	0	1	0	1	1
Queen Eliz. High	40	3	2	118	435	90	45	0	1	0	1	0	1	1
Dartmouth														
Dart. H.S.	18	2-4	2-4	132	236	80	80	0	1	1	0	0	1	1
Prince Andrew H.S.	18	2	2	61	163	90	90	0	1	0	1	1	0	2
Hfx.-Dart. Avg.	29	2.5-3.3	2-2.5	Total 426 106.5	Total 1247 311.8	85-88	64-65	- 0%	4	1 25%	3	1 25%	3	1.3

TABLE 39

...ilities in Area B (1965-66)

Avg. No. of Experiments Run Concurrently in Physics	Ques. 5B Yes	Ques. 5B No	Equipment Adequate Yes	Equipment Adequate No	Average Number of AC Volt-Meters	Average Number of Linear Expansion Apparatus	Average Number of Vernier Calibers	Average Number of Hooke's Law Appar.	Average Number of Beam Balances	No. of Rooms
1	1	0	1	0		12	12	2	15	1
1	0	1	1	0	3	10	15	10	10	1
1	0	1	1	0	1	12	9	6	20	1
2	0	1	1	0	2	3	11	1	16	1
1.3	1	3	3	1	2	9.3	11.8	4.8	15.3	1
	25%		75%							

TABLE 40

Biology Laboratory Facilities in Area B (1966

School	No. of Rooms	No. of Stations /Lab.	No. of Students Working Together	Ques. 2C Yes	Ques. 2C No	Min./Wk. XII	Stereo Binocular Micro-Scopes /School	Oil Immersion Lens Yes	Oil Immersion Lens No	Temp. Control Oven Yes	Temp. Control Oven No	Refra Yes
Halifax												
St. Pat.	1	40	2	0	1	80→90	1	1	0	0	1	0
Queen Eliz. High	1	40	2	0	1	90	1	1	0	1	0	0
Dartmouth												
Dart. H.S.	1	18	2 or 3	0	1	80		0	1	0	1	0
Prince Andrew H.S.	1	10	4	0	1	90		1	0	1	0	0
Avg. Hfx. and Dart.	1	27	2.5→ 2.8	0	4	85→88	0.50	3	1	2	2	0
Percent			2.65			86.5		75%		50%		0%
No. of Schools	4											

...ities in Area B (1966)

...ation	Temp. Control Oven		Refrrator		Small Animal Cages		Aquaria and Terraria		Micro-scopes /School	Need additional Facilities		
No	Yes	No	Yes	No	Yes	No	Yes	No		Chemistry	Physics	Biology
0	0	1	0	1	0	1	1	0	22			
0	1	0	0	1	0	1	1	0	21	1	1	1 or 2
1	0	1	0	1	0	1	1	0	12	1	1	1
0	1	0	0	1	1	0	1	0	14	1	1	1
1	2	2	0	4	1	3	4	0	17	3	3	3
	50%		0%		25%		100%			75%	75%	87.5%

(d) THE QUALIFICATIONS OF SCIENCE TEACHERS

The qualifications of science teachers by subject for Area B is recorded in Tables 41-44.

I. The Qualifications of Mathematics Teachers

A total of seventy-two teachers were involved with the teaching of mathematics in grades 9-12 in Area B with the majority concentrated in grade level two. Examination of the data in Table 41 reveals the following information.

(a) The teachers in grade level one have obtained an average of 5.6 credits in mathematics. However, this group of teachers represents less than ten percent of the total teachers in all grade levels.

(b) The teachers in grade level two appear to be the least qualified, averaging 2.4 credits per teacher. Approximately thirty percent of these teachers had obtained three or more university credits in mathematics.

(c) Consideration of all grade levels reveals that the average teacher in this area has completed 3.3 university courses in mathematics. In terms of the percentage of teachers with three or more university credits, this average represents forty-seven percent of all teachers.

(d) If the teaching experience of all teachers is considered, seventy percent have been teaching for a period which ranges from zero to ten years.

II. The Qualifications of Physics Teachers

The total number of physics teachers is too small to permit a meaningful examination of each grade level. The seventeen physics teachers in this area averaged 2.3 university credits in this subject. Computed on a percentage basis, this average indicated that only forty percent of all physics teachers had obtained three or more university credits. Sixty percent of all physics teachers were teaching for less than ten years.

III. The Qualifications of Chemistry Teachers

There were nineteen chemistry teachers employed in Area B with almost three quarters located in grade level one.

On an average basis, each chemistry teacher was credited with 4.8 university courses. Approximately eighty-four percent of all chemistry teachers had obtained a minimum of three university credits in this subject. Seven out of every ten teachers had been employed for period of less than ten years.

IV. The Qualifications of Biology Teachers

The nine biology teachers in the four high schools in Area B possessed an average of 6.1 credits in this subject field. There was only one teacher who had failed to obtain at least three university courses in biology.

Two teachers had been actively employed as teachers for a period which exceeded ten years.

Examination of Tables 41-44 reveal the following general observations.

1. Biology and chemistry teachers are the most qualified in their respective subject fields in this Area. Physics teachers who possess the lowest qualifications of all groups considered, are the only teachers whose average credits fall below three university courses.

2. Teachers of science subjects in grade 11 and 12 (grade level one) have obtained more university credits in the subject they are teaching than teachers of other grade levels. This observation suggests that the most highly qualified teachers are utilized in teaching the higher grade levels.

3. Fifty percent or more of all teachers at each grade level have been teaching for a period of less than ten years. However there is no definite correlation between teaching experience and the number of university credits possessed by each teacher.

TABLE 41

Qualifications of Mathematics Teachers in Area B (1965-66)

	Grade Level 1				Grade Level 2				Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.		No. of Teachers /Credit	% Teachers	Avg. Yrs.		No. of Teachers /Credit	% Teachers
8	2	25.0	7.5		4	8.33	8		3	17.6
7	1	12.5	24	62.5	1	2.08	15	22.91	2	11.76
6	1	12.5	28		2	4.17	0.5		2	11.76
5	0				0				3	17.64
4	1	12.5	4		4	8.33	4.3		2	11.76
3	1	12.5	24		3	6.25	10.7		2	11.76
2	0				9	18.75	4.2		1	5.88
1	1	12.5	6		21	43.7	5.4		2	11.76
0	0		16		4	8.33	14.3		0	
Total Teachers	7				48				17	
Avg. No. Credits /Teacher	5.3				2.4				4.9	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	25.0	1-5	68.8	1-5	35.3
6-10	12.5	6-10	10.4	6-10	29.4
11-15	12.5	11-15	6.3	11-15	11.8
16-20	12.5	16-20	8.3	16-20	11.8
21-25	25.0	21-25	4.2	21-25	5.9
26-30	12.5	26-30	-	26-30	-
31+		31+	2.1	31+	5.9

TABLE 41

Mathematics Teachers in Area B (1965-66)

Grade Level 2				Grade Level 3				
. of chers Credit	% Teachers	Avg. Yrs.		No. of Teachers /Credit	% Teachers	g. Yrs.		Combined Grade Levels
4	8.33	8		3	17.64	8		9
1	2.08	15	22.91	2	11.76	2.5	70.56	4
2	4.17	0.5		2	11.76	4		5
0				3	17.64	3.3		3
4	8.33	4.3		2	11.76	8		7
3	6.25	10.7		2	11.76	0		6
9	18.75	4.2		1	5.88	6		10
21	43.7	5.4		2	11.76	3		24
4	8.33	14.3		0				4
48				17				72
2.4				4.9				3.3

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
-5	68.8	1-5	35.3
-10	10.4	6-10	29.4
-15	6.3	11-15	11.8
-20	8.3	16-20	11.8
-25	4.2	21-25	5.9
-30	-	26-30	-
+1	2.1	31+	5.9

TABLE 42

Qualifications of Physics Teachers in Area B (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	0	0	0	0	0	0	0	0
7	1	10	12	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	1	10	25	1	25.0	1	1	33.3
3	1	10	4	2	50.0	15.5	0	0
2	3	30.0	14.7	0	0	0	0	0
1	3	30.0	2	1	25.0	2	2	66.7
0	1	10.0	6	0	0		0	0
Total Teachers	10			4			3	
Avg. No. Credits /Teacher	2.3			2.8			2.0	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	40	1-5	50	1-5	33.3
6-10	20	6-10	25	6-10	0
11-15	10	11-15	0	11-15	0
16-20	20	16-20	0	16-20	66.7
21-25	10	21-25	25	21-25	0
26-30	0	26-30	0	26-30	0
31+	0	31+	0	31+	0

