STUDENTS' REASONS FOR ELECTING OR REJECTING ENROLLMENT IN GRADE XII PHYSICS

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Gerald Francis Caron

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ABSTRACT

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by Gerald Francis Caron

The purpose of the study was to ascertain the reasons for the decline in enrollment in Grade XII physics relative to the total enrollment in all Grade XII science, in the secondary schools of a ninety thousand student urban school system in Alberta.

Students enrolled in at least their third year of high school, and also enrolled in at least one Grade XII subject in February 1971, were the subjects of this study. These Grade XII students were a sample of 871 from the approximately 6,000 such students in the Calgary Public School District #19, during the second semester of the 1970-71 school year.

A survey instrument, "Grade XII Physics: Why Take It? Why Not?" was constructed to assess the reasons, as perceived by students, for enrolling, or for not enrolling in Grade XII physics. A trial version of

the instrument was constructed from statements in the words of students, which had been tape-recorded by the writer during 28 student interviews. The trial instrument was administered to a trial group of forty students. The final instrument was devised following analysis of the trial results, and feedback sessions with the trial students.

The survey instrument is in two parts. Part A, 29 items, attempted to find the mechanical or objective reasons advanced by students for enrollment or non-enrollment in Grade XII physics. Part B, 35 items, was designed to ascertain the affective reasons for enrollment or non-enrollment in Grade XII physics. The affective reasons are associated with the attitude differences of students toward physics, science teaching, science teachers, and junior high school science experiences.

The survey instrument was administered to 1,231 Grade XII students in seven selected high schools. A total of 871 accurately completed response sheets was obtained.

The investigator used computer techniques to determine and to display percentage and absolute response

distributions to questionnaire items.

The investigator also used computer sorting techniques to relate the responses to mechanical items to responses to the affective items of the questionnaire. Statistical techniques established that total group response distributions to all items of the questionnaire were significant at the .01 level of probability or better. Statistical techniques were used to determine significant pairs of percentage response distributions to the affective items, related to percentage response distributions to the mechanical items. Pairs of percentage response distributions showing significant differences at the .01 level or less were determined, listed, and analysed.

The analysis showed that Grade XII students elected physics for mechanical reasons primarily related to future education or career objectives. Students had generally not followed counselling advice when choosing high school science, but had made their own decision. Students reported having been told negative statements about physics. They tended to believe these negative statements.

There were more significant differences in attitudes toward physics and toward junior high school science experiences than toward science teaching or science teachers, among physics students, compared to non-physics students. Non-physics students held generally negative attitudes toward physics. Many physics students, though not as high a percentage as non-physics students, had negative attitudes toward physics. Physics students found junior high school physical science experiences enjoyable, compared to non-physics students who found them boring.

The study showed that attitudes toward physics and attitudes toward junior high school science experiences appear to be related to decisions to enroll or not to enroll in Grade XII physics.

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INTRODUCTION

STATEMENT OF THE PROBLEM

It is the purpose of the study to ascertain the reasons for the decline in enrollment in Grade XII physics, relative to the total enrollment in all Grade XII science, in the secondary schools of a ninety-thousand student urban school system in Alberta.

As the students may elect physics the study will investigate reasons advanced by students for electing or rejecting physics as a course of study.

The Grade XII physics program under study consists of two alternative courses. The authorized text for Physics 30, the first of the alternatives, is Frontiers of Physics.[1] Physics 30X, the second alternative, uses Physics [2] as the authorized text. Both courses are

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[1]Robert Stollberg and Faith Fitch Hill, Frontiers of Physics (Don Mills, Ontario: Thomas Nelson and Sons, Ltd., 1968).

[2]Physical Science Study Committee, Physics (2d ed.; Toronto, Ontario: D. C. Heath, 1965).

acceptable as prerequisites for entrance to the three universities in Alberta as well as to other post-secondary institutions.

The student shall be defined as a person enrolled in a public high school in the province of Alberta, in at least his third year of attendance, and registered for credit in at least one Grade XII (30) subject.

BACKGROUND AND IMPORTANCE OF THE STUDY

Enrollment in physics as part of the secondary curriculum would appear to be declining, continent wide. In Alberta physics enrollment has dropped (expressed as a percentage of either all Grade XII subject enrollment, or of all Grade XII science enrollment) from 1951 to 1969. If steps are to be taken by Departments of Education, by universities and colleges, by administrators and teachers to halt the decline, reasons for the decline must be established. It is the purpose of this study to establish some of the reasons that students give for electing or rejecting Grade XII physics.

DESIGN OF THE STUDY

Students enrolled in their third year of high school, and also enrolled in at least one Grade XII subject in February 1971, were the subjects of the study. These Grade XII students were a sample of 871 from the approximately 6,000 such students in the Calgary Public School District #19, during the second semester of the 1970-71 school year.

A survey instrument, "Grade XII Physics: Why Take it? Why Not?" (see Appendix A), was constructed to assess the reasons (as perceived by students) for enrolling in Grade XII physics, or for not enrolling. The survey instrument is in two main sections. Part A, the first section, attempts to find the "mechanical" reasons advanced by students for enrollment or non-enrollment in Grade XII physics. Mechanical reasons are those related to administrative restrictions, time tables, prerequisite for the course, perceived need of the course for achievement of goals, advice by counsellors and the like. Part B, the second part of the instrument, seeks to explore the "affective" reasons perceived

by students for enrolling or not enrolling in Grade XII physics. Affective reasons can be further subdivided into four kinds of statements to which students responded on a modified Likert scale. The four subdivisions relate to feelings toward physics as a subject of study, toward science teaching as students have experienced it and as they expect it to be, toward the science teacher, and toward their Junior High School science experiences.

In order to develop an inclusive instrument, the writer interviewed 28 Grade XII students. The students included equal numbers of those enrolled and those not enrolled in Grade XII physics. These groups each included equal numbers of males and females. The writer, who conducted the interviews at one composite high school (Calgary Public School Board), taped the interviews for subsequent analysis for suitable survey questions and statements. The interaction possible in the confidential interview yielded a fairly inclusive range of statements for the survey questionnaire.

When assembled, the survey instrument was checked for construct validity by trial on two groups

of 20 each of Grade XII students. One of the groups was enrolled in Grade XII physics, the other was not. Discussion with each group following administration of the instrument established that most of the possible reasons advanced for reaching decisions were sampled by the instrument. Allen L. Edwards' Techniques of Attitude Scale Construction[3] was used as a guide in the development of appropriate scale items.

Subsequent to the feedback sessions with the students, the writer completed an analysis of the responses. Modifications to and deletions of statements, and improvements in the format and instructions were based on the feedback and the analysis.

Experienced researchers of the Calgary Public School Board's Special Services Division checked the instrument before its administration to 1,341 Grade XII students in seven Calgary Public School Board high schools. The high schools were selected to include schools of various ages, offering the full range of

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[3]Allen L. Edwards, Techniques of Attitude Scale Construction (New York: Appleton-Century-Crofts, Inc., 1957).

available courses, and drawing from the full Calgary range of socio-economic and cultural backgrounds.

The optical score sheets used by the students to respond to the statements of the instrument were checked for accuracy, and for suitability for optical scoring. There were 871 score sheets available for scoring by the IBM 1130 computer. Cards were cut simultaneously for sorting purposes. Choice distributions and percentages were produced from the cards for later statistical analysis.

ASSUMPTIONS AND LIMITATIONS

Assumptions

It was assumed that students participating in the study were able to read and understand the instructions, and successfully complete the response sheet for the questionnaire. It was assumed that satisfactory test conditions were maintained.

Delimitations

The study was restricted to students of the Calgary Public School System in at least their third

year in high school, enrolled in at least one Grade XII subject, during the second semester of the 1970-71 school year.

Limitations

The study is limited by the way the population was obtained. However, the application of non-parametric techniques to the data obtained does not require the researcher to make assumptions that the scores were obtained from a population distributed in any known way. The results can be applicable to the sample population and to the same identifiable groups in the universal population as well.

QUESTIONS STUDIED

The following questions were studied in the investigation:

Question I: What are the "mechanical" (objective) reasons selected by Grade XII students for enrolling or not enrolling in Grade XII physics?

Question II: What are the affective reasons perceived by Grade XII students for enrolling or not enrolling in Grade XII Physics?

Each question was broken down into a number of sub-questions (see Chapter III). Null hypotheses (see Chapter III) were stated, in line with the sub-questions, and were tested by use of the Kalmogorov-Smirnov one-sample, and two-sample tests. Rejected null hypotheses identified the significant choice distributions and percentages which are shown and discussed in detail in Chapter IV.

Chapter 2

REVIEW OF THE LITERATURE

INTRODUCTION

Since about 1956 there has been no lack of concern with the relative decline of interest in physics in secondary schools. However, the major attempts to improve physics courses have had their beginnings in dissatisfaction with the structure or content of existing physics courses. Project Physics may be an exception. Little attempt seems to have been made to ask students for their reasons for electing to take physics, or for their reasons for rejection of physics. There seems to be an assumption by the developers of PSSC (Physical Sciences Study Committee) Physics and to a lesser degree by the Project Physics group, that if the course is rigorous, relevant, humanistic and appealing to science teachers it will increase the appeal of physics. Such has not proved to be the case.

BACKGROUND TO THE PROBLEM

In Newsletter 1, Fall 1964, of Harvard Project Physics[1] the authors presented a graph (Figure 1) that is subject to disturbing interpretations. 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 enrollment holding steady, and biology enrollments increasing. The writers of the Harvard Project Physics (now called Project Physics)[2] assumed that one of the causes for the decreasing enrollment in physics at the high school level was the lack of a wide variety of curriculum alternatives. Thus the authors felt justified in proceeding with the course development.

In the same Newsletter, the authors attempted to make a case for the importance of physics at the secondary level. They alluded to the necessity for good

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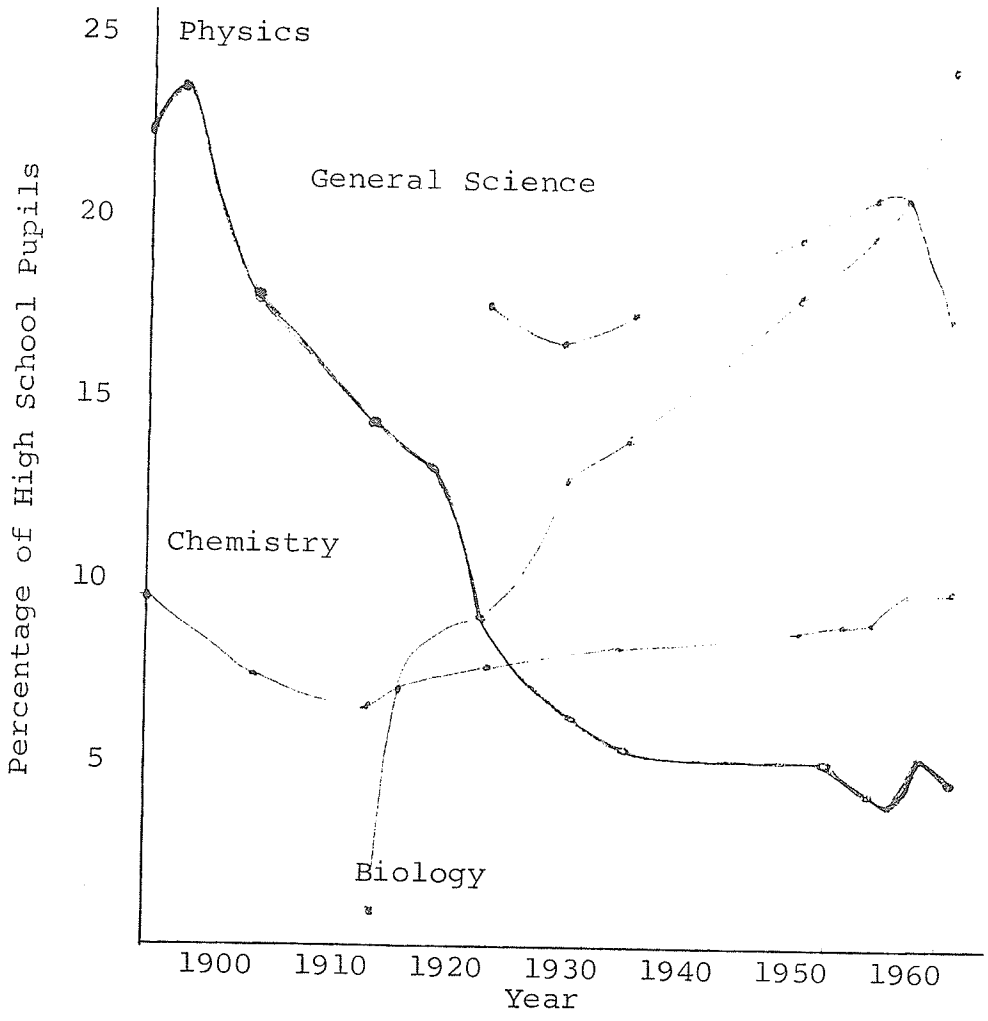
[1]Newsletter, Harvard Project Physics, Fall 1964, 4.

[2]Gerald Holton, F. James Rutherford, and Fletcher G. Watson, The Project Physics Course (Toronto: Holt, Rinehart and Winston of Canada, Limited, 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.

preparatory courses for future physicists. They referred to the need for physics literacy for citizens working in industry and business in an increasingly technical society. They referred to the cultural values inherent in physics. With reference to students in the humanities and social studies they claimed that "to be ignorant of physics may therefore leave such students unprepared for their time."[3]

An analysis of Annual Reports of the Department of Education, Province of Alberta 1951 to 1969 inclusive,[4] has given Table 1. Table 1 shows the numbers of Grade XII physics, chemistry and biology papers written 1951 to 1969, inclusive. Numbers of candidates writing at least one Grade XII paper in each year of the same period are shown. Percentages of numbers of candidates writing at least one paper 1951 to 1969 inclusive, who wrote the physics, or chemistry, or biology papers, were calculated and are shown on the table. The graph of

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[3]Newsletter, Harvard Project Physics, Fall 1964, 4.

[4]Alberta, Department of Education, Annual Reports (Edmonton: Queen's Printer, 1951-1969 inclusive).

TABLE 1

ENROLLMENT IN SCIENCES COMPARED TO TOTAL ENROLLMENT

Year	Physics Papers	Percentage Physics	Chemistry Papers	Percentage Chemistry	Biology Papers	Percentage Biology	Total Candidates
1951	2224	34.7	2635	41.1	2115	33.0	6410
1952	2018	32.1	3078	49.0	2114	33.6	6287
1953	2395	37.3	3047	47.5	2266	35.3	6417
1954	2553	37.6	3626	53.4	2818	41.5	6793
1955	2670	34.7	4030	52.3	3256	42.3	7703
1956	2506	30.6	4311	52.7	3504	42.9	8177
1957	2387	27.5	4570	52.6	3815	44.0	8680
1958	2682	30.9	5363	61.8	4241	48.9	9683
1959	2796	25.6	5730	52.5	4886	44.7	10923
1960	2943	23.7	6496	52.2	5918	47.6	12440
1961	3203	21.8	7362	50.2	6720	45.8	14671
1962	3276	20.3	8115	50.2	7094	43.9	16158
1963	3491	21.3	8329	50.8	7534	45.9	16397
1964	3963	22.6	9027	51.5	8201	46.8	17525
1965	4619	21.7	9076	42.7	8580	40.3	21270

TABLE 1 (continued)

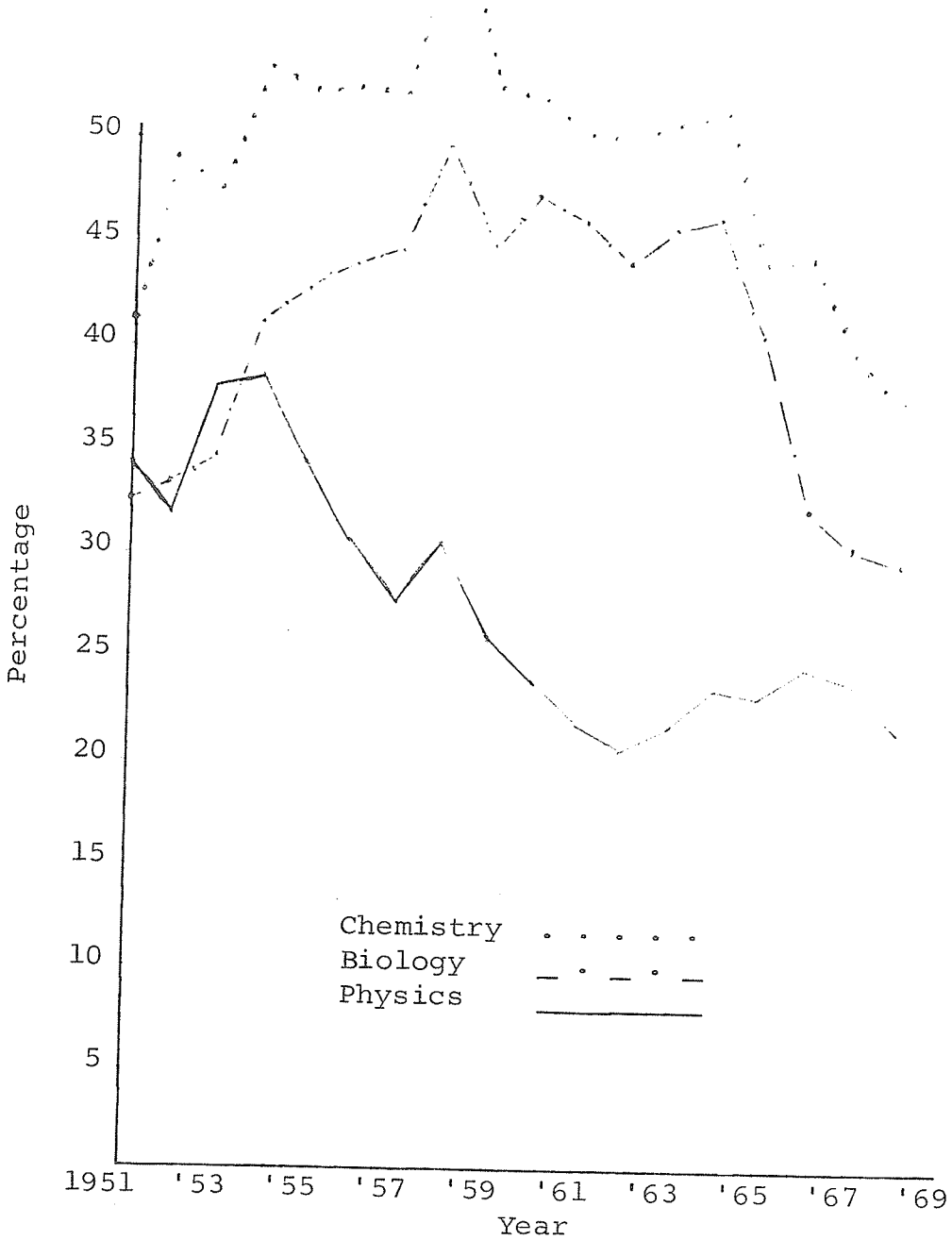
Year	Physics Papers	Percentage Physics	Chemistry Papers	Percentage Chemistry	Biology Papers	Percentage Biology	Total Candidates
1966	5320	24.6	9362	43.2	7067	32.6	21662
1967	5113	22.9	8914	40.0	6750	30.3	22297
1968	4716	21.1	8254	37.0	6558	29.4	22303
1969	4892		7347		8221		N/A

Note: Table shows papers written in Grade XII Physics, Chemistry and Biology and total candidates writing at least one Grade XII paper, 1951-1969 inclusive, Alberta.

