FACTORS RELATING TO FEMALE ENROLLMENT IN HIGH SCHOOL PHYSICS

A THESIS

PRESENTED TO

THE FACULTY OF GRADUATE STUDIES AND RESEARCH

UNIVERSITY OF MANITOBA

IN PARTIAL FULFILMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF EDUCATION

by

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APRIL, 1974

ACKNOWLEDGEMENTS

I wish to express my gratitude to those individuals who have assisted me in the production of this thesis. I am especially grateful to Dr. K. Slentz, for his patient interest and guidance in the writing of this thesis. Dr. Slentz's suggestions and criticisms were much appreciated. Dr. S. Leith also deserves recognition for her many acute and helpful comments.

ABSTRACT

The purpose of this study was to identify factors relating to female enrollment in high school physics courses, and to develop a practical rationale for encouraging female enrollment.

The subjects of the study were female students enrolled in grades eleven and twelve at Sisler High School, in Winnipeg. The sample consisted of 164 girls; 60 were enrolled in physics, and 104 were not.

Three questionnaires were administered to the girls, in order to determine their reasons for enrolling or not enrolling in physics. A fourth questionnaire was sent out to the girls' guidance counsellors in the Winnipeg School Division #1, to assess their attitudes toward physics.

An analysis of the questionnaire results indicated that a majority of the girls said they did not need the course, so they did not enroll in it. Many stated they thought physics would be too difficult. A smaller number gave a lack of interest in the subject as their reason; while some said they did not enroll because they were unfamiliar with the course content.

The study then attempted to identify the underlying reaons for female underenrollment. It was concluded that when it comes to making course or career selections, girls are the victims of sex stereotyping. The reasons females do not perceive physics as being of value to them is that they have relatively low aspirations for the future. Female students also lack self-confidence in the areas of mathematics and the physical sciences.

As a result of the study, a rationale for encouraging female enrollment was developed. Girls should be made to feel that physics is of value to them. The study points out that this could be accomplished by trying to raise their career aspirations beyond the stereotypes of professions such as nursing and teaching. The exaggerated difficulty of physics should be de-emphasized. A public relations programme should be undertaken to explain physics to all students. Lastly, a better rapport between the physics and guidance departments should be developed.

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Chapter 1

Introduction

Statement of the Problem and Importance of the Study

The purpose of this study is to identify factors which relate to female enrollment in high school physics courses and to develop a practical rationale for encouraging female enrollment.

Females have never enrolled in physics courses to the same degree that males have, and it seems that within the last ten years, as universities ease their entrance requirements, the male to female ratio is increasing. Most high school physics classes have a disproportionate number of males as compared to females. It is not uncommon to find physics classes consisting of boys only. This state of affairs is certainly a source for concern. If females account for fifty-one percent of the population it is logical to assume that any academic course of study, such as physics, should have an equal number of males and females enrolled. Why then, do so few girls, as compared to boys, select physics?

The situation is alarming. Physics is the most basic and encompassing of all the sciences. In a sophisticated and technological age, it is important that a majority of the population be exposed to, and encouraged to pursue, the study of physics. Some knowledge of physics is fundamental to understanding and coping with such vital societal issues as space exploration, environmental pollution, nuclear weaponry, and the

energy crisis. Yet, there has been a general decline in physics enrollment. This decline must be reversed. If female enrollment could be brought up to a par with the male enrollment in physics courses, the total number of students selecting physics would be greatly increased. In some schools, the enrollment would almost double, since their physics classes now are almost entirely male. In order to combat the trend away from physics, and to develop a rationale for encouraging girls to select the course, it is first necessary to identify the reasons why girls hesitate in enrolling.

What are the real reasons behind the decisions of most females to avoid the 'hard' sciences such as physics and chemistry, and to sign up in droves for biology? Is biology so much more intrinsically rewarding than physics? Do girls 'naturally' prefer biology? Will the study of biology benefit a girl more than will the study of physics? As enrollment (female) in physics decreases, general enrollment in biology constantly rises. The pattern must be reversed. To do this, a public relations program to encourage students, especially girls, to select physics must be developed. However, if one wishes to persuade people to enroll in a course, one must first try to identify why they might initially hesitate to sign up for it. When these factors are identified, one can attempt to refute them. Again, this is the essential purpose of this study.

Moreover, this thesis will endeavour to show that physics, although theoretically not limited to one sex, becomes practically a one sex course through formal and informal counselling and subtle discouragement. Courses that are predominantly for one sex

are questionable, and the reasons for their being one sex should be identified and altered.

Suppose a certain community had an evenly distributed population which was half white and half black. It would be certainly logical to expect that the enrollment in any academic class would be half white and half negro. Teachers and administrators would certainly be concerned if, year after year, the white students greatly outnumbered the black students in any one course, say physics. The situation would smack of racial discrimination. Black students were not getting equal educational opportunities. For some reason, they were not aspiring to the same degree as the white students. In any enlightened community every effort would be made to change the situation. The black students would be encouraged to aspire to higher goals. Efforts would be made to raise their self-images. Educational opportunities must be open to both races equally, in theory and in practice.

This unequal state of affairs has always existed when it comes to the sexes. Statistics show that males have traditionally outnumbered females in physics classes. And yet, this has never been questionned as unnatural. It was merely an accepted fact that few females chose physics. Not many people have been concerned with sex discrimination in our schools. Perhaps no one really cared whether or not females studied physics.

However, when one segment of a population consistently opts for a different program of studies than the other, something is wrong in the overall education system. Although most courses are offered to

both boys and girls, they select different options. Having a different program for males and females (no matter how small the difference) implies an inequality in educational opportunity. Different implies unequal. Inequality implies inferiority. And in this light, female education is inferior to male education.

Girls' aspirations have been consistently discouraged since infancy by parents, and then by teachers. Perhaps it is no wonder that they readily fall into the sex-stereotyped image that society has of them. This study will attempt to show the relationship between the negative and inferior self-image girls have of themselves, and their course selection, namely their avoidance of physics.

Questions Studied

This study will consider the following questions:

Question I: What are the reasons girls give for selecting or not selecting physics?

Question II: What is the relationship between the reasons girls give for not selecting physics and the present findings regarding self-image that girls have of themselves?

Question III: What are the attitudes of girls' guidance counsellors toward the physics course and what kind of advice are they giving the girls about physics?

Question IV: What type of rationale will best encourage girls to enroll in physics?

Design of the Study

As a teacher of physics, the author's essential concern was to increase female physics enrollment at her own school. Hence, the students surveyed for their reasons for selecting or not selecting physics were from one high school. Girls enrolled in grades eleven and twelve at Sisler High School in Winnipeg were the subjects of the study. This included all the grade eleven and twelve girls in the school except those enrolled in the commercial or occupational entrance programmes. The population consisted of 164 students.

Three questionnaires were constructed and were administered to the girls in November, 1973. Girls at this level were selected as the subjects of the study since they had already made the decision to enroll or not to enroll in physics.

The first questionnaire (see Appendix A) was an objective one, intended to ascertain the reasons the girls did or did not select physics. It was intended for self-administration, with responses to be recorded on an IBM optical scan score sheet. The statements in Parts A,B,C, and D of the questionnaire were deemed to be factual, and the subjects were requested to respond to "true", "false", or "don't know", as each applied to them. Part A was answered by all subjects; Part B was answered by those currently enrolled in physics; Part C, by those who had taken physics in grade eleven but had dropped it; and Part D, by those who had never taken physics and were not currently taking it. Part E of the questionnaire was to be answered

by all the students. It consisted of eighteen statements, designed to ascertain the attitudes of the girls to physics. The subjects were to respond to the statements on a modified Likert scale.

This questionnaire was based on interviews the author had with several of her female students concerning their reasons for taking or not taking physics, and their attitudes toward the course. It was also patterned after an instrument developed by G. F. Caron (1971) which surveyed students, both male and female, in Calgary, for their reasons for electing or rejecting enrollment in Grade XII Physics.

Questionnaire #2 (see Appendix B) was designed to ascertain the career preferences of the students. It consisted of a list of seventeen possible careers. The subjects were asked to select, in order, the five careers they would most prefer.

The third questionnaire (see Appendix C) was a narrative one. The subjects were asked to state their reasons for selecting their courses of study, and specifically why they did or did not enroll in physics. They were also asked what their career plans were.

The fourth questionnaire (see Appendix D) was designed to survey the attitudes of girls' guidance counsellors to physics. It was sent out to the girls' counsellors in the high schools of the Winnipeg School Division in November, 1973.

Chapter 2

Review of the Literature

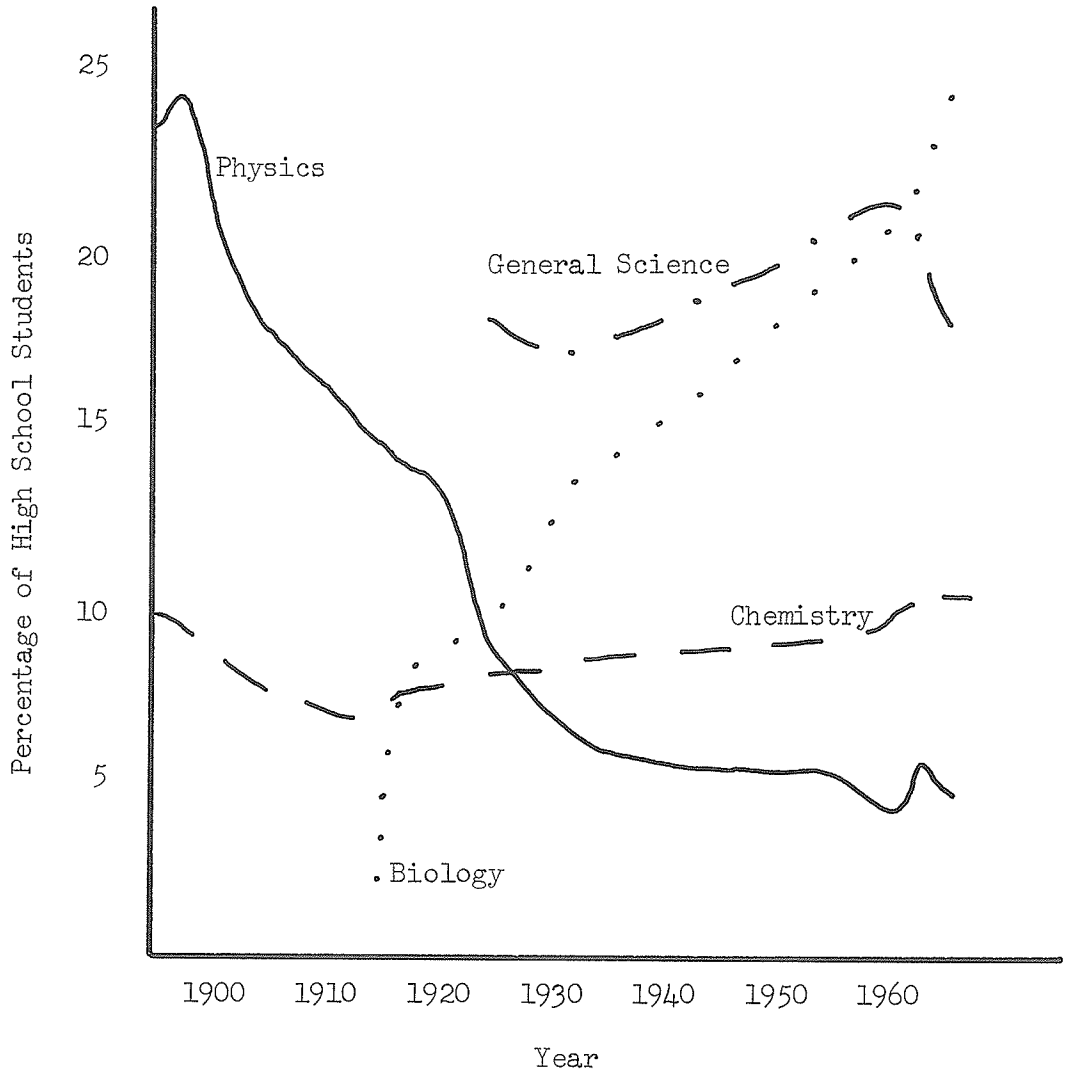
Introduction

During the last decade there has been a marked decline in the total number of students selecting and studying physics in secondary schools. This trend has continued despite major attempts to improve the physics courses offered in high schools. When PSSC (Physical Sciences Study Committee) Physics was developed and introduced into the high schools, physics became at once more rigorous, relevant, and interesting. Yet, the enrollment in physics in Manitoba has not increased since its introduction; it has continued to decline.

Background to the Problem

In Newsletter 1, Fall 1964, of Harvard Project Physics, the following graph (Figure 1) appeared, which showed an alarming trend. The percentage of American high school students electing to take physics shows a decline from the 1890's to the 1960's. The graph also shows chemistry enrollments staying relatively constant, while biology enrollments are rapidly increasing. The writers of the Harvard Project Physics assumed that one of the reasons for the decreasing enrollment in high school physics was the lack of a wide variety of curriculum alternatives. This was their justification for proceeding with the development of their course. (Holton, Rutherford, and Watson, 1970)

Figure 1. Physics Enrollment, United States.



Percentage of high school students in the United States, taking physics, chemistry, biology, and general science, 1890 to 1963. (Newsletter 1, Fall 1964, Harvard Project Physics)

The same trends are in evidence when one analyzes the percentages of Manitoba students enrolled in the different science courses offered during the four year period from 1968 to 1972. These are given in Table I. These figures are from Mr. B. Soprovich, Science Curriculum Consultant, of the Manitoba Department of Education. Grade XII physics enrollment has decreased from 27.7% of total student enrollment in 1968-69 to 22.4% in 1971-72, a decrease of 5.3% over four years. Enrollment in Chemistry 300 has decreased from 40.5% in 1968-69 to 33.5% in 1971-72. It is significant to note that in 1971-72, 33.5% of the student population was enrolled in Chemistry 300, while only 22.4% was enrolled in Physics 300, representing a difference of 11.1%. Enrollment in Biology 300 has increased from 29.4% in 1968-69 to 37.2% in 1971-72, an increase of 7.8%. Biology registrations have expanded at all grade levels. Biology 200 has had an increase in enrollment of 9.9% over the last four years. This has probably been at the expense of physics.

Figure 2 is a graph of the data in Table I, showing the percentages of grade eleven students enrolled in the various science courses offered. In 1971-72, it is interesting to note that 54% of all grade eleven students were studying biology, compared to only 25.2% who were taking physics.