TABLE 42

of Physics Teachers in Area B (1965-66)

Grade Level 2			Grade Level 3			
No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
0	0	0	0	0	0	0
0	0	0	0	0	0	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	25.0	1	1	33.3	4	3
2	50.0	15.5	0	0	0	3
0	0	0	0	0	0	3
1	25.0	2	2	66.7	19	6
0	0		0	0	0	1
4			3			17
2.8			2.0			2.3

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	50	1-5	33.3
6-10	25	6-10	0
11-15	0	11-15	0
16-20	0	16-20	66.7
21-25	25	21-25	0
26-30	0	26-30	0
31+	0	31+	0

TABLE 43

Qualifications of Chemistry Teachers in Area B (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3		
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Av
8	1	7.14	18	0	-	-	-	-	
7	3	21.4	24.3	1	25.0	15	1	100.0	
6	1	7.14	2	0	-	-	-	-	
5	3	21.4	13.3	1	25.0	2	-	-	
4	1	7.14	2	0	-	-	-	-	
3	4	28.56	5	0	-	-	-	-	
2	1	7.14	21	1	25.0	1	-	-	
1	0			1	25.0	2	-	-	
0	0			0	-	-	-	-	
Total Teachers	14			4			1		
Avg. No. Credits /Teacher	4.9			3.8			7		

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	42.9	1-5		1-5	100.0
6-10	21.4	6-10		6-10	
11-15	14.3	11-15	25	11-15	
16-20	7.1	16-20		16-20	
21-25	7.1	21-25		21-25	
26-30	-	26-30		26-30	
31+	7.1	31+		31+	

TABLE 43

Chemistry Teachers in Area B (1965-66)

Grade Level 2			Grade Level 3		
% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
-	-	-	-	-	1
25.0	15	1	100.0	5	5
-	-	-	-	-	1
25.0	2	-	-	-	4
-	-	-	-	-	1
-	-	-	-	-	4
25.0	1	-	-	-	2
25.0	2	-	-	-	1
-	-	-	-	-	0
		1			19
		7			4.8

% Teachers	Teaching Exp.	% Teachers
	1-5	100.0
	6-10	
25	11-15	
	16-20	
	21-25	
	26-30	
	31+	

TABLE 44

Qualifications of Biology Teachers in Area B (1965-66)

	Grade Level 1			Grade Level 2			Grade Level 3	
No. of Credits	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers
8	1	20.0	14	0	-	-	2	100
7	2	40.0	12.5	1	50.0	0	-	-
6	0	-	-	0	-	-	-	-
5	1	20.0	1	0	-	-	-	-
4	1	20.0	1	-	-	-	-	-
3	0	-	-	0	-	-	-	-
2	0	-	-	0	-	-	-	-
1	0	-	-	1	50.0	2	-	-
0	0	-	-	0	-	-	-	-
Total Teachers	5			2			2	
Avg. No. Credits /Teacher	6.2			4			8	

Teaching Exp.	% Teachers	Teaching Exp.	% Teachers	Teaching Exp.	% Teachers
1-5	60	1-5	100	1-5	100
6-10	-	6-10	-	6-10	-
11-15	20	11-15	-	11-15	-
16-20	-	16-20	-	16-20	-
21-25	20	21-25	-	21-25	-
26-30	-	26-30	-	26-30	-
31+	-	31+	-	31+	-

TABLE 44

f Biology Teachers in Area B (1965-66)

Grade Level 2			Grade Level 3			
of hers edit	% Teachers	Avg. Yrs.	No. of Teachers /Credit	% Teachers	Avg. Yrs.	Combined Grade Levels
0	-	-	2	100	3	3
	50.0	0	-	-	-	3
0	-	-	-	-	-	0
0	-	-	-	-	-	1
	-	-	-	-	-	1
0	-	-	-	-	-	0
0	-	-	-	-	-	0
	50.0	2	-	-	-	1
1	-	-	-	-	-	-
			2			9
			8			6.1

ing .	% Teachers	Teaching Exp.	% Teachers
	100	1-5	100
0	-	6-10	-
5	-	11-15	-
0	-	16-20	-
5	-	21-25	-
0	-	26-30	-
	-	31+	-

(e) THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATIONS IN GRADES 11 AND 12

Table 45 reveals that mathematics was the subject that provided the most difficulty to students in grade 11 and 12 if geology is excluded from this comparison. Students were more successful in physics than chemistry at both grade levels with the most marked difference existing in grade 11. The pass rate for biology is considerably higher than other subjects in grade 12.

Students achieved greater success in science subjects as a whole at the grade 12 level.

TABLE 45

The Success of Science Students in Area B in P

GRADE 11

School	Chemistry		Physics		Algebra		Geometry		Chemistry	
	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes
A	456	329	464	416	526	359	498	300	89	78
B	383	297	380	331	458	297	449	235	95	88
C	296	250	281	264	347	271	318	256	133	117
D	151	133	162	152	175	140	171	121	51	43
TOTALS	1286	1009	1287	1163	1506	1067	1436	912	368	326
Percent Pass	78.5		90.1		70.8		62.8		88.6	

Provincial Examinations in 1964-65

Physics		Biology		Geology		Algebra		Geom.-Trig.	
No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes	No. of Cand.	No. of Passes
119	108	79	77	1	0	272	206	257	219
91	80	98	98	65	39	214	177	214	201
108	96	73	60	1	1	182	145	177	144
49	43	46	43	1	0	92	56	87	59
367	327	296	278	68	40	760	584	735	623
	89.1		93.9		59.9		76.8		84.3

PART II

A Comparison of Science Education in Grades 10-12 between the Pilot Area and Area A and the Pilot Area and Area B

CHAPTER VI

A Comparison of Science Education in Grades 10-12 between the Pilot Area and Area A

(a) THE ENROLMENT IN SCIENCE SUBJECTS

The academic program of the majority of students of Grade 10 in both areas consists of english, mathematics, science and french. Approximately nine out of every ten students in each area have chosen science and mathematics as their elective subjects. The general program is offered in some of the schools in each area but it is significant to note that although there are twice as many students in the Pilot Area there are almost six times as many students enroled in the general program. Agricultural courses are not offered in any schools in Area A but in the Pilot Area two counties have students enroled in this subject. A greater percentage of the students in the Pilot Area take french while Area A has a greater percentage enrolment in geography.

Grade 11 students in the Pilot Area selected mathematics, science and french in that order as their elective preferences. In Area A science has been relegated to the position of third elective choice with economics following mathematics as the chief preferences of most students. The percentage in the

general program in Area A has increased resulting in the fact that, proportionately, there are almost as many students taking general program courses in Area A as in the Pilot Area.

Area A has incorporated agricultural courses into the curriculum of the schools in Grade 11 but lags behind the Pilot Area in enrolment. Mathematics and chemistry are the chief elective choices of most Grade 12 students in both areas with french and physics varying as the third and fourth elective choices. It appears evident from the enrolment statistics for both areas that geology does not form an integral part of the curriculum of most schools. Many schools in both areas do not offer biology at this grade level.

An examination of student retention rates in the grades under consideration furnishes some important data. Using english as the base for comparison, since it is a compulsory subject the following data will provide some concept of the loss in student potential.

TABLE 46

The percentage of students withdrawing from school at the end of Grade X and XI in the Pilot Area and Area A, for the school year 1964-65

	PILOT AREA		AREA A	
Grade	Enrolment in English	Percentage loss	Enrolment in English	Percentage loss
X	5057	0	2737	0
XI	4364	13.7	2222	18.8
XII	2085	58.8	972	64.5

The significant reduction in student enrolment in both areas occurs at the Grade 12 level. Area A appears to lose a greater percentage of its students at both the grade 11 and 12 level.

(b) THE DISTRIBUTION OF SUBJECT TIME BETWEEN THE PILOT AREA AND AREA A

A comparison of the distribution of subject time between the Pilot Area and Area A must of necessity be very general as the sampling of schools is too small to formulate concrete similarities and differences.

The average time in minutes per week allocated to science subjects in Area A exceeds the time spent on science in the Pilot Area in all three grades. However mathematics is given more emphasis in grade 10 and grade 11 in the Pilot Area. On an average basis most schools are within the time allocation for each subject suggested by the Department of Education. Distinct variations between schools in various counties are evident. For example, there are five schools in the Pilot Area at the grade 10 level that devoted less than 150 minutes per week on academic science and three schools in Area A that devoted less than 150 minutes on french.