Figure 2, numbers of students writing Grade XII final examinations in each year in chemistry, physics and biology are compared by percentages with the total numbers of students writing at least one Grade XII final examination in each year. The percentage of students writing physics shows an overall decline from 1951 (34.7%) to 1962 (20.3%) with little further change to 1968 (21.1%). The years 1968 and 1967 each showed a decline over the previous year. In the same period students writing chemistry rose from 1951 (41.0%) to 1955 (52.3%) and maintained nearly 50% until 1965 when a decline set in to 1968 (37.0%). Biology papers written reached a peak in 1960 (47.6%), declining after then to 1968 (29.4%).

Table 2 shows the numbers of Grade XII papers written in physics, chemistry and biology from 1951 to 1969 inclusive. Totals for numbers of science papers written each year are also shown. Percentages that each of physics, chemistry and biology papers written were of total of science papers written were calculated and are shown in this table.

FIGURE 2. SCIENCE ENROLLMENT COMPARED TO ALL-SUBJECTS ENROLLMENT, ALBERTA



Percentage of students writing at least one Grade XII examination who wrote examinations in chemistry, biology and physics, 1951-1968, Alberta.

TABLE 2

SCIENCE FINAL EXAMS

Year	Physics Papers	Percentage Physics	Chemistry Papers	Percentage Chemistry	Biology Papers	Percentage Biology	Total Papers Science
1951	2224	31.9	2635	37.8	2115	30.3	6974
1952	2018	28.0	3078	42.7	2114	29.3	7210
1953	2395	31.1	3047	39.5	2266	29.4	7708
1954	2553	28.4	3626	40.3	2818	31.3	8997
1955	2670	26.8	4030	40.5	3256	32.7	9956
1956	2506	24.3	4311	41.8	3504	34.0	10321
1957	2387	22.2	4570	42.4	3815	35.4	10772
1958	2682	21.8	5363	43.7	4241	34.5	12286
1959	2796	20.8	5730	42.7	4886	36.4	13412
1960	2943	19.2	6496	42.3	5918	38.5	15357
1961	3203	18.5	7362	42.6	6720	38.9	17285
1962	3276	17.7	8115	43.9	7094	38.4	18485
1963	3491	18.0	8329	43.0	7534	38.9	19354
1964	3963	18.7	9027	42.6	8201	38.7	21191
1965	4619	20.7	9076	40.7	8580	38.5	22275

TABLE 2 (continued)

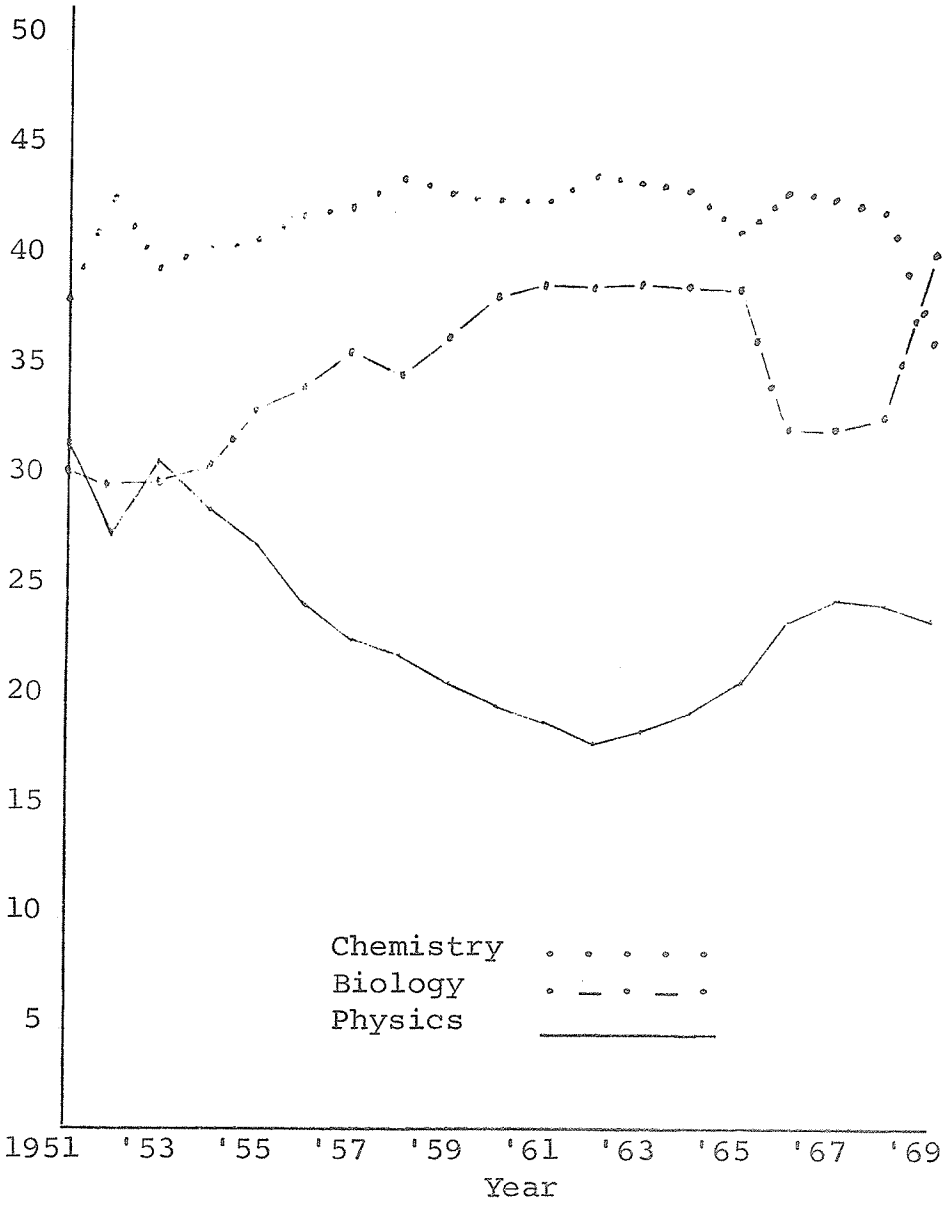
Year	Physics Papers	Percentage Physics	Chemistry Papers	Percentage Chemistry	Biology Papers	Percentage Biology	Total Papers Science
1966	5320	24.5	9362	43.0	7067	32.5	21749
1967	5113	24.6	8914	42.9	6750	32.5	20777
1968	4716	24.1	8254	42.3	6558	33.6	19528
1969	4892	23.9	7347	35.9	8221	40.2	20460

Note: Table shows papers written in Grade XII Physics, Chemistry and Biology, and totals of science papers written 1951-1969 inclusive, Alberta.

Figure 3, derived from Table 2, depicts the change in percentages of each of physics, chemistry and biology Grade XII papers written, relative to the total number of papers written in the three sciences from 1951 to 1969, inclusive. Chemistry enrollment maintained a high relative position until 1968, but suffered a severe drop in 1968 and 1969. Biology registrations appear to have expanded from 1963 to 1965, at least in part at the expense of physics. Numbers of students writing biology final examinations suffered a steep relative reduction in the period 1965 to 1967, apparently due to increases in physics and chemistry. After a slight recovery from 1962 to 1966 physics enrollments began a gradual decline, which continued through 1969.

During the period 1951 to 1969 a number of concurrent events are worthy of note. Vocational high school programs began in many Alberta high schools in 1963. Students were able to take vocationally oriented courses that could lead to employment or to post-secondary institutions other than university. These students were not required to take more than one science course in high school. The first students of the

FIGURE 3. SCIENCE ENROLLMENTS, COMPARED



Percentage of students writing Grade XII final examinations in the three sciences who wrote examinations in chemistry, biology and physics, 1951 to 1969, Alberta.

vocational program graduated in 1966. A new Grade XII chemistry program using Chemistry[5] was introduced in 1964. Chemistry, An Experimental Science (CHEMStudy)[6] was introduced as an alternative program for Grade XII in 1967. Biology programs were revised at Grade XII in 1965 with the introduction of Elements of Biology[7] as the authorized text.

Before 1968 physics and chemistry were combined at the Grade X and Grade XI levels as Science 10 and Science 20. In 1968 an ad hoc committee of the Alberta Department of Education changed physics and chemistry to half courses; physics 10 and chemistry 10, physics 20 and chemistry 20. The committee's aim was to provide flexibility of student choice. It made it possible, if school scheduling and post-secondary plans permitted,

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[5]Mitchell J. Sienko and Robert A. Plane, Chemistry (Toronto: McGraw Hill of Canada, 1964).

[6]Chemical Education Material Study, Chemistry, An Experimental Science (San Francisco: W. H. Freeman and Company, 1963).

[7]Paul B. Weiscz, Elements of Biology (Canadian ed.; Toronto: McGraw Hill Company of Canada Ltd., 1965).

for students to reject experience with physics, chemistry or biology from Grade XI on. In 1968 many schools and faculties of universities in Calgary and Edmonton changed their admission requirements to five Grade XII examination subjects rather than the previous six. This made it possible for many Grade XII students to drop one science course of the two or three they could carry in Grades X and XI.

As shown by the Project Physics group, and by the numbers writing Grade XII physics examinations, physics enrollments at the secondary level are declining in both the United States and in Alberta. The fundamental question that must be answered is why? What are some of the reasons why students elect to enroll in physics, or reject enrollment in physics? If such reasons, both objective and affective, can be ascertained teachers, university staffs and curriculum developers may design remedial action related to the root causes of the problem.

RELATED RESEARCH

Since 1959 when H. B. Reed conducted his pace-setting study, "Pupils' Interest in Science as a Function

of the Teacher Behaviour Variables of Warmth, Demand, and Utilization of Intrinsic Motivation,"[8] many attempts have been made to create instruments to assess student attitudes toward science, science teaching, and scientists.

Moore and Sutman[9] have summarized the history of Scientific Attitude scale construction:

> In the thirty years prior to 1962, several tests of scientific attitudes or understandings have been prepared and reported in the literature; four of these have been used in experimental studies. These include instruments prepared by Allen, Brandyberry, Cooley and Klopfer, and Noll. Since 1962, the number of tests of scientific attitudes or understandings has increased. These include instruments prepared by Kimball, Welch and Pella, Kaplan, Lowery, Vitrogan, Schwirian and Dutton and Stephens.

An examination of Moore and Sutman's research and instrument, and that of Cooley and Klopfer, yielded

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[8]H. B. Reed, "Pupils' Interest in Science as a Function of the Teacher Behavior Variables of Warmth, Demand, and Utilization of Intrinsic Motivation," The Journal of Experimental Education, 29:205-209, 1961.

[9]Richard W. Moore, and Frank X. Sutman, "The Development, Field Test and Validation of an Inventory of Scientific Attitudes," Journal of Research in Science Teaching, 7:2885, 1970.

ideas for scale construction but no instrument that could be used to determine why Alberta students elect or do not elect to take physics courses. The instruments were designed to test scientific attitudes, but were not designed to test attitudes toward physics. The SATS (Student Attitude Toward Science) developed by Hedley (1966) and used by Charlesworth (1969) appeared closer to the need. However, because more specific information about attitudes toward physics was desired SATS was not the instrument selected for the study.

Three recent studies bear more directly on the problem. Snelling and Boruch[10] initiated a study in 1967, which they reported in 1970, in which they tried to answer the 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 major influences in determining such choices?

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[10]N. Rodman Snelling and Robert Boruch, "Factors Influencing Student Choice of College and Course of Study," Journal of Chemical Education, 47:326, May, 1970.

The sample was restricted to graduates from 49 colleges, and to those graduates who majored in mathematics and the sciences. Responses to a questionnaire indicated that the grade level at which science was chosen as a major field of interest was Grade IX for from 37.7% to 51.2% of the graduates in the years from 1957 to 1967. More than any other subject group, physics majors made their choice prior to Grade IX. For persons choosing science as a career, the effect of junior high school experiences and the advice of junior high school teachers and counsellors would appear to be strong and increasing.

A second study, reported in October 1970 by Haym Kruglak[11] of Western Michigan University, is more directly pertinent. Approximately 3,000 freshmen at Western Michigan University were polled in the autumn of 1968 for their reasons for taking or not taking high school physics. They were also asked to rate their physics teachers on a five point scale and to estimate

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[11]Haym Kruglak, "A Poll of College Freshmen on High School Physics," The Physics Teacher, 8:394, October, 1970.

the frequency of demonstrations and laboratory work.

Reasons selected by students for not taking high school physics were reported by Kruglak[12] as:

> 1. Lack of interest in the subject was the preponderant response of boys and girls (67% and 83%).
> 2. The counselor's advice was ranked second by both groups (19% and 8%).
> 3. Fear of a low mark appears to have influenced relatively few students (7% and 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[13] as:

> 1. Interest in the subject had the highest priority for boys (40%) followed closely by counselor's recommendation (37%). The order was reversed for girls (24% and 41%).
> 2. The challenge of a tough subject was ranked third by both boys and girls (15% and 19%).
> 3. The reputation of the teacher had the lowest ranking for each group.

In the conclusions and implications Kruglak[14] reported:

> The entering freshmen do not feel that the difficulty of physics or the teacher quality are serious

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[12]Ibid.

[13]Ibid.

[14]Ibid., p. 395.

> obstacles in the selection or non-selection of the subject. Interest in subject matter and the counselor'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 in the physical sciences is of crucial importance. Also there is need for establishing a better rapport with the high school counselors.

In the third study Walter Elliot[15] 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 also obtained data relevant to the physics teachers which he attempted to correlate with the data obtained from students. Elliot reported:

> The 2438 nonphysics students were about evenly divided on the basis of sex. Eighty-eight percent 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, in this order.

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[15]Walter Elliot, "Perceptions of High School Physics and Physics Teachers," The Physics Teacher, 9:37, January, 1971.

Elliot[16] further reported:

> The 10,528 physics students 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 this order.

Though the three studies discussed have the most relevance to the present study, they also leave some questions unanswered. Snelling and Boruch have suggested that more than half the science graduates they studied decided before Grade IX that they were going to take up a science career. Elliot[17] studied the relationships between high school students and their teachers. The writer asked, may it not be more important to examine the students' perceptions of their junior high teachers and experiences? The study of Elliot[18] was concerned with a relatively small sample of students not taking physics. This group (at the Grade XII level) can make up to 80% of the Alberta

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[16]Ibid., p. 33.

[17]Ibid., pp. 33, 37.

[18]Ibid.

population. Kruglak's[19] study is concerned only with college students. This would exclude approximately 75% of the Alberta high school population.

Elliot[20] claims that students do not enroll in physics due to lack of interest, and Kruglak asks, as one of five questions, "I had little interest in the subject matter." In the present study it was proposed to pursue this question of lack of interest into its components and causes. If students do not take physics because it does not interest them, why does it not interest them?

Students in Alberta have a somewhat different science experience than their counterparts in the United States. In American schools physics is usually offered as an option at the Grade XII level, or less frequently at Grade XI. The subject is offered as an option at Grades X, XI, and XII in Alberta, and all Grade IX students must take physical science.

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[19]Kruglak, op. cit., pp. 394-95.

[20]Elliot, op. cit., pp. 33, 37.

It is hoped that the present study has been able to investigate more thoroughly the reasons why Calgary students have interest, or lack of interest, in physics. Canadian studies are lacking, and the Alberta student population would appear to have somewhat different physics exposure than their American counterparts.

Chapter 3

EXPERIMENTAL DESIGN

OBJECTIVE OF THE STUDY

It was proposed that a survey instrument in the form of a questionnaire be constructed to be administered to the subject population to ascertain mechanical or objective, and affective reasons why some Grade XII students enroll in physics and others do not.

SUBJECTS OF THE STUDY

Students enrolled in at least their third year of high school and also enrolled in at least one Grade XII subject and hereafter referred to as Grade XII students were the subjects of the investigation. The subjects amounted to 871 (14.5%) of the approximately 6,000 Grade XII students enrolled in the Calgary Public School District No. 19 during the second semester of the 1970-71 school year. Subject students enrolled in, or having credit in, Grade XII physics totalled 403, which is approximately 46% of the survey group of 871 persons.