Figure 3, derived from Table I, depicts the changes in percentages of grade twelve students enrolled in the various high school science courses. Again, 48.2% of all grade twelve students were taking a biology course, while only 22.4% were enrolled in

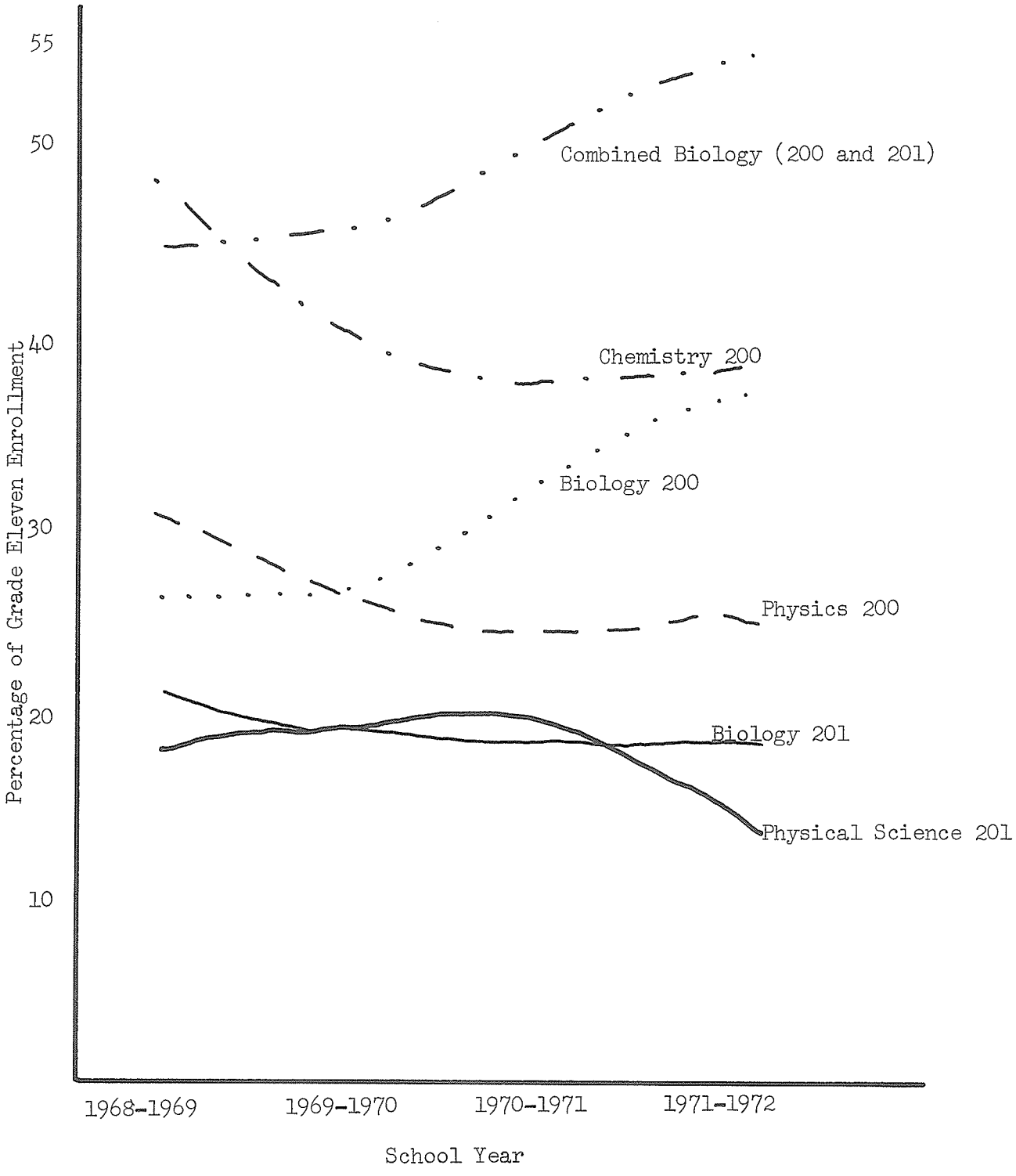
Table I

Student Enrollment - Manitoba

	1968-69	1969-70	1970-71	1971-72
Physical Science 201	21.7	19.0	19.0	14.6
Physical Science 301	12.6	12.0	12.0	10.3
Physics 200	30.5	26.0	24.0	25.2
Physics 300	27.7	20.0	21.0	22.4
Chemistry 200	48.4	40.0	37.0	37.8
Chemistry 300	40.5	(21.0)?	30.0	33.5
Biology 200	26.2	26.0	32.0	36.1
Biology 300	29.4	30.0	31.0	37.2
Biology 201	18.0	19.0	18.0	17.9
Biology 301	9.8	12.0	14.0	11.0

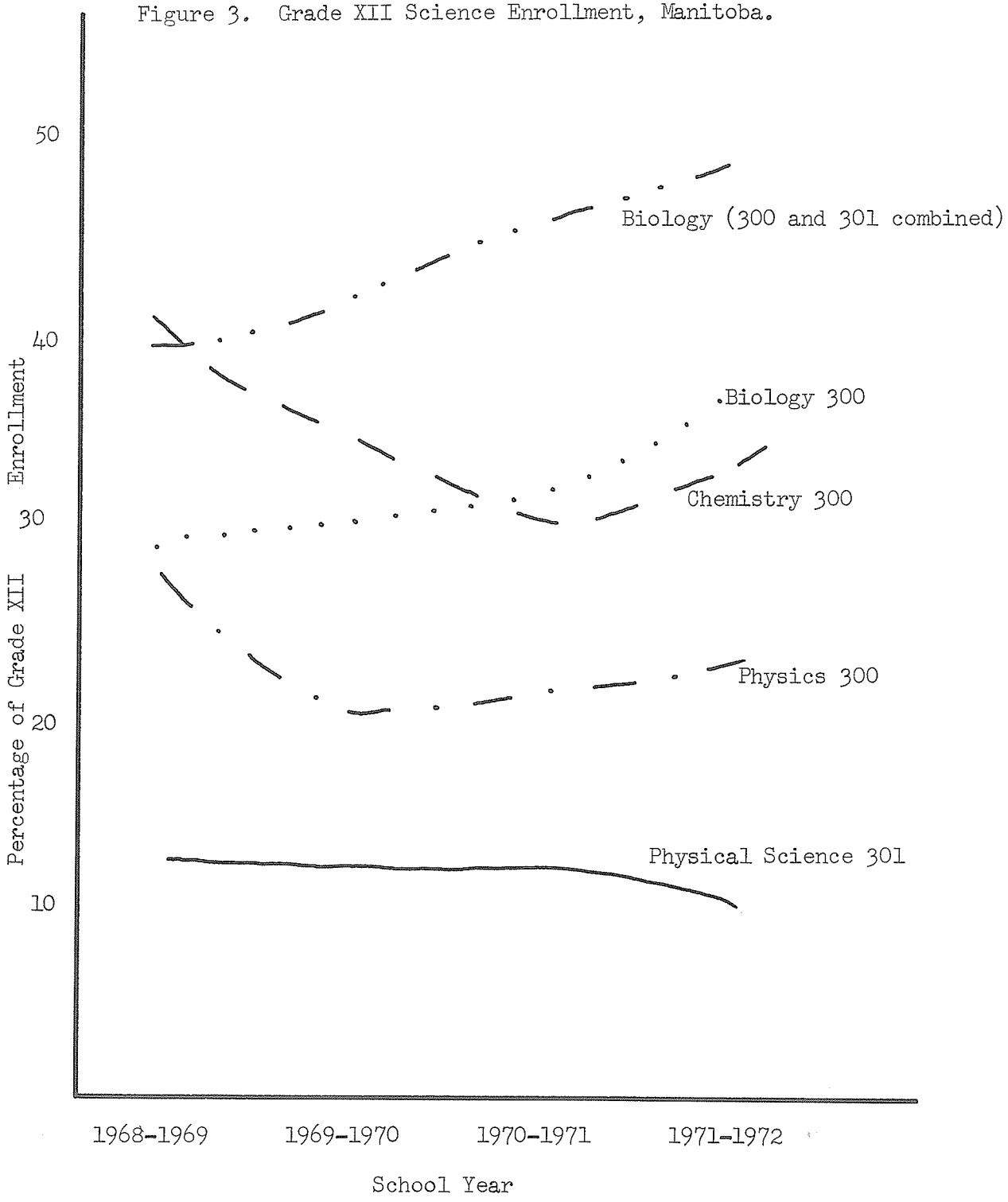
Percentage of total student enrollment in high school science courses in Manitoba. (from the Science Curriculum Consultant, Manitoba Department of Education)

Figure 2. Science Enrollment in Grade XI, Manitoba.



Percentage of grade eleven students taking the high school science courses in Manitoba. (Based on data from the Science Consultant, Manitoba Department of Education)

Figure 3. Grade XII Science Enrollment, Manitoba.



Percentage of total Grade XII enrollment in high school science courses in Manitoba. (Based on data from the Science Consultant, Manitoba Department of Education)

physics.

The decline in physics enrollment over the years is not limited to Manitoba. A study done by G. F. Caron (1971) shows that the situation is similar in the high schools of Alberta. In his thesis he presented a table, Table II, showing the number of grade twelve papers written in physics, chemistry, and biology from 1951-1969 inclusive, in Alberta (pp. 17-18). Totals for numbers of science papers written each year were also shown. Percentages that each of physics, chemistry, and biology papers written were of total science papers written were calculated and are shown in this table. Figure 4 is derived from Table II (p. 20). It shows that chemistry enrollments maintained a high relative position until 1968, but suffered a severe drop in 1968 and 1969. Biology enrollment has been generally on the increase, while physics enrollment has been in a general decline.

Thus, as shown by the Project Physics report, and by provincial statistics, high school physics enrollment is declining across the United States and Canada. To educators who believe that a study of physics is basic to the education of the average person, this state of affairs is certainly a source of concern. As succinctly put by Don Dietrich in a recent issue of 'Science Education', (Dietrich,D.,1973):

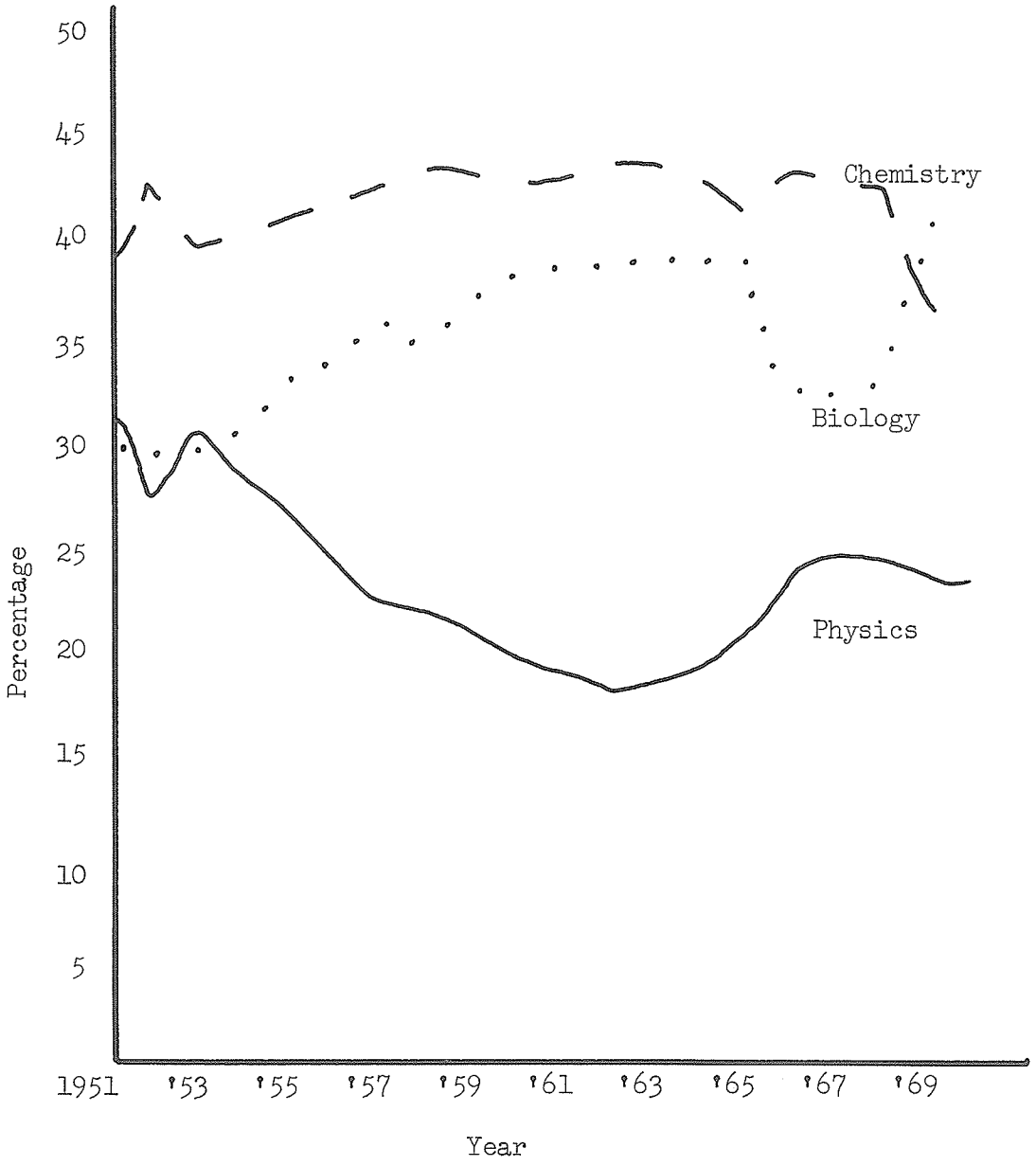
> The concern appears to stem from the assumption that high school physics can and does contribute to the development of individual scientific literacy rather than from the concern for attracting more people into the profession of physics or physics related areas.(Gatewood, 1968; Winthrop, 1966; Pella, 1967; and Cloud, 1969). If the sole purpose of the high school physics course would be the preprofessional preparation of young people going into science and the present conditions are accepted, the decline in physics enrollments should not be viewed with alarm; however, if the goal of increased scientific literacy

Table II Science Final Exams

Year	Physics Papers	%Physics	Chemistry Papers	%Chemistry	Biology Papers	%Biology
1951	2224	31.9	2635	37.8	2115	30.3
1952	2018	28.0	3078	42.7	2114	29.3
1953	2395	31.1	3047	39.5	2266	29.4
1954	2553	28.4	3626	40.3	2818	31.3
1955	2670	26.8	4030	40.5	3256	32.7
1956	2506	24.3	4311	41.8	3504	34.0
1957	2387	22.2	4570	42.4	3815	33.4
1958	2682	21.8	5363	43.7	4241	34.5
1959	2796	20.8	5730	42.7	4886	36.4
1960	2943	19.2	6496	42.3	5918	38.5
1961	3203	18.5	7362	42.6	6720	38.9
1962	3276	17.7	8115	43.9	7094	38.4
1963	3491	18.0	8329	43.0	7534	38.9
1964	3963	18.7	9027	42.6	8201	38.7
1965	4619	20.7	9076	40.7	8580	38.5
1966	5320	24.5	9362	43.0	7067	32.5
1967	5113	24.6	8914	42.9	6750	32.5
1968	4716	24.1	8254	42.3	6558	33.6
1969	4892	23.9	7347	35.9	8221	40.2

Table shows papers written in Grade XII Physics, Chemistry, and Biology, 1951-69 inclusive, Alberta.
(Caron, G.F., 1971, p.17)

Figure 4. Science Enrollments, Alberta.



Percentage of students writing Grade XII final examinations in the three sciences, 1951-1969, Alberta. (Caron, G.F., 1971, p.16)

> for the general citizenry is held, then the concern presents a problem that needs more and immediate attention.

It is significant that in Manitoba no male-female breakdown of enrollment in science courses is available from the Department of Education. Females have always been outnumbered in physics classes. In some schools, physics classes consist solely of boys. Yet, few people have questionned this state of affairs. In Manitoba, no information has been collected regarding this. The reason, of course, is that perhaps no one has really cared whether or not girls studied physics. It has always been accepted that physics was essentially a male interest and that having few or no girls in a physics class was only natural.

In order to obtain some information on the male to female ratio in the various science courses offered in Manitoba, a survey of science enrollments was done on a sample of high schools from the Winnipeg School Division, by the author. The data obtained is illustrated in Table III.

The greatest inequity in enrollment is in the PSSC Physics courses. Chemistry has a majority of males, but not as great as the male majority in physics. The situation is reversed in Biology, where females outnumber the males.