It is significant to note that both areas are considerably above the time allocations suggested for both science and mathematics subjects. Although the other

subjects are within the time allocations suggested for these subjects by the Department of Education, the science and mathematics subjects appear to exceed their suggested limits to a far greater extent than other subjects in respective grades. This general observation would appear to suggest that there is more emphasis placed on science subjects than other subjects within the curriculum.

The stress on science is more pronounced in Area A at the grade 12 level. It is significant to note the reversal of trends evident in mathematics and the respective science subjects. In all cases the Pilot Area lags behind Area A concerning the time allocated to these subjects.

(c) THE LABORATORY FACILITIES AVAILABLE FOR THE TEACHING OF SCIENCE

The laboratory facilities offered in each area will be discussed separately for each science. Any significant differences between the areas in each subject field has been noted in the following tables to simplify the comparison of these facilities.

CHEMISTRY

PILOT AREA

1. The supply of chemical balances is more adequate
2. Basic student equipment as well as other additional equipment is more adequate
3. The chemistry laboratory is used more extensively for the administration of physics experiments and other classes

AREA A

1. Fewer students are working together in each experiment in Grade 11 and 12
2. The chemistry laboratory is used more extensively for the teaching of biology
3. More time is allocated to chemistry labs in Grade 11 and 12
4. Fume hood facilities more adequate

Chemistry students in the Pilot Area have the use of more adequate equipment to conduct each experiment. However this function is facilitated because more students are working together on each experiment than in Area A.

Each student in Area A participates more fully in the performance of each experiment because more time is allocated to individual laboratory experiments and fewer students participate in each experiment. The lack of adequate fume hoods seriously handicaps the variety of experiments that can be conducted.

PHYSICS

PILOT AREA	AREA A
1. Facilities are used more extensively for physics and regular classes	1. Facilities used more extensively for biology
2. More experiments are run concurrently	2. Fewer students are working together on each experiment in Grade 11
3. Hooke's Law apparatus and beam balances are more adequate	3. More time is allocated to physics labs in Grade 11 and 12
4. Greater possibility of having equipment established for another group	

The laboratory situation for physics is very similar to the conditions noted in chemistry. Although the Pilot Area is generally stocked with more adequate equipment than Area A, approximately seventy percent of the schools in each area are not properly equipped to maintain their present laboratory program.

Laboratory facilities are combined for physics and chemistry in the Pilot Area suggesting that this area cannot operate its laboratory program on an efficiency level comparable to Area A. This point is further substantiated upon examination of the additional facilities required in the following table.

BIOLOGY

1. Fewer additional facilities required in biology
2. Not equipped for new biology course in Grade 10

1. Fewer additional facilities required in physics and chemistry
2. Not equipped for new biology course in Grade 10
3. More time is allocated to laboratory experiments
4. Fewer students are working together in the laboratory
5. Laboratories are better equipped with refrigerators, animal cages and aquaria and terraria

Facilities for the teaching of biology appear to warrant most immediate attention in both areas. Although this situation is not as severe in the Pilot Area, the lack of adequate equipment seriously handicaps students of this subject. Biology students in Area A operate their experiments in smaller numbers and generally devote more time to each experiment than biology students in the Pilot Area.

In conclusion, several similarities and differences can be noted in science laboratory facilities in the Pilot Area and Area A.

1. Additional laboratory facilities are a problem which burden schools of the Pilot Area to a greater extent than schools in Area A. Facilities for the respective science subjects are used less extensively

for other subjects in Area A.

2. Smaller groups of students work on individual experiments in Area A.

3. More time in minutes per week is devoted to science laboratory experiments in Area A.

4. With the exception of biology, laboratories in the Pilot Area are more adequately equipped to conduct experiments at each laboratory station.

(d) THE QUALIFICATION OF SCIENCE TEACHERS

Separate comparisons of the qualifications of science teachers will be made for each science subject in the Pilot Area and Area A. General conclusions will be formulated on the basis of each comparison.

To facilitate this comparison tables have been constructed indicating the average number of credits at each grade level, the percentage of teachers with four or more credits in each subject and the average number of credits for all grade levels.

1. Qualifications of Mathematics Teachers

TABLE 47

A statistical comparison of the Qualifications of Mathematics Teachers in the Pilot Area and Area B, for the school year 1965-66

	PILOT AREA		AREA A		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. Credits
Grade Level One	3.1	35.19	4.2	55	1.1
Grade Level Two	1.5	10.70	2.1	21.18	0.6
Grade Level Three	2.7	23.93	3.6	47.83	0.9
All gr. Levels	2.16	19.24	3.01	35.3	0.85

An examination of the information in this table suggests the following conclusions.

(a) Teachers of mathematics in Area A are more qualified, in terms of average number of credits, at all three grade levels. A greater percentage of these teachers have four or more credits in the subject field they are teaching; namely mathematics.

(b) Teachers with less than ten years experience constitute the bulk of the teaching group.

It would appear from these observations that the schools in Area A have attracted more qualified teachers in the field of mathematics.

2. The Qualifications of Physics Teachers

TABLE 48

A Statistical Comparison of the Qualifications of Physics Teachers in the Pilot Area and Area A, for the School Year 1965-66

	PILOT AREA		AREA A		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. Credits
Grade Level One	1.9	13.79	2.9	27.07	1.0
Grade Level Two	1.7	0	1.2	0	0.5
Grade Level Three	2.7	28.58	2.0	0	0.7
All gr. Levels	1.9	14.08	2.6	21.66	0.7

The following observations can be made from the tables for each area.

(a) The teachers of grade level one, which constitute approximately eighty percent of all teachers in each area, are more qualified in Area A. The difference in average credits of 1 is significant.

(b) The teachers in grade level two and grade level three which constitute twenty percent of the teachers in each area are more qualified in the Pilot Area.

(c) A greater percentage of teachers in Area A have four or more credits at grade level one. This difference is significant because this trend is maintained when the averages are examined for the combined grade levels.

The small number of teachers instructing in grade level two and grade level three relative to the total number

of teachers in each area reduces the significance of the increased qualifications of teachers of the Pilot Area at these grade levels. A consideration of the average number of credits for all grade levels and the percentage of teachers with four or more credits in this category indicate that Area A has a slight advantage in terms of the qualifications of physics teachers.

3. Qualifications of Chemistry Teachers

TABLE 49
A Statistical Comparison of the Qualifications of Chemistry Teachers in the Pilot Area and Area A, for the School Year 1965-66

	PILOT AREA		AREA A		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. Credits
Grade Level One	3.4	39.9	3.3	30.4	0.1
Grade Level Two	2.0	0	1.0	0	1.0
Grade Level Three	2.8	33.32	2.6	20	0.2
All gr. Levels	3.2	36.1	2.9	30.9	0.3

The information contained in this table suggests the following points.

(a) Chemistry teachers in the Pilot Area have more credits in this subject in all three grade levels. This advantage is marginal in grade level one and grade level three.

(b) A greater percentage of the teachers in the Pilot Area have four more credits in chemistry at university.

Examination of any one grade level does not suggest

that the Pilot Area possesses more highly qualified teachers in chemistry because in many cases the differences are marginal. Consideration of all categories, as a whole, however, suggest that chemistry teachers in the Pilot Area have obtained more university credits in this subject.

4. Qualifications of Biology Teachers

TABLE 50

A Statistical Comparison of the Qualifications of Biology Teachers in the Pilot Area and Area A, for the School Year 1965-66

	PILOT AREA		AREA A		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. No. of Credits
Grade Level One	3.8	45	4.2	60	0.4
Grade Level Two	1.8	15.38	1.3	8.33	0.5
Grade Level Three	0.4	0	6.0	80	5.6
All gr. Levels	2.7	28.95	3.6	47.62	0.9

The comparative data in this table shows distinct differences in the qualifications of biology teachers.

(b) Biology teachers of grade level one and grade level two in Area A have obtained more university credits in this subject than similar teachers in the Pilot Area. The average number of credits for teachers of all grade levels is substantially higher in Area A although there

is a disparity in grade level two.

(b) There are considerably more teachers in Area A that have obtained four or more credits in this subject.

(c) The majority of teachers in both areas having been employed in this profession for a period less than ten years.

(d) The teachers with the larger number of credits in both areas have been teaching for a relatively short period of time.

The differences revealed in this comparison place the teachers in the Pilot Area at a slight disadvantage in terms of the number of university credits in this subject.

Two general conclusions can be formulated regarding the qualifications of science teachers in the areas compared.