Of the 6,000 Grade XII students, 1,613 (27%) wrote Grade XII physics. The survey group of 403 physics students made up 25% of the 1,613 students writing Grade XII physics in 1970-71.

DEVELOPMENT OF THE INSTRUMENT

Permission was sought and obtained from the principal of a large composite high school (1,190 students) in the Calgary Public School system to conduct interviews with a broad cross-section of Grade XII students. Facilities were generously made available during May of 1971 for the writer to conduct half-hour tape-recorded interviews with 28 students. Names of likely prospects were suggested by the guidance department Head, who approached them and obtained the required number of volunteers for the interviews. The school draws from a section of the city which includes a wide spectrum of socio-economic backgrounds among its students. Of the students interviewed, there were approximately equal numbers enrolled in Grade XII physics and those not so enrolled. Within these categories, equal numbers of males and females were interviewed. Among

the students interviewed not enrolled in physics were several whose science experience at the high school level was at the minimum level set by the Department of Education in their Senior High School Handbook[1] for high school graduation with diploma, in Alberta. That is, they had obtained credit but not necessarily a passing grade in a single, half-year, three-credit course in science.

The interviews generally yielded students' reasons for taking or not taking physics, and explored their attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences.

Students were exceedingly frank and communicative in the interviews, which make an interesting study in themselves.

The statements made by the interviewees were transcribed during three hearings of the tapes. The statements were then categorized into those of fact or

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[1]Alberta, Senior High School Handbook (Edmonton: Queen's Printer, 1971), p. 25.

those of opinion. Twenty-nine of the most important and often-made statements of fact, and 41 of the most frequently made statements of opinion were assembled into a trial instrument.

CONSTRUCT VALIDATION OF THE INSTRUMENT

Permission was requested from, and granted by, the principal of the same school to administer the trial instrument to one group of students enrolled in Physics 30 and to a group of equal size not so enrolled. This was done in the latter half of May. Following the administration of the trial instrument the writer spent more than an hour with each of the groups discussing their reactions to and criticisms of the trial instrument.

The writer then analyzed the responses of the groups to the individual items of the trial instrument. Poorly worded or unsatisfactory items were re-worked or deleted. Sixty-four items survived.

At this point the revised instrument was submitted to Dr. Carl Safran, Superintendent of Special Services for the Calgary Public School Board, and to

his associates, Dr. C. Sangster, Assistant Superintendent of Special Services and Mr. D. Feltham, Supervisor of Guidance, for their suggestions. They concurred in the construct validity of the instrument as revised.

THE INSTRUMENT

The revised instrument, entitled "Grade XII Physics: Why Take It? Why Not?," was planned for self-administration, with responses to be recorded on an IBM optical scan score sheet (see Appendix A). The 29 statements of Part A were deemed to be factual, and the subjects were requested to respond "true," "false," or "don't know," as each applied to them. The statement #15 provided a division point for the subjects. This statement reads, "I have credit in Physics 10." Those subjects answering "false" (no) to this statement could not be enrolled or have credit in Physics 30, 30X, or 32. Physics 10 is a prerequisite for such enrollment.[2] Subjects not having credit in Physics 10 were to respond

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[2]Alberta, Senior High School Handbook, 1971b-12.

to statements 16, 17 and 18, which sought for reasons for no credit in Physics 10, and then they were expected to go on to Part B, the attitude portion of the instrument. Subjects responding "true" (yes) to statement 15 went on to statements 19 to 23, which explore objective reasons for obtaining credit in Physics 10. Statement 24, "I have credit in, or am now enrolled in Physics 30, or 30X, or 32," provided another division point for the remaining subjects. Those subjects answering "false" (no) to the statement went on to complete responses to statements 25 and 26 before going on to Part B. Statements 25 and 26 offered possible reasons for not taking physics, even though credit had been obtained in Physics 10. Subjects responding "yes" to statement 24 completed responses to statements 27, 28 and 29 concerning reasons for taking Physics 30, 30X, or 32, before going on to Part B of the questionnaire.

Part B of the questionnaire consists of 35 statements in the words of interviewed students. The subjects were expected to respond to the statements on a modified Likert scale. The statements may be grouped into four categories. One category refers to attitudes

of students toward physics, another, attitudes toward the way science is taught, another, the attitudes toward science teachers, and the last, the attitudes of the subjects toward their science experience in junior high school.

QUESTIONS TO BE STUDIED

With the development of the questionnaire completed, it was possible to expand the objective of the study into the questions to be studied. These questions are two in number, each with subsidiary questions:

Question I

What are the "mechanical" (objective) reasons selected by Grade XII students for enrolling or not enrolling in physics at the high school level?

Sub-Question I-a. What reasons related to career are selected by Grade XII students for enrollment or non-enrollment in high school physics?

Sub-Question I-b. What have the students been told about physics, and about its relationships to the other sciences?

Sub-Question I-c. What counselling advice has been given students regarding enrollment in high school sciences?

Sub-Question I-d. What reasons for their decision do students select who did not gain credit in Physics 10?

Sub-Question I-e. What reasons for the decision to take Physics 10 were selected by those students who obtained credit in Physics 10?

Sub-Question I-f. What reasons for their decision were selected by students who did not take Grade XII physics, though they had the prerequisites?

Sub-Question I-g. What reasons for their decision were selected by students who elected to enroll in Grade XII physics?

Question II

What are the affective reasons, as related to attitudes, perceived by Grade XII students for enrolling or not enrolling in Grade XII physics?

Sub-Question II-a. What are the attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the group of all subjects surveyed?

Sub-Question II-b. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who did or did not see a need for physics for their career?

Sub-Question II-c. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who have or have not heard certain statements about physics?

Sub-Question II-d. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who have been counselled in differing ways?

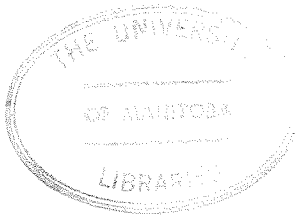
Sub-Question II-e. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, toward their junior high school science experiences of the groups who did or did not obtain credit in Physics 10 and who selected various reasons for their decision?

Sub-Question II-f. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who had credit or were enrolled in Grade XII physics or who did not have credit or were not enrolled in Grade XII physics, and who gave various reasons for their decisions?

Sub-Question II-g. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups of females and males?

SELECTION OF THE SUBJECTS

Permission had been obtained from the principals of seven high schools of the Calgary Public School system for administration of the instrument to Grade XII students on a voluntary, self-administration basis. These seven schools are a cross-section of the fourteen high schools of the system. The schools include composite high schools with balanced enrollments of academically and vocationally oriented students, and academic high schools without vocational facilities (other than business education) sending a high proportion of their students to college and university, and composite high schools with high proportions of vocationally career-oriented students. Ages of the schools vary from one several decades old to one completed in the last two years. The socio-economic regions from which students are drawn run the full gamut from "affluent" to "deprived."



PROCEDURE

The revised instrument entitled "Grade XII Physics: Why Take It? Why Not?" was distributed in numbers sufficient for administration to all Grade XII students in the seven selected schools. Twenty-five hundred copies of the instrument were distributed, together with an equal number of optical score sheets #505, for IBM 1130 computer. The science department heads in the schools volunteered to distribute and to co-ordinate the administration of the instruments and to return the completed score sheets. This was completed in the second week of June.

DATA ANALYSIS

After the 1231 completed IBM optical score sheets were returned the investigator examined each one for accuracy of completion and for assurance that they could be scored accurately by the scorer attachment of the IBM 1130 computer operated by The University of Calgary Engineering Data Center. This process reduced the number to a total of 871 score sheets

distributed by school, as follows: School A - 43; School B - 64; School C - 88; School D - 256; School E - 124; School F - 100; and School G - 196.

The score sheets were then scored at the Data Center, and IBM cards were cut automatically at the same time. Using a program from the Data Center files, modified by the Center Supervisor, print-outs were produced to yield statistics suitable for analysis in line with the questions to be studied.

Print-out I yielded choice distributions and percentages for each of the 64 items of the questionnaire for all 871 respondents.

Print-out II gave choice distributions and percentages for all 64 items, for each of the responses "yes" or "no" for each of the items 1-29 inclusive. This print-out, through a special sort, gave choice distributions and percentages for all 64 items for those not responding to item 24. These latter persons were those not having credit in Physics 10, and thus were asked not to respond to item 24.

Print-out III yielded choice distributions and percentages for all 64 items for the 217 males and

213 females who so identified their score sheets.

Consultations with Mr. D. Morris, Assistant Superintendent of Elementary Schools, Calgary Public School Board, were instrumental in developing the approach taken by the writer to the statistical procedures instituted with the data.

Two conditions in the construction of the questionnaire and in the make-up of the population to which it was applied indicated the use of non-parametric techniques in the analysis. The Likert scale used in the attitude portion of the instrument and the "yes," "no," "don't know" response system of the mechanical reasons section are ordinal scales. The population of the sample was a sub-set of a sub-set of the universal population. Siegel[2] says:

> At the risk of being excessively repetitious, the writer wishes to emphasize here that parametric statistical tests, which use means and standard deviations (i.e., which require the operations of arithmetic on the original scores), ought not to be used with data in an ordinal scale.

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[2]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (Toronto: McGraw-Hill Book Company, 1956), p. 26.

Siegel[3] says, further: "A nonparametric statistical test is a test whose model does not specify conditions about the parameters of the population from which the sample was drawn."

Hypotheses Tested

In line with the questions to be studied and the data obtained, the following hypotheses were tested in the study:

Hypothesis I. For the choices (true, false, don't know) of the 871 subjects to items 1-15 inclusive of the instrument:

H_o there is no difference among the expected percentage of responses for each of the three choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3$.

H_i (alternative hypothesis) the percentages of responses for each of the three choices are not equal.

Hypothesis II. For the choices (no response, true, false, don't know) of the 871 subjects to item 24 of the instrument:

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[3]Ibid., p. 31.

H_o there is no difference among the expected percentages of responses for each of the four choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3 = f_4$

H_i the percentages of responses for each of the four choices are not all equal.

Hypothesis III. For the choices (true, false, don't know) of the varying numbers of subjects to items 16-29 inclusive of the instrument:

H_o there is no difference among the expected percentages of responses for each of the three choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3$

H_i the percentages of responses for each of the three choices are not all equal.

Hypothesis IV. For the choices (agree strongly, agree mildly, cannot decide, disagree mildly, disagree strongly) of the 871 subjects to items 30-64 inclusive of the instrument:

H_o there is no difference among the expected percentages of responses for each of the five choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3 = f_4 = f_5$

H_i the percentages of responses for each of the five choices are not all equal.

It should be noted that the Hypotheses I, II and III were derived from Question I, Sub-Questions Ia-Ig, inclusive. Hypothesis IV was derived from Question II, Sub-Question IIa. The data associated with these Hypotheses and Questions was from print-out I.

From Question II, Sub-Questions IIb-IIg, inclusive (data of print-outs II and III) 32 X 35 (1120) similar null hypotheses were derived. That is, there is a null hypothesis for each of the 35 items of Part B of the instrument that was tested against the two groups responding "yes" or "no" to items 1-23 inclusive and items 25-29 inclusive, and the two groups responding "yes" or "no" to item 24, and the two groups responding "yes" and "no response" to item 24, and the two groups responding "no" and "no response" to item 24, and the two groups comprised of females and males.

The form only of the 1120 null hypotheses and alternative hypotheses is given--Null Hypothesis V (an example, the 496th Hypothesis is used)

> Hypothesis V.
> H_O the percentages of students having credit in Physics 10 (item 15 "yes") who agree strongly, agree mildly, cannot decide, disagree mildly,

disagree strongly with the statement (item 30) "You have to be good in Mathematics to be good in Physics" is the same as the percentages of students not having credit in Physics 10 who agree strongly, agree mildly, cannot decide, disagree mildly, or disagree strongly with the statement (item 30) "You have to be good in Mathematics to be good in Physics," and any observed differences are merely chance variations.

H_i the percentage of students having credit in Physics 10 (item 15 "yes") who agree that "You have to be good in Mathematics to be good in Physics" (item 30) is significantly greater (at the .01 or .05 level) than the percentage of students not having credit in Physics 10 who agree that "You have to be good in Mathematics to be good in Physics" (Item 30).

Statistical Tests

The Kolmogorov-Smirnov one-sample, two-tailed test[4] was chosen to test the null hypotheses I, II, III and IV, using the data from print-out I. The writer chose this test because he wished to compare the observed distribution of responses to the 64 items of the questionnaire with the theoretical distribution that would have been obtained if the distribution had been due to chance. Items for which H_O would have to be accepted were to be deleted from further consideration. The .01

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[4]Siegel, op. cit., p. 47.

level of probability was selected as the level for rejection of the null hypothesis.

The Kolmogorov-Smirnov two-sample, one-tailed test was selected for testing null hypothesis V (representing the null hypotheses 5-1124 inclusive), using the data from print-outs II and III.[5] This test was selected because it compares two sample cumulative frequency distributions and determines whether the observed D (deviation) indicates that they have been drawn from two populations, one of which is stochastically larger than the other. The test was applied to the cumulative percentage choice distributions of each of the 35 pairs of attitude statements (30-64) for each pair of "yes-no" choice distributions for items 1-23 inclusive, and for items 25-29 inclusive. The test was also applied to the cumulative percentage choice distributions for each of the 35 pairs of attitude statements for each pair of "yes-no," "yes-no response" and "no-no response" choice distributions for item 24. The test was also applied to the cumulative percentage choice distributions of each

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[5]Ibid., p. 127.

of the 35 pairs of attitude statements (30-64) inclusive) for each pair of the "female-male" choice distributions.

The tests were run on the PDP-8 DIGITAL computer by the writer, using programs devised by the writer based on the formulas of Siegel.[6]

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[6]Ibid., p. 134.

Chapter 4

ANALYSIS OF THE DATA

INTRODUCTION

The present study is designed to determine the reasons why Grade XII students elect to enroll in Grade XII physics, or not to so enroll. In this chapter the treatment of the data is described. Findings to each of the questions and sub-questions in Chapter 3 are reported.

PRESENTATION OF THE FINDINGS

Question I

> What are the "mechanical" (objective) reasons selected by Grade XII students for enrolling or not enrolling in physics at the high school level?

Null Hypothesis I. The absolute and percentage choice distributions of students responding true (yes), false (no), and don't know for items 1-15 inclusive of the questionnaire are presented in Table III. These data are from computer print-out I. Sub-questions Ia,

TABLE III

WHOLE POPULATION CHOICE DISTRIBUTIONS, RELATED TO SUB-QUESTIONS Ia, Ib, Ic

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
1	1	467	284	119			.1	53.6	32.6	13.7			.203
2	1	220	417	233			.1	25.3	47.9	26.8			.080
3	1	502	312	56			.1	57.6	35.8	6.4			.268
4	2	270	536	62			.2	31.0	61.5	7.1			.259
5	1	207	581	82			.1	23.8	66.7	9.4			.344
6	0	590	250	31			.0	67.7	28.7	3.6			.359
7	0	603	222	46			.0	69.2	25.5	5.3			.222
8	2	206	567	95			.2	23.7	65.1	10.9			.313
9	2	563	239	67			.2	64.6	27.4	7.7			.226
10	3	146	631	90			.3	16.8	72.4	10.3			.270
11	1	358	457	55			.1	41.1	52.5	6.3			.264
12	1	466	344	60			.1	53.5	39.5	6.9			.271
13	0	54	750	67			.0	6.2	86.1	7.7			.433
14	0	667	170	33			.0	76.6	19.5	3.8			.342
15	0	588	279	4			.0	67.5	32.0	.5			.376

TABLE III (continued)

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
16	578	105	159	29			66.4	12.1	18.3	3.3			.414
17	578	205	70	18			66.4	23.5	8.0	2.1			.414
18	594	97	156	24			68.2	11.1	17.9	2.8			.432
19	260	213	380	18			29.9	24.5	43.6	2.1			.230
20	274	178	366	53			31.5	20.4	42.0	6.1			.189
21	277	91	451	51			31.8	10.4	51.8	5.9			.190
22	277	279	271	44			31.8	32.0	31.1	5.1			.199
23	280	247	279	65			32.1	28.4	32.0	7.5			.175
24	268	403	200	0			30.8	46.3	23.0	0.0			.251
25	658	79	120	14			75.5	9.1	13.8	1.6			.505
26	659	24	155	33			75.7	2.8	17.8	3.8			.507
27	506	223	114	28			58.1	25.6	13.1	3.2			.337
28	513	76	255	26			58.9	8.7	29.3	3.0			.339
29	520	219	113	18			59.7	25.1	13.0	2.1			.348

TABLE III (continued)

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
30	11	244	462	75	64	15	1.3	28.0	53.0	8.6	7.3	1.7	
31	1	622	144	36	48	20	.1	71.4	16.5	4.1	5.5	2.3	
32	2	67	100	172	235	295	.2	7.7	11.5	19.7	27.0	33.9	
33	2	70	140	88	214	357	.2	8.0	16.1	10.1	24.6	41.0	
34	1	114	324	153	162	117	.1	13.1	37.2	17.6	18.6	13.4	
35	1	211	255	174	148	82	.1	24.2	29.3	20.0	17.0	9.4	
36	1	221	297	106	164	82	.1	25.4	34.1	12.2	18.8	9.4	
37	1	70	218	190	252	140	.1	8.0	25.0	21.8	28.9	16.1	
38	2	268	314	160	95	32	.2	30.8	36.1	18.4	10.9	3.7	
39	2	36	50	165	290	328	.2	4.1	5.7	18.9	33.3	37.7	
40	3	172	135	127	223	211	.3	19.7	15.5	14.6	25.6	24.2	
41	1	43	107	82	231	407	.1	4.9	12.3	9.4	26.5	46.7	
42	3	274	319	117	119	39	.3	31.5	36.6	13.4	13.7	4.5	
43	1	320	231	226	49	44	.1	36.7	26.5	25.9	5.6	5.1	
44	1	73	182	147	272	196	.1	8.4	20.9	16.9	31.2	22.5	