The point is, that if as many girls as boys selected physics, the total enrollment would greatly increase. In fact, in some schools the total enrollment might conceivably double, since in many schools physics classes are almost 100% male. If girls are to be encouraged to enroll in physics, it is first necessary to determine what

Table III

Science Enrollments - Winnipeg School Division

1972 - 1973

	% Males Enrolled in Course	% Females Enrolled in Course
PSSC Physics 300	79	21
PSSC Physics 200	75	25
Chemistry 300	57	43
Chemistry 200	62	38
Biology 200	46	54
Biology 300	46	54

arguments might convince them that they would benefit from and enjoy the study of physics.

Related Research

As yet, no studies have been located by the author on why females, specifically, do not enroll in physics, but there have been various studies done on why students, in general, do or do not select physics--or rather, what reasons students give for selecting or not selecting physics.

Snelling and Boruch (1970) initiated a study in 1967 in which they tried to answer the following questions:

> When do students form vocational judgements about entering the sciences? At what stage of his education is the choice of a specific scientific field made? What do graduates perceive as influences in determining such choices?

The sample was restricted to graduates from forty-nine colleges, and to those graduates who majored in mathematics and the sciences. Responses to a questionnaire indicated that from 37.7% to 51.2% of the graduates, from 1957 to 1967, had chosen which science was to be their major field of interest by Grade IX. More than any other subject group, physics majors had made their choice by Grade IX. This study would seem to indicate that junior high school science experiences were a great influence on persons selecting science as a career.

A second study, done by H. Kruglak (1970), polled 3000 freshmen at Western Michigan University in 1968 for their reasons for taking or not taking high school physics.

Reasons selected by students for not taking high school physics were reported by Kruglak as:

1.	Lack of interest in subject.	Boys	67%	Girls	83%
2.	Counsellor's advice.	Boys	19%	Girls	8%
3.	Fear of low marks.	Boys	7%	Girls	5%
4.	The poor reputation of the teacher and subject difficulty were given as reasons by a very small fraction of the respondents.				

Reasons selected by students for taking high school physics were reported by Kruglak (p. 395) as:

1.	Interest in subject.	Boys	40%	Girls	24%
2.	Counsellor's advice.	Boys	37%	Girls	41%
3.	Challenge of a difficult subject.	Boys	15%	Girls	19%
4.	The reputation of the teacher had the lowest ranking for each group.				

In his conclusions Kruglak stated (p. 395):

> The entering freshmen do not feel that the difficulty of physics or the teacher quality are serious obstacles in the selection or non-selection of the subject. Interest in the subject matter and the counsellor's recommendation are the two most important influences cited by the students. Consequently, if high school physics is to remain competitive with other disciplines, then introductory science courses in the lower grades deserve greater emphasis. Therefore, the preparation of elementary and junior high science teachers is of crucial importance. Also, there is a need for establishing a better rapport with the high school counsellors.

In a third study Walter Elliot (1971) obtained data from approximately one-half of students registered in physics in the public schools of California during 1967-68, and about one percent of California students not taking physics. He reported:

> The 2438 non-physics students were about evenly divided on the basis of sex. 88% were B or C students; 91% ranked themselves in the upper two-thirds of their graduating class; and 74% planned further academic work after graduation. The predominant reasons given for not enrolling in physics were lack of interest, and fear that physics was too difficult.

> The 10,528 students enrolled in physics were predominantly male (81.5%); 83% were A or B students; 93% ranked themselves in the upper two-thirds of their graduating class; and 92% planned further academic work after graduation. Their reasons for enrolling in physics were anticipated need in college and interest in physics, in that order.

Dietrich (1973, pp. 25-29) did a study to attempt to determine if the grading practices of high school physics teachers was a contributing factor to declining enrollments in physics. He was influenced by the work of Bridgham and Welch, who, in 1969 conducted a study in which they computed the correlation between a measure of severity of grading by twenty physics teachers and the student drop-out rate in physics courses. Although they did not find correlations obtained to be statistically significant they did interpret the pattern of correlations as supporting the hypothesis that severity in grading is associated with diminished physics enrollments. The authors suggested that additional research should be done to determine if the grading practices of physics teachers might be acting more as a deterrent to the student enrolling in physics rather than as a factor contributing to his dropping out of a physics class after he has started.

Dietrich followed their suggestion and decided to compare the severity of the physics teacher's marking procedures to the physics enrollment in his school. The study was conducted in a midwestern state where the percent enrollment in physics in the various high schools ranged from 0 to 62. Two groups of high schools were arbitrarily defined: (1) those with a relatively high (25 or more) percent enrollment in physics (referred to as HE schools), and (2) those with a relatively low (12 or less) percent enrollment in

physics (referred to as LE schools). This definition led to the identification of 17 HE and 18 LE schools and the selection of the 18 teachers employed by each group of schools. Grading data were collected for five students randomly selected from the physics class(es) of each of the physics teachers. The data included were: (1) physics grade; (2) overall grade point average; (3) grade point average in science other than physics. From these data two measures were computed for each student to serve as indices of the grading severity of the physics teachers. These two measures were: (1) Physics grade-Overall grade point average; (2) Physics grade-Other science grade point average.

Each student was then placed into one of four grading severity categories:

I. Physics grade $\leqslant$ Overall GPA and $\leqslant$ Other science GPA.
II. Physics grade $<$ Overall GPA and $>$ Other science GPA.
III. Physics grade $\geqslant$ Overall GPA and $\geqslant$ Other science GPA.
IV. Physics grade $>$ Overall GPA and $<$ Other science GPA.

Grouping of all the students within each set of physics teachers allowed a comparison of the grading severity between the physics teachers in the HE schools with the physics teachers in the LE schools.

He found that:

1. Although both groups of teachers tended to be severe graders, the physics teachers in HE schools were more severe than the physics teachers in LE schools.
2. When the physics grades of the students were compared to their overall GPA, both groups of physics teachers tend to give physics grades lower than the students' overall GPA; however, the physics teachers in HE schools were statistically more severe graders.
3. The physics teachers in the LE schools gave a larger percent of physics grades which were equal to or greater than the students' GPA in other sciences than physics grades which

> were less than the students' GPA in other sciences. The opposite pattern existed for teachers of physics in HE schools. Differences in grading severity were statistically significant.
>
> He concluded that:
>
> The results of this study do not appear to support the idea that the grading practices of high school physics teachers are discouraging students away from enrolling in high school physics courses.

A fifth study done by G. F. Caron (1971), in an attempt to ascertain the reasons for the decline in physics enrollment in the Calgary area, surveyed students for their reasons for electing or rejecting enrollment in Grade XII Physics. He concluded that grade twelve students selected physics primarily for reasons related to future education or career. Furthermore, he determined that the majority of grade twelve students had heard negative statements made about physics. Most of the Calgary students had made up their own minds when selecting their science options, rather than following counsellors' advice. This would contrast with Kruglak's findings that counsellors' recommendations rank second as reasons cited by students for their science choices. This, perhaps, could be attributed to the fact that counsellors in American high schools usually have more prestige than their Canadian counterparts.

Thus, it is seen, from the studies done to date, that students cite anticipated need in college and/or in career as the main reason for choosing physics. Counsellor advice was also cited; but presumably their advice is related to the career a student has suggested he might be interested in. Conversely, it would seem that if a student planned on a career that did not require physics, he would not think it necessary

to select the course, and since the course does not seem to fit in with his perceived career plans he would not feel interested in the course. He might not even take the time to find out what physics was about. He might just rationalize and say that he was not interested in physics, merely because he had never thought it would be necessary for him to take physics and so he had never found out what the course consisted of. In all of the studies, it was shown that some students hesitated to enroll in physics because they had heard it was difficult.

In all the studies done, career reasons for selecting physics seem to be the most important. Counsellor advice is also important; but, the advice a counsellor gives a student usually consists of a list of the courses a student must take if the student wants a specific career. For example, a young girl who told her counsellor she would like to become a practical nurse, is told of the necessary requirements for becoming one. So the advice of a counsellor usually depends on the stated career objectives of a student. It would therefore seem that, if students are to be encouraged to select physics in high school, it should be stressed that the study of physics would lead to a variety of interesting careers and would furthermore leave the student with many more career options at the end of high school which he would not have if he did not select physics. The fact that so many non-physics students stated that they were not interested in physics points out the necessity of attempting to inform students at the grade ten level exactly what physics is about. Many say they are not interested in it, but they probably have no idea what topics are covered in physics, or have a very vague idea of the course content.

Since career reasons figure so importantly in the reasons cited by students for selecting or rejecting physics, it is no wonder that so few females select physics. Most high school girls have a very narrow and stereotyped image of what the future holds for them. A grade ten girl, when selecting her courses, selects those which she needs——requires for her career. The majority of girls see their future occupational roles limited to that of a homemaker, or to sex-stereotyped occupations, such as secretary, teacher, salesclerk or nurse. Parental, teacher. and counsellor attitudes and practices often discourage girls' aspirations and limit their sense of autonomy and self-image.

If one is going to convince a girl that she should study physics, it is necessary to convince her that she needs it for her future. To do this, girls' career aspirations must be broadened. It is disheartening to see so many intelligent young girls bypassing physics because they do not need it to become nurses or elementary school teachers. Why do they not want to become architects or doctors? Many of them certainly have the ability. It is necessary to broaden their career aspirations. By increasing women's employment and career opportunities, their interest in subjects such as physics will be increased, and the enrollment in the course should rise.

The need to broaden women's educational opportunities stems from several important concerns. It is axiomatic that legal requirements for equal opportunity employment must be accompanied by equal educational opportunities. Table IV (United States Department of Labor Employment Standards Administration, 1972) compares the enrollment of women in

Table IV

Female College Enrollment - United States

	1969-70	1930
Women College Students	3,507,000	481,000
Women Receiving Degrees	433,594	55,266

Women as Percent of Total

	1969-70	1930
College Enrollment	41.3	43.7
Bachelor's Degrees	41.6	39.9
Master's Degrees	39.8	40.4
Doctorates	13.3	15.4

(U.S. Department of Labor Employment Standards Administration, 1972)

American colleges in 1930 and in 1969-70. The figures show that college enrollment is still far below the 50-50 division that would make the situation equitable.

Much less heartening for women is their persistent concentration in college courses which prepare them for the traditional women's professions. Table V shows that there is still rampant occupational segregation of women, and that this segregation is not disappearing. (United States Department of Labor Employment Standards Administration, 1972).

Analysis of additional data by majors supports the conclusion that the distribution of women's college majors changed to only a limited degree in the thirteen year period, illustrated in Table V. (United States Department of Labour Employment Standards Administration, 1972).

The concentration of women in specific college courses and in specific occupations was noted and deplored by the Manitoba Volunteer Committee on the Status of Women (1968). The Committee found that about 1,800 girls out of 5000 who graduate each spring from high school go on to advanced programs of learning at colleges, universities, and technical institutes. Only a third of the student population was female in each of the institutions for advanced learning in Manitoba. It was felt that "this must be because the high school environment and family environment still do not encourage a girl to develop her capacities." It was a "matter of concern and worry to the Committee, because it was felt that many of these girls are capable of advanced training and study but simply are not interested." (p. 77).

Table V

Percentage of Females Enrolled in American Colleges Majoring in Selected Subjects

	1969-70	1955-56
Teacher Education	39	49
Humanities	22	17
Social Sciences	15	10
Health Professions	4	6
Natural Sciences	4	4

(U.S. Department of Labor Employment Standards Administration, 1972)

Furthermore, in Manitoba, it was found that in the University, the following faculties or schools had a majority of women: Home Economics, Nursing Education, Interior Design, Fine Arts, Music, Education, Dental Hygiene, and Medical Rehabilitation. Another group had nearly equal numbers of women: Arts, Physical Education, and Social Work. Still another had a small number of women: Science, Medicine, Commerce, Agriculture, Law, Accountancy, Graduate Studies, and Architecture. Engineering and Dentistry did not appear to attract women students. Table VI gives the enrollment figures for selected faculties at the University of Manitoba. (Manitoba Volunteer Committee on the Status of Women, 1968).

Table VII, based on information from the Registrar's Office, University of Manitoba, compares the numbers of degrees granted by the University to both men and women, in May,1932, and in May, 1973.

It is interesting to note that in 1973 women formed a minority in all graduating classes except those considered to be traditionally female, namely home economics, nursing, and dental hygiene. Women formed a small or negligible minority in all other faculties.

Compare, for example, the faculties of Medicine and Nursing. In Medicine, in 1973, men received 88% of the degrees granted; women received only 12%. In nursing, women received 100% of degrees granted. Consider Dentistry and Dental Hygiene: 100% of Dentistry graduates were men; 100% of those receiving a diploma in Dental Hygiene were women. It is significant to note that in the above two pairs of related professions, females abound in the subordinate one of the pair —— the one with both lower pay and lower social status.

In the 41 year interval from 1932 to 1973 the number of men receiving

Table VI

Full-time Registrations, All Years, Selected Faculties, Male and Female

December 1, 1967

Faculty or Course	Male	Female	
		Number	% of Total
Engineering	1,057	6	0.6%
Science	1,454	232	13.8%
Medicine,Dentistry	374	31	9.2%
Commerce	400	33	7.6%
Home Economics	-	425	100.0%
Education	226	694	75.4%
Master's Program	366	58	13.7%
Doctoral Program	149	15	9.1%

(Report of the Manitoba Volunteer Committee on the Status of Women, 1968)

Table VII

Degrees Granted, University of Manitoba

Faculty	May, 1932						May, 1973					
	Male		Female		Total		Male		Female		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Engineering	36	100	-	-	36	100	186	99	1	1	187	100
Law	15	94	1	6	16	100	89	92	8	8	97	100
Medicine	33	97	1	3	34	100	68	88	9	12	77	100
Science	38	71	9	19	47	100	346	78	97	22	443	100
Arts	96	47	107	53	203	100	416	54	361	46	777	100
Home Economics	-	-	19	100	19	100	-	-	72	100	72	100
Nursing							-	-	59	100	59	100
Dentistry							26	100	-	-	26	100
Dental Hygiene (Diploma)							-	-	25	100	25	100
Doctor of Philosophy	-	-	1	100	1	100	32	97	1	3	33	100

(Based on information from the Registrar, University of Manitoba)

the Doctor of Philosophy degree has increased from 0 to 32. The number of women receiving the degree has not changed in 41 years.

Also, based on information from the Registrar's Office, the University of Manitoba, it was found that in the 41 year interval from 1932 to 1973 the University conferred Honorary degrees on 237 men, while only conferring 13 on women.

The Manitoba Volunteer Committee further found that at the Manitoba Institute of Technology (now Red River Community College), women were found to be enrolled primarily in the Secretarial Science, Drafting Technology, and Library Assistants courses. In the Business Education Teacher Training program, 83% of the students were women. Hairdressing and Practical Nursing had nearly all female registrants. Courses in which a few women were enrolled were: Short Order Cooking, Barbering, Baking, and Business Administration. Electronic Technology had only one woman enrolled in 1966, while Chemical Technology had no females in 1967.

The Manitoba Volunteer Committee on the Status of Women concluded that:

> It would appear that there is a decided image in the minds of most students about the kinds of work which they would like to do. In every case, admissions are open to women as well as men. It is felt that girls may be handicapping themselves because of lack of knowledge or a fear of being different. It is possible that girls need more information and encouragement in order to attempt the more masculine occupations.

The report went on to recommend that the government, through Manpower and the National Film Board, should act to develop programs encouraging girls to broaden their career aspirations.