1. The small differences in the number of university credits in any one science subject would not represent a distinct advantage for any one area. The marginal advantage s of Area A in the fields of mathematics, physics and biology, which constitute seventy-five percent of the science subjects, is a factor, however, that cannot be disregarded. This factor, evaluated in it's proper perspective, does indicate a favorable trend towards the qualifications possessed by science teachers in Area A.

2. The younger element of the teaching profession appears to be concentrated in the field of science in both areas which have been studied.

(e) THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATIONS IN GRADES 11 AND 12

Any statistical analysis involving masses of numbers is susceptible to possible errors which could influence the final results. There are two factors which are noteworthy of consideration.

1. A greater number of students wrote examinations in the Pilot Area enhancing the possibility of additional students failing the exams in any one subject.

2. The number of failures in each subject was totalled for each minute sheet provided by the Department of Education. Errors in these additions would alter the percentage pass rate in any one subject.

To facilitate the comparison of each area under consideration the following tables were extracted from the information provided in the initial tables.

TABLE 51

The differences in the percentage pass rate in provincial examinations in Grade XI science subjects in the Pilot Area and Area A, for the school year 1964-65

GRADE XI	PILOT AREA Pass Rate	AREA A Pass Rate	Difference in Percent
Chemistry	69.1	70.3	1.2
Physics	80.3	82.2	1.9
Algebra	73.0	66.6	6.4
Geometry	59.1	67.4	8.3

TABLE 52

The differences in the percentage pass rate in provincial examinations in Grade XII science subjects in the Pilot Area and Area A, for the school year 1964-65

GRADE XII	PILOT AREA Pass Rate	AREA A Pass Rate	Difference in Percent
Chemistry	77.2	80.7	3.5
Physics	76.0	82.6	6.6
Biology	93.2	96.4	3.2
Geology	66.6	69.8	3.2
Algebra	70.6	69.7	0.9
Geometry	74.1	75.6	1.5

Students in the Pilot Area were less successful in three subjects; Chemistry, Physics and Geometry. The deviation in the percentage differences in chemistry and physics is not significant enough to warrant any comment. There are noticeable differences in percentages for algebra and geometry. The students in the Pilot Area appear to have been more successful in algebra while Area A appeared to excel in geometry.

The significance of this data does not reside within the magnitude of the percentage differences but rather the trend which is portrayed. The students in Area A were more successful in seventy-five percent of the science subjects examined at this grade level.

The differences in the percentage pass rate recorded

in the comparison for Grade 12 reveals more marked differences.

First, students in Area A have been more successful in 83.3% or five of the six science subjects in the grade 12 curriculum.

Secondly, the differences in the percentage pass rate for each subject are more meaningful.

The general trend evident in the combined grades would suggest that on an average basis science students in Area A have been more successful in provincial examinations than students in the Pilot Area.

A reservation must be attached to this conclusion. The differences are not sufficiently acute to suggest a vast superiority of science students in Area A. An evaluation of the general academic performance of students in both areas would be necessary before any specific conclusions could be stated.

CHAPTER VII

A Comparison of Science Education in Grades 10-12 between the Pilot Area and Area B

(a) THE ENROLMENT IN SCIENCE SUBJECTS

The trend in student enrolment in the sciences in Area B follows a pattern similar to the Pilot Area in grades 10 and 11. Science and mathematics are the first two elective choices of the majority of students in these grades. In grade 12, mathematics is the first elective choice of most students in both areas. Chemistry and physics are the third and fourth elective choices of the majority of students in Area B while chemistry, french and physics follow mathematics as the elective choices of students in the Pilot Area.

An examination of the enrolment figures for the general program would appear to indicate that more emphasis is placed on this program in the schools of the Pilot Area. Sixteen percent of grade 10 students in the Pilot Area are enroled in the general program while only four percent are enroled in the same program in Area B.

Table 53 indicates the reduction in student enrolment in grades 10 to 12 inclusive.

TABLE 53

The percentage of students withdrawing from school at the end of Grade X and XI in the Pilot Area and Area B, for the school year 1964-65

	PILOT AREA		AREA B	
	Enrolment	Percentage Loss	Enrolment	Percentage Loss
Grade X	5057	-	1858	-
Grade XI	4364	13.7	1558	16.2
Grade XII	2085	58.8	850	54.3

The student retention rate is higher in Grade 11 in the Pilot Area than Area B with a reversal of trend evident in Grade 12.

(b) THE DISTRIBUTION OF SUBJECT TIME BETWEEN THE PILOT AREA AND AREA B

Each area is considerably above the time allotment suggested for the various science subjects at each grade level. Some variations within these subjects can be noted in each area. More time is devoted to mathematics in all three grade levels in the Pilot Area. General Science in grades 10 and 11 and chemistry, physics and biology in grade 12 have more generous time allotments in Area B. The presence of only four schools in Area B influences the average time in minutes. Queen Elizabeth High School in Halifax allocates 135 minutes per week for each science subject in grade 12 while the remaining three schools allocate

over 200 minutes to each of these subjects. With a larger sampling of schools showing the same distribution of time, the average would have been considerably higher than 194 minutes.

(c) THE LABORATORY FACILITIES AVAILABLE FOR THE TEACHING OF SCIENCE

The laboratory facilities available for the teaching of chemistry reveal distinct differences between the Pilot Area and Area B.

1. All schools in Area B are equipped with running water and gas at each desk, a fume cabinet, chemical stockroom and adequate balances.

2. The basic equipment in each school in Area B is adequate for the various laboratory programs and the audio-visual aids are adequate in 75 percent of the schools.

3. Each school in Area B has a laboratory used exclusively for instruction in chemistry.

4. Considerably more time is devoted to laboratory experiments in grade 12. The Pilot Area allocates slightly more time to their grade 11 laboratory program.

5. A maximum of two students work at each laboratory station in Area B. Approximately three students perform the required experiments at each laboratory station in the Pilot Area.

Schools in Area B appear to offer more adequate laboratory facilities for their students in grade 11

and 12. The large student enrolment in the schools of Area B ensures maximum use of these facilities. The smaller classes in the schools of the Pilot Area necessitate the use of these facilities for other laboratory programs.

An analysis of the laboratory facilities available for the teaching of physics indicate that the schools in Area B are equipped to provide a more complete laboratory program to their students than the schools of the Pilot Area. The following points support this contention.

1. The laboratories in Area B are used more exclusively for the teaching of physics enabling these schools to avoid running experiments concurrently.

2. Students in Area B are given more time to complete their experiments in grade 12 and fewer students are working at each laboratory station in grade 11.

3. The equipment is much more adequate in the schools of Area B and instruments widely used in the program are more plentiful enabling greater student involvement in each experiment.

4. Substantially more time is devoted to the laboratory program in grade 12 in Area B.

A comparison of the biology laboratory facilities reveals the following differences which are listed in tabular form.

PILOT AREA	AREA B
1. More schools are capable of offering a new biology course in grade 11	1. Fewer students are working on an experiment at each station
2. Fewer additional facilities are required in chemistry, physics and biology	2. Considerably more time is spent on laboratory experiments

The differences in biology facilities in each area permits the formulation of certain general conclusions.

1. The smaller number of students working at each laboratory station and the additional time allocated for each laboratory period enables each student in Area B to devote more individual attention to each experiment.

2. The present facilities in the schools of the Pilot Area could accomodate the demands of an increased student enrolment in the sciences more adequately than schools in Area B.

3. The schools in Area B provide their students with more laboratory equipment in biology. Individual laboratory classes have larger enrolments in Area B and quantitatively more equipment is required. However, the greater diversity of biological equipment available in the schools of Area B signifies that a more varied laboratory program is possible.

Certain general similarities and differences can be noted in the science laboratory facilities available in the Pilot Area and these facilities available in the other areas which have been studied.

1. The need for additional laboratory facilities is a common requirement for all areas. This need is most immediate in Area B.

2. Larger groups of students participate in individual experiments at each laboratory station in the Pilot Area.

3. The Pilot Area devotes the least amount of time in minutes per week to its laboratory program.

4. The schools in Area B possess the better equipped laboratories and can administer a more varied laboratory program.

(d) THE QUALIFICATION OF SCIENCE TEACHERS

The qualifications of teachers in each science subject will be discussed separately. The comparison will follow a similar pattern to the qualifications of science teachers in Chapter VI.