TABLE III (continued)

Item	Absolute Numbers						Percentages						Dmax
	0	1	2	3	4	5	0	1	2	3	4	5	
45	2	141	272	244	135	77	.2	16.2	31.2	28.0	15.5	8.8	
46	2	212	232	305	81	39	.2	24.3	26.6	35.0	9.3	4.5	
47	3	374	320	71	73	30	.3	42.9	36.7	8.2	8.4	3.4	
48	1	97	147	84	268	274	.1	11.1	16.9	9.6	30.8	31.5	
49	0	74	211	347	160	79	.0	8.5	24.2	39.8	18.4	9.1	
50	2	52	125	322	173	197	.2	6.0	14.4	37.0	19.9	22.6	
51	1	233	443	92	78	24	.1	26.8	50.9	10.6	9.0	2.8	
52	0	333	279	145	76	38	.0	38.2	32.0	16.6	8.7	4.4	
53	2	144	309	131	193	92	.2	16.5	35.5	15.0	22.2	10.6	
54	4	364	101	158	90	154	.5	41.8	11.6	18.1	10.3	17.7	
55	4	84	151	313	176	143	.5	9.6	17.3	35.9	20.2	16.4	
56	4	411	282	79	69	26	.5	47.2	32.4	9.1	7.9	3.0	
57	3	101	208	328	130	101	.3	11.6	23.9	37.7	14.9	11.6	
58	0	197	209	166	179	120	.0	22.6	24.0	19.1	20.6	13.8	
59	1	186	252	230	144	58	.1	21.4	28.9	26.4	16.5	6.7	

TABLE III (continued)

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
60	0	131	113	162	129	336	.0	15.0	13.0	18.6	14.8	38.6	
61	6	254	241	95	146	129	.7	29.2	27.7	10.9	16.8	14.8	
62	3	85	191	180	183	229	.3	9.8	21.9	20.7	21.0	26.3	
63	6	225	316	206	90	28	.7	25.8	36.3	23.7	10.3	3.2	
64	12	174	232	220	120	113	1.4	20.0	26.6	25.3	13.8	13.0	

Note: Choice distributions (absolute and percentages) of responses for items 1-64 of questionnaire "Grade XII Physics: Why Take It? Why Not?" for 871 subjects.
Data of print-out 1.
Dmax for each item 1-29 inclusive.
Dmax for .01 level of significance is .055

Ib and Ic apply to this section. Null hypothesis I was derived from the sub-questions Ia, Ib and Ic.

> H_oI. For the choices (true, false, don't know) of the 871 subjects to items 1-15 inclusive of the instrument, there is no difference in the expected percentage of responses for each of the three choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3$
>
> H_iI. The percentages of responses for each of the three choices are not all equal.

The hypothesis was tested by the application of the Kolmogorov-Smirnov one-sample, two-tailed test. The D_{max} for significance at the .01 level of probability was calculated to be .055 for each of the items 1-15 inclusive. All values of D_{max} (see Table III) were greater than this value and the null hypothesis was rejected and the alternative hypothesis was accepted for the choice distributions and percentages of responses for items 1-15 of the questionnaire.

> Sub-Question Ia. What reasons related to career are selected by Grade XII students 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 as reported

in Table III. Though 46.3% of the sample population had credit in, or were enrolled in, Grade XII physics, only 32.6% felt they needed it for enrollment in university, and 35.8% felt that they needed it for their further education. A surprising 25.8% agreed that they needed physics for enrollment in an Institute of Technology. It seems likely that some of the subjects agreed both that they needed physics for enrollment in university and for an Institute of Technology, due to some lack of firmness in their future educational plans. Reference to item 29, Table IV (page 62), shows that 62.6% of Grade XII physics students were enrolled in the subject because of vague career plans, hoping to keep alternatives open. There appear to have been very few subjects with credit in, or who were enrolled in, Grade XII physics who did not associate this with a career reason.

Summary, Sub-question Ia. What reasons, related to career, are likely to be selected by a typical Grade XII student, for enrollment or non-enrollment in physics? The student enrolled in physics would be most likely to need it for further education, probably university or Institute of Technology. The student would be very

unlikely to be enrolled in physics without having a career reason in mind.

> Sub-Question Ib. What have the students been told about physics, and about its relationships to the other sciences?

This sub-question is related to the responses to items 5, 6, 7, 11, 12 and 13 of the questionnaire, as reported in Table III. Only 23.8% of the subjects had been told that physics is a subject for boys, but 67.7% had been told that physics is a very difficult subject. Students not confident in their intellectual powers were not being encouraged to attempt physics. And 69.2% of the subjects had been told that they needed to be good in mathematics to be good in physics. It is perhaps surprising to see that while 53.5% of students had been told that chemistry goes with biology, only 41.1% had been told that chemistry goes with physics. Only 6.2% of the subjects were told that biology goes with physics.

Summary, Sub-question Ib. What has a typical Grade XII student been told about physics and its relationships to the other sciences? The student is highly likely to have been told that physics is a difficult

subject, that he needs to be good in mathematics to be good in it, and that chemistry goes best with biology. The student is very unlikely to have been told that physics goes with biology, or that it is a subject for boys.

Sub-Question Ic. What counselling advice has been given students regarding enrollment in high school sciences?

This sub-question relates to the responses to items 8, 9, 10 and 14 of the questionnaire as reported in Table III. The very considerable number of 64.6% of students reported that the junior high counsellor left the choice of high school sciences to their clients. Twenty-three point seven percent of subjects reported that their junior high counsellor advised them to take Physics 10, while the smaller number, 16.8%, reported that their high school counsellor had advised them to take Physics 10. Although the matriculation diploma from high school was discontinued more than 12 years ago in Alberta, 76.6% of students reported that they had been told that they needed two sciences for "matric." Some faculties and schools of some universities and

colleges specify two sciences as part of their entrance requirements, but in general item 14 is an untrue or at least imprecise statement. Yet 76.6% of students say they have been told this.

Summary of Sub-question Ic. What counselling regarding high school sciences has a typical Grade XII student received? The student is most likely to have been allowed to make up his own mind about his selection of high school science. The student is unlikely to have been advised by his junior high counsellor, and less likely to have been advised by his senior high counsellor, to take physics in high school. The student is highly likely to have been incorrectly advised that he needs two high school sciences for "matric."

Null Hypotheses II and III. The absolute and percentage choice distributions of students responding "true" (yes), "false" (no), and "don't know" for items 16-29 inclusive of the questionnaire are presented in Table IV, which was derived from Table III. Table III gives absolute and percentage choice distributions of

TABLE IV

PARTIAL POPULATION CHOICE DISTRIBUTIONS,
RELATED TO SUB-QUESTIONS Id, Ie, If, Ig

	Absolute Numbers			Percentages				
Item	1	2	3	1	2	3	D_{max}	D_{max} for .01 sig.
16	105	159	29	35.8	34.2	9.8	.234	.085
17	205	70	18	69.9	23.9	6.1	.366	.095
18	97	156	24	35.0	56.3	8.6	.282	.098
19	213	380	18	34.8	62.2	2.9	.304	.066
20	178	366	53	29.8	61.3	8.9	.245	.067
21	91	451	51	15.3	76.0	8.2	.247	.067
22	279	271	44	47.0	45.6	7.4	.260	.067
23	247	279	65	41.8	47.2	11.0	.224	.067
24	403	200	0	66.8	33.2	0.0	.335	.066
25	79	120	14	37.1	56.3	6.6	.268	.112
26	24	155	33	11.3	73.1	15.6	.220	.112
27	223	114	28	61.1	31.2	7.7	.278	.085
28	76	255	26	21.3	71.4	7.3	.261	.086
29	219	113	18	62.6	32.3	5.1	.293	.087

Note: Choice distributions (absolute and percentages) of responses for items 16-29 of questionnaire "Grade XII Physics: Why Take It? Why Not?" for various numbers of subjects responding "yes," "no," "don't know."
Data of print-out I.
D_{max} for each item.
D_{max} for .01 level of significance

students responding "no response," "true" (yes), "false" (no), and "don't know" for items 16-29 inclusive. However, the only item for which the "no response" category was needed was item 24. In all the other cases, items 16-29 inclusive, it was only necessary to deal with the sub-groups of "yes," "no" and "don't know." Sub-questions Id, Ie, If and Ig apply to this section. Null hypothesis II and null hypothesis III are derived from the sub-questions.

> H_oII. For the choices (no response, true, false, don't know) of the 871 subjects to item 24 of the instrument, there is no difference among the expected percentages of responses for each of the four choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3 = f_4$
>
> H_iII. The percentages of responses for each of the four choices are not all equal.
>
> H_oIII. For the choices (true, false, don't know) of the varying numbers of subjects to items 16-29 inclusive of the instrument, there is no difference among the expected percentages of responses for each of the three choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3$
>
> H_iIII. The percentages for responses for each of the three choices are not all equal.

Null hypothesis II was tested by the application of the Kalmogorov-Smirnov one-sample, two-tailed test to the cumulative percentages of "no response," "true" (yes), "false" (no), and "don't know" responses for item 24 (Table III). The D_{max} was calculated to be .055 for significance at the .01 level of probability. The D_{max} for item 24 was calculated to be .251 (Table III) and the null hypothesis was rejected and the alternative hypothesis was accepted.

Null hypothesis III was tested by the application of the Kalmogorov-Smirnov one-sample, two-tailed test to the cumulative percentages of "true" (yes), "false" (no), and "don't know" responses for items 16-29 inclusive (Table IV). The D_{max} for significance at the .01 level of probability was calculated for each item, as was the actual D_{max}, and is shown in Table IV. For all items 16-29 inclusive each D_{max} is greater than the D_{max} for .01 significance and the null hypothesis was rejected and the alternative hypothesis accepted.

Sub-Question Id. What reasons for their decision do students select who did not gain credit in Physics 10?

The reasons for decision are related to the responses to items 16, 17 and 18 of the questionnaire, reported in Table IV. From Table III, item 15, it is shown that 279 students, that is 32.0%, reported not receiving credit in Physics 10. Not receiving credit usually means that the student has never enrolled in the course, though for a few it might mean that they obtained so low a mark that credit could not be obtained. The most popular reason selected for no credit in Physics 10 was not needing the subject for one's career. Of the 279 students, 69.9% selected this response. The other two reasons selected, needing biology or chemistry and deciding not to take physics, each received approximately 35% of the choices.

Summary, Sub-question Id. What reason would a typical student select for not gaining credit in Physics 10? The most likely reason selected would be not needing physics for his career. The student would be unlikely to advance the need for chemistry or biology as a reason for not taking physics.

Sub-Question Ie. What reasons for the decision to take Physics 10 were selected by those students who obtained credit in Physics 10?

This sub-question relates to the responses to items 19, 20, 21, 22 and 23 of the questionnaire as reported in Table IV. Of the total of 871 subjects, 588 (67.5%) (Item 15, Table III) signified that they had credit in Physics 10. These students were reporting on the situation as they saw it in the 1968-69 school year. The most popular reason selected for taking Physics 10 was, with 47.0%, "I thought I needed it for my career." Next in popularity with 41.8% was "I took Physics 10, though I didn't need it for my career." More interesting, perhaps, was third choice with 34.8% of "I had no choice, I had to take Physics 10." The 29.8% of students who said, "Biology didn't appeal to me, so I took Physics 10" is next. The absolute number, 178, of those responding "yes" to the latter item might indicate that relatively few students turn to physics because of a dislike for biology. The smallest percentage, 15.3, took physics as an interim measure because they could not enroll in the science of their choice in their first high school year.

Summary, Sub-question Ie. What reasons for this decision to take Physics 10 would be selected by a typical student? The student would be most likely to select need for physics in his career. He would be less likely to have taken physics because he had been forced to, or because he rejected biology or chemistry.

Sub-Question If. What reasons for their decision were selected by students who did not take Grade XII physics, though they had the prerequisites?

This sub-question relates to the responses to items 24, 25 and 26 of the questionnaire as reported in Table IV. Five hundred and eighty-eight of the subjects indicated that they had credit in Physics 10 (item 15, Table III). However, 403 subjects indicated enrollment in, or credit in, Grade XII physics. Why did 31% of the students who obtained credit in Physics 10 reject physics in Grade XII? The most popular reason selected was "I don't have room in my timetable for Physics" with 37.1%, followed by "I dropped Physics when the universities changed their entrance requirements in some faculties and schools from six courses to five" with 11.3%.

Summary, Sub-question If. What reasons would a typical student be likely to select for not taking physics, though they had the prerequisites? The typical student would be likely to select not having room in their timetable, over dropping physics due to university entrance requirement changes, but not either of these reasons appear to be the primary ones.

> Sub-question Ig. What reasons for their decision were selected by students who elected to enroll in Grade XII physics?

This sub-question relates to the responses to items 27, 28 and 29 of the questionnaire, as reported in Table IV. The most popular reason selected was "I'm taking Physics because my career plans are vague, and I want to keep as many doors open as possible," with 62.6% of the 403 subjects agreeing. Almost equally popular was, with 61.1%, "I'm taking Physics because I have the prerequisites." Last in popularity, with 21.3% "yes," was "I'm taking Physics to fill out my timetable."

Summary, Sub-question Ig. What reasons would a typical student be likely to select for enrolling in Grade XII Physics? The student would be most likely to be enrolled in Grade XII Physics for career reasons (keeping future educational alternatives open), and because he had the prerequisites. He is unlikely to be, but could be enrolled purely for the credits--to fill out his timetable.

Question II

> What are the affective reasons, as related to attitudes, perceived by Grade XII students for enrolling or not enrolling in Grade XII Physics?

Null Hypothesis IV. The absolute and percentage choice distribution of students responding "agree strongly," "agree mildly," "cannot decide," "disagree mildly," "disagree strongly" for items 30-64 inclusive are presented in Table III (page 52). These choice distributions were re-grouped by attitude object and are presented in re-grouped form in Table V. (The questionnaire statements, re-grouped by attitude object, are presented in Appendix B.) These data are from computer print-out I. Sub-question IIa applies to this

TABLE V

WHOLE POPULATION CHOICE DISTRIBUTIONS, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIa

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
Attitudes Toward Physics (Average D_{max} .173)													
30	11	244	462	75	64	15	1.3	28.0	53.0	8.6	7.3	1.7	.410
34	1	114	324	153	162	117	.1	13.1	37.2	17.6	18.6	13.4	.103
35	1	211	255	174	148	82	.1	24.2	29.3	20.0	17.0	9.4	.135
37	1	70	218	190	252	140	.1	8.0	25.0	21.8	28.9	16.1	.120
45	2	141	272	244	135	77	.2	16.2	31.2	28.0	15.5	8.8	.154
46	2	212	232	305	81	39	.2	24.3	26.6	35.0	9.3	4.5	.259
54	4	364	101	158	90	154	.5	41.8	11.6	18.1	10.3	17.7	.134
55	4	84	151	313	176	143	.5	9.6	17.3	35.9	20.2	16.4	.131
60	0	131	113	162	129	336	.0	15.0	13.0	18.6	14.8	38.6	.186
62	3	85	191	180	183	229	.3	9.8	21.9	20.7	21.0	26.3	.102
Attitudes Toward Science Teaching (Average D_{max} .273)													
31	1	622	144	36	48	20	.1	71.4	16.5	4.1	6.5	2.3	.514
33	2	70	140	88	214	357	.2	8.0	16.1	10.1	24.6	41.0	.258
36	1	221	297	106	164	82	.1	25.4	34.1	12.2	18.8	9.4	.195

TABLE V (continued)

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
38	2	268	314	160	95	32	.2	30.8	36.1	18.4	10.9	3.7	.254
41	1	43	107	82	231	407	.1	4.9	12.3	9.4	26.5	46.7	.334
42	3	274	319	117	119	39	.3	31.5	36.6	13.4	13.7	4.5	.281
48	1	97	147	84	268	274	.1	11.1	16.9	9.6	30.8	31.5	.224
49	0	74	211	347	160	79	.0	8.5	24.2	39.8	18.4	9.1	.125
51	1	233	443	92	78	24	.1	26.8	50.9	10.6	9.0	2.8	.377
61	6	254	241	95	146	129	.7	29.2	27.7	10.9	16.8	14.8	.169
Attitudes Toward Science Teachers (Average D_{max} .248)													
32	2	67	100	172	235	295	.2	7.7	11.5	19.7	27.0	33.9	.171
43	1	320	231	226	49	44	.1	36.7	26.5	25.9	5.6	5.1	.291
44	1	73	182	147	272	196	.1	8.4	20.9	16.9	31.2	22.5	.138
47	3	374	320	71	73	30	.3	42.9	36.7	8.2	8.4	3.4	.396
52	0	333	279	145	76	38	.0	38.2	32.0	16.6	8.7	4.4	.302
53	2	144	309	131	193	92	.2	16.5	35.5	15.0	22.2	10.6	.120
56	4	411	282	79	69	26	.5	47.2	32.4	9.1	7.9	3.0	.396
59	1	186	252	230	144	58	.1	21.4	28.9	26.4	16.5	6.7	.167

TABLE V (continued)

Item	Absolute Numbers						Percentages						D_{max}
	0	1	2	3	4	5	0	1	2	3	4	5	
Attitudes Toward Junior High Science (Average D_{max} .169)													
39	2	36	50	165	290	328	.2	4.1	5.7	18.9	33.3	37.7	.313
40	3	172	135	127	223	211	.3	19.7	15.5	14.6	25.6	24.2	.102
50	2	52	125	322	173	197	.2	6.0	14.4	37.0	19.9	22.6	.196
57	3	101	208	328	130	101	.3	11.6	23.9	37.7	14.9	11.6	.132
58	0	197	209	166	179	120	.0	22.6	24.0	19.1	20.6	13.8	.066
63	6	225	316	206	90	28	.7	25.8	36.3	23.7	10.3	3.2	.258
64	12	174	232	220	120	113	1.4	20.0	26.6	25.3	13.8	13.0	.119

Note: Choice distributions (Absolute and Percentages) of responses for items 30-64 of questionnaire "Grade XII Physics: Why Take It? Why Not?" for 871 subjects, grouped by attitude object.
Data of print-out 1.
D_{max} for each item
Average Dmax for items related to each attitude object
D_{max} for .01 significance of response distributions is .055

section. Null hypothesis IV was derived from sub-question IIa.