Table VIII, also from the report, shows the evident concentration

Table VIII

Manitoba

Percent Distribution by Sex of Selected Professional Occupations

1961 Census

Occupation	Male	Female	Total
Engineers	100.0	-	100
Physical, biological, and agricultural scientists	95.0	5.0	100
Physicians, dentists	94.1	5.9	100
Pharmacists	93.4	6.6	100
Law professionals	98.5	1.5	100
Accountants	94.9	5.1	100
Nurses	4.3	95.7	100
Dieticians	5.4	94.6	100
Teachers	34.9	65.1	100
Medical and dental technicians	30.1	69.9	100
Librarians	17.2	82.8	100

(Report of the Manitoba Volunteer Committee on the Status of Women, 1968)

of women in certain professions.

Why is there this occupational segregation of females? Why do females persist in enrolling in the traditionally feminine faculties of home economics, nursing, and arts; and wind up in the traditionally feminine occupations of homemaking, teaching, and nursing? It is significant that the last five professions listed in Table VIII, which have a majority of females in them, are also the lowest paid professions. Of course, certain teachers advance to become well paid administrators, and some librarians rise to the position of head librarian; but the ones who do are usually male.

For example, as illustrated in Table IX, it is apparent that while women and men seem to qualify for the certificate in education in almost equal numbers, when it comes to the more advanced degrees in Education, men graduate in far higher numbers than women. Perhaps this is why so few women get ahead in the teaching profession. Table IX is based on information from the Registrar's Office, the University of Manitoba.

The reasons why women do not aspire beyond the stereotyped careers are many. From infancy, females suffer from overt and subtle discrimination, first on the part of their parents, and then on the part of their teachers and counsellors. While most parents are interested in seeing their sons aspire to a rewarding and challenging career, when it comes to their daughters, they do not have the same attitudes. Marriage is still regarded as the real career for women. According to Nancy Reeves (1971):

> Few boys are naturally ambitious, but the necessity of earning a living is drummed into them at an early age. Most parents go on to point out that a specialized education

Table IX

Degrees and Certificates Granted

Faculty of Education

University of Manitoba, 1973

	Men	Women	Total
Master's in Education	18	5	23
Bachelor of Education	70	56	126
Certificate in Education	246	260	506

(Based on information from the Registrar, University of Manitoba)

> makes it easier to earn a comfortable living, and that the pleasures of art and music, for instance, have to be balanced with the greater remuneration likely from the study of engineering or dentistry. This, together with the law of supply and demand, ensures that we have enough engineers and dentists, and that only the very gifted or very determined stick to music or art. The fact that we have no women dentists or engineers, and very few women lawyers or physicists results from the notion that, since her real career is going to be marriage, a woman might as well study the things she really enjoys, like the arts. And if she happens to have no particular talent and does have to earn her living for a year two, well, she can always take a course in shorthand and typing. It is also the reason why women are so often content to go on doing subordinate and ill-paid jobs——teaching and nursing, for instance, and why these essential jobs continue to be so badly paid.

According to Katherine Ollerenshaw (1961, p. 186)

> At present all the indications are that the majority of girls at every level of ability are too easily content to work at levels beneath their full intellectual capacity. A boy knows that his eventual standard of living will depend of his own efforts and the level of work which he can attain. It is at present different for a girl, for her eventual standard of living is more likely to depend on her future husband's position than on her own earning capacity. If this situation changes and if (as may well happen) a girl becomes valued in the marriage market as much for her potential capacity as an earner as for her personal charm and her skill as a homemaker there might be a marked change in the attitudes of the girls themselves toward extended education.

Once girls start school, the inferior (dependent and passive) self-image they already have of themselves is further developed. Analysis of widely used textbooks provides evidence that women and girls are usually represented as passive followers of men and boys, and the occupational roles for women and girls are usually limited to housewife, or the sex-stereotyped occupations of secretary, teacher, etc. (Citizens' Advisory Council on the Status of Women, 1973). Books for young children are among the worst offenders in sex role stereotyping. Systematic surveys of public schools in Ann Arbor, Michigan,

and New York City by women's organizations document areas of inferiority afforded girls at all levels of the public schools surveyed. (Citizens' Advisory Committee, 1973, p. 4). Included in the report of the survey of New York City schools is a study of early grade readers, which reports that:

> In the early grade readers the oldest child in the family is always a boy. Boys are associated with making, earning, playing active games, learning, romping with dogs, and helping their fathers.
>
> Girls are associated with helping their mothers or brothers, playing with kittens, getting into minor forms of trouble and being helped out by their brothers. Patterns of dependence passivity, and domesticity are apparent. Story lines from Scott Foresman's first three primers are as follows:
>
> Boy sets up carnival act. Boy teaches dog to jump for food. Boy solves problem of keeping mother's floors clean. Boy solves problem of runaway dog. Boy plays ball. Boy uses magnet to solve problem for girl. Boy builds car, girls interfere.
>
> Story lines for girls go:
>
> Girl is frightened by older brother. Girl is helped by older brother. Girl plays with Teddy and kitten. Girl is helped by older boy. Girl solves her own problem. (this is very unusual). Girl mistakes cat on television for her kitten. Girl helps mother choose books. Girl paints picture of cat.

Girls see the inferiority of women when it comes to the discriminatory way in which teachers are promoted. The sex discrimination in filling supervisory and administrative positions in educational institutions not only harms the teachers, but also the female students by reinforcing the occupational stereotypes depicted in textbooks and the media. In a recent American survey it was found that women constitute 84.7% of elementary school teachers, but only 19.4% of supervisory principals; 45.9% of secondary teachers, but only 35.3% ofjunior high principals, and 3.0% of high school principals. (Citizens' Advisory Council, 1973, p. 5)

This unfair situation is even worse in Canada. A survey was done by the author to determine the number of male and female principals in the public schools of the Greater Winnipeg area. The results are illustrated in Table X.

This table points out the fact that a very small percentage of women obtain principalships, and the few they do obtain are usually in the elementary schools.

Many counsellors and teachers lack information on and sensitivity to changing life patterns for women and to widening vocational and higher educational opportunities resulting from changing attitudes and equal opportunity legislation. These counsellors go right on advising girls into the traditionally female occupations, seeing no need for encouraging girls to broaden their aspirations. According to Berry (1972, p. 106):

> The 70's require that more counsellors tune in to the consequences of an evolutionary change in attitudes concerning girls and women that has been in motion for over a decade.
>
> Counsellors must now redefine what it means to be a woman in the 70's and, in many instances, must take a giant step to increase their understanding. And while it is true that many young girls still seek traditional roles and life styles, marry early, and have a child or two, it is equally true that many will become disenchanted with this pattern. As they tire of total domestic responsibilities or are forced into action by divorce, many will seek day care for their children and launch themselves into the world of work.
>
> The times are changing, and high school counsellors must begin to counsel girls for what is really going on in the world today.
>
> Barriers to career opportunities and vocational advancement are being demolished by equal opportunity legislation, enforcement procedures, and social pressures. But young girls and women must learn that this is happening, and that involves new responsibilities and tasks for school counsellors.

It is unfortunate that many counsellors in Manitoba schools are

Table X

Elementary, Junior High, and Senior High Principals in the Schools of Greater Winnipeg, 1973

	% Male Principals	% Female Principals
Elementary Schools K-6	78	22
Junior High Schools 7-9	93	7
Senior High Schools 10-12	97	3

unaware of the changing life patterns for women. Rather than being in the forefront, trying to encourage girls to make occupational choices other than in the traditionally female fields, they seem to be hanging in the background, often actually discouraging young women from pursuing courses in the physical sciences and careers in such professions as dentistry or electronics. It is hard to say what this reticence is due to. Perhaps it is because most counsellors have come from the traditional female mould, are content with themselves, and see nothing wrong in most girls' trying to follow in the stereotyped pattern. Most are very humanities oriented, and perhaps think that this should be the norm for females. Perhaps they were weak in the sciences, and therefore think it is 'natural' for female students to avoid such topics as physics and chemistry, and science oriented careers. Counsellors are in a very advantageous position when it comes to trying to influence the career aspirations of their students. All indications are that they are not broadening the aspirations of their female students, however. They seem to be doing the reverse--reinforcing the old stereotype.

One glaring example of the insensitivity of Manitoba counsellors is in the continued use of the Strong Vocational Interest Blank as an aid in helping young women to determine their career aptitudes. There are two forms of the test: the male and the female. The occupational groups for the male are:

I. Biological Science
II. Physical Science
III. Technical Supervision
IV. Technical and Skilled Trades
V. Social Service

VI. Aesthetic-Cultural
VII. CPA Owner
VIII. Business and Accounting
IX. Sales
X. Verbal-Linguistic
XI. President, Manufacturing Concern

The occupational groups for the female are:

I. Music
II. Verbal-Linguistic
III. Social Service
IV. Sales
V. Business-Clerical
VI. Domestic
VII. Health-Related Services
VIII. Medical Sciences
IX. Physical Sciences

(Strong, E. , 1972, p. 13)

It is interesting to note that there is not one test, but two different ones, with two different sets of occupational categories for men and for women. Strong even admits that "the tendency of a large number of women to score high on only a few scales has resulted in several comments in the professional literature. It is occasionally suggested that the Women's form is not as useful in identifying occupational interests as the Men's form." (Strong, E., 1972, p. 13). The point is, that this form is being used by counsellors to guide female students.

Girls are not even encouraged in high schools to live up to their own potential. Ausubel (1969, pp. 431-432) suggests that females:

> ... adopt socially shaped attitudes which lead to a serious underdevelopment of their intellectual potential. Kagan (1964), for example, suggests that the female student soon becomes convinced that the ability to solve problems in mathematics is a uniquely masculine skill, and that her motivation to attack such problems is low. As early as 8 or 9 years of age, a sex difference in

> analytical attitude, independence of thought, and persistence in problem solving begins to appear. This difference, according to Kagan, "... increases with time, and by late adolescence and adulthood the typical female feels inadequate when faced with most problems requiring analysis and reasoning."
>
> Coleman (1961) evinced an equal concern for the apparent negative influence of the adolescent subculture on the performance of female high school students. According to Coleman's data, the high ability female who wants approval from the peer group and realizes that very high scholastic performance is not likely to enhance her popularity, adopts a level of aspiration beneath her real potential (although sufficiently high for university entrance). Coleman found, for instance, that the girls earning the highest marks were not necessarily those with the highest ability; and, consistent with the above analysis, clever and status conscious girls learn quickly that they should not compete with males in the latter's traditional intellectual sanctuaries of mathematics and science.

Canadian women are suffering from lack of employment opportunities, and the reason for this is their lack of educational opportunities. It is time that women were not treated as second class citizens by their parents and teachers. Girls must be encouraged to aspire to higher goals. They will never do this unless they get the encouragement of their families and schools. An effort must be made in assisting them to see beyond the traditionally female occupations. When they realize that they can and want to become dentists and doctors and engineers, then their interests will broaden. When they see that there are more careers open to them than teaching and nursing, then they will realize that they are indeed interested in subjects like physics. There is not much benefit derived from having an interest in an area in which one has no chance of a future. This is perhaps why so few girls opt for physics. But, if new professions are opened to women, at least there is a possible future for them. Equal opportunity legislation has improved the situation for women. It is now up to the schools to see that girls are given equal educational opportunity, actually as well as theoretically.

Chapter 3

Experimental Design

Objective of the Study

In order to try to ascertain the reasons given by females for enrolling or not enrolling in physics, a set of three questionnaires was constructed to be administered to the girls. Similarily, to determine the attitudes of girls' guidance counsellors to physics, a questionnaire was constructed and administered to the girls' guidance counsellors of the Winnipeg School Division.

Subjects of the Study

The three questionnaires were designed and administered to the girls enrolled in grades eleven and twelve at Sisler High School, in the Winnipeg School Division. Girls at this level were selected since they had already made the decision to enroll or not to enroll in physics. The girls who answered the questionnaires consisted of all the females enrolled in grades eleven or twelve at the school, with the exception of those enrolled in the commercial or occupational entrance programmes. The sample size consisted of 164 students; 60 of these girls were enrolled in physics, while the remaining 104 were taking other sciences. Since the purpose of the study was to try to determine the reasons the girls at Sisler High School were not taking physics, and to try to alter the situation there, the study was restricted to this one school.

The fourth questionnaire, designed for girls' guidance counsellors,

was administered to a sample of these people in the different high schools of the Winnipeg School Division.

The Questionnaires

The first questionnaire, Questionnaire #1, (see Appendix A) was an objective one, intended to ascertain the reasons why the girls did or did not select physics. It was intended for self-administration, with responses to be recorded on an IBM optical scan score sheet. The statements in parts A, B, C, and D of the questionnaire were deemed to be factual and the subjects were requested to respond to "true", "false", or "don't know", as each applied to them. Part A was to be answered by all of the subjects; part B was to be answered by those currently enrolled in physics; part C, by those grade twelve students who had taken physics in grade eleven, but had dropped it; and part D, by those who had never taken physics, and were not currently taking it. Part E of the questionnaire was to be answered by all the subjects. It consisted of eighteen statements, designed to determine the attitudes of the girls to physics. The subjects were to respond to the statements on a modified Likert scale. This questionnaire was based on interviews the author had with several female students concerning their reasons for taking or not taking physics, and their attitudes toward the course. It also was patterned after an instrument developed by G.F. Caron (1971), which surveyed students, both male and female, in Calgary, for their reasons for electing or rejecting enrollment in Grade XII Physics.

Questionnaire #2 (see Appendix B) was designed to determine the career preferences of the students. It consisted of a list of

seventeen possible careers. The subjects were asked to select, in order, the five careers they would most prefer.

Questionnaire #3 (see Appendix C) was a narrative one. The subjects were asked to state their reasons for selecting their courses of study, and specifically why they did or did not enroll in physics. They were also asked to state their career plans. The questionnaires were administered to the girls in November, 1973.

The fourth questionnaire (see Appendix D) was designed to survey the attitudes of the girls' guidance counsellors to physics, in an attempt to determine what attitudes and advice they might be passing on to their students. It was sent out to the guidance counsellors in the Winnipeg School Division, in November, 1973.

The Questions Studied

Question I

What are the reasons girls give for selecting or not selecting physics?

The data obtained from questionnaires #1 and #3 was analyzed, item by item, to determine the reasons most often cited by the girls for taking or not taking physics, and to see if the attitudes and opinions of the girls taking physics are different from the attitudes and opinions of the girls who did not take the subject.

Question II

What is the relationship between the reasons girls give for selecting or not selecting physics and the present findings regarding

self-image that girls have of themselves?

Questionnaire #2 is an attempt to determine the career preferences of female students, and hence to determine the extent of their aspirations. Are they high? low? typical of the female stereotype? Both the physics girls' and the non-physics girls' preferences were ranked, and then compared, to see if the student who chose physics had higher or lower ambitions than the non-physics student.

Items from questionnaires #1 and #3 also shed light on the attitudes of the physics and non-physics students to physics, to their futures, and to their self-images.

Basically, however, Question II of the thesis was not answered directly by the replies of the students to the questionnaires. It was instead answered by an interpretation of their replies. Whereas these questionnaires might have arrived at the reasons girls give for their course selection, the reasons advanced by the students for taking or not taking physics are not necessarily the real reasons. For example, many girls feel that physics is a masculine subject and that they could not hope to handle it; therefore, they do not enroll. Yet, the reason these girls do not enroll in physics is not because physics is a masculine subject that girls find incomprehensible, but rather because these girls may lack self-confidence and have a generally negative self-image. They have heard that physics and mathematics are masculine interests and after having this drummed into them subtley for sixteen years, they have come to believe it.