1. The Qualifications of Mathematics Teachers

TABLE 54

A statistical comparison of the Qualifications of Mathematics Teachers in the Pilot Area and Area B, for the school year 1965-66

	PILOT AREA		AREA B		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. No. of credits
Grade Level One	3.1	35.19	5.3	62.5	2.2
Grade Level Three	1.5	10.70	2.4	22.91	0.9
Grade Level Three	2.7	23.93	4.9	70.56	2.2
All gr. Levels	2.16	19.24	3.26	38.88	1.10

The teachers in the schools of Area B possess higher qualifications in mathematics at all three grade levels. The most noticeable differences are located in grade level one and grade level three. At these grade levels, teachers in Area B have been credited with two more university courses in mathematics than teachers of this subject in the Pilot Area. Similarily, the significant differences in the percentage of teachers who have completed four or more university courses in this subject, reinforces the conclusion that teachers in Area B are more qualified in this subject field.

2. Qualifications of Physics Teachers

TABLE 55

A statistical comparison of the Qualifications of Physics Teachers in the Pilot Area and Area B, for the school year 1965-66

	PILOT AREA		AREA B		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. No. of credits
Grade Level One	1.9	13.8	2.3	20	0.4
Grade Level Two	1.7	0	2.8	25	1.1
Grade Level Three	2.7	28.6	2.0	33.3	0.7
All gr. Levels	1.9	14.1	2.3	23.5	0.4

Certain generalizations are possible from the data provided in Table 55.

(a) Marginal differences in the average number of credits in the first two grade levels favor physics teachers in Area B. The situation is reversed in grade level three; physics teachers in Area B possesses fewer university credits than parent teachers in the Pilot Area.

(b) The majority of teachers in both areas have been teaching for less than ten years.

3. Qualifications of Chemistry Teachers

TABLE 56

A statistical comparison of the Qualifications of Chemistry Teachers in the Pilot Area and Area B, for the school year 1965-66

	PILOT AREA		AREA B		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. No. of Credits
Grade Level One	3.4	39.9	4.9	64.2	1.5
Grade Level Two	2.0	0	3.8	50	1.8
Grade Level Three	2.8	33.3	7.0	100	4.2
All gr. Levels	3.2	36.1	4.8	63.2	1.6

The results of the comparison in Table 56 could support the contention that teachers in Area B are more highly qualified in this subject. There are two reasons for this statement.

1. Chemistry teachers in the Pilot Area possess fewer university credits in each grade level which was examined.

2. The differences in the average number of credits at

each grade level as well as the differences for the combined grades are large enough to be meaningful.

4. Qualifications of Biology Teachers

TABLE 57

A statistical comparison of the Qualifications of Biology Teachers in the Pilot Area and Area B, for the school year 1965-66

	PILOT AREA		AREA B		
	Avg. No. of Credits	% Teachers with 4 or more credits	Avg. No. of Credits	% Teachers with 4 or more credits	Difference in Avg. No. of credits
Grade Level One	3.8	45	6.2	100	2.4
Grade Level Two	1.8	15.38	4.0	50	2.2
Grade Level Three	0.4	0	8.0	100	7.6
All gr. Levels	2.7	28.95	6.1	88.9	3.4

The differences in the qualifications of science teachers in each area is most acute and widespread in the field of biology. It is apparent from the data in Table 57 that biology teachers in the Pilot Area possess lower qualifications in all grade levels regardless of the selected category.

A brief summary of the qualifications of science teachers is necessary to complete this study.

1. The schools in Area B have been able to attract more highly qualified science teachers. In the fields of chemistry, mathematics and biology, the credentials of these teachers are most apparent.

2. An examination of teacher qualifications in Area A and Area B was not included in this comparative study; because the author did not feel it would serve any useful function. In a general sense, teacher qualifications are more satisfactory in Area B, providing the following qualifications are inserted.

1. The gap in the average number of credits in chemistry, biology and mathematics between these areas is diminished in magnitude.

2. Physics teachers in Area B have fewer credits in this subject than teachers in Area A.

(e) THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATIONS IN GRADES 11 AND 12

The percentage of students who were successful in each of the science subjects in the provincial exams are represented for each area in Table 58.

TABLE 58

The differences in the percentage pass rate in provincial examinations in Grade XI science subjects in the Pilot Area and Area B, for the school year 1964-65

Grade XI	PILOT AREA	AREA B	
	Pass Rate in %	Pass Rate in %	Difference in Percent
Chemistry	69.1	78.5	9.4
Physics	80.3	90.1	9.8
Algebra	73.0	70.8	2.2
Geometry	59.1	62.8	3.7

TABLE 59

The differences in the percentage pass rate in provincial examinations in Grade XII science subjects in the Pilot Area and Area B, for the school year 1964-65

Grade XII	PILOT AREA	AREA B	
	Pass Rate in %	Pass Rate in %	Difference in Percent
Chemistry	77.2	88.6	11.4
Physics	76.0	89.1	13.1
Biology	93.2	93.9	0.7
Geology	66.6	59.9	6.7
Algebra	70.6	76.8	6.2
Geometry	74.1	84.3	10.2

An analysis of this table reveals significant differences in the success of science students in each area.

1. Grade 11 students in Area B have achieved more satisfactory results in seventy-five percent of the science subjects. The difference in the percentages for chemistry and physics, in particular, suggest that students in Area B have achieved greater success in these subject fields.

2. Science students in grade 12 in Area B have merited a higher percentage pass standing in 83.3 percent of the subjects recorded in these tables. The differences are more widespread in all cases. The superiority in chemistry and physics in the previous grade has been maintained and increased at this grade level. Students of the Pilot Area achieved greater success than their counterparts in Algebra in Grade 11. However this success is reversed in Grade 12,

with students in Area B obtaining more satisfactory results in both algebra and geometry.

3. The total performance of science students in Area B in provincial examinations suggests a level of success which is markedly superior to the results achieved by students in the Pilot Area.

The discussion would not be complete without a comparison of Area A and Area B.

TABLE 60

The differences in the percentage pass rate in provincial examinations in Grade XI science subjects in the Area A and Area B for the school year 1964-65

Grade XI	AREA A Pass Rate	AREA B Pass Rate	Difference in Percent
Chemistry	70.3	78.5	8.2
Physics	82.2	90.1	7.9
Algebra	66.6	70.8	4.2
Geometry	67.4	62.8	4.6

TABLE 61

The differences in the percentage pass rate in provincial examinations in Grade XII science subjects in the Area A and Area B for the school year 1964-65

Grade XII	AREA A Pass Rate	AREA B Pass Rate	Difference in Percent
Chemistry	80.7	88.6	7.9
Physics	82.6	89.1	6.5
Biology	96.4	93.9	2.5
Geology	69.8	59.9	9.9
Algebra	69.7	76.8	7.1
Geometry	75.6	84.3	8.7

Tables 60-61 indicate that students in Area B have been more successful in 75 percent of the science subjects in grade 11 and 66.6 percent of the subjects in grade 12. Chemistry and physics in grade 11 and 12 and mathematics in grade 12 are the subjects in which science students in Area B have achieved the greatest success.

The performance of the science students in Area B generally would suggest a higher level of success than the science students in the Pilot Area or Area A.

PART III

AN INTERPRETATION OF THE SIMILARITIES AND DIFFERENCES IN SCIENCE EDUCATION IN THE PILOT AREA AS REVEALED IN THE COMPARATIVE APPROACH

CHAPTER VIII

Factors which Influence and Account for the Similarities and Differences revealed in the Comparative Approach

The discovery of basic similarities and differences between the Pilot Area, Area A and Area B lacks meaning unless factors can be isolated which influence and account for these similarities and differences. An attempt will be made in this chapter to offer reasons for the existence of certain trends in subject enrolment, distribution of subject time, laboratory facilities, teacher qualifications and provincial examination results. Each of these headings will be examined separately.

1. ENROLMENT IN SCIENCE SUBJECTS

Data revealed in preliminary chapters suggests that the vast majority of students in each area under study were selecting mathematics and science subjects as their chief elective choices in grade 11 and 12. Two possible reasons may be offered to explain this trend.

Firstly, most post-high school programs insist upon a general mathematics and science background as a basic entrance requirement.

Secondly, a student enroled in the academic program has a limited choice of elective subjects in many schools. Consequently, science subjects must necessarily form part of their elective choices. Limited elective choices in some schools is due to the fact that these schools do not support a large student population and cannot afford to hire the necessary specialist teachers for these elective subjects. In many cases schools cannot attract specialist teachers in certain subjects to a particular area and are forced to remove certain elective choices from their academic program.