> H_oIV. For the choices (agree strongly, agree mildly, cannot decide, disagree mildly, disagree strongly) of the 871 subjects to items 30-64 inclusive of the instrument, there is no difference among the expected percentages of responses for each of the five choices, and any observed differences are merely chance variations to be expected in a random sample from the rectangular population where $f_1 = f_2 = f_3 = f_4 = f_5$.
>
> H_iIV. The percentages of responses for each of the five choices are not all equal.

Null hypothesis IV was tested by the application of the Kalmagorov-Smirnov one-sample, two-tailed test to the cumulative percentage of "agree strongly," "agree mildly," "cannot decide," "disagree mildly," "disagree strongly" responses for items 30-64 inclusive. The D_{max} for significance at the .01 level of probability was calculated for the 35 items (the same for all) and was found to be .055. The D_{max} for each item was calculated and these are shown in Table V. For all items 30-64 inclusive each D_{max} was found to be greater than .055, and thus the null hypothesis was rejected and the alternative hypothesis accepted.

Sub-question IIa. What are the attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the group of all subjects surveyed?

This sub-question does not relate directly to the attitude reasons selected by students who do or do not enroll in Grade XII Physics. However, detailed analysis reveals the attitudes held in common by all students surveyed. The detailed analysis is reported in Appendix E. The summary of the attitudes of a typical Grade XII student is based on the detailed analysis. Readers wishing to verify the basis for statements in the summary are referred to the detailed analysis and to Table V (page 70).

The D_{max}'s for the items related to attitudes toward physics, toward science teaching, toward science teachers, and toward junior high school science experiences were averaged for each attitude object, and are presented in Table V. The largest average D_{max} (.273) was found for the attitude toward science teaching. This may be interpreted to mean that the greatest unanimity of attitude among the entire subject

population was toward this attitude object. This was confirmed by an examination of Table XIV (Appendix D) (significant choice distributions by variables and attitude object) which shows that there are fewer significant differences between groups who are identified by this attitude object than for the groups identified for the other three attitude objects. That is to say, there are fewer identifiable groups (or more unanimity of attitude in the whole group of 871) for attitudes toward science teaching than toward the other three attitude objects.

The average D_{max} for attitudes toward science teachers was found to be .248, also high. This attitude object also had few identifiable groups by variable (Table XIV, Appendix D) and hence a high unanimity of attitude among the total subject population of 871.

The average D_{max} for attitudes toward physics was found to be .173, indicating a low unanimity of attitude in the subject population. This was confirmed by the large number of significantly different groups by variable identified by Table XIV (Appendix D).

The lowest average D_{max} was found to be .169 for attitudes toward junior high school science experiences, indicating least unanimity of attitude toward this attitude object. This was confirmed by the large number of significantly different groups by variable revealed by Table XIV (Appendix D).

To summarize, students have the greatest unanimity of opinion and are most strongly polarized in their attitudes toward science teachers and toward science teaching. They are much less strongly polarized, and have more diversity of opinion toward physics and junior high school science experiences.

Summary, Attitudes Toward Physics. What would be the attitudes of a fairly typical Grade XII student toward physics? He would likely be strongly convinced that he needs to be good in mathematics to be good in physics, that chemistry goes best with biology and that there is little connection between physics and his choice of career. The fictional student would be likely to feel strongly that biology is more appealing than physics, and that physics is mostly a bunch of formulas.

He would probably be convinced that physics is slanted toward boys and is one of the most difficult subjects. He might or might not be sure that physics deals with things the average person needs to know, or whether the most interesting part of the subject is the problem solving, but he would be likely to feel that a person need not have studied physics to be well educated.

Summary, Attitudes Toward Science Teaching. What would a fairly typical student feel about science teaching? He would believe strongly that you have to know science to teach it well, and that writing notes on the board is poor instructional practice, as is a lecture approach. He would be more likely to be ambivalent toward demonstrations as compared to experiments and to a ray diagram approach to teaching optics. He would feel strongly that his science courses ought to prepare him for a career, that they have enough experiments, and that the labs seem to relate to the course. Though he would be likely to think that one ought to go on field trips often, he might disagree, or have no opinion. He would be more likely than not to agree

that Grade XII teachers ought to teach for finals most of the year.

Summary, Attitudes Toward the Science Teacher. What expectation would a typical student have of his science teacher? He would have a strong expectation that the science teacher will attempt to get students involved in the subject, and that he will have the skill and patience (and depth of knowledge) to explain his subject matter simply. The science teacher would be expected to be approachable without showing favoritism, humble (remembering his own lack of knowledge at one time), not strict in class but probably forceful and thorough. The student would likely have strong expectations that the science teacher have a sense of humor and be enthusiastic about the laboratory work.

Summary, Attitudes Toward Junior High School Science Experiences. What attitudes would the typical Grade XII student have toward his junior high school science experiences of 4, 5 and 6 years before? As might be expected, his attitudes here would be less well defined (remembered). Our fictitious student's

memory of the style of Grade IX instruction, while poor, would most likely be to agree that it was mostly arid, "read the chapter and made notes," though this does not seem to have determined whether he took physics or not. Our typical student, not surprisingly, would not feel that there was any too much laboratory work in junior high; as a matter of fact he would feel that the best part of junior high science was working with apparatus. He would be slightly more likely to have found Grade VIII science, including the study of rocks, more fun than he found Grade VIII English. He would be slightly more likely to have found the study of internal combustion engines in Grade IX more interesting than boring, but this depends on which of 10 pairs of groups we might find him in. Finally, he would be more likely to have found Grade VII plant study interesting than not, though this also depends on which group he would find himself in, in his selections from Part A of the questionnaire.

Null Hypothesis V. Tables VI, VII, VIII, IX, X, XI and XII present the significant percentage choice

distributions of items 30-64 inclusive for each of the 32 pairs of variables, grouped by attitude object. The 32 pairs of variables are derived from the "yes"-"no" responses to items 1-29 of the questionnaire, the "yes"-"no response" to item 24, the "no"-"no response" to item 24, and the female/male responses. These data are the data of print-outs II and III. Tables VI, VII, VIII, IX, X, XI and XII are a re-organization of Table XIII of Appendix C. Table XIII shows the same data as in Tables VI-XII inclusive, though the percentage distributions are for items in numerical order, rather than grouped by attitude object. Table XIII (Appendix C) also lists pairs of percentage distributions found significant at the .05 level, for the reference of readers who wish to use this level of significance. The analysis of data is confined to pairs of percentage distributions significant at the .01 probability level or less.

Sub-questions IIb, IIc, IId, IIe, IIf and IIg apply to this section. Null hypotheses 5-1124 (represented by the example of the 496th null hypothesis) are represented in form by null hypothesis V.

H_oV. The percentages of students having credit in Physics 10 (item 15 "yes") who agree strongly, agree mildly, cannot decide, disagree mildly, disagree strongly with the statement (item 30) "You have to be good in Mathematics to be good in Physics" is the same as the percentages of students not having credit in Physics 10 who agree strongly, agree mildly, cannot decide, disagree mildly, or disagree strongly with the statement (item 30) "You have to be good in Mathematics to be good in Physics," and any observed differences are merely chance variations.

H_iV. The percentage of students having credit in Physics 10 (item 15 "yes") who agree that "You have to be good in Mathematics to be good in Physics" (item 30) is significantly greater (at the .01 or .05 level) than the percentage of students not having credit in Physics 10 who agree that "You have to be good in Mathematics to be good in Physics" (Item 30).

Null hypotheses 5-1124 as represented in example form by H_oV were tested by the application of the Kalmogorov-Smirnov two-sample, one-tailed test to the cumulative percentage choice distribution of each of the 35 pairs of attitude statements (items 30-64 inclusive) for each pair of "yes-no" choice distributions for items 1-29 inclusive. The test was also applied to the cumulative percentage choice distributions for each of the 35 pairs of attitude statements for each pair of "yes-no response" and "no-no response" choice distributions for item 24. The test was also applied to the

cumulative percentage choice distributions of each of the 35 pairs of attitude statements for each pair of the "female/male" choice distributions.

The application of the test described in the preceding paragraph yielded a D_{max} for each pair of the 32 pairs of variables (choice distributions) for significance at the .01 level of probability and at the .05 level of probability. These are listed by variable in Table XIII (Appendix C). Only the D_{max}'s for .01 probability are listed by variable in Tables VI-XII. The actual D_{max} for each of the 1120 pairs of cumulative percentage distributions was calculated. For pairs of cumulative percentage distributions in which the D_{max} exceeded the D_{max} for .01 probability, the null hypotheses were rejected at the .01 level and these pairs of percentage choice distributions as well as the calculated D_{max} were listed in Tables VI-XII inclusive, and in Table XIII, Appendix C. For pairs of cumulative percentage distributions in which the D_{max} exceeded the D_{max} calculated for .05 probability (but not as great as .01) the null hypothesis was rejected at this (.05) level of probability and the pairs of percentage

choice distributions together with the calculated D_{max} were listed in Table XIII, Appendix C.

The reader will note that the D_{max}'s calculated for the pairs of percentage distributions and shown in Tables VII-XII inclusive (and in Table XIII, Appendix C) are signed. A positive sign for D_{max} for a pair of cumulative percentage distributions indicates that the maximum deviation (difference) between the cumulative percentages of the distributions is such that the cumulative percentage on the left exceeds the corresponding cumulative percentage on the right. This means that the subjects answering "true" (or yes) to one of the items 1-29 (or "no" to item 24c, or the females) have a greater percentage of agreement (or less disagreement) than the subjects answering "false" (or no) to the same item (or "no response" to item 24b or c, or the males). Such an example would be null hypothesis number 496 which refers to variable 15 and item 30 (Table IX, page 111).

From Table IX, the D_{max} for .01 significance was .110, and the D_{max} for the two groups (left--"I have credit in Physics 10" - "yes," right--"I have

credit in Physics 10" - "no") is +.113. This may be interpreted to mean the group of 588 subjects who responded "yes" to "I have credit in Physics 10" (item 15) agree more (or disagree less) with the statement "You have to be good in Mathematics to be good in Physics" (item 30) than the group of 279 subjects who responded "no" to the statement "I have credit in Physics 10." The difference in cumulative percentage of agreement has a probability of less than .01 of being due to chance. The actual figures are: 84.8% of those having credit in Physics 10 agree with the statement "You have to be good in Mathematics to be good in Physics" as compared to 73.5% of those not having credit in Physics 10 who agree with the statement. Both groups agree with Item 30, but one group has a significantly higher percentage of subjects agreeing than the other.

The array of 1120 null hypotheses has been illustrated in Table XIV, Appendix D, where null hypotheses rejected at the .01 level of probability or better have been indicated by a double asterisk, **, and null

hypotheses rejected at the .05 (up to .01) level of probability have been identified by a single asterisk, *. By grouping the attitude items according to attitude object, the unanimity of the groups responding to items related to science teachers and teaching and the lack of unanimity (more significantly different groups) of groups responding to items related to physics and junior high science experiences is graphically clarified.

> Sub-question IIb. What are the differences in attitude toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who did or did not see a need for physics in their career?

This question is related to variables 1, 2, 3 and 4 of Table VI. Detailed analysis will be found in Appendix E. Variables 1 and 3 produced the largest number of significantly different pairs of percentage distributions, mainly in response to statements about physics. Moreover, variable 1 ("I don't need physics for enrollment in a university") and variable 3 ("I don't need physics for my further education") showed significantly different percentage distributions on identical items in attitude toward physics and in

TABLE VI

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIb

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 1. D_{max} .114 "I don't need physics for enrollment in university."											
(a) Attitude Object Physics											
35	26.6	29.3	23.1	14.3	6.4	21.8	29.6	11.6	21.1	15.8	+.160
37	5.1	21.2	24.0	30.8	18.6	14.8	31.2	12.0	29.2	12.7	-.198
45	15.4	29.6	35.1	13.9	5.8	19.4	36.3	12.0	18.7	13.4	+.124
46	28.3	29.3	30.2	8.6	3.2	21.5	21.8	38.4	10.9	7.4	+.143
54	56.1	12.8	12.4	7.9	10.5	21.1	10.2	22.2	14.4	31.0	+.376
55	6.6	12.4	44.5	18.6	17.6	15.5	26.8	17.3	22.9	16.5	-.233
60	7.7	7.3	15.2	16.7	53.1	29.6	22.5	20.1	12.7	15.1	-.420
62	6.6	20.1	18.2	22.7	32.1	16.9	27.1	22.9	17.6	14.8	-.220
(b) Attitude Object Science Teacher											
43	41.5	25.1	23.6	6.0	3.9	28.9	27.8	31.0	5.3	6.7	+.126
56	52.7	27.8	7.3	9.4	2.4	41.2	37.0	10.9	6.0	4.2	+.115

TABLE VI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(c) Attitude Object Junior High Science											
40	22.7	17.3	14.1	25.9	19.3	13.4	11.6	15.8	26.8	32.4	+.150
64	23.3	28.7	23.3	13.3	10.3	15.8	19.0	28.9	15.1	19.4	+.172
Variable 2. D_{max} .127 "I need physics for enrollment in an Institute of Technology."											
(a) Attitude Object Physics											
37	13.2	30.5	20.0	22.3	13.6	7.0	23.3	20.4	30.5	18.9	+.134
54	39.1	8.2	19.1	10.0	27.7	46.5	12.9	17.7	9.8	12.5	-.171
60	27.3	20.5	11.8	13.6	26.8	10.3	9.1	18.7	15.8	46.0	+.284
62	14.1	25.5	23.2	17.7	19.5	7.7	19.4	21.1	20.1	31.4	+.146
(b) Attitude Object Junior High Science											
39	5.9	5.5	23.6	37.3	27.3	4.1	7.4	17.5	30.2	40.5	+.131

TABLE VI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 3. D_{max} .114 "I don't need physics for enrollment in university."											
(a) Attitude Object Physics											
35	26.6	29.3	23.1	14.3	6.4	21.8	29.6	11.6	21.1	15.8	+.160
37	5.1	21.2	24.0	30.8	18.6	14.8	31.2	12.0	29.2	12.7	-.198
45	15.4	29.6	35.1	13.9	5.8	19.4	36.3	12.0	18.7	13.4	+.124
46	28.3	29.3	30.2	8.6	3.2	21.5	21.8	38.4	10.9	7.4	+.143
54	56.1	12.8	12.4	7.9	10.5	21.1	10.2	22.2	14.4	31.0	+.376
55	6.6	12.4	44.5	18.6	17.6	15.5	26.8	17.3	22.9	16.5	-.233
60	7.7	7.3	15.2	16.7	53.1	29.6	22.5	20.1	12.7	15.1	-.420
62	6.6	20.1	18.2	22.7	32.1	16.9	27.1	22.9	17.6	14.8	-.220
(b) Attitude Object Science Teaching											
38	31.9	39.6	15.7	9.2	3.2	28.8	30.8	21.5	14.1	4.8	+.119
48	10.6	15.1	9.0	25.9	36.3	11.9	18.9	9.3	34.9	25.0	-.114
(c) Attitude Object Science Teacher											
40	23.7	18.1	13.7	24.7	19.3	13.1	11.2	15.1	28.5	32.1	+.175
64	23.3	30.5	21.7	12.9	9.8	15.1	19.9	31.1	16.0	17.0	+.188

TABLE VI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 4. D_{max} .113 "I need physics for my choice of career."											
(a) Attitude Object Physics											
35	17.0	29.6	15.9	21.9	15.6	28.0	29.3	22.6	13.2	6.7	-.174
37	18.9	30.4	14.1	24.4	12.2	3.2	21.8	24.4	32.3	18.1	+.243
54	27.8	7.4	17.4	15.2	31.5	51.3	12.9	16.6	8.0	10.8	-.290
55	15.2	28.1	18.9	23.7	13.3	7.3	12.1	44.0	18.8	17.4	+.239
60	38.1	24.1	13.0	12.2	12.6	5.2	7.1	16.8	16.4	54.5	+.499
62	18.5	27.8	20.4	19.3	14.1	6.2	18.1	20.0	22.4	32.8	+.224
(b) Attitude Object Junior High Science											
40	13.7	14.8	14.4	24.4	32.6	23.5	16.6	13.8	25.6	20.0	-.122

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 4 pairs of variables.
Data of print-outs II
All pairs of distribution percentages significant at .01 level of probability, or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

attitudes toward junior high school science experiences. Variable 1 showed no significant differences in percentage distributions in attitudes toward science teaching, but showed two significant pairs of percentage distributions in attitudes toward the science teacher. Variable 3 reversed this, with no significantly different groups in attitudes toward the science teacher and with two pairs of significantly different attitudes toward science teaching. A suggestion is that most students responding equated university enrollment with their further education.

Variable 2 produced five significantly different pairs of percentage distributions, four with reference to physics, one pair with reference to junior high school science experiences. Significantly different pairs of percentage distributions were shown by each of the four variables for the same four attitude items (37, 54, 60, 62), and with reference to physics.

> Summary, Sub-question II-b. What would be the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of two typical students, one of whom needed physics for career or further education and one who did not?