In order to answer Question II, and get at the real reasons

behind the female avoidance of physics, the information obtained by the questionnaires was interpreted, showing the relationship between the reasons given by girls for taking or not taking physics and the current findings regarding the self-image that girls have of themselves.

Question III

What are the attitudes of girls' guidance counsellors toward the physics course, and what kind of advice are they giving the girls about physics?

Each item of Questionnaire #4 was analyzed, and percentages were calculated to determine what the most prevalent attitudes are toward physics on the part of these counsellors, and to see what advice regarding physics they are handing out to their students.

Question IV

What type of rationale will best encourage girls to enroll in physics?

Once it had been determined what the reasons were behind the poor female enrollment in physics, a rationale was developed that might hopefully encourage girls to enroll by refuting those reasons.

Chapter 4

Presentation of the Findings

Questionnaire #1

Part A

Part A of the questionnaire was answered by all the girls who participated in the survey. They replied True, False, or Don't Know to twenty-one statements. The absolute and percentage choice distributions of their replies are presented in Tables XI, XII, and XIII.

Part B

This portion of the questionnaire was answered by the girls who were currently enrolled in physics. Their replies are illustrated in Table XIV.

Part C

Part C of the questionnaire was answered by those girls who had dropped physics after taking it in grade eleven, to determine their reasons for discontinuing the course. There was only one student who fell in this category. She replied that she had dropped physics when she found out that she did not need it for her career.

Part D

Part D was to be answered by students who had never taken physics and were not currently taking it. Their replies are illustrated in Table XV.

Table XI
Whole Population Choice Distributions, Related to Part A of Questionnaire #1

Item	Absolute Numbers			Percentages		
	1	2	3	1	2	3
1	93	47	23	56.7	28.6	14.0
2	43	92	28	26.2	56.0	17.0
3	22	102	39	13.4	62.1	23.7
4	41	97	25	25.0	59.1	15.2
5	15	144	3	9.1	87.8	1.8
6	130	28	6	79.2	17.0	3.6
7	22	133	9	13.4	81.0	5.4
8	20	138	6	12.1	84.1	3.6
9	12	142	10	7.3	86.5	6.0
10	150	10	4	91.4	6.0	2.4
11	19	142	3	11.5	86.5	1.8
12	7	147	10	4.2	89.6	6.0
13	20	138	6	12.1	84.1	3.6
14	49	105	10	29.8	64.0	6.0
15	46	112	6	28.0	68.2	3.6
16	65	89	10	39.6	54.2	6.0
17	30	119	15	18.2	72.5	9.1
18	6	139	18	3.6	84.7	10.9
19	55	97	12	33.5	59.1	7.3
20	139	21	4	84.7	12.8	2.4
21	46	115		28.0	70.1	

n=164

Table XII

Physics Girls Choice Distributions, Related to Part A, Questionnaire #1

	Absolute Numbers			Percentages		
Item	1	2	3	1	2	3
1	11	39	9	18.3	65.0	15.0
2	37	13	9	61.6	21.6	15.0
3	19	19	21	31.6	31.6	35.0
4	37	13	9	61.6	21.6	15.0
5	10	49	1	16.6	81.6	1.6
6	45	14	1	75.0	23.3	1.6
7	18	40	2	30.0	66.6	3.3
8	19	38	3	31.6	63.3	5.0
9		58	2		96.6	3.3
10	50	7	3	83.3	11.6	5.0
11	15	43	2	25.0	71.6	3.3
12	2	56	2	3.3	93.3	3.3
13	17	41	2	28.3	68.3	3.3
14	14	43	3	23.3	71.6	5.0
15	36	21	3	60.0	35.0	5.0
16	22	34	4	36.6	56.6	6.6
17	10	44	6	16.6	73.3	10.0
18	3	51	6	5.0	85.0	10.0
19	16	41	3	26.6	68.3	5.0
20	58	1	1	96.6	1.6	1.6
21	13	47		21.6	78.3	

n = 60

Table XIII

Non-physics Girls Choice Distributions, Related to Part A, Questionnaire #1

	Absolute Numbers			Percentages		
Item	1	2	3	1	2	3
1	82	8	14	78.8	7.6	13.4
2	6	79	19	5.7	75.9	18.2
3	3	83	18	2.8	79.8	17.3
4	4	84	16	3.8	80.7	15.3
5	5	96	2	4.8	92.3	1.9
6	85	14	5	81.7	13.4	4.8
7	4	93	7	3.8	89.4	6.7
8	1	100	3	.9	96.1	2.8
9	12	84	8	11.5	80.7	7.6
10	100	3	1	96.1	2.8	.9
11	4	99	1	3.8	95.1	.9
12	5	91	8	4.8	87.5	7.6
13	3	97	4	2.8	93.2	3.8
14	35	62	7	33.6	59.6	6.7
15	10	91	3	9.6	87.5	2.8
16	43	55	6	41.3	52.8	5.7
17	20	75	9	19.2	72.1	8.6
18	3	88	12	2.8	84.6	11.5
19	39	56	9	37.5	53.8	8.6
20	81	20	3	77.8	19.2	2.8
21	33	68		31.7	65.3	

n=104

Table XIV

Physics Girls Choice Distribution, Related to Part B, Questionnaire #1

	Absolute Numbers			Percentages		
Item	1	2	3	1	2	3
22	45	13	2	75.0	21.6	3.3
23	20	31	9	33.3	51.6	15.0
24	52	5	3	86.6	8.3	5.0
25	13	37	10	21.6	61.6	16.6
26	2	56	2	3.3	93.3	3.3
27	38	20	2	63.3	33.3	3.3
28	48	13		80.0	21.6	
29	24	30	6	40.0	50.0	10.0
30	18	38	4	30.0	63.3	6.6
31	38	14	8	63.3	23.3	13.3
32	18	39	3	30.0	65.0	5.0

n=60

Table XV

Non-physics Girls Choice Distribution, Related to Part D, Questionnaire #1

	Absolute Numbers			Percentages		
Item	1	2	3	1	2	3
39	26	62	9	25.0	59.6	8.6
40	19	69	9	18.2	66.3	8.6
41	17	71	9	16.3	68.2	8.6
42	78	9	10	75.0	8.6	9.6
43	5	83	9	4.8	79.8	8.6
44	65	31	1	62.5	29.8	.9
45	26	70	1	25.0	67.3	.9
46	65	32		62.5	30.7	
47	72	11	13	69.2	10.5	12.5
48	38	54	5	36.5	51.9	4.8
49	55	41	1	52.8	39.4	.9
50	69	26	2	66.3	25.0	1.9
51	56	23	19	53.8	22.1	18.2

n=104

Part E

In order to determine the attitudes of physics and non-physics girls toward the course, Part E of the questionnaire consisted of a set of statements, items 52 to 68, to which the girls were to respond "agree strongly", "agree mildly", "cannot decide", "disagree mildly", and "disagree strongly". The absolute and percentage choice distributions of the subjects' replies are presented in Tables XVI and XVII.

Questionnaire #2

Questionnaire #2 (Appendix B) was designed to attempt to determine the career preferences of the female students. It consisted of a list of seventeen possible professions. Nine were deemed to be traditionally regarded as female occupations: elementary school teacher, nurse, secretarial work, saleswoman, key punch operator, librarian, laboratory or X-ray technician, and high school English teacher. The other eight were deemed to be traditionally male occupations: accountant, dentist, lawyer, doctor, electrician, research scientist, engineer, and high school science teacher. The girls were asked to rate the occupations they would most prefer, from one to five.

In analyzing the results, everytime a profession was given a rating of 1 it was assigned a score of five. Everytime it was rated as a second choice, it was assigned a score of four. Everytime it was rated as a third choice, it was assigned a score of three; and so on. For each profession the scores were added up. The professions were ranked according to their scores. This would presumably show how these professions ranked in the eyes of the girls. This was first

Table XVI

Non-physics Girls Choice Distribution, Related to Part E, Questionnaire #1

	Absolute Numbers					Percentages				
Item	1	2	3	4	5	1	2	3	4	5
52	33	58	8	4	1	31.7	55.7	7.6	3.8	.9
53	8	23	16	21	36	7.6	22.1	15.3	20.1	34.6
54	22	34	32	11	5	21.1	32.6	30.7	10.5	4.8
55		12	41	24	27		11.5	39.4	23.0	25.9
56	3	28	9	24	40	2.8	26.9	8.6	23.0	38.4
57	17	19	50	12	6	16.3	18.2	48.0	11.5	5.7
58	64	17	14	5	4	61.5	16.3	13.4	4.8	3.8
59	10	18	26	22	28	9.6	17.3	25.0	21.1	26.9
60	33	24	30	14	3	31.7	23.0	28.8	13.4	2.8
61	2	9	20	19	54	1.9	8.6	19.2	18.2	51.9
62	60	27	10	3	4	57.6	25.9	9.6	2.8	3.8
63	2	11	2	18	71	1.9	10.5	1.9	17.3	68.2
64	10	16	30	17	31	9.6	15.3	28.8	16.3	29.8
65	8	18	9	19	50	7.6	17.3	8.6	18.2	48.0
66	6	16	11	25	46	5.7	15.3	10.5	24.0	44.2
67	33	26	16	10	19	31.7	22.0	18.3	9.6	18.2
68	4	14	53	16	17	3.8	13.4	50.9	15.3	16.3

n=104

Table XVII

Physics Girls Choice Distribution, Related to Part E, Questionnaire #1

	Absolute Numbers					Percentages				
Item	1	2	3	4	5	1	2	3	4	5
52	11	34	6	8	1	18.3	56.6	10.0	13.3	1.6
53	5	10	8	10	27	8.3	16.6	13.3	16.6	45.0
54	18	11	5	16	10	30.0	18.3	8.3	26.6	16.6
55	6	12	7	25	10	10.0	20.0	11.6	41.6	16.6
56	12	31	10	5	2	20.0	51.6	16.6	8.3	3.3
57	5	16	10	15	14	8.3	26.6	16.6	25.0	23.3
58	4	8	23	6	18	6.6	13.3	38.3	10.0	30.0
59	12	17	17	12	2	20.0	28.3	28.3	20.0	3.3
60	12	12	28	4	4	20.0	20.0	46.6	6.6	6.6
61	21	11	15	10	3	35.0	18.3	25.0	16.6	5.0
62	31	15	9	3	2	51.6	25.0	15.0	5.0	3.3
63		5	2	8	45		8.3	3.3	13.3	75.0
64	5	9	5	12	29	8.3	15.0	8.3	20.0	48.3
65	6	12	7	8	27	10.0	20.0	11.6	13.3	44.0
66	3	6	3	10	38	5.0	10.0	5.0	16.6	63.3
67	9	14	9	9	18	15.0	23.3	15.0	15.0	30.0
68	19	16	11	8	5	31.6	26.6	18.3	13.3	8.3

n=60

done for the girls who were not taking physics, and then the process was repeated for the girls who were enrolled in the course. The results are illustrated in Table XVIII.

It seems that both sets of girls have a decided image of what careers they would prefer. In both cases, the traditionally female careers are ranked at the top. The non-physics girls ranked only one traditionally male profession in the top half of the list. The physics girls ranked three traditionally male professions in the top half of the list of seventeen. It seems that the girls who take physics have a slightly wider outlook on their futures. Perhaps that is why they selected physics as one of their options.

To determine how the rankings of the physics and non-physics girls compared, a Spearman Rank Correlation Coefficient was calculated. The results are shown in Table XIX.

Using the data in Table XIX the Spearman Rank Correlation Coefficient was calculated by:

$$r_{rank} = 1 - \frac{6\sum D^2}{n(n^2 - 1)}$$

The r_{rank} was calculated to be .61, indicating a weak, positive relationship between the rankings of the physics and non-physics girls.

Thus, upon examining the data, it would appear that the vast majority of girls, whether they take physics or not, have a very narrow idea of what they can do with their lives. The girls who take physics can be said to have slightly higher aspirations, however.

Table XVIII

Career Preferences

Non-physics Girls	Physics Girls
1. Elementary school teacher	1. Lab or X-ray technician
2. Nurse	2. Elementary school teacher
3. Secretarial work	3. Nurse
4. Lab or X-ray technician	4. Lawyer
5. Lawyer	5. Research scientist
6. Dental hygienist	6. Doctor
7. Saleswoman	7. Dental hygienist
8. Key punch operator	8. High school science teacher
9. Accountant	9. Engineer
10. Librarian	10. Secretarial work
11. Research scientist	11. High school English teacher
12. Doctor	12. Accountant
13. High school English teacher	13. Key punch operator
14. High school science teacher	14. Saleswoman
15. Engineer	15. Librarian
16. Dentist	16. Dentist
17. Electrician	17. Electrician

Table XIX

Relationship Between Ranks

Career	Ranking by: Physics girls	Ranking by: Non-physics girls	Difference in ranks	D^2
elementary teacher	2	1	1	1
nurse	3	2	1	1
secretary	10	3	7	49
lab or X-ray technician	1	4	-3	9
lawyer	4	5	-1	1
dental hygienist	7	6	1	1
saleswoman	14	7	7	49
key punch operator	13	8	5	25
accountant	12	9	3	9
librarian	15	10	5	25
research scientist	5	11	-6	36
doctor	6	12	-6	36
high school English teacher	11	13	-2	4
high school science teacher	8	14	-6	36
engineer	9	15	-6	36
dentist	16	16	0	0
electrician	17	17	0	0

Questionnaire #3

Questionnaire #3 was a narrative one, asking the students for their opinions. Questions 1, 2, and 3 asked the girls to list the courses they were taking, to give a reason for taking each course, and then to specifically state why they had or had not selected physics.

For the non-physics students, the reasons they gave for not taking physics were recorded as falling into one of the following categories:

a) Did not need physics for future education or career.

b) Felt that physics would be too difficult.

c) Uninterested in the subject; felt it would be boring.

d) No idea of what physics was about.

e) Aversion to the physics teacher.

f) Counsellor's advice.

The frequency of replies was tabulated, percentages calculated, and the reasons for not taking physics were ranked. The results were as follows:

Reasons stated by the girls for not taking physics:

1.	Felt physics would be too difficult.	36.5%
2.	Did not require physics for future education or career.	31.4%
3.	Uninterested in the subject; felt it would be boring.	14.6%
4.	No idea of what physics was about.	10.9%
5.	Counsellor's advice.	4.4%
6.	Aversion to the physics teacher.	2.2%

For the physics girls, questions 1, 2, and 3 were analyzed in the following fashion: the reasons the girls gave for taking physics were recorded as falling into one of the following categories:

a) Need physics for future education or career.

b) Interest in the subject.

c) Counsellor's or teacher's advice.

The frequency of replies was tabulated, percentages calculated, and the reasons for taking physics were ranked.

Reasons stated by the girls for taking physics:

1.	Need for future career or education.	66.2%
2.	Interest in the subject.	31.1%
3.	Counsellor's or teacher's advice.	2.7%

In question 4 of Questionnaire #3, the non-physics girls were asked to describe what they thought physics was about. The results are illustrated in Table XX.

Question 5 of this questionnaire asked the girls to state what career they were planning on. The frequencies of replies were tabulated, percentages calculated, and the career preferences were ranked for both physics and non-physics girls. These results are illustrated in Table XXI.

Questionnaire #4

Questionnaire #4 (Appendix D) was sent to the girls' guidance counsellors in the Winnipeg School Division, in an attempt to determine their attitudes to the physics course, and therefore what attitudes or advice they might be passing on to their students. All of these counsellors were female. The replies were tabulated for each question and percentages calculated. The results are summarized below, for each question:

Table XX

What Do You Believe Physics Is About?