A second general observation which can be made concerning all three areas of study is the significant drop-out rate at the termination of the grade 11 program. Approximately fifty percent or more of all students in grade 11, in the academic year 1965-66, did not return to complete the grade 12 program.

There are several factors which may account for this loss in student potential.

1. The majority of universities in the Maritimes will accept grade 11 matriculation as the prerequisite for entrance to undergraduate degree courses. Many students, for this reason, will leave high school at the end of grade 11 and proceed directly to university.

An examination of enrolment statistics in grades 11 and 12 revealed that the drop-out rate in Area B at the

end of grade 11 was the lowest of all areas considered. Possibly the fact that universities in the Halifax-Dartmouth area require successful completion of grade 12 as the entrance requirement may partially account for the lower drop-out figures in this area.

2. Students who, for one reason or another, do not proceed to university constitute the majority of students in grade 12. Some post-high school training programs only require a grade 11 certificate. Students in this category would contribute to the reduced enrolment in grade 12.

There are many students in this group who leave school at the end of grade 11 due to a lack of interest in the academic program. Educators today are conscious of this fact. The general, occupational and modified programs have been introduced into the Nova Scotia school system in an attempt to offer programs which will accomodate the needs and interests of students whose abilities are not directed towards the normal academic program. Unfortunately these programs have not been incorporated into the curriculum of many schools in the Pilot Area or Area A; judging from the statistics which were presented earlier.

General, occupational and modified programs, for example, stress the practical aspect of science rather than abstract theoretical concepts which are beyond the mental capacity

of many students. The following statement summarizes the objective of these programs. "The subject matter should be drawn mainly from physics, chemistry and biology, the several branches being co-ordinated as far as possible. Local conditions and interests may suggest the inclusion of other branches such as geology and astronomy. At each stage the study of everyday applications of scientific principles should constitute an important feature. A course on these lines leading to some understanding of natural phenomena and of the ways in which man has applied his scientific knowledge, and to some study of man as a physical organism would meet the education requirements of all pupils".[5]

2. THE DISTRIBUTION OF SUBJECT TIME

The limited information which was obtained concerning the time allocated to science subjects within the curriculum indicated that the vast majority of schools in each area exceeded the suggested minimum time allocations of the Department of Education. The Pilot Area, in general, appeared to devote less time to science subjects than the other areas which were considered. The discrepancies which were noted in the examination of subject time distribution can be attributed to several possible factors.

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[5]Science in Secondary Schools, (Edinburgh: His Majesty's Stationery Office, 1951).

1. The diversity of the present academic program places a premium on the number of periods per week that can be accomodated for each subject in the time table of a particular school.

The Education Act of Nova Scotia stipulates that there shall be five hours of teaching in each classroom in each school day and the number of school days shall not exceed 190. A school board may direct that not more than six hours of teaching shall be provided on each school day in any classroom. Examination of time tables submitted by various schools suggests that the average school day consists of five hours of teaching which if segmented into periods would provide seven forty minute periods each day or thirty-five periods per week. A minimum of five subjects constitutes a year's work in the higher school grades which would allow seven periods per week for each subject. However this period allotment is not feasible in the normal curriculum today because students can choose from seven or eight subjects. In some cases a student may decide to increase his subject load by enroling in six or possibly seven subjects in order to meet the requirements of his future educational endeavours. The administrator who is constructing the time table must consider the equal distribution of subject time for each teacher and ensure that the scheduling of any subject does not overlap with the subject teacher's individual time table.

The net effect of such practices is a limiting of the number of periods which can be allocated for each subject.

The extent of this limiting factor will depend upon the diversity of the curriculum offerings and the individual qualifications of teachers in any given area.

2. Schools have developed practices which have derived from the individual needs of their pupils

There are many schools in Nova Scotia which allocate one or two periods each week for an assembly where the school usually meets as a body. Special speakers, student council representatives and other individuals may address the student body. The extra-curricular business as well as the in-school training programs which characterize high schools in Nova Scotia today have required the insertion of assembly periods in the regular time table. The majority of schools offer a physical education program which usually absorbs one or two periods each week during the regular school time. Assemblies, physical education and other activities further reduce the number of periods which are available for the regular academic program.

3. The effect of pressures of individual teachers for additional time allocation in particular subjects

The opinions of experienced teachers actively engaged in the profession for many years can exert a strong influence upon the decisions which are made by the principal of a school. The assessment of a teacher's ability is determined, rightly or wrongly, in grade 11 and 12, by the number of

students that pass or fail the provincial examinations in the teacher's subject or subjects. A teacher in this position will strive to obtain the maximum number of periods possible in his subject to enhance the likelihood of student success in that subject in provincial examinations. A teacher who is new to the profession or has been teaching for a relatively short period of time may discover that a barrier exists which prevents his opinions and suggestions carrying as equal a weight as the opinions and suggestions of more experienced teachers. The ultimate decision reached by the principal often reflects the ideas generated by the more experienced teachers. In this context, experienced teachers may be able to obtain additional periods in their subject field whether it be a science or arts related subject. Some principals may be partial to the subjects which are related to the humanities rather than the sciences for a specific variety of reasons. A principal may have been educated in an environment in which science was not stressed; consequently, he may display a disinterest or ignorance in science subjects.

3. THE LABORATORY FACILITIES USED FOR THE TEACHING OF SCIENCE

The similarities that exist in laboratory facilities for the three areas which have been considered can be summarized briefly.

(a) Laboratories are being used for the teaching of more

than one science subject. In particular, many of the schools in each area use one laboratory to conduct both physics and chemistry experimentation. The lack of adequate facilities in each science subject is reflected by the urgent need for additional laboratory facilities in many schools of each area.

(b) Laboratories in the Pilot Area and Area A, in general, are inadequately stocked with the necessary equipment to conduct the laboratory program. The schools in Area B appear to satisfy these requirements in most cases but there are shortages of certain kinds of equipment in some science laboratories.

School boards in Nova Scotia as well as elsewhere in Canada and the United States are faced with three basic problems in providing adequate laboratory facilities.

1. The rapidly expanding school population has increased the demand for additional classroom and laboratory facilities
2. The spiralling cost of living index has increased the cost of physical plant facilities
3. Scientific equipment is expensive to purchase

All of these factors must be carefully considered by a school board that operates on a predetermined budget. If the budget is exceeded, the taxpayers may be faced with an increased tax assessment. Any municipal government must carefully consider the political consequences of such action.

The net result on the school system is an inertia among school boards to satisfy the immediate needs of the school system. Maximum use is made of existing facilities resulting in larger classes using each laboratory. A laboratory, unlike an additional classroom, must contain intricate plumbing and gas connections which become costly items. In addition, the expense of stocking the laboratory with adequate equipment for an average class of 36 students must also be included in the total laboratory costs. A problem which is common to Area A and the Pilot Area and to a lesser extent in Area B is the inadequate stock of required laboratory equipment. The laboratory facilities, when initially constructed, probably satisfied the original needs of the school population. In subsequent years as the number of students increased, the supply of equipment became inadequate. Most high school laboratories are alloted a small sum of money each year to replenish used and broken equipment and restock used chemicals or animal specimens. In most cases, all of the budget is expended for the above purpose and no money remains to purchase new equipment and supplies for the increased numbers of students in the laboratory the following year. The only way money could be made available for this purpose would be an increase in budgetary allotment or expenses claimed for capital expenditures on new laboratory construction.

Certain differences have been noted in the laboratory facilities offered in each area.

The most apparent difference is the large number of students operating at each laboratory station in the Pilot Area relative to the other areas which were considered.

The reasons for this difference is not readily apparent upon examination of the number of students enroled in each science subject in the schools of the Pilot Area. The data supplied for laboratory facilities does not indicate a serious need for additional facilities if related to laboratories in Area A and Area B.

Surface analysis would indicate that fewer laboratory stations may be present in each laboratory in the Pilot Area; forcing students to group in larger numbers for experimentation.

The Pilot Area devotes the least amount of time to laboratory experiments in general in grades 11 and 12. The fact that a larger number of students can work at each desk may enable students to complete their experiment in a relatively shorter period of time but it is questionable whether the students derive maximum understanding and facility in the use of equipment.

Chemistry and physics laboratories in the Pilot Area appear to be more adequately equipped to conduct experimentation than laboratories in Area A. However, consideration must be given to the fact that fewer students are operating at each laboratory desk in Area A. Assuming the laboratories

in each area can handle the same number of students, laboratories in the Pilot Area would not be required to use as much equipment as laboratories in Area A.