Both students would likely differ more in their attitudes toward physics, and toward their junior high science experiences, than toward science teaching or teachers. Toward physics, the student needing physics would find biology much less appealing and would see a close connection between physics and his career. Both students might not see a need for physics for a good education, with the student not needing physics even less likely to see a need than his counterpart. Similarly, both students would be unlikely to believe physics deals with things the average person needs to know and the student not needing physics would be less likely to believe. The student needing physics would be likely to believe that physics is difficult, and the student not needing physics would be somewhat more likely to feel that way. Both students would likely disagree that the interesting part of physics is the problem solving, with the student not needing physics more likely to disagree. Physics is mostly formulas would be likely to draw agreement from the student needing physics, less agreement and more no opinion from the other. Both students would be likely to say chemistry goes with biology, but the

student needing physics somewhat less likely than his opposite. With reference to science teaching, both students would be likely to approve of field trips, but the student not needing physics would be more likely to approve than the other. Both students would be likely to disagree strongly that demonstrations by the teacher are as useful as student experiments for student learning, but the student needing physics would be not as likely to feel strongly negative.

Both students would be likely to have similar attitudes toward science teachers, agreeing that science teachers need to remember that at one time they did not know any science, though the student needing physics would be slightly less likely to agree than the student not needing physics. Both students would be strongly likely to agree, but the student not needing science slightly more strongly, that the best science teachers explain things simply.

Toward their junior high science experiences the student needing physics is likely to have found the study of the internal combustion engine interesting, but the other student probably would have found it

boring. The student not needing physics would likely have found plant study in Grade VII interesting, and the student needing physics would be only slightly less likely to have found it so. Both would be likely to agree that there was not enough laboratory work in Grade IX, but the student needing physics would not be as likely to be concerned as would the other student.

> Sub-question IIc. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the group who have or have not heard certain statements about physics?

Variables 5, 6, 7, 11, 12, and 13 of Table VII apply to this sub-question. Detailed analysis will be found in Appendix E. Variable 6 (item 6) produced the largest number of significantly different pairs of percentage distributions, mainly in response to statements about physics. Variables 5, 7, 11 and 12 showed significantly different pairs of percentage distributions in response to statements about physics. Variable 13 produced the only pair of percentage distributions in response to statements about the science teacher.

TABLE VII

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIc

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 5. D_{max} .123 "I've been told that physics is a subject for boys."											
(a) Attitude Object Physics											
34	28.0	43.0	13.0	10.1	5.8	8.8	34.8	18.1	21.5	16.7	+.274
Variable 6. D_{max} .115 "I've been told that physics is a very difficult subject."											
(a) Attitude Object Physics											
34	14.9	39.8	17.1	16.1	11.9	10.4	32.8	17.2	23.2	16.4	+.115
35	31.4	31.7	20.7	11.9	4.2	8.0	25.2	17.6	28.4	20.8	+.330
37	6.9	21.4	23.6	30.7	12.5	10.0	33.2	18.0	24.8	13.6	-.149
45	15.6	33.4	30.8	13.9	6.1	17.6	26.8	20.8	18.8	15.6	+.146
54	48.3	11.7	15.9	8.5	15.3	27.6	10.0	22.8	14.0	24.8	+.224
55	7.6	15.4	40.7	19.2	16.8	14.4	21.2	25.2	22.0	16.4	-.126
60	12.0	10.2	20.2	13.6	44.1	21.6	19.6	14.8	18.4	25.6	-.189
62	9.5	19.7	20.7	19.8	30.0	10.8	26.8	20.8	23.6	17.6	-.123

TABLE VII (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(b) Attitude Object Junior High Science											
40	23.6	16.1	12.2	24.7	23.2	10.8	15.6	20.8	26.0	26.4	+.133
64	21.7	29.2	22.2	13.4	11.7	17.2	21.2	33.6	13.6	14.0	+.125
Variable 7. D_{max} .119 "I've been told that you have to be good in mathematics to be good in physics."											
(a) Attitude Object Physics											
30	34.7	53.4	5.3	4.5	1.0	12.2	53.2	14.0	15.8	4.1	+.227
35	27.7	31.2	18.2	15.4	7.5	16.2	24.2	23.4	20.7	15.3	+.185
45	18.2	33.3	25.4	15.3	7.5	11.7	27.0	32.4	16.2	12.6	+.128
Variable 11. D_{max} .107 "I've been told that chemistry goes with physics."											
(a) Attitude Object Physics											
55	9.5	17.0	29.1	24.9	19.3	9.8	16.6	40.7	16.8	15.3	-.115
62	12.8	24.9	18.7	19.8	23.2	7.7	18.8	21.2	22.1	30.0	+.112
Variable 12. D_{max} .108 "I've been told that chemistry goes with biology."											
(a) Attitude Object Physics											
46	36.3	33.3	22.5	4.9	2.8	11.9	18.9	45.3	16.3	7.3	+.388
54	48.7	14.4	15.2	7.5	13.9	37.2	8.7	18.3	13.1	21.8	+.172

TABLE VII (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 13. D_{max} .214 "I've been told that biology goes with physics."											
(a) Attitude Object Science Teacher											
32	18.5	18.5	22.2	20.4	20.4	7.5	11.3	18.7	27.3	34.9	+.217
(b) Attitude Object Junior High Science											
40	18.5	25.9	27.8	16.7	11.1	20.5	14.1	13.2	26.3	25.5	+.244

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 6 pairs of variables.
Data of print-outs II.
All pairs of distribution percentages significant at .01 level of probability, or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

Variables 6 and 13 produced pairs of significantly different percentage distributions in response to attitudes toward junior high school science experiences. There were no differences in the groups' attitudes toward science teaching.

Summary, Sub-question IIc. What differences in attitudes toward physics, science teaching, science teachers, and their junior high science experiences would students be likely to have, depending on whether they had been told positive or negative things about physics?

Generally, the student who has heard negative statements about physics is more likely to have negative feelings about the subject than one who has not.

The student who has been told that physics is a very difficult subject (compared to one not so told) would be more likely to think physics is slanted toward boys, that it is difficult, that it does not deal with things the average person needs to know, that it is mostly a bunch of formulas, that it is less appealing than biology, that the least interesting part of physics is problem solving, that it has little connection with his choice of career, and that it is not necessary for a good education. He would be also likely to feel that studying

internal combustion engines in Grade IX was boring and that plant study in Grade VII was interesting. If the student had been told that he had to be good in mathematics to be good in physics, or that it is a subject that is slanted toward boys, he would be more likely to believe it than the student not so told, and he would be more likely to feel that physics is difficult, and mostly a bunch of formulas. Very few students would likely have been told that biology goes with physics, and if they had they would be more likely to accept humorless science teachers, and to have found studying internal combustion engines interesting. The many students who have been told that chemistry goes with biology would tend to believe this, and also would more likely choose biology over physics. The student who remembered being told that chemistry goes with physics would be more likely to disagree that the most interesting part of physics is problem solving and would be less likely to feel that physics has value in general education.

Sub-question IId. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who have been counselled in differing ways?

Variables 8, 9, 10 and 14 of Table VIII apply to this sub-question. Detailed analysis will be found in Appendix E. Variable 8 (item 8) produced the largest number of significantly different pairs of percentage distributions, mainly in response to statements about physics. Variable 8 produced the only significant pair of percentage distributions applying to the science teacher. Variable 9 produced the only significant pair of percentage distributions applying to science teaching. Variable 14, "I've been told that I need two sciences for 'matric,'" produced no significantly different distributions. No variable of this group produced any significantly different distributions related to junior high science experiences.

Summary, Sub-question IId. What differences in attitudes toward physics, toward science teaching, toward science teachers and toward their junior high school science experiences would students be likely to have depending on their counselling experiences?

TABLE VIII

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IId

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 8. D_{max} .124 "My junior high counsellor advised me to take Physics 10."											
(a) Attitude Object Physics											
45	22.8	38.3	13.1	13.1	12.1	13.9	29.1	33.5	16.0	7.2	+.181
55	10.7	23.3	18.0	21.4	26.2	9.0	15.0	43.2	19.6	13.1	-.152
62	11.7	28.2	19.4	21.4	18.9	7.8	19.2	21.5	21.0	30.3	+.129
(b) Attitude Object Science Teachers											
59	14.1	23.3	29.1	21.4	12.1	23.5	31.7	25.0	14.6	4.9	-.178
Variable 9. D_{max} .117 "My junior high counsellor left the choice of Grade X Science to me."											
(a) Attitude Object Science Teaching											
48	8.5	16.9	8.7	31.3	35.5	15.9	19.2	10.9	26.8	27.2	-.119

TABLE VIII (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 10. D_{max} .140 "My senior high counsellor advised me to take Physics 10."											
(a) Attitude Object Physics											
37	13.7	31.5	8.9	26.7	18.5	6.2	23.1	25.2	29.8	15.7	+.159
Variable 14. D_{max} .130 "I've been told that I need two sciences for 'Matric.'"											
No sig. different groups.											

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 4 pairs of variables.
Data of print-outs II
All pairs of distribution percentages significant at .01 level of probability, or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

The student who had been advised by his junior high counsellor to take Physics 10, compared to those not so advised, would be more likely to feel that physics is mostly a bunch of formulas, that problem solving is not its most interesting part, and that it is a subject that a well educated person ought to have taken. He would be less likely to expect the science teacher to enjoy the laboratories as much as he does. The student who had his choice of Grade X science left up to him, by his junior high counsellor, would be less likely to feel that a student learns more from demonstrations the teacher does than experiments he does himself. The student who was advised by his senior high counsellor to take Physics 10 would be more likely to feel that physics deals with things the average person needs to know than those not so advised. Students told that they need two sciences for "matric" compared to those not so told would likely show no differences in attitudes surveyed by the instrument. The students would be not likely to differ in attitudes toward their junior high school science experiences.

The fewer number of different attitudes between groups exposed by variables related to counselling (sub-question IId) as compared to the great number of attitude differences revealed by responses to what students had been "told" (by students, teachers, parents, etc.) (sub-question IIc) suggests that counselling is less important in attitude development toward physics, science teaching, science teachers and especially junior high science experiences than what students have been "told."

> Sub-question IIe. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who did or did not obtain credit in Physics 10, and who selected various reasons for their decision?

Variables 15, 16, 17 and 18 (Table IX) and variables 19, 20, 21, 22 and 23 (Table X) are related to this sub-question. Data from variable 15 have not been analyzed in detail because the data are similar to those of variables 24b and 24c, which are given detailed analysis later. A summary of the analysis of variable 15 is given here.

TABLE IX

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIe

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 15. D_{max} .110 "I have credit in Physics 10."											
(a) Attitude Object Physics											
30	25.3	59.5	3.6	8.2	2.4	33.7	39.8	19.4	5.4	.4	-.113
35	24.1	31.6	11.4	20.4	12.2	24.4	24.7	38.0	9.3	3.6	-.200
37	10.4	29.4	11.9	32.0	16.2	2.9	16.1	42.7	22.6	15.8	+.208
45	18.5	37.2	12.8	19.2	12.1	11.5	18.3	60.2	7.5	2.2	+.259
54	32.0	10.7	19.1	13.4	24.5	62.7	13.3	16.5	3.6	3.2	-.333
55	12.4	22.6	18.2	25.2	21.1	3.6	5.7	73.5	10.0	6.8	-.296
60	19.9	15.3	17.5	17.3	29.9	5.0	7.9	20.4	9.7	57.0	+.270
62	12.8	26.4	19.7	21.3	19.6	3.2	12.9	22.2	20.8	40.5	+.231
(b) Attitude Object Science Teaching											
48	11.9	16.7	8.7	34.7	27.9	9.7	16.8	11.5	22.9	39.1	+.201
49	10.0	28.2	32.7	19.7	9.4	5.4	16.1	54.5	15.4	8.6	+.167
61	27.4	26.7	9.9	18.9	16.3	33.3	30.1	12.5	12.5	11.1	-.119

TABLE IX (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(c) Attitude Object Science Teacher											
52	33.8	34.2	17.2	9.7	5.1	47.7	28.0	14.7	6.8	2.9	-.139
59	17.0	27.9	27.7	19.0	8.2	30.5	31.5	22.9	11.5	3.6	-.171
(d) Attitude Object Junior High Science Experiences											
40	15.0	15.0	14.3	28.1	27.4	29.4	16.8	14.7	20.8	17.9	-.183
57	9.7	21.3	41.3	15.0	12.6	15.4	29.7	29.7	15.1	9.3	-.141
64	14.1	24.7	28.9	14.8	16.2	32.6	30.8	16.8	11.8	6.5	-.246
Variable 16. D_{max} .191 "I needed biology, so I decided not to take Physics 10."											
(a) Attitude Object Physics											
46	37.1	28.6	28.6	3.8	1.9	14.5	27.7	45.9	8.2	3.1	+.235
54	79.0	11.4	3.8	3.8	1.9	54.1	13.8	24.5	1.9	4.4	+.249
(b) Attitude Object Junior High Science Experiences											
40	39.0	18.1	12.4	18.1	12.4	22.0	15.7	17.6	23.9	20.1	+.194

TABLE IX (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 17.	D_{max} .210 "I didn't take Physics 10 because I didn't need it for my career."										
No sig. different groups.											
Variable 18.	D_{max} .196 "I needed chemistry, so I decided not to take Physics 10."										
(a) Attitude Object Physics											
46	34.0	33.0	25.8	5.2	2.1	14.7	26.9	48.7	6.4	2.6	+.254
(b) Attitude Object Science Teaching											
33	9.3	30.9	9.3	19.6	30.9	6.4	14.1	14.7	19.9	44.2	+.197
61	46.4	23.7	8.2	12.4	9.3	25.6	35.9	14.7	12.8	10.3	+.208

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 4 pairs of variables.
Data of print-outs II
All pairs of distribution percentages significant at .01 level of probability or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

Summary, Sub-question IIe, Variable 15. What significant differences in attitudes toward physics, toward science teaching, toward science teachers and toward their junior high school science experiences would students be likely to have who did or did not obtain credit in Physics 10?

The differences would be more, and more pronounced, relative to physics and to junior high science experiences than toward science teaching or science teachers. Generally, the student who had credit in Physics 10, compared to one who had not, would be more likely to agree; that one has to be good in mathematics to be good in physics; that physics is difficult or not difficult; that physics deals with things the average person needs to know; that physics is mostly a bunch of formulas; that biology is not as appealing as physics; that the most interesting part of physics is or is not the problem solving; that physics has a close connection with his choice of career; and that a well educated person ought to have taken physics. Students with credit in Physics 10 would likely show more agreement, and more disagreement, with item 35 ("Physics is one of the most difficult high school subjects") than students without credit. The students without credit in Physics 10 would select

"don't know" more often. Similarly, students with credit in Physics 10 would both agree more and disagree more with item 55, "The most interesting part of physics is the problem solving," than those not having credit in Physics 10. The reason lies in the percentage of respondents who "didn't know"--73.5%.

The students who had credit in Physics 10, compared to those who did not, would be more likely to agree that you learn more from demonstrations the teacher does than experiments you do yourself, though there is overall disagreement with this item; that a good way to teach optics is to use ray diagrams; and that Grade XII teachers should not teach for finals most of the year.

The students who had credit in Physics 10, compared to those who did not, would be less likely to agree that the science teacher ought to be friendly but not have favorites, and ought to enjoy the science laboratories as much as the students.

Finally, the students who had credit in Physics 10, compared to those who did not, would be less likely to agree that: studying internal combustion engines in Grade IX was boring; the study of rocks in Grade VIII

was enjoyable, and that plant study made Grade VII science interesting.

Attitudes of students without credit in Physics 10. With reference to variables 16, 17 and 18 of Table IX, the groups responding were in fact sub-groups of the group who responded "no" to item 15. That is, they did not have credit in Physics 10, and they differed in their attitudes rather little--only six differing groups in the three variables. Detailed analysis of responses related to sub-question IIe, variables 16, 17, 18, will be found in Appendix E.

> Summary, Sub-question IIe, Variables 16, 17, 18. What would be the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of those respondents who did not obtain credit in Physics 10 and who selected various reasons for their decision?

Generally, their attitudes would be pretty similar; with some exceptions. A subject who took biology in preference to physics would be more likely, than one who did not, to agree that biology appealed more than physics, that chemistry goes best with biology, and that studying internal combustion engines in Grade IX was

boring. There were no significantly different attitudes in those not having credit in Physics 10, who elected or rejected "I didn't need Physics 10 for my career" as a reason. Students who gave needing chemistry as a reason for rejecting physics, as compared to those who rejected this reason, would be more likely to agree that chemistry goes best with biology, that a good method of teaching science is to write notes on the board, and that Grade XII teachers should teach for finals most of the year.

Attitudes of students with credit in Physics 10. With reference to variables 19, 20, 21, 22 and 23 (Table X), the groups responding were sub-groups of the group who responded "yes" to item 15. That is, they had obtained credit in Physics 10 and were asked to respond to various possible reasons for taking Physics 10. They showed more differences in attitude than the sub-group who did not gain credit in Physics 10. Most of the attitude differences were related to physics.

Detailed analysis of responses related to sub-question IIe, variables 19, 20, 21, 22 and 23 (Table X) will be found in Appendix E.