Replies of Non-physics Girls

1. 43.3% replied that physics was essentially mathematics and involved much memorization of formulae.
2. 38.4% replied that they did not know.
3. 15.4% were able to mention at least one topic covered in the course.
4. 2.9% replied that it consisted of 'complicated chemistry'.

Table XXI

Career Choices

Non-physics girls		Physics girls	
1. Teacher	18.7%	1. Lab Technician	21.8%
2. Nurse	17.8%	2. Teacher	15.6%
3. Social worker	8.4%	3. Nurse	14.1%
4. Lab technician	7.8%	4. Doctor	12.5%
5. Secretary	7.8%	5. Stewardess	6.3%
6. Stewardess	6.5%	6. Research technician	4.7%
7. Dental assistant	4.7%	7. Lawyer	3.1%
8. Journalist	3.7%	8. Secretary	3.1%
9. Veterinarian	2.8%	9. Pharmacist	1.6%
10. Police woman	1.9%	10. Dentist	1.6%
11. Artist	1.9%	11. Computer programmer	1.6%
12. Interior designer	1.9%	12. Engineer	1.6%
13. Hairdresser	1.9%	The remainder were undecided.	
14. 'Just a mother'	1.9%		
15. Lawyer	0.9%		
16. Musician	0.9%		
The remainder were undecided.			

Question 1

Do you feel the present PSSC Physics course is meant for the average female student?

62.5% of the girls' guidance counsellors felt that the course was not meant for the average female student.

Question 2

Do you feel the present PSSC course is too difficult?

62.5% felt that the course was not too difficult.

25.0% felt that it was too difficult.

12.5% felt that they did not know.

Question 3

Do you feel that the PSSC course is too mathematical?

75% replied that since physics is mainly mathematics, then no, in that sense the PSSC course was not too mathematical.

12.5% replied that it was too mathematical.

12.5% replied that they did not know.

Question 4

The counsellors were asked to rank the science courses being taught in the high schools as to degree of difficulty. They ranked them in this order:

Physics 200
Chemistry 200
Biology 200
Physical Science 201
Biology 201

With one exception, the counsellors ranked physics as most difficult. The exception ranked physics and chemistry to be of equal difficulty.

Question 5

Would you recommend that the average girl take physics if she does not specifically need it for her future education or career?

100% of the counsellors stated they would not recommend that a girls take physics if she did not specifically need it. This seems to indicate a negative attitude on the part of counsellors, showing that they see no value in taking physics merely to learn something about the world around them.

Question 6

Would you recommend or discourage a student from taking Grade 11 physics if she will be taking mathematics 201 instead of 200?

87.5% replied that they would discourage a girl from taking physics if she were in the 201 mathematics programme. Again, since most counsellors perceive physics to be very mathematical, they tend to discourage some prospective physics students.

Question 7

Do you feel that the PSSC Physics course deals with things that the average person should know?

62.5% felt that physics did not deal with things that the average person should know.

25% felt that they did not know.

12.5% replied positively.

It is surprising that such a large percentage (25) of counsellors are unfamiliar with the content of the physics course. It must be difficult for them to counsel their students intelligently concerning option choices.

Question 8

Do you feel that the physics courses being taught at your school are slanted toward the male students?

87.5% felt that the physics courses were not slanted toward the boys.

12.5% felt that they were.

Question 9

Are you aware of any efforts in your school that the physics department may have actively made to encourage girls to enroll in physics?

12.5% of counsellors said they were aware of special efforts being made to attract girls to enroll in physics.

Question 10

How many high school science teachers in your school are females?

It was determined that there was an average of one female science teacher per high school in the Winnipeg School Division. Since these are all large schools, with science departments of from four to seven members, this does not seem a very equitable situation.

Question 11

Do you have a science background (B.Sc.) or a background in the humanities (B.A.)?

It was determined that 75% of the guidance counsellors had backgrounds in the humanities; 12.5% had science backgrounds; and 12.5% had other backgrounds.

Question 12

Have you any opinions or ideas that might be used to improve the PSSC Physics course in order to attract more girls to it?

The few who replied to this question were in agreement that before more girls could be attracted to physics, their future career aspirations had to be broadened, beyond the narrow and stereotyped image universally held by the majority of females. At least one counsellor stated that

she found the thinking of girls, regarding their future careers, as archaic—— 'early 20th century'. Societal pressures tend to deter girls from pursuing careers in mathematics and science, and hence from studying physics.

Chapter 5

Interpretations and Conclusions

Answers to the Questions

Question I

What are the reasons girls give for selecting or not selecting physics?

In answering this question, the results of Questionnaires #1 and #3 were analyzed. In order to answer the question more systematically, several sub-questions were formulated, which were related to the various items in Questionnaire #1. An analysis of these sub-questions follows:

Sub-question Ia)

What reasons related to career are selected by the girls for enrollment or non-enrollment in high school physics?

The career reasons are related to the responses to items 1,2,3, and 4 of the questionnaire.

Of the girls who were enrolled in physics, 65% felt that they needed physics for their future education. 18.3% felt that this was not true, and that they did not need physics as a prerequisite. 61.6% of physics girls stated that they would need physics for enrollment at University, and 31.6% for enrollment at Red River Community College. Again, 61.6% of girls taking physics agreed with the statement that they would need physics for their career. 21.6% of the physics girls felt that this was not true.

Of the girls who were not taking physics, 78.8% felt that physics was not necessary for their future education; 75.9% felt they would not

need physics to enroll at University; and 79.8% felt that they would never need the subject for enrollment at Red River Community College. 80.7% saw no need for physics when it came to their future career. Only 3.8% of non-physics girls felt that physics might be necessary for their career.

Thus, it would seem that the majority of girls in physics perceive the subject as being necessary for their future education or career. Similarily, the great majority of female students not enrolled in physics, would feel it was not necessary for their future education or career, and feel they have no need for the subject.

Sub-question Ib)

What have the girls been told about physics, and its relationship to the other sciences?

This sub-question was related to items 5,6,16,17,18, and 19 of the questionnaire. In response to item 5 it was found that 16.6% of physics girls and 4.8% of non-physics girls had been told that physics was a subject for boys. Perhaps this is due to the fact that if a girl showed an interest in taking physics, some people might attempt to dissuade her by telling her that physics was essentially a male interest. 75% of physics girls, and 81.7% of non-physics girls were informed that you had to be good at mathematics to be good at physics. The mathematical ability required of physics students consistently seems to be exaggerated. 36.6% of physics girls and 41.3% of non-physics girls were advised that chemistry and physics were a good combination. 16% of physics and 19.2% of non-physics students were advised that biology and chemistry went well together. Only 5% of physics and 2.8% of non-physics girls were told

that biology goes with physics. This leaves the impression that an either-or situation is created here. A girl chooses either biology or physics, rarely both.

26.6% of physics girls and 37.5% of non-physics girls erroneously believed that a student could take only two sciences in grade eleven. If a girl wanted, she could easily take three. This may have prevented some girls, who had already chosen chemistry and biology as their sciences, from picking physics as a third choice.

Thus, most girls have been told that one must be good at mathematics to succeed at physics. A small percentage had been told that physics was for males. The girls were advised that chemistry and physics was the most logical combination, and that biology and physics was the most unlikely. Some girls were under the misconception that a student was limited to two sciences in grade eleven.

Sub-question Ic)

What counselling advice has been given girls regarding enrollment in high school physics?

This sub-question relates to the responses to items 7,8,9,10, and 15 of the questionnaire. The very considerable percentage of 83.3% of physics girls and 96.1% of non-physics girls reported that the senior high guidance counsellor had left the choice of high school sciences to their clients. However, 11.5% of non-physics girls replied that the counsellor at one time had advised them not to take physics. Only .9% of these non-physics girls had been advised by their counsellor to try physics. Of the physics girls, 31.6% replied that they were told by the counsellor to take physics. The counsellors do not seem to be encouraging

enrollment in the course. More significantly, 60% of the physics girls were advised by their grade 10 science teacher to take physics in grade eleven, while only 9.6% of non-physics students were so advised. This might suggest that when the grade ten science teacher is interested enough to encourage enrollment in physics, the girls in her class will opt for the course. Conversely, if the girls are not encouraged, they will hesitate to enroll.

Sub-question Id)

What is the influence of friends and family regarding enrollment in physics?

This sub-question is related to items 11,12,13,14, and 21. Parental influence seems slight for girls when it comes to their course selection. 25% of physics girls had been advised by their parents to take physics, while only 3.8% of non-physics girls had been so advised. 3.3% of physics girls and 4.8% of non-physics girls were advised by their parents not to take physics. The influence of peers, on the other hand, seems greater. 28.3% of physics girls and 2.8% of non-physics girls were advised by their friends to take physics. 23.3% of physics and 33.6% of non-physics girls were advised to avoid the course. 21.6% of physics and 31.7% of non-physics girls reported that they had no close friends enrolled in physics. Since girls at that age usually prefer peer companionship to going into something alone, this might be a factor preventing some girls from enrolling in physics. They do not want to seem different or follow alternate paths from their friends.

Sub-question Ie)

What is the background of the physics student?

This was answered by item 20. 96.6% of girls enrolled in physics had taken Science 100 in grade ten. For the non-physics students, 77.8% reported having taken Science 100.

Sub-question If)

What are the reasons related to future career for taking physics?

This would be answered by items 22,23,24,25,27, and 30. 75% of the girls replied that they took physics because they might need it in University; 33.3% replied they took physics because they might need it to enter an institute of technology; and 86.6% said they took it because they might need it for their future education. 63.3% replied they enrolled in the course because they wished to keep as many doors open as possible, since their career plans were not definite. Only 21.6% replied that they took physics, knowing that it was not a specific requirement for their future education. 30% of the girls replied that they would not have taken the course if they had not required it.

Sub-question Ig)

What other reasons are given for taking physics?

This sub-question was related to items 26 and 29. 40% of the girls replied that they took physics, feeling it would be a challenging subjects. A mere 3.3% reported taking the course just to fill out their timetable.

Sub-question Ih)

What are the attitudes of the girls in the course towards physics?

The replies to items 28,31, and 32 are related to this sub-question. 63.3% of the girls in the course would advise a good friend to take physics, while 23.3% would not. 65% of the girls found that physics was not one of the most difficult courses they had taken, while 30% found that it was. Thus, it would seem that the attitudes of the girls to the physics course were generally positive, and that girls do not find physics as difficult as popular opinion would make it out to be. It is also noteworthy that 80% of the girls in physics were enrolled in at least one other science.

Sub-question Ii)

What are the reasons, stated by the girls, for not taking physics?

This sub-question is related to items 39,40,41,42,43,44, and 48. The reasons for not taking physics were selected by the girls as follows: 75% stated that they did not take physics since they did not need it for their career. 62.5% stated that they avoided physics because they had heard that it was difficult. 36.5% stated that they did not select physics because they did not know what it was about. These reasons point out the great necessity of informing girls about the physics course, explaining what it covers, what it leads to, of what value it is, and of playing down the exaggerated difficulty of the course. Obviously, the girls who answered the questionnaire had never been exposed to any of the above facts. A small percentage (25) said they needed biology, so they did not take physics. However, since selecting biology does not prevent a student taking physics, not too much credence can be allowed this reason. Similarily, 18.2% said they needed chemistry, and so could not take physics. A surprising 16.3% said they were taking Mathematics 201, and were under

the false impression that one needs Mathematics 200 in order to take physics. Only 4.8% said they would have taken physics if they could have fitted it into their timetable.

Sub-question Ij)

What is the background of the girls who have not taken physics?

This sub-question related to items 45 and 46 of the questionnaire. For 69.2% of these girls, biology was their only science. 25% of the girls were enrolled in biology and chemistry. The tendency of most of these girls to take only one science contrasts markedly with the girls enrolled in physics, 80% of whom were taking at least two sciences.

Sub-question Ik)

What other influences might have prevented these girls from taking physics?

This sub-question related to items 47,49,50, and 51. 52.8% of the girls replied that no one had ever explained to them what physics was about. And yet, although they did not know what physics involved, 53.8% stated that they were not interested in it, and 69.2% stated they found biology more appealing than physics. One wonders how a person can state she is not interested in something she has never been exposed to. Are these girls merely rationalizing, saying they are glad they took biology without even investigating the other possibilities? 25% of these girls stated they had no close friends taking physics. Perhaps this is one reason why they did not enroll.

Sub-question Il)

How do the opinions and attitudes (toward physics) of the

physics and non-physics girls differ?

This sub-question relates to items 52 to 68 of the questionnaire. Following,is an item analysis:

Item 52: You have to be good at math to be good at physics.

74.9% of physics girls and 87.4% of non-physics girls agreed to this statement. Perhaps this illustrates that with some exposure to physics they realize that it is not so mathematical as they were led to believe before enrolling in the course.

Item 53: Physics is slanted toward boys.

24.9% of physics and 29.7% of non-physics girls agreed to this statement.

Item 54: Physics is one of the most difficult of high school subjects.

Of the physics girls, 48.3% agreed with the above statement, while 43.2% disagreed. Of the non-physics girls, 53.7% agreed with the statement, while 15.3% disagreed. Again, with some exposure to physics, the girls find the subject not to be as difficult as they had expected.

Item 55: Physics deals with things that the average person needs to know.

Only 11.5% of non-physics girls agreed with this statement. This is not surprising, since so many of them stated they had no idea what physics was about. It is surprising that only 30% of the physics girls agreed.

Item 56: I feel I have a good idea of what physics is about.

61.4% of non-physics students disagreed with the above statement. It seems a public relations programme for physics is sorely needed if the girls' ignorance of the course is to be rectified.

Item 57: Physics is mostly a bunch of formulae.

Of the physics girls, 34.9% agreed; 58.6% disagreed. Of the non-physics girls, 34.5% agreed; 17.2% disagreed.

Item 58: To me, biology is more appealing than physics.

19.9% of physics girls agreed; 77.8% of non-physics girls agreed.

Item 59: A well educated person ought to have taken physics.

48.3% of physics girls agreed; 23.3% disagreed. 26.9% of non-physics girls agreed; 48% disagreed.

Item 60: A study of biology is more beneficial to the average person than a study of physics.

54.7% of non-physics, and a surprising 40% of physics girls, agreed.

Item 61: I see a close connection between physics and my choice of career.

53.3% of physics girls agreed to the statement, while only 10.4% of non-physics girls agreed.

Item 62: I have a fairly good ides of what career I want.

83.5% of non-physics girls and 76.6% of physics girls agreed. This indicates that the girls make their career choices early in life and probably select their high school courses to steer them toward their perceived goals.

Item 63: When I selected the sciences I would take, I was influenced by my friends' choices.

Only 8.3% of physics and 12.4% of non-physics girls admitted this influence.

Item 64: Physics and chem labs seem to be more difficult for the girls than for the boys.

24.9% of non-physics and 23.3% of physics girls agreed to this.

Item 65: I was influenced by my guidance counsellor when I selected my science courses.

24.9% of non-physics and 30% of physics girls agreed to this. The guidance counsellor does not seem to be a very great influence on her students.

Item 66: I was influenced by the reputations of the various science teachers when I selected my science courses.

15% of physics and 21% of non-physics students agreed to this.

Item 67: I was hesitant to enroll in physics because I was afraid that my marks in it would be low.

56.7% of non-physics and 38.3% of physics students agreed.

Item 68: Physics is a good course to take even if one is not going into any scientific field.

57.7% of physics students agreed, while only 17.2% of non-physics students agreed.