The most adequately equipped laboratories are located in Area B. Several factors may account for this apparent trend. Firstly, each laboratory in Area B may be given a larger annual budget than laboratories in the other areas. Secondly, additions have been made to some of the high schools in Area B. The additional laboratories would allow schools to expend monies above the budget allowance as capital expenditures. Enrolment increases are less pronounced in the other areas and any additional laboratory facilities would not be as frequent. Thirdly, numerous large industries and several universities are easily accessible to the high schools in Area B. These institutions often donate used equipment and supplies to the schools enabling these schools to increase the magnitude of their stock.

4. THE QUALIFICATIONS OF SCIENCE TEACHERS

The comparative study of teacher qualifications in the three areas of Nova Scotia revealed certain observations relating to the Pilot Area.

1. Science teachers in the Pilot Area possess fewer credits than teachers of Area A in all science subjects except chemistry.

2. Science teachers in Area B have obtained more university credits in all science subjects in comparison to teachers in the Pilot Area.

3. Mathematics, chemistry and biology teachers in Area B have obtained more university credits than their counterparts in Area A.

4. The majority of science teachers in all areas in Nova Scotia have been employed in the teaching profession for less than ten years.

The lower number of average credits obtained by biology, physics and mathematics teachers in the Pilot Area could be attributed to several possible factors. Let us consider some of these factors.

Firstly, the salary scale may influence the number of qualified science teachers attracted to a given area. The province of Nova Scotia has established a foundation grants program to assist any given urban or local school board in meeting the costs of education. The foundation grants allotment to an area is operated on a cost-sharing basis. The percent of the total costs of education in any area in Nova Scotia which the provincial government contributes is determined by the ability of that area to obtain revenue or pay its way. All school boards in Nova Scotia must offer a minimum salary scale called "The Foundation Scale" which is outlined in Table 62.

TABLE 62

Nova Scotia Foundation Grant Scale
Effective August 1, 1966[6]

	Teacher's License				Professional Certificate			
	Class 4	Class 3	Class 2	Class 1	Class III	Class II	Class I	Class IA
Min.	2,200	2,200	2,700	3,600	4,200	5,000	6,200	7,800
Max.	2,200	3,100	3,900	5,100	6,000	7,400	8,400	9,600
Increments /yr.	0	150	150	150	180	200	200	200

[6]Nova Scotia Teacher's Union, NSTU Economic Handbook, 1965, p. 5.

An area which pays above the foundation scale may be able to entice more qualified teachers. An examination of all the areas in Nova Scotia which pay above the foundation scale may reflect the differences in qualifications which appear to exist in the Pilot Area in relationship to other areas which were studied.

The following areas in Nova Scotia offer salaries above the foundation scale. The difference in the two salary scales is given in Table 63.

TABLE 63

Salary Scales Above Foundation Scale[7]

1. PILOT AREA		TL3	TL2	TL1	PC3	PC2	PC1	PC1A
Truro	Min.	100-	200-	0-	100-	100		-
	Max.	250	350	50	200	100	100	
Sydney	Min.	120-	50-	0	0	0	0	-
	Max.	420	350	0	0	0	0	

Table 63 (Continued)

Pictou	2% over the grant scale.
Louisburg	$150 above grant.
Port Hawkesbury	$25 bonus to TL classification and $50 bonus to professional certificate teachers.

2. AREA A		TL3	TL2	TL1	PC3	PC2	PC1
St. Mary's	Min.	250	250	250	300	300	300
	Max.	250	250	250	300	300	300
Shelburne	-	local experience bonus up to $500					

3. AREA B		TL3	TL2	TL1	PC3	PC2	PC1	PCIA
Halifax	Min.	400	400	300	300	400	200	0
	Max.	900	900	800	800	800	600	600
Dartmouth	Min.	50	100	100	200	200	0	-
	Max.	375	475	400	600	800	600	

[7]Nova Scotia Teacher's Union, NSTU Economic Handbook, 1965, p. 6.

Examination of the data in Table 63 reveals the following information.

1. The cities of Halifax and Dartmouth offer the most attractive salary scale in Nova Scotia. The higher salary scale offered in Area B would partially account for the fact that the schools in this area have been able to attract more highly qualified science teachers.

2. Salaries above the foundation scale are principally confined to urban areas where sources of revenue are more easily obtainable.

3. There are five municipalities in the Pilot Area as opposed to two in Area A which have been able to offer a salary scale which exceeds the basic foundation scale. This fact, however, does not appear to offer sufficient incentive to attract more highly qualified teachers to the Pilot Area than Area A.

A second factor which could account for lower qualifications of science teachers in Area A as well as the Pilot Area is the geography of the area.

Any teacher who is contemplating acceptance of a teaching position in a given area will carefully consider the social, economic and educational conditions which are peculiar to that area.

Mention has been made of the fact that laboratory facilities and equipment are inadequate in many schools of the Pilot Area and Area A.

Such conditions would discourage prospective teachers from accepting a position in these schools. At the same time, any teacher with a family would want his children to have the best education available. In many rural schools, a shortage of qualified teachers exists. To ensure continuity of education in the area, these school boards are forced to fill vacancies by one or all of these methods; contracting teachers with lower teaching licenses, or increasing the teaching load of the present teachers in the system by giving them added subjects in which their background is

limited or non-existent. As a parent, a teacher applying for a position in this area would probably choose to apply to another area where the school system is staffed by more competent teachers. Many teachers, on the other hand, do not want to reside in an isolated area where the amenities of life are scarce. These teachers would prefer to choose an urban area where the population has a greater density.

5. THE SUCCESS OF SCIENCE STUDENTS IN PROVINCIAL EXAMINATIONS

The results of the provincial examinations in Grades 11 and 12 indicated the following general trends.

1. Science students in Area B achieved a greater level of success in provincial examinations than science students in Area A and the Pilot Area.

2. Science students, in general, in the Pilot Area were the least successful in the provincial examinations.

The qualifications possessed by science teachers in the three areas followed the same general trend that is evident for the success achieved by science students in these areas in provincial examinations; suggesting a strong correlation may exist between these two factors. The correlation which appears to exist is worthy of some consideration. The broad general nature of the topics discussed in the science subjects offered in grades 11 and 12 requires that a teacher instructing these subjects possess a broad background in the subject field. The teacher who has completed the greatest number

of credits in a subject field should be able to adapt most readily to problems which may arise in the comprehension of this material by students in the classroom. All textbooks contain sections which will not discuss a topic in the detail required for complete comprehension nor will any textbook be free of scientific material which is incorrect. The teacher with the higher qualifications in that subject should be able to isolate these facts and adapt most readily to the situation. These teachers, if given the same group of students, should be more successful in obtaining a higher level of achievement than teachers that possess lower qualifications in that subject.

The educational background of the parents can influence the attitudes and practices of their children who are obtaining an education. Assuming the child has the ability to achieve satisfactory progress in school, proper direction from educated parents can often mean the difference between success and failure. The cities of Halifax and Dartmouth have the ability to attract educated manpower to the area because numerous research centers, industries and universities are concentrated within the boundaries of this area. An academic atmosphere is more likely to be generated in high school students in this area than any other area in the province. Environmental conditions which promote the proper psychological approach to education must influence to some extent the success of

these students in examinations.

Science is a subject, which if exploited adequately, can stimulate student interest. The science subject becomes more meaningful if the practical and applied aspects of the subject are explored. The numerous scientific institutions located in the Halifax-Dartmouth area provides teachers with an ample opportunity to arrange visits where students can observe first-hand the material which may be occupying their thoughts in school. Students in other areas of Nova Scotia are not blessed with the same opportunities. The distance factor in rural areas often impedes the opportunity of students to visit areas of scientific interest.

The account of regional influences in Area B which have been mentioned in the previous paragraph may partially explain the higher level of success of science students in this area in provincial examinations.

An effort has been made in this study to analyze the state of science education in the Pilot Area in an attempt to discover whether science students in grades 10 to 12 were educationally disadvantaged in science. An examination of all facets of science education was not attempted because research material was limited in this field. Consequently, the general conclusions reached in this study must be confined to the topics which were considered and cannot be generalized to include the whole spectrum of science education in the schools of the Pilot Area. However,

an attempt has been made in this discussion to establish some common ground or tertium comparationis between each area in the field of high school science education. The fact that all areas face similar problems in adjusting to an increase in student enrolment, recruitment of qualified teachers, allotment of adequate time for science subjects and the improvement of existing laboratory facilities ensures enough similarity to make, as George F. Bereday would put it, "divergences from the common root meaningful".[8]

The examination of the state of science education in the Pilot Area, in the context of this study, suggests a general trend which places it in the least favorable position of the areas which were considered. The significance of this conclusion is not a product of the magnitude of the differences in each category but rather resides in the fact that these differences were repetitious for the majority of categories which were evaluated. The marginal differences in most categories in Area A provide some ammunition to support the contention that many of the counties in this area may require the same degree of economic assistance as the designated area originally stipulated by the federal government. High school science education in Area B appears to occupy a more favorable position than Area A because the magnitude of the differences in each category are more apparent.