TABLE X

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIe

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 19. D_{max} .123 "I had no choice, I had to take Physics 10."											
(a) Attitude Object Physics											
35	32.4	27.7	13.1	19.2	7.5	19.7	34.2	11.6	19.7	14.5	+.127
54	40.8	12.7	17.4	9.4	19.2	29.2	11.1	17.9	14.7	26.6	+.132
Variable 20. D_{max} .139 "Biology didn't appeal to me, so I took Physics 10."											
(a) Attitude Object Physics											
46	12.9	17.4	46.1	15.2	7.9	33.6	29.5	23.8	8.7	4.4	-.328
54	11.2	6.7	17.4	20.2	43.8	46.2	12.6	17.5	9.6	13.9	-.410
60	26.8	17.4	21.9	14.6	20.2	16.7	15.6	15.0	17.8	35.0	+.178
(b) Attitude Object Science Teaching											
38	20.8	32.6	23.0	17.4	6.2	34.7	35.2	15.8	10.4	3.6	-.165

TABLE X (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(c) Attitude Object Science Teacher											
59	22.5	30.9	21.9	16.3	8.4	14.2	26.5	31.7	20.5	6.8	+.127
Variable 21. D_{max} .174 "I couldn't get biology (or chemistry) until Grade XI, so I took Physics 10."											
(a) Attitude Object Physics											
46	39.6	27.5	22.0	8.8	2.2	23.9	23.7	34.8	11.3	6.0	+.195
54	56.0	17.6	12.1	3.3	1.1	27.3	10.2	20.0	15.5	26.6	+.361
60	7.7	8.8	15.4	20.9	47.3	21.3	17.7	19.3	16.4	25.3	-.264
(b) Attitude Object Junior High Science Experiences											
64	22.0	33.0	26.4	8.8	8.8	11.5	25.1	29.3	16.0	17.1	+.184

TABLE X (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 22. D_{max} .129 "I thought I needed Physics 10 for my career, so I took Physics 10."											
(a) Attitude Object Physics											
37	15.3	34.1	10.0	27.2	12.9	5.5	24.7	14.0	37.3	18.5	+.193
54	25.1	8.6	20.1	16.5	29.4	40.2	12.9	17.3	10.3	18.8	-.194
55	15.8	27.6	13.3	21.1	21.5	10.3	19.2	24.7	26.6	18.8	+.139
60	28.7	22.6	15.4	16.5	16.8	10.7	9.2	19.2	18.1	42.8	+.314
62	17.2	31.9	21.5	17.9	11.1	8.1	20.3	18.1	25.5	27.7	+.241
Variable 23. D_{max} .133 "I took Physics 10, though I didn't need it for my career."											
(a) Attitude Object Physics											
37	6.1	26.7	10.9	38.1	18.2	14.0	31.2	12.2	28.0	14.3	-.137
46	27.1	31.6	27.5	9.7	3.6	24.4	20.8	35.1	12.5	7.2	+.135
54	44.1	14.2	13.4	9.7	18.2	22.9	8.6	22.6	15.8	30.1	+.268
60	7.7	8.1	15.0	18.6	50.6	29.7	22.2	18.3	15.4	14.3	-.394
62	6.5	23.1	16.2	25.1	28.7	16.1	29.4	21.9	19.7	12.5	-.216

TABLE X (continued)

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 5 pairs of variables.
Data of print-outs II
All pairs of distribution percentages significant at .01 level of probability, or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

Summary, Sub-question IIe, Variables 19-23. What would be the likely differences in attitudes of those respondents who earned credit in Physics 10 and who selected or rejected various reasons for their decisions?

Perhaps surprisingly, the subjects who had been forced to take physics would be likely to show a great similarity in attitude to those who had freedom to choose. The student who had to take physics would be more likely to feel that physics is one of the most difficult high school subjects, and that he would find biology more appealing. Subjects who took Physics 10 because biology didn't appeal would be more likely to disagree that chemistry goes with biology, that biology is more appealing than physics, and that one ought to go on field trips often. They would be more likely to agree that they saw a close connection between physics and their choice of career, and that they would expect the science teacher to enjoy the laboratories as much as they did. Those subjects who had to defer chemistry or biology and fill in with physics would be more likely to agree that chemistry goes best with biology, that biology appeals more than physics and that the study of plants in Grade VII was interesting. They would be less

likely to agree that they saw a close connection between physics and their choice of career. Subjects who took Physics 10 because they thought, at the time, that they needed it for their career would be more likely to agree that physics deals with things the average person needs to know, that the most interesting part of physics is the problem solving, that physics has a close connection with their career, and that a well educated person ought to have taken physics. They would be less likely to agree that biology appeals more to them than physics, or that chemistry goes best with biology.

> Sub-question IIf. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who had credit or were enrolled in Grade XII physics or who did not have credit or were not enrolled in Grade XII physics, and who gave various reasons for their decisions?

Variables 24a, 24b, 24c, 25, 26, 27, 28 and 29 of Table XI apply to this sub-question. The group respondents to variable 24a included the subjects enrolled in Grade XII physics, or who had obtained credit in the subject ("yes" to item 24a), and those subjects who, after obtaining credit in Physics 10, had decided not

TABLE XI

CHOICE DISTRIBUTIONS BY VARIABLE, GROUPED BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIf

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 24(a). D_{max} .131 "I have credit, or am now enrolled in, Physics 30, or 30X or 32."											
(a) Attitude Object Physics											
35	21.8	33.3	7.7	23.6	13.6	28.5	30.5	19.5	13.0	8.0	-.157
37	12.7	31.3	9.9	31.3	14.6	5.5	24.0	17.5	32.5	20.5	+.145
45	17.9	38.7	6.5	21.8	15.1	19.5	32.0	29.0	14.0	5.0	-.174
54	30.6	8.9	21.6	17.9	30.8	56.5	15.5	13.0	4.0	10.5	-.425
55	16.4	26.8	10.9	27.0	18.6	4.0	14.5	36.5	19.0	25.0	+.247
60	25.1	18.4	20.6	17.4	18.6	7.0	9.5	15.0	16.0	52.5	+.340
62	15.6	30.0	21.3	20.3	12.4	6.5	17.5	17.5	23.0	35.0	+.254
(b) Attitude Object Science Teacher											
56	41.4	36.5	9.9	7.7	4.0	55.0	25.5	8.5	8.5	2.0	-.136
(c) Attitude Object Junior High Science Experiences											
40	10.4	13.2	15.1	30.5	30.8	26.0	18.5	13.5	22.5	18.5	-.209

TABLE XI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 24(b). D_{max} .120 "I have credit, or am now enrolled in, Physics 30, or 30X, or 32," "yes" and "no response"											
(a) Attitude Object Physics											
30	25.8	61.3	1.7	8.2	2.5	33.2	39.6	20.1	4.9	.4	+.143
35	21.8	33.3	7.7	23.6	13.6	24.6	22.4	38.8	10.4	4.1	-.230
37	12.7	31.3	9.9	31.3	14.6	3.0	16.4	42.9	22.8	14.9	+.246
45	17.9	38.7	6.5	21.8	15.1	11.2	19.4	59.7	7.1	2.2	-.272
54	20.6	8.9	21.6	17.9	30.8	62.7	12.7	16.8	3.7	3.4	-.459
55	16.4	26.8	10.9	27.0	18.6	3.7	5.2	73.1	10.8	6.7	+.343
60	25.1	18.4	20.6	17.4	18.6	6.0	7.5	18.3	10.1	58.2	+.396
62	15.6	30.0	21.2	20.3	12.4	3.4	13.1	22.0	20.5	40.7	+.291
(b) Attitude Object Science Teaching											
38	27.3	33.3	19.4	14.6	5.5	33.2	40.3	16.0	7.8	2.2	-.129
48	12.2	18.4	9.4	34.2	25.8	9.7	16.8	11.9	22.0	39.6	+.138
49	8.9	29.0	31.5	21.8	8.7	5.6	16.4	53.4	16.0	8.6	+.159
61	26.1	27.8	7.7	20.8	16.6	34.0	29.5	12.7	12.3	11.2	-.146

TABLE XI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(c) Attitude Object Science Teacher											
43	31.8	25.8	31.3	5.5	5.7	42.9	26.9	19.8	5.2	4.9	-.122
47	37.5	41.2	8.7	7.9	4.5	49.6	30.2	7.5	9.7	2.6	-.121
52	30.3	36.5	18.9	9.9	4.5	49.3	26.9	14.9	6.3	2.6	-.190
59	15.4	27.3	27.5	19.9	9.7	30.6	31.3	22.8	11.6	3.7	-.192
(d) Attitude Object Junior High School Science Experiences											
40	10.4	13.2	15.1	30.5	30.8	29.1	16.8	14.6	20.5	18.7	-.223
57	8.4	19.9	41.4	17.4	12.9	15.3	29.5	29.5	14.9	10.1	-.165
64	12.4	23.1	31.0	16.1	16.1	33.2	31.0	16.4	11.2	6.7	-.287
Variable 24(c). D_{max} .142 "I have credit in, or am now enrolled in, Physics 30, or 30X or 32," "no" and "no response"											
(a) Attitude Object Physics											
37	5.5	24.0	17.5	32.5	20.5	3.0	16.4	42.9	22.8	14.9	-.153
45	19.5	32.0	29.0	14.0	5.0	11.2	19.4	59.7	7.1	2.2	+.209
46	31.5	27.0	26.5	10.5	4.0	22.0	29.1	38.8	6.7	3.0	+.164
55	4.0	14.5	36.5	19.0	25.0	3.7	5.2	73.1	10.8	6.7	-.270

TABLE XI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
(b) Attitude Object Science Teaching											
49	11.5	25.0	38.5	14.5	10.5	5.6	16.4	53.4	16.0	8.6	+.145
(c) Attitude Object Junior High School Science Experiences											
64	17.5	28.0	25.5	12.5	15.0	33.2	31.0	16.4	11.2	6.7	-.187

Variable 25. D_{max} .220
"I don't have room in my timetable for physics."

No sig. different groups

Variable 26. D_{max} .333
"I dropped physics when the universities changed their entrance requirements in some faculties from six courses to five."

No sig. different groups

Variable 27. D_{max} .175
"I'm taking physics because I have the prerequisites."

No sig. different groups

TABLE XI (continued)

Item	Percentage Distribution "Yes" 1	2	3	4	5	Percentage Distribution "No" 1	2	3	4	5	D_{max}
Variable 28. D_{max} .198 "I'm taking physics to fill out my timetable."											
(a) Attitude Object Physics											
45	28.9	44.7	5.3	14.5	6.6	14.9	34.5	8.2	25.1	17.3	+.242
Variable 29. D_{max} .176 "I'm taking physics because my career plans are vague, and I want to keep as many doors open as possible."											
No sig. different groups											

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 7 pairs of variables.
Data of print-outs II
All pairs of distribution percentages significant at .01 level of probability, or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significance for each pair of variables listed.

to take Grade XII physics ("no" to item 24b). Differences in attitudes between the two groups may be related to reasons for the decision to drop out of physics.

> Summary, Sub-question IIf, Variable 24a. What would be the differences in attitude toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of those respondents who continued with physics in Grade XII, compared to those respondents who dropped the subject between Grade X and Grade XII?

The subjects who dropped physics would be more likely to agree that physics is one of the most difficult high school subjects; that physics is mostly a bunch of formulas; that biology is more appealing than physics; that the best science teachers explain things simply; and that studying internal combustion engines in Grade IX was boring. The subjects who dropped physics would be less likely to agree that physics deals with things the average person needs to know; that the most interesting part of physics was the problem solving; that they saw a close connection between physics and their choice of career; and that a well educated person ought to have taken physics. The subjects who dropped physics would probably show no difference in attitude toward

science teaching, as measured by the questionnaire. Further analysis of variable 24a will be brought in in conjunction with the detailed analysis of variable 24b.

Variable 24b had the distinction of yielding more significantly different groups than any other variable. The group which responded "yes" to item 24b was a sub-group of the group which responded "yes" to item 15. The group which responded "no response" to item 24b is the same group which responded "no" to item 15. The group which responded "yes" to item 24b included those subjects who had obtained credit in Physics 10, and had obtained credit or were enrolled in Grade XII physics. The group which responded "no response" to item 24b included the subjects who had not obtained credit in Physics 10 and had had no further contact with physics courses.

Attitudes Toward Physics. Only item 34, "Physics is a course that is slanted toward boys," and item 46, "Chemistry goes best with biology," did not produce differences in percentage responses. Whether they took physics or not the subjects were likely to agree (50.3%,

Table V) that physics is a course that is slanted toward boys, and that (50.9%, Table V) chemistry goes best with biology.

Forty-three percent of those subjects who responded "yes" to item 24 agreed with item 55, "The most interesting part of physics is the problem solving," while only 8.9% of the subjects agreed who responded "no response" to item 24b. A very large proportion, 73.1%, of the "no response" group wisely and perhaps tolerantly withheld judgment. It should be noted that 45.6% of the subjects who had had experience with physics to the Grade XII level disagreed that the most interesting part of the physics is the problem solving. Forty-three point five percent of the physics students agreed with item 60, "I see a close connection between physics and my choice of career," compared to 13.5% of non-physics students. A total of 75.4% of non-physics students agreed that biology was more appealing than physics (item 54), which is not a surprise. What does surprise is that 29.5% of Grade XII physics students agreed that biology is more appealing to them than physics. Of the physics students, 45.6% agreed that a well educated

person ought to have taken physics (item 62) while only 16.5% of non-physics students agreed. It should be noted that 32.7% of physics students disagreed that a well educated person ought to have taken physics. After most exposure to physics, 56.6% of physics students agreed that physics is mostly a bunch of formulas (item 45) while 30.6% of non-physics students had this attitude: 59.7% of non-physics students reserved judgment. Forty-four percent of physics students agreed that physics deals with things that the average person needs to know (item 37) compared to 19.4% agreement from non-physics students: and 41.2% of physics students disagreed with item 37.

Fifty-five point one percent of physics students agreed that physics is one of the most difficult high school subjects (item 35) compared to 47.0% of non-physics students who agreed: 38.8% of non-physics students reserved judgment, and 37.2% of physics students disagreed. After experience with physics up to Grade XII level 87.1% of physics students agreed that you have to be good in mathematics to be good in physics (item 30) compared to 72.8% of non-physics students who

agreed.

Attitudes toward science teaching. Four items (38, 48, 49, 61) related to science teaching drew differing attitudes from physics and non-physics students: 37.9% of physics students agreed that a good way to teach optics was to draw ray diagrams (item 49) compared to 22.0% agreement and 53.4% "don't know" from non-physics students; 53.9% of physics students agreed that Grade XII science teachers should teach for finals most of the year (item 61) compared to 63.5% of non-physics students; 30.6% of physics students agreed that you learn more from demonstrations the teacher does than experiments you do yourself (item 48) compared to 26.5% of non-physics students who agreed; 60.6% of physics students agreed with item 38, "In science courses, one ought to go on field trips often," compared to 73.5% of non-physics students. This compared with 59.6% agreement from those needing physics for further education ("no" to variable 3) compared to 71.5% agreement from those not needing physics. Overall, the differences were small between physics and non-physics students in attitude

toward science teaching.

Attitudes toward the science teacher. Four items (43, 47, 52, 59) related to attitudes toward the science teacher showed differences in responses of physics and non-physics students. However, even these few differences were small. The greatest difference was found in reactions to item 59, "I expect the science teacher to enjoy the labs as much as I do," with 42.7% of physics students agreeing, and 61.9% of non-physics students agreeing. A total of 66.8% of physics students agreed that the science teacher ought to be friendly without showing favoritism (item 52) while 76.2% of non-physics students agreed. Of the physics students, 57.6% agreed with item 43, "Science teachers ought to remember that at one time they didn't know any science," compared to 69.8% of non-physics students. Seventy-eight point seven percent of physics students agreed with item 47, "The science teacher's main job is to get the students involved in the subject," compared to 79.8% of agreement from non-physics students. However, the difference was in the percentages responding "strongly agree," which

were 37.5% for physics students and 49.6% for non-physics students.

Attitudes toward junior high school science experiences. Three items (40, 57, 64) related to attitudes toward junior high school science experiences showed differences between physics and non-physics students. The differences were generally about the same magnitude as for attitudes toward physics. The greatest difference was found in reactions to item 64, "The plant study made Grade VII science interesting," with 35.5% of physics students who agreed compared to 64.2% of non-physics students who agreed. Only 23.6% of physics students agreed that studying internal combustion engines in Grade IX was boring (item 40), but 45.9% of non-physics students agreed. Twenty-eight point three percent of physics students agreed and 41.4% didn't know that the study of rocks in Grade VIII was enjoyable, while 44.8% of non-physics students found it so and only 29.5% didn't know.

Summary, sub-question IIf, Variable 24b. What would be the differences in attitudes toward physics, science teaching, science teachers, and

their junior high school science experiences of students with Grade XII physics experience compared to students with no credits in physics in high school?

The two groups would be likely to show the most, and some of the strongest, differences in attitude of any pair of groups, with most of the differences focused on physics.

The physics students would be more likely to accept, and the non-physics students to reject, that there is a close connection between physics and their career and that a well educated person ought to have taken physics. The physics students would be more likely to be equally divided on agreement-disagreement and the non-physics students to reject that the most interesting part of physics is the problem solving, and that physics deals with things the average person needs to know. The physics students would be likely to reject and non-physics students accept strongly that biology is more appealing than physics. Both physics and non-physics students would be likely to accept, but non-physics students less likely, that physics is mostly a bunch of formulas, that physics is one of the

most difficult high school subjects and that you have to be good in mathematics to be good in physics.

Physics students would be more likely than non-physics students to feel that a good way to teach optics is to use ray diagrams and that you learn more from demonstrations the teacher does than from experiments you do yourself, though both groups would be more likely than not to reject this kind of teaching. Physics students would be less likely than non-physics students to feel that science teachers should teach all year for Grade XII finals and that one ought to go on field trips often, though both groups would be more likely to accept this kind of teaching than not.

In their attitudes toward the science teacher, physics students would agree but would be slightly less likely to do so than non-physics students that they would expect the science teacher to enjoy the laboratories as much as they do, that the science teacher ought to be friendly without showing favoritism, that the science teacher's main job is to get the students involved in the subjects, and that the science teacher ought to remember that at one time he didn't know any science.

In their attitudes toward their junior high school science experiences, physics students would be as likely to agree as disagree, and non-physics students to agree, that the study of rocks in Grade VIII was enjoyable. Physics students would be likely to have found the study of internal combustion engines in Grade IX enjoyable, while non-physics students would overwhelmingly have found it boring.