Continuing in an attempt to answer Question I, namely, what are the reasons given by girls for selecting or not selecting physics, the results of Questionnaire #3 were also examined. Questionnaire #3 was a narrative one, directly asking the students for their reasons for taking or not taking physics. The results were as follows:

Reasons stated by the girls for not taking physics:

1.	Felt physics would be too difficult.	36.5%
2.	Did not require physics for career or future education.	31.4%
3.	Uninterested in the subject; felt it would be boring.	14.6%
4.	No idea of what physics was about.	10.9%
5.	Counsellor's advice	4.4%
6.	Aversion to the physics teacher.	2.2%

It seems that many girls are afraid of tackling physics. Many said that they were not very strong in mathematics, and hence hesitated to enroll in physics, because they believed it involved complicated mathematics that they could not handle. This points out the necessity of dispelling students' fears that physics is mainly mathematics and formulae. Certainly a physics student must be able to handle calculations, but she does not have to be a mathematical genius. Many students who had taken 101 and then 201 mathematics felt that they lacked the concepts needed to understand physics. This misconception should be refuted by clearly explaining to them what the course involves and playing down the mathematical content involved. Also, girls should be encouraged to be less fearful of anything involving mathematics. Many females subconsciously feel mathematics and the related physical sciences are something they could not hope to handle, these always having been traditionally male domains.

Although counsellor advice is rated fifth, it is astonishing that many girls stated that the counsellor had advised them "You only need biology to become a lab technician, so why struggle through physics and chemistry?" This attitude on the part of counsellors is shocking. It hardly encourages girls to take challenging and interesting courses, nor does it encourage high standards of scholarship and excellence in the high schools. What it does do is convey the message that the easiest way out is the best. Moreover, these counsellors seem very laggard in doing anything to raise the girls' aspirations. It would seem logical that a counsellor would try to encourage a student who was willing to attempt physics and chemistry, to go on to higher goals than the ones

she had originally stated, rather than advise her to stop wasting her time with the 'hard' sciences and take the easier route.

It is also interesting to note that several of the non-physics students had been advised, at the end of grade ten, by the counsellor, that they did not need physics to gain admittance into the post-secondary courses of their choice. It later turned out that the counsellor's advice had been wrong. These students were forced to change their career plans for something less ambitious, or face the prospect of trying to pick up physics at summer school. It would seem some counsellors are very anxious to advise that physics is not necessary, and should be avoided if possible.

Also, in Questionnaire #3, the girls who were not in physics were asked to describe what they thought physics was about. The results are listed in Table XX. From the results of this table, it would seem that few of these girls have any idea of what the physics course is about. It was interesting to note that the majority of non-physics girls had made the choice not to enroll in physics without even going to the trouble to investigate what the course involved, or what they would be missing.

It is also interesting that many of the girls who stated they felt physics would be boring, also stated that they did not know what the course would be about. This seems contradictory. How can you be bored by something if you have no idea of what it involves? It would seem that they are rationalizing. Feeling that they did not require physics, or feeling that it was too difficult to tackle, they might justify not taking it by saying they were not interested in it.

There were quite a few girls who stated that it had just never occurred to them to take physics. This perhaps points out the stereotyping that goes on subtley in our schools. Girls just 'naturally' go into biology. It also points out the lack of guidance they received when choosing their options. No one had ever explained to them the value of physics, or what it can lead to.

Finally, taking into account the information revealed in the questionnaires, it is possible to attempt to answer Question I.

What are the reasons girls give for taking or not taking physics? It would seem that most girls say they do not take physics because they do not need it for their future education or career. They are also hesitant to enroll in the course for they fear that the subject is difficult and that they would not be able to handle it. Also mentioned, but by fewer girls, were a lack of interest in physics, and the fact that many of the girls were unaware of what physics was about. No one had ever explained to them what physics involved. Many stated that they lacked confidence in their mathematical skills and felt that physics demanded a high level of algebraic and geometrical proficiency. The guidance counsellor seemed to offer advice on course selection to only a very few. When it was given, it was usually negative, telling the girls not to take physics.

The majority of girls studying physics, said they enrolled in the course because they felt they needed, or might need it, for their future education or career. This was true for those who had specific career plans, and for those undecided students who wished to leave themselves open to follow any path at the end of high school. Many

also expressed having taken the course because they felt it would be a challenging or interesting subject. The guidance counsellor had not been a very great influence on the girls when it came to the decision of selecting a science. Of greater influence on the girls was their grade ten science teacher. It would seem that, if the grade ten teacher had recommended physics, more girls in the class would opt for the course than if the teacher had neglected giving any advice on course selection. For example, of the non-physics students, only a small percentage (9.6) had been advised by their grade ten science teacher to take physics. This might suggest that girls will automatically select biology rather than physics, unless someone stresses the advantages of the latter to them. Almost all of the girls in physics had come from the Science 100 course, indicating that even the girls who had done well in the 101 course were hesitant to enroll in physics.

Question II

The above were the reasons given by the girls for not enrolling in physics, but is this all one needs to know to attempt to increase their numbers in the course? Perhaps it is more important to investigate what lies behind these reasons. Question II of this thesis asked how the reasons given by the girls for taking or not taking physics relate to their self-image.

First of all, the essential reason for not taking physics seems to be that the girls do not feel any need for the course. They do not perceive it as necessary for their future education, future career, nor for taking it in order to be a better informed individual. This attitude has as its basis the fact that these girls see themselves in very restricted future roles. They have an extremely

narrow idea of what the future holds for them. They are very much in the traditional mould, with the vast majority aiming for careers in the sex-stereotyped vocations of nursing, teaching, or lab technology, and perhaps ultimately retiring after a few years' work to the utopian existence of a happy housewife. Few have ambitions beyond these.

Questionnaire #2 was designed to ascertain the career preferences of the girls. The girls were asked to rank seventeen possible professions. They were to select, in order, the five that they would most prefer. The results are illustrated in Table XVIII.

It would seem that both physics and non-physics girls have a decided image of what careers they would prefer. In both cases the traditionally female careers are ranked at the top. The non-physics girls ranked only one traditionally male profession in the top half of the list. The physics girls ranked three traditionally male professions in the top half of the list of seventeen.

Question 5 of Questionnaire #3 asked the girls to state what career they were planning on. Their career choices are shown ranked in Table XXI. Upon examination of this table, it is evident that the greatest number of girls see themselves in the traditionally female professions. Only four of the sixteen professions listed by the non-physics girls could be considered to be not traditionally female: veterinarian, journalist, musician, and lawyer. For the physics students, seven of the twelve careers listed could be considered as not traditionally female. Perhaps this shows that if the girls have slightly broader horizons, they will consider physics.

Thus, females persistently concentrate themselves in a few,

relatively low-prestige occupations. It was also obvious from the questionnaires that girls make their career choices quite early in adolescence. By the age of fifteen, the majority of girls feel they are fairly sure of what career they desire. Thus, it is no wonder that girls feel they do not need physics. The occupational goals they have in mind do not require physics. Moreover, they are so sure they want to follow the traditionally female career pattern, they do not even consider that physics might be required if they change their plans for the future at the end of high school. Therefore, even if they realize at some later date that they really do not want to go into nursing, it is a little too late for them to raise their ambitions to a higher level. By narrowing themselves in high school to a single science, like biology, they have closed themselves off from many paths. They will probably wind up as clerical workers, not because this is what they desire, but rather because it is the only choice left open to them.

If girls could be made to realize, at an early age, that there are many career opportunities open to them, other than the traditionally female, they might appreciate that a study of physics could benefit them. If one could convince them to seriously consider careers like electronics or medicine, they might then become interested in physics, feeling that it is relevant to them personally. Most young people alter their vocational plans at some time during their secondary or post-secondary education. It is therefore necessary to suggest to these girls that they consider careers other than the original sex-stereotyped one they had selected. They need to be made aware of the alternatives available. Their horizons must be broadened, and their

aspirations raised. When this is done, their interest in subjects like physics and mathematics will increase to the same level as the boys'. When one sees some hope of a future in a certain field, the relevance of a discipline increases, and so should female enrollment in that discipline.

In contrast, perceiving a future need for physics was the main reason given by the girls for selecting the course. Those girls who chose physics as an option felt that since their plans were not definite they should take the course, for they would thereby have more opportunities open to them at the end of high school. Although the career preferences of the physics girls were also sex-stereotyped, these girls had slightly higher aspirations than their non-physics counterparts. It is also significant that they were not as firm in their plans for the future as were the non-physics girls. They were, perhaps, more likely to consider something apart from the traditional pattern.

The next most prevalent reason given by the girls for avoiding physics was the fear that the subject was too difficult, and that they would not be able to handle it. This may definitely be true for some weak students, but one wonders why the average girl should be more fearful of physics than the average male student. There are many more males than females in typical physics classes. Is one to assume that only bright students take physics and, therefore, there are more bright boys than girls? Certainly, no one could accept this, so it must be that more boys of average ability opt for the course than girls of similar ability. Why do the girls hesitate when the boys do not?

This goes back to the often documented fact that most girls feel (perhaps without consciously realizing it) that physics is traditionally a male discipline, of interest to boys, and easier for them to handle. Girls do not feel confident when it comes to the problem solving situations that arise in mathematics and the hard sciences. This societal attitude has been forced on them since childhood and they readily fall into the image of the female who finds herself helpless when confronted by a problem requiring any analysis.

It would therefore seem necessary to inform the girls thoroughly about physics and explain to them that the difficulty of the subject is grossly exaggerated. Their confidence in their ability must be built up. They should be made to realize that most girls do very well in physics, often outperforming the boys in the class. It should also be explained that while a girl should be capable of handling calculations in physics problems, she does not have to be a mental giant in the fields of geometry and algebra. It is necessary to play down the exaggerated mathematical proficiency that some girls feel is required of the typical physics student.

In addition to the formerly mentioned reasons for not selecting physics, many stated that they were not interested in the subject. Oddly enough, these same people admitted to not knowing very much about physics, of what topics it covered, or of where physics leads. How can one express a disinterest in a subject about which one knows nothing? Do you not need to be exposed to something before you can accurately judge it? Perhaps these girls are rationalizing the fact that they rejected physics for no good reason. They never expected

to need the subject, and hence did not even take the effort to determine what the course offered. It would seem that these girls, when selecting options at the end of grade ten, automatically selected biology, without so much as even bothering to consider physics. Since a student's course of study prepares her for a future career, it would seem logical that all options should be investigated, and their advantages compared, before a choice is made. Why do so many girls neglect this? Could it be because the majority of them see themselves in a very restricted future, pursuing the traditionally female careers which have never demanded physics, that these girls unquestioningly opt for biology as countless females have done before? Most of the high schools in Manitoba used to have sex-segregated classes, where the girls took biology and the boys' classes took physics. In some cases, girls had no choice; they had to take biology. This external compulsion is gone today, of course, but in the minds of many females, biology still seems to be an automatic choice over physics. They feel a knowledge of biology is more relevant to women than a knowledge of physics. Physics is not regarded as being of interest or value to the average female. However, since such an unreasonably large proportion of girls feel they wish to enter nursing, it is not surprising why they regard biology as being of greater value.

Perhaps it could thus be said that while girls may say they are not interested in physics, this lack of interest is not due to the nature of the discipline; it is instead due to the fact that most females perceive it as being of little value to them. These girls see themselves in rigidly restricted future roles, that require no

vast scientific literacy. They have not been encouraged to look beyond the narrow pathway society has prescribed for them. They automatically choose biology as their science, as generations of females have before them. They lack ambition. They do not seem to carefully consider what the future holds for them. They take the course they are expected to take. If they are questionned as to why they did not select or even consider an alternative option like physics, they rationalize and say they are not interested in it. They do not know exactly what it is they are not interested in, but they are very definitely not interested.

Of course, such attitudes should be changed. If a girl considers physics, and,after examining the course content, is thoroughly bored by it, then she can certainly claim a lack of interest. But, to claim a lack of interest merely because one is not openminded enough to consider alternatives to a traditional pattern is not a valid reason for rejecting physics. Women have been trained to be very narrowminded when it comes to making career plans. Few will deviate from the accepted pattern. To combat this, girls must be encouraged to actively consider professions which are not typically female. If their interests are expanded, perhaps then they will give some consideration to selecting their courses, rather than automatically opting for certain ones without a second thought.

Ranking fourth in importance, of the reasons for not taking physics, was the fact that many girls were totally unfamiliar with the subject and so hesitated to take it. This points out the need to inform these girls about the subject and its potential, and why it would be beneficial for them to take it. It also seems to illustrate that a lot of girls

knew nothing of the subject, but were not willing to do anything to find out about it. But, after all, why should they bother? One does not need physics to go into nursing anyway.

When one considers the reasons advanced by girls for taking physics, again future need for the subject predominates. Those girls enrolled in the course felt they would need it for their future. This suggests that if one wished more females to enroll in physics, it might be profitable to convince more girls that they should consider professions beyond the typical low-paying,stereotyped set that society reserves for women. Then, as their interests broaden, they will be more willing to consider a course that has been formerly regarded as not typically a female domain.

Also, many of the girls who selected physics, said they did so because they felt it would be interesting and challenging. Thus, females can become as interested as males in this 'hard' science. There is no need to create special watered-down courses called 'Physics for Girls', which would stress how physics applies to things 'of interest to women' (presumably electric refrigerators and sewing machines). What is needed, instead, is to get girls to realize that there is a future for them in studying physics——whether that future involves a professional career related to physics, or merely involves being a well informed individual. Girls will then be as interested in the subject as boys.

Question III

Question III of this thesis concerned attitudes of the girls' guidance counsellors to physics. Whether a girl had selected physics or not, it seemed that the guidance counsellor was of little aid to the student when it came to choosing options. The only advice given, concerning physics, was negative, advising that some girls not bother with physics since it was not a prerequisite for the post-secondary course they were planning on. Girls were rarely encouraged to enroll in physics if they did not absolutely require it.

In analyzing the questionnaire sent to these counsellors, it seems that the majority have a very negative attitude toward the course. Most of them felt that PSSC Physics was the most difficult of the high school sciences, and that it was not meant for the average female. The majority had the impression that physics was largely mathematical, and stated they would discourage girls who felt weak in mathematics from taking physics. Most also stated they would discourage a student who was enrolled in Mathematics 201 from taking physics. All of the counsellors stated that they would not encourage a girl to take physics unless she specifically required the course. There was a general consensus that physics was not the kind of course that dealt with things that the average person should know. By far, most counsellors had an arts background, and stated they were unfamiliar with physics. It is certainly quite reasonable to assume that these counsellors are not going out of their way to encourage female enrollment in physics. They seem to regard the subject as being very difficult, not necessarily of value to the educated woman. After all,

these counsellors have done very well without it. Their attitudes are undoubtedly passed on to their clients. They also seem quite content with advising girls into the same traditionally female courses, and hence careers. They seem to see no need to counsel their students into looking beyond the typical stereotype.

Question IV

Finally, once the reasons for the tendency of girls to avoid physics have been established, it is the ultimate goal of this thesis to attempt to develop a rationale which would encourage females to enroll in the course.

Consistently, it seems that girls take physics if they perceive a need for the subject, and avoid it if they feel they do not need the course. Hence, it would seem that it is of paramount importance to convince girls that they need physics, and that it will be of value to them. To do this, it is necessary to try to encourage girls to look beyond the traditionally female occupations of teaching and nursing, to explain that today there are many alternatives for them to consider besides these sex-stereotyped ones, and to convince them that they should at least leave themselves open to attempt alternate plans at the end of high school. One must actively try to raise their aspirations. By showing them how physics can and does lead to a variety of interesting and rarely considered careers, hopefully one can increase their interest in physics. Once they see a future for themselves beyond the narrow ones usually reserved for females, they might see a need to study physics.