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[8]George F. Bereday, Comparitive Method in Education (New York: Holt, Rhinehart and Winston Inc., 1964), p. 48.

CHAPTER IX

Considerations for the Improvement of Science Education in the Pilot Area

Let us re-examine some of the factors which have contributed to the discrepancies which now exist in the field of high school science and attempt to suggest possible steps that could be taken by educational authorities to overcome these deficiences.

Any program of adjustment to meet the challenges of this scientific age cannot be implemented effectively without some consideration of the common problems which exist in Nova Scotia in particular and for that matter in Canada as a whole. John J. Goodlad, in reference to the past decade of reform in the United States, states:

> "Tens of thousands of schools have been scarcely touched or not touched at all, especially in areas of very sparse population. Tens of thousands of teachers have had little opportunity to realize what advances in knowledge and changes in subject fields mean for them. Tens of thousands hold emergency certificates or teach subjects other than those in which they were prepared. Surburban schools with their ability to provide resources for in-science education and for attracting qualified teachers,

have fared better by comparison".[9]

The gaps between the haves and the have-nots is apparent from previous examination of the state of science education in Area B in relationship to the other areas of Nova Scotia.

The existence of smaller school units in many of the rural area in Nova Scotia has affected the quality of education that rural students obtain. James B. Conant, under a grant from the Carnegie Corporation, made a study in 1957 of the immediate problems facing the American high schools. After visiting different schools in the United States, he concluded.

"I am convinced small high schools (those with graduating classes less than one hundred) can be satisfactory only at exorbitant expense. It will be a rare district where more than twenty-five percent of a high school class can study with profit, grade 12 mathematics, physics and a foreign language for four years (assuming that standards are maintained)". Dr. Conant lists the basic disadvantages of these small high schools.

1. There are a small number of students in any specialized subject, which means that it would be extremely expensive to obtain teachers for these subjects.
2. Local districts cannot afford to provide adequate laboratory facilities to support a few students

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[9]J. I. Goodlad, "School Curriculum Reform in the United States". (New York, The Fund for the Advancement of Education, 1963), p. 10.

3. Wide academic programs are unlikely to be offered in schools where the academically talented are few in number

He proposes the elimination of the small high school and a district reorganization to establish larger school units. The province of Nova Scotia is attempting to eliminate the smaller schools and establish larger regional high schools to improve the quality of teaching. However this reorganization of the school unit is proceeding slowly in rural areas in Nova Scotia because the districts concerned cannot agree upon the location of the larger school unit and in addition the radius that a larger school unit serves present difficulties in the transportation of students if the area is sparsely populated.

The discrepancies in science teacher qualifications from area to area in the province poses a serious problem for educators. There are many reasons why the high schools are not attracting qualified science teachers bu the chief consideration is the present teachers salary scale. The salaries of high school science teachers are not competitive with those of industry and secondly industry offers better facilities and equipment for the prospective graduate. In order to attract a portion of the graduating classes in science, the high schools must increase the present scale and offer bonuses for teaching at the senior high school level. This could be achieved by issuing specialist licenses with

higher renumerations to graduates who have majored in a subject field taught at the high school level. However, this could not be made realistic unless the provincial government provided subsidies to local school boards since these boards cannot presently meet the costs of education. A further inducement could be the offering of teaching scholarships to prospective major and honor's students in science. Consideration, however, must be given to the problem of improving the present qualifications of the high school teaching force in science. The Department of Education in Nova Scotia has recently introduced a four year block program in science to familiarize teachers with the new American programmes in the sciences and at the same time give them an opportunity to raise their teaching license. However, very few teachers judging by the poor attendance in 1965, have taken advantage of this opportunity. This lack of initiative on the part of teachers to improve their qualifications is borne out in a survey carried out in 1962 by the Chemical Institute of Canada on the qualifications of chemistry teachers in the Maritime provinces. In its' report it stated "less than one-third of the teachers have taken a refresher course in chemistry since graduation and only 19% of those having taught chemistry for ten years or more in high school."[10] It would appear evident that if this

[10]B. T. Newbold, The Qualifications of High School Chemistry Teachers in the Maritimes (Chemical Institute of Canada, 1963), p. 6.

trend continues, students are going to find it increasingly difficult to adjust to university courses in this subject. The university, being the center of research and learning, must attempt to keep abreast of new discoveries and ideas. It is imperative that the teacher familiarize himself with these advances by keeping in close contact with university life. This can only be achieved by taking refresher courses at university during periodic intervals. Professor Fehr of Columbia University had this idea in mind when he stated "Every high school teacher of mathematics should plan a periodic return to the University Campus. After nine years at most perhaps four years at least, of full-time teaching the teacher should return to the college classroom. Here he should take specially prepared courses and a seminar on mathematics and the methods and materials for teaching mathematics that will bring him to the forefront in research and knowledge related to his profession. This return to the University graduate school should not be conceived as a sabbatical leave but as part of the teacher's professional activities in which he pays no tuition or suffers any salary loss. All salary and expenses of study should be borne by the school or public finance to which the school is related".[11]

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[11] Mathematics Teachers Association Bulletin (Vol. 2, No. 1, 1964). Mathematics Teachers Association of the Nova Scotia Teachers Union, Halifax, N.S.

Teachers, many of whom just cannot be bothered wasting their free time during the summer months taking courses at university should be required to take refresher courses periodically. The Ontario Education Department enforces this regulation by requiring teachers to complete summer school courses every three years and at the same time provides substantial salary increases for each course completed. The science graduate who chooses high school teaching is denied the most fundamental need in his career - the opportunity for professional growth in his field. This is one of the reasons why graduates with high standing are not attracted to teaching. It would increase the status of the chemistry, biology and physics teachers and help them greatly if they could work in industry and research for the summer months. These teachers would be keeping abreast with much of the present day research in the individual science subject(s) and at the same time this enthusiasm would undoubtedly be transferred to their pupils.

The net effect of all of these practices if they could be complemented would be:

(a) To provide an incentive for teachers to improve their qualifications;

(b) It would give greater status and prestige to the profession by removing or improving those teachers who were attracted to the profession because it was an easy job which required very little work for ten months of the year.

(c) It would attract more highly qualified college

graduates and teachers to the teaching profession in Nova Scotia.

The cost-sharing arrangement for education in Nova Scotia has been constructed on the ability of an area to pay at $1.20 per 100.00 valuation. The municipalities of Guysborough and Shelburne, for example, only contribute twenty percent of the total costs of education in their areas while the municipality of Halifax contributes fifty-two percent of the total costs of education. The cost-sharing arrangement called the foundation program is subject to revision each year. Critics of this programme have argued that an area such as Guysborough would have greater difficulty in raising additional funds to meet educational costs than an urban area such as Halifax where tax revenue is more easily obtainable at any given instance. An economically disadvantaged area such as Guysborough will tend to move more cautiously in implementing any necessary changes in the physical plant until revenue is obtainable.

The province of New Brunswick is in the process of abolishing the structure of municipal government and replacing it with a central administrative agency which has control over municipal taxation. Any necessary funds which a given area requires is obtained from the provincial treasury. This type of municipal reform alleviates the difficulties of obtaining revenue in any given area and enables a fairer distribution of monies for educational purposes. This program can be abused if the interests of a few are favoured at the expense

of others. An objective reform program similar to New Brunswick may enable Nova Scotia to overcome some of the regional discrepancies in the financing of education.

The costs of financing the education of youth in all provinces is consuming an increasing proportion of annual provincial budgets.

Nationalism is not as strong a social vehicle in Canada as the United States and consequently educational reform tends to have its roots in provincial rather than national soil. The school in Canada tends to serve the needs of the individual rather than the nation as a whole with each province having the right, according to the British North America Act, to educate its people in the way it sees fit. However, with the growing costs of education today, it appears probable that in the near future the Federal Government will have to assume an increasing role in education if the provinces are to meet the demands of a growing school population.

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