Of course it will be difficult to broaden the aspirations of the

majority of the girls. They have been thoroughly indoctrinated since infancy by their families and then by their teachers, as to what roles they should seek out in life. Perhaps the only thing that one can do is to start them thinking that perhaps they are setting their goals too low. Trying to raise the aspirations of these girls should logically be the task of their guidance counsellors. However, to date, these women do not seem to be too active in this area. Therefore, it has become, by default, the concern of physics teachers who see so many bright girls avoiding their subject, because they feel they do not require the subject.

Furthermore, it is regrettable to see the girls persistently concentrating themselves in a few traditionally female occupations. In addition to talking to the girls to try to convince them, one might also collect materials describing emerging opportunities for women in new fields such as ecology, consumer health and welfare, apprentice professional training, and in the traditionally male occupations of dentistry, engineering, law, and medicine. One might seek and secure newly developed materials, such as pamphlets, films, cassettes, and other media presentations that combat sexism by showing women in job, career, and political situations commonly set aside only for men. These might be obtained from the Women's Bureau of the U.S. Department of Labor, or its Canadian counterpart. An effort could be made to invite female speakers for talks on potential careers for students. The school should be encouraged to invite female doctors, lawyers, and business-women, not just stewardesses or nurses. One should try to allow the girls to see a woman who is successful in a profession formerly

regarded as being one that only a man could handle. Girls must be made to realize how many of these interesting careers physics can lead to, and how studying the subject will permit them to pursue any future career.

Physics is sorely in need of a public relations programme. Girls need to be informed about the course and the varied and interesting topics that are covered. A good way to do this would perhaps be with demonstrations. For example, a series of experiments involving mirrors, lenses, and colour would be an effective way of interesting the girls and illustrating optics to them. Static and current electricity demonstrations would also be attractive. Physics displays throughout the year might also be effective in increasing the number of interested students.

Girls should be made to realize that the difficulty of physics has been greatly exaggerated. They also need to be convinced that girls do very well in the subject. It should be pointed out that while a physics student must be proficient in doing calculations, the algebraic and geometrical skills required are minimal. Moreover, the physics teacher will undertake to teach her students most of the mathematical skills they will need, such as scientific notation, the use of the slide rule, graphing techniques, trigonometry, etc.

Finally, it is important for the physics department to try to develop a closer rapport with the guidance people than presently exists. By speaking to the counsellors and telling them of the genuine concern of physics teachers to attract more girls to their subject, a closer alliance might be created between the two departments.

The counsellors should be informed of what interesting topics are covered in the physics course, and made aware of all the varied careers to which physics can lead. It should also be explained to them, just as it was to the students, that physics is meant for the average female student, and that its difficulty has been exaggerated. Similarly, they should be informed that the mathematical skills required of physics students are not as great as they are sometimes made out to be. The counsellor should be told of the physics teachers' disappointment at seeing so many young girls blindly opt for traditionally female, unambitious careers. Perhaps the counsellors can be made to see the point. These counsellors could be invited into the physics classroom to observe an interesting lesson or experiment. Once the counsellor has been convinced that physics is a valuable course and her attitude toward it improves, she might start to encourage more girls to enroll in the course. We need these people as allies, who will work along with physics teachers to try to get more girls in the course.

Thus, one can actively try to increase the number of girls selecting physics. And, as female enrollment increases, the overall student enrollment in physics will also increase. After all, the main reason physics teachers want more students in their course is because they feel it is a subject that will benefit these young people. As the times become more technical it is important that the general population be scientifically literate,in order to function intelligently. Females as well as males should study physics, if only to be better informed individuals.

Summary and Conclusions

The purpose of this study was to identify factors relating to female enrollment in high school physics courses, and to develop a practical rationale for encouraging female enrollment.

A set of three questionnaires was developed and administered to the girls enrolled in grades eleven and twelve at Sisler High School, in the Winnipeg School Division, in November, 1973. These questionnaires attempted to ascertain the girls' reasons for selecting or not selecting physics. A fourth questionnaire was sent to the senior high girls' guidance counsellors in the Winnipeg School Division, also in November, 1973, in an attempt to determine their attitudes toward physics.

The thesis tried to speak to four main questions. These were:

Question I: What are the reasons girls give for selecting or not selecting physics?

Question II: What is the relationship between the reasons girls give for not selecting physics and the present findings regarding self-image that girls have of themselves?

Question III: What are the attitudes of girls' guidance counsellors toward the physics course and what kind of advice are they giving the girls about physics?

Question IV: What type of rationale will best encourage girls to enroll in physics?

Question I was essentially answered by analyzing the questionnaire results. Most girls say they did not take physics because they felt they did not need it for their future education or career. Many stated they were reluctant to enroll in the course for they feared the subject would be too difficult. A smaller number mentioned a lack of interest in the subject, and some stated they were completely unaware of what

the physics course was about. Many girls lacked confidence in their mathematical skills and felt that physics would involve a great deal of complicated mathematics.

The majority of girls studying physics said they enrolled in the course, feeling they would need it for their future education or career. Many stated that they selected the course because they thought it would be an interesting and challenging subject.

The advice of the guidance counsellor was not perceived by the majority of girls as having a very great influence on their course selection.

In answering Question II, an attempt was made to relate the reasons the girls gave for selecting or not selecting physics to the self-image that the girls might have of themselves.

It seems that the main reason girls gave for not taking physics is because they do not feel any need for the course. Most young girls have a very narrow idea of what the future holds for them. An unreasonably large proportion of the female population wish to be nurses or teachers, relatively low-paying and subordinate positions in our society, but ones which have traditionally been reserved for women. These professions have no requirement for an understanding of the principles of physics. Thus, most girls, aspiring to these careers, do not feel they need physics. In contrast, those girls who select physics, have slightly higher career aspirations, and thus feel that studying physics might be of benefit to them at some future date.

Secondly, many girls stated they avoided physics, fearing it would be too difficult. Since more girls than boys seem to exhibit this lack of confidence in their abilities, this phenomenon could

perhaps be attributed to the well documented fact that most females feel inadequate when it comes to the traditionally male dominated fields of mathematics and the 'hard' sciences. This is a societal attitude which is subconsciously adopted by most girls and women.

A lack of interest was expressed by some girls as their reason for avoiding physics. This reason could not be accepted at face value, since the same girls also mentioned that they had little or no idea of what physics was about. Rather than investigating the options they would be taking, most girls just automatically selected biology. Perhaps they did this because it is the traditional route followed by females in high school.

Question III was answered by examining the results of the questionnaire sent to the girls' guidance counsellors. It seemed that the majority of these counsellors have a negative attitude toward physics. Most of them feel it is too difficult for the average student. They ranked it as the most difficult of the science courses offered, and stated that they would not recommend that a girl enroll in the course unless she specifically required it. These counsellors felt physics dealt with topics of little value to the average, educated person. They themselves, almost universally, had an arts background, and were admittedly unfamiliar with the physics course. This generally negative attitude toward physics might be passed on to their clients, and it would certainly influence the advice given.

Lastly, in answer to Question IV, there are several things one might try to do to increase female enrollment in physics. The most

important would be to try to convince the girls that there is a future for them in studying physics. Physics can lead to a variety of interesting careers. If one can convince the girls to consider careers beyond the traditionally acceptable ones of teaching and nursing, they might be persuaded that physics is of interest to them. The exaggerated difficulty and mathematical complexity of physics should be refuted, and the girls' confidence built up if one is going to overcome their hesitancy to enroll in the course. Finally, it is important for the physics teacher to seek out the guidance counsellor as an ally, and attempt to familiarize the counsellor with the physics course and with one's genuine concern for attracting more girls to the subject.

Thus, an active attempt can be made to combat the unfortunate trend away from physics, and to get more young people studying a very basic and valuable subject. Hopefully this rationale will work at Sisler High School, and at others with a similar problem of female underenrollment in physics.

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Appendix A

Questionnaire #1

Questionnaire #1

This questionnaire is to be used to gather information from girls, in grades eleven and twelve, about their reasons for taking or not taking PSSC Physics. It is hoped that this information will be helpful in improving physics courses. It is also hoped that it will help physics teachers who are interested in increasing the enrollment of girls in their subject. The information is confidential. Fill in the other information on the answer sheet, but omit your name, and the name of your instructor.

Part A: TO BE ANSWERED BY ALL STUDENTS.

Instructions for completing Part A:

Read each statement and decide if it is true (T) or false (F). If it is true (T) blacken the corresponding space under T on the answer sheet. If the statement is false (F) blacken the corresponding space F on the answer sheet. If the statement does not apply, or if you don't know, blacken the corresponding space with the small number 3 above it on the answer sheet.

Part A

1. I do not need physics for my future education.
2. I need physics for enrollment at the University.
3. I need physics for enrollment at Red River Community College.
4. I need physics for my career.
5. I have been told that physics is a subject for boys.
6. I have been told that you need to be good at mathematics to be good at physics.

7. I was advised in junior high school to take physics.

8. My senior high guidance counsellor advised me to take physics.

9. My senior high guidance counsellor advised me not to take physics.

10. My senior high counsellor left the choice of a science up to me.

11. My parents advised me to take physics.

12. My parents advised me not to take physics.

13. I have been advised by friends to take physics.

14. I have been advised by friends not to take physics.

15. My grade ten science teacher advised me to take physics.

16. I have been told that chemistry goes with physics.

17. I have been advised that chemistry goes with biology.

18. I have been advised that biology goes with physics.

19. In grade eleven a student can only take two sciences, not three.

20. I took IPS Science in grade ten.

21. None of my close friends are taking physics.

Part B is to be answered by grade 11 and 12 students who are currently taking physics. If you are not taking physics this year, go to Part C of the questionnaire.

Part B:

22. I took physics because I may need it for University.

23. I took physics because I may need it for an Institute of Technology.

24. I took physics because I may need it for my future education.

25. I took physics, although it is not required for my future education or career.

26. I took physics to fill out my timetable.

27. I took physics because my career plans are vague, and I want to keep as many doors open as possible.

28. I am taking at least one other science.

29. I took physics because I felt it would be a challenging subject.

30. I would not have taken physics if it had not been required for my future education.

31. I would advise a good friend to take physics.

32. Physics is one of the most difficult courses I have taken.

END OF PART B. NOW GO TO PART E OF THE QUESTIONNAIRE.

Part C:

Part C of the questionnaire is to be answered by grade 12 students who have credit for PSSC 200, but who are not taking PSSC 300 this year.

If you have never taken physics, go to Part D.

Part C:

33. I took physics in grade 11 because I thought I needed it for my career.

34. I dropped physics because I found it too difficult.

35. I dropped physics because I found it uninteresting.

36. I dropped it when I found out that I did not need it for my career.

37. I dropped physics because I could not fit it into my timetable.

38. I dropped physics because I did not like my teacher.

END OF PART C. NOW GO TO PART E OF THE QUESTIONNAIRE.

Part D: To be answered by students who have never taken physics, and are not taking it this year.

39. I needed biology, so I did not take physics.

40. I needed chemistry, so I did not take physics.

41. I took Mathematics 201, and thought I would not be able to take physics without taking Mathematics 200.

42. I did not take physics since I did not need it for my career.

43. I would have taken physics, but I could not fit it into my timetable.

44. I did not take physics because I have heard it was difficult.

45. I take biology and chemistry.

46. Biology is my only science.

47. I find biology more appealing than physics.

48. I did not take physics because I did not know what it was about.

49. No one has ever explained to me what physics was about.

50. At least one of my close friends is taking physics.

51. I am not interested in physics.

END OF PART D. NOW GO TO PART E OF THE QUESTIONNAIRE.

Part E: TO BE ANSWERED BY ALL STUDENTS.

There are some statements about physics in this section. After you have carefully read a statement, decide whether or not you agree with it. If you agree, decide if you agree mildly or strongly. If you disagree, decide whether you agree mildly or strongly.
Then, find the number of that statement on the answer sheet, and blacken the space by the number

1- if you agree strongly.
2- if you agree mildly.
3- if you cannot decide, or if the statement does not apply.
4- if you disagree mildly.
5- if you disagree strongly.

Example:

0. I would like to have a lot of money.

0. 1 2 3 4 5

(The person who marked this example agrees strongly with the statement, "I would like to have a lot of money.") Please respond to each statement and blacken only one space for each statement.

52. You have to be good at mathematics to be good at physics.

53. Physics is slanted toward boys.

54. Physics is one of the most difficult of high school subjects.

55. Physics deals with things that the average person needs to know.

56. I feel I have a good idea of what physics is about.

57. Physics is mostly a bunch of formulas.

58. To me, biology is more appealing than physics.

59. A well educated person ought to have taken physics.

60. A study of biology is more beneficial to the average person than a study of physics.

61. I see a close connection between physics and my choice of career.

62. I have a fairly good idea of what career I want.

63. When I selected the sciences I would take, I was influenced by my friends' choices.

64. Physics and chemistry labs seem to be more difficult for the girls than for the boys.

65. I was influenced by my guidance counsellor when I selected my science courses.

66. I was influenced by the reputations of the various science teachers when I selected my science courses.

67. I was hesitant to enroll in physics because I was afraid that my marks in it would be low.

68. Physics is a good course to take even if one is not going into any scientific field.

Appendix B

Questionnaire #2

Questionnaire #2

Listed below are 17 possible careers. Of the 17 given, select, in order, five of the careers that you would most like to have. Write 1 beside the career that you would most prefer; write 2 beside the career that you would prefer secondmost; and so on, until you have selected five.

a) Laboratory or X-ray technician _____

b) Accountant _____

c) Librarian _____

d) Elementary school teacher _____

e) Dentist _____

f) Secretarial work _____

g) Nurse _____

h) Lawyer _____

i) Saleswoman _____

j) Doctor _____

k) Electrician _____

l) Key punch operator _____

m) Research scientist _____

n) Engineer _____

o) High school English teacher _____

p) High school science teacher _____

q) Dental hygienist _____

Appendix C

Questionnaire #3

Questionnaire #3

1. In the space below, please list the courses that you are presently taking.

i) _____

ii) _____

iii) _____

iv) _____

v) _____

vi) _____

vii) _____

2. Beside each course, state one of your reasons for selecting that course.

3. Why did you or did you not select physics?

4. Describe what you think physics is about.

5. What career have you in mind for the future?

Appendix D

Questionnaire #4

Questionnaire for Girls' Guidance Counsellors

1. Do you feel that the present PSSC Physics course is meant for the average female student?

2. Do you feel that the present PSSC Physics course is too difficult?

3. Do you feel that the PSSC course is too mathematical?

4. Would you rank the following science courses as to degree of difficulty. Mark the most difficult as 1, the next most difficult as 2, etc.

   Chemistry 200 _____

   Biology 200 _____

   Physics 200 _____

   Physical Science 201 _____

   Biology 201 _____

5. Would you recommend the average girl take physics if she does not specifically need it for her future education or career?

6. Would you recommend or discourage a student from taking PSSC 200 if she will be taking Mathematics 201 instead of Mathematics 200?

7. Do you feel that the PSSC Physics course deals with things that the average person should know?

8. Do you feel that the physics courses being taught at your school are slanted toward the male students?

9. Are you aware of any efforts in your school that the physics department may have actively made to encourage female enrollment in the physics course?

10. How many high school science teachers in your school are females?

11. Do you have a science background (B.Sc.) or a background in the humanities (B.A.)?

12. Have you any opinions or ideas that might be used to improve the PSSC Physics course in order to attract more girls to it?