Variable 24c. Table XI shows the significant pairs of percentage response distributions for the groups who responded "no" and "no response" to item 24 (Variable 24c). The group responding "no" to item 24 would have credit in Physics 10 but would not have credit or be enrolled in Grade XII physics. The group responding "no response" to item 24 would not have credit in Physics 10, and would either have no physics experience, or a failing physics experience in high school.

Attitude toward physics. The responses to item 55, "The most interesting part of physics is the problem solving," showed more agreement with 18.5% and more

disagreement with 44.0% by the "no" group than the corresponding percentages of the "no response" group of 8.9% and 17.5%. A total of 73.1% of the "no response" group selected "don't know," compared to 36.5% for the "no" group. Limited experience with physics would appear to crystallize attitudes in more students showing disagreement with item 55 than students showing agreement. Responses to item 45, "Physics is mostly a bunch of formulas," showed a similar pattern to those of item 55: 51.5% of "no" students agreed with item 45, compared to 30.6% of "no response" students who disagreed; 29.0% and 59.7% of students, respectively, "didn't know." The situation of experience with physics produced more agree and disagree, with correspondingly fewer "don't know" responses obtained in the response pattern for item 46, "Chemistry goes best with biology." Percentages of agreement were 58.5% and 51.1%, and of disagreement were 14.5% and 9.7% respectively. "Don't know" responses were 26.5% and 38.8% respectively. The response pattern was the same for item 37, "Physics deals with things the average

person needs to know," with the percentages of agreement 29.5% and 19.4%, percentages of disagreement 53.1% and 37.7%, and"don't know" 17.5% and 42.4%, respectively. Comparison with the responses for these items to variable 24b shows that the more extended experience with physics corresponded with more positive responses. The responses to item 49, "A good way to teach light (optics) is to draw ray diagrams," were similar in pattern to those referred to above. The respective percentages of agreement were 36.5% and 22.0%, for disagreement 25.0% and 24.6%, and for don't know, 38.5% and 53.4%. The response pattern to item 64, "The plant study made Grade VII interesting," was different: 45.5% of the "no" students agreed while 64.2% of the "no response" students agreed. The only variable of those (25, 26) suggesting reasons for not taking Grade XII physics, and of those (27, 28, 29) suggesting reasons for taking Grade XII physics, that produced a different pair of groups was variable 28, "I'm taking physics to fill out my timetable," for item 45, "Physics is mostly a bunch of formulas." A total of 73.6% of the students who agreed with variable 28 agreed with item 45, while 49.4% of students who

disagreed with variable 28, agreed with item 45. More students who take physics to fill out a timetable were likely to see physics as mostly a bunch of formulas than were those who did not give "filling out a timetable" as a reason for taking physics.

> Summary, sub-question IIf, Variables 24c, 25, 26, 27, 28, 29. What would be the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of students with credit in Physics 10 (but no physics experience at the Grade XII level) compared to students having no high school physics credit?

Students who had credit in Physics 10 would be more likely to agree, and to disagree, than students with no high school physics credit that the most interesting part of physics is the problem solving; that physics is mostly a bunch of formulas; that physics deals with things the average person needs to know; and that chemistry goes best with biology. The students who had credit in Physics 10 compared to those who had no credit in high school physics would have no differences in attitude toward science teachers. The students who had credit in physics would be more likely to agree that a good way to teach light (optics) is to draw ray diagrams, and

less likely to agree that plant study made Grade VII science interesting, than students who had no high school physics credit. Only the students who said they were taking physics to fill out their timetables compared to those who rejected this reason for enrollment would be likely to show differences in attitude and that only toward the statement that physics is mostly a bunch of formulas. They would be more likely to agree.

> Sub-question IIg. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups of females and males?

Variable female/male of Table XII applies to this sub-question. The subjects were the 213 who identified themselves as female, and the 217 who identified themselves as male. They included representatives from all the sampled schools and both physics and non-physics students.

More significant differences were revealed toward physics than any other attitude object. There were no differences in attitudes of females/males toward science teaching as sampled by the questionnaire.

TABLE XII

CHOICE DISTRIBUTIONS BY VARIABLE, BY ATTITUDE OBJECT, RELATED TO SUB-QUESTION IIg

Item	Percentage Distribution Female 1	2	3	4	5	Percentage Distribution Male 1	2	3	4	5	D_{max}
Variable. Female/Male. D_{max} .146											
(a) Attitude Object Physics											
34	20.0	42.0	15.0	13.0	10.0	7.0	37.0	15.0	26.0	15.0	+.180
35	27.0	27.0	27.0	16.0	4.0	20.0	32.0	11.0	23.0	14.0	+.180
37	5.0	19.0	30.0	31.0	15.0	11.0	32.0	11.0	27.0	19.0	-.190
54	59.0	15.0	10.0	9.0	7.0	25.0	13.0	20.0	12.0	30.0	+.360
60	5.0	11.0	19.0	15.0	50.0	22.0	14.0	24.0	16.0	24.0	-.260
62	5.0	14.0	19.0	24.0	38.0	12.0	28.0	23.0	20.0	18.0	-.240
(b) Attitude Object Science Teacher											
56	54.0	31.0	8.0	6.0	1.0	35.0	41.0	12.0	8.0	3.0	+.190
59	25.0	31.0	23.0	16.0	3.0	13.0	28.0	26.0	20.0	12.0	+.150
(c) Attitude Object Junior High Science Experiences											
40	29.0	15.0	16.0	22.0	17.0	10.0	16.0	14.0	29.0	31.0	+.199
64	29.0	33.0	20.0	11.0	6.0	12.0	20.0	35.0	12.0	20.0	+.300

TABLE XII (continued)

Note: Choice distribution percentages of responses for items 30-64 of questionnaire for 1 pair of variables.
Data of print-out III.
All pairs of distribution percentages significant at .01 level of probability or better.
D_{max} for each pair of distribution percentages listed.
D_{max} for .01 significiance for each pair of variables listed.

Seventy-four percent of females agreed that biology was more appealing to them than physics (item 54) compared to 38% agreement from the males. With regard to item 60, 16% of females and 36% of males saw a close connection between physics and their choice of career. The percentages of agreement with item 67, that a well educated person ought to have taken physics, were 19% for females and 40% for males. "Physics deals with things the average person needs to know" (item 37) drew 24% agreement from females and 43% agreement from males. Item 35, "Physics is one of the most difficult high school subjects," recorded 54% agreement from the females compared to 52% agreement from the males. However, while 20% of females disagreed with item 35, 37% of males disagreed. Sixty-two percent of females agreed that physics is a course that is slanted toward boys (item 34) while 44% of males agreed. It is worth noting that no differences in attitude toward this item were shown by physics/non-physics groups (variables 24a, b, and c).

Females agreed (85%) strongly that the best science teachers explain things simply (item 56) compared

to agreement from 76% of males. Fifty-six percent of females expected the science teacher to enjoy their labs as much as they did (item 59) compared to 41% of males.

Item 64, "The plant study made Grade VII science interesting," elicited 62% agreement from the females compared to 32% of males who agreed. Forty-four percent of females agreed and 39% disagreed that the study of internal combustion engines in Grade IX was boring (item 40). The corresponding percentages of agreement and disagreement for the males were 26% agreement and 60% disagreement.

> Summary, sub-question IIg. What are the likely differences in attitudes toward physics, toward science teaching, toward science teachers and toward their junior high school science experiences of the females compared to the males?

Both females and males would be likely to disagree, but females would be somewhat more likely to disagree than males, that they see a close connection between physics and their choice of career, that a well educated person ought to have studied physics, and that physics deals with things the average person needs to

know. Females would be more likely to agree, and males to disagree, that biology is more appealing than physics and that physics is a course that is slanted toward boys. Females and males would be equally likely to agree that physics is one of the most difficult high school subjects, but more males than females would be likely to disagree. Females and males would be likely to show no differences in attitude toward science teaching, though they would differ in attitude toward science teachers. Both groups would be very likely to agree that the best science teachers explain things simply, but females would be somewhat more likely to have this expectation than males. Females would be likely to agree, males likely to disagree, that science teachers ought to enjoy the labs as much as they do. Females would be likely, males unlikely to feel that plant study made Grade VII science interesting. Females would be as likely to agree as to disagree that Grade IX study of internal combustion engines was boring, while males would be more likely to disagree.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

In this investigation, 871 students enrolled in Grade XII in seven high schools operated by the Calgary Public School Board completed a questionnaire, "Grade XII Physics: Why Take It? Why Not?" The students were enrolled in at least one Grade XII subject, and were in at least their third year of high school.

In general, the purpose of the study was to ascertain the reasons for the decline in enrollment in Grade XII physics, relative to the total enrollment in all Grade XII science, in the secondary schools of a large urban school system in Alberta. To this end the questionnaire, "Grade XII Physics: Why Take It? Why Not?," was devised to assess the reasons, as perceived by students, for enrolling or not enrolling in Grade XII physics.

A trial questionnaire was constructed following an analysis of twenty-eight half-hour, tape-recorded

interviews with a carefully selected cross-section of Grade XII students. The statements of this questionnaire were in the students' own words. The trial questionnaire was revised to yield the final questionnaire on the basis of feedback from groups of students to whom the trial instrument had been administered.

In Part A, the questionnaire purported to find "mechanical" or objective reasons advanced by students for electing or rejecting enrollment in Grade XII physics. The mechanical reasons are those related to administrative restrictions, timetables, prerequisites for the course, perceived need of the course for the achievement of goals, advice by counsellors, and the like. The second part of the instrument (Part B) purported to explore the affective reasons perceived by students for enrolling or not enrolling in Grade XII physics. The affective reasons related to attitude differences exhibited by different groups of students toward physics, toward science teaching, toward science teachers and toward the students' junior high school science experiences.

The investigator used computer techniques to determine and to display percentage and absolute response distributions to questionnaire items. The investigator also used computer sorting techniques to relate the responses to mechanical items to the response to the affective items of the questionnaire. Statistical techniques established that total group response distributions to all items of the questionnaire were significant at the .01 level or better. Statistical techniques were used to determine significant pairs of percentage response distributions to the affective items, related to percentage response distributions to the mechanical items (variables).

Pairs of percentage response distributions showing significant differences at the .05 to .01 level were determined and listed, but not discussed. Pairs of percentage response distributions significant at the .01 level or less were determined, listed and discussed.

The main questions studied were two in number. They were stated in Chapter I and re-stated with their appropriate sub-questions in Chapters III and IV. The null hypotheses related to the questions were stated in

Chapters III and IV. The main questions and associated sub-questions are reproduced here, with the answers suggested by the analysis of the questionnaire data. The answers were based on data that had been established to be significant by the testing of the null hypotheses.

Question I

> What are the "mechanical" (objective) reasons selected by Grade XII students for enrolling or not enrolling in physics at the high school level?
>
> Sub-question Ia. What reasons related to career are selected by Grade XII students for enrollment or non-enrollment in high school physics?

A typical Grade XII student enrolled in physics would be likely to need it for further education, probably at a university or an institute of technology. Very few Grade XII students would enroll in physics for reasons not associated with a career.

> Sub-question Ib. What have the students been told about physics and its relationships to the other sciences?

Students would be highly likely to have been told that physics is a difficult subject and that you have to be good in mathematics to be good in physics. They would

be likely to have been told that chemistry goes with biology, less likely that chemistry goes with physics, and not likely at all that biology goes with physics. Students would be unlikely to have been told that physics is a subject for boys.

Sub-question Ic. What counselling advice have students been given regarding enrollment in high school sciences?

Students would be most likely to have selected their high school science(s) themselves. Students would be unlikely to have been advised by their junior high counsellors, and less likely by their high school counsellors, to take physics in high school. Students would be likely to have been incorrectly advised that they needed two sciences for "matric."

Sub-question Id. What reasons do students select for not obtaining credit in Physics 10?

Students would be most likely to have selected, as a reason, not needing physics for their career. Needs to take chemistry or biology would be unlikely to be selected as reasons.

Sub-question Ie. What reasons for the decision to take Physics 10 were selected by those students who obtained credit in Physics 10?

The most likely reason would be need for physics for their careers. The students would be unlikely to have been forced to take Physics 10 and less likely to have taken it because of a dislike for biology, or because they could not get chemistry or biology in their first year.

Sub-question If. What reasons for their decision were selected by students who did not take Grade XII physics, though they had the prerequisite?

Students would be most likely to have responded that they did not have room in their timetables, more so than that they had dropped physics when university entrance requirements changed. It would appear that not enough mechanical reasons were offered by the questionnaire to fully sample the responses.

Sub-question Ig. What reasons for their decision were selected by students who elected to enroll in Grade XII physics?

Students would be most likely to select career reasons (keeping educational alternatives open) and

possession of prerequisites as reasons for enrolling in Grade XII physics. They would be unlikely to be, but could be enrolled for the credits, and to complete a timetable.

Question II

> What are the affective reasons, as related to attitudes, perceived by Grade XII students for enrolling or not enrolling in Grade XII physics?

> Sub-question IIa. What are the attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the group of all subjects surveyed?

The greatest unanimity of attitudes was found to be toward science teaching and toward science teachers. This suggests that differences in attitudes toward science teaching and science teachers do not play a large part in decisions to enroll or not enroll in physics. Students' attitudes showed greatest diversity toward physics and toward junior high school science experiences. This suggests that students' attitudes toward physics and toward their junior high school science experiences do play a large part in their decision process.

Keeping in mind that there is the most difference in opinion among the sub-groups in attitudes toward physics, students would be very likely to believe that they have to be good in mathematics to be good in physics, as they have been told (sub-question Ib), that chemistry goes best with biology, as they have been told (sub-question Ib), and that there is little connection between physics and their career. This would be likely even if they took Physics 10 (sub-question Ie). Students would be very likely to feel strongly that biology is more appealing than physics, and that physics is just a bunch of formulas. The students would be likely to believe that physics is slanted toward boys, even if they had not been told so (sub-question Ib). Students would be highly likely to believe that physics is a very difficult subject as they have been told (sub-question Ib). The students would be likely to be unsure if physics deals with things the average person needs to know, or if the most interesting part of physics is the problem solving, or not. The students would be likely to feel that study of physics is unnecessary to obtain a good general education.

Similarly, it is necessary to keep in mind that attitudes toward junior high school science experiences are likely to differ among sub-groups of students. Students' attitudes toward their junior high school science experiences would be likely to have more "don't know" responses, due perhaps to faulty memory. Students would be likely to remember Grade IX science (physical science) as being of the "read the chapter and make notes" variety, and the work on internal combustion engines about equally likely to have been boring or not. The students would be likely to feel that there was not enough laboratory work, though it was the most interesting part of the work. The students would be about as likely as not to have found the plant study of Grade VII interesting, but would be more likely to have found the Grade VIII study of rocks more fun than work.

The students' attitudes toward science teaching and science teachers are not likely to vary much with the students' sub-group placement. Students would be strongly likely to believe that you have to know science to teach it well, and that writing notes on the board is a poor science teaching method, as is the lecture

method. The students would be very likely to feel that science courses ought to prepare them for a career, and that the science courses have enough experiments which relate to the course. The students would be as likely to agree as to disagree that demonstrations are as good as experiments, that using ray diagrams is a good method of teaching optics, and that one ought to go on field trips often. The students would be fairly likely to agree that Grade XII teachers ought to teach for finals most of the year. This latter would be consistent with the career orientation displayed by the students.

The students would be very likely to expect the teacher to involve them in his subject, and to explain his subject matter simply. The teacher would be expected to have a sense of humor; to be forceful and thorough, but not strict; to be approachable without showing favoritism; and to be humble, remembering his own lack of knowledge at one time. The teacher would also be expected to show enthusiasm for laboratory work.

> Sub-question IIb. What are the differences in attitude toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups

who did or did not see a need for physics in their career?

Students who see a need for physics in their career, compared to those who do not, would be likely to differ more in their attitudes toward physics and their junior high school science experiences than in their attitude toward science teaching or science teachers.

Students who see a need for physics in their career compared to those who do not would be more likely to find biology less appealing than physics, and more likely to see a connection between physics and their choice of career. While both kinds of students would be likely to agree that physics is difficult and that chemistry goes with biology, the students who see a need for physics in their career would not be quite as likely to agree as their counterparts. Both groups would be likely to disagree that physics is necessary for a good education, or that it deals with things the average person needs to know, though students needing physics would not be as likely to disagree as the others. Similarly, both groups of students would be

likely to disagree that the interesting part of physics is the problem solving, though students not needing physics would be more likely to disagree. Both groups, with students needing physics, somewhat less, would be likely to agree that physics is mostly a bunch of formulas.

Students needing physics would be likely to have found the study of internal combustion engines in Grade IX interesting, while students not needing physics would have found it boring. Both probably would have found plant study in Grade VII interesting but not enough laboratory work in junior high, with students not needing physics a little more likely to have found this so.

Both groups of students would be likely to approve of field trips, but with those not needing physics more likely than the others to approve. Both groups of students would be likely to agree that demonstrations are not as useful as student experiments with, again, students not needing physics more likely to agree.

While the groups are likely to agree in their attitudes toward science teachers, students needing

physics would be less likely to agree that science teachers ought to remember that at one time they did not know any science, and that the best science teachers explain things simply.

> Sub-question IIc. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who have or have not heard certain statements about physics?

Generally, the students who reported hearing negative statements about physics would be more likely to hold negative feelings toward the subject than those who have not.

The group of students who have been told, compared to those not told, that physics is a very difficult subject would be more likely to believe that physics is difficult, that it is slanted toward boys, that it does not deal with things the average person needs to know, that it is mostly a bunch of formulas, that it is less appealing than biology, that the least interesting part is problem solving, that it has little connection with their choices of career, and that it is not necessary to study physics to have a

good education. The group who have been told that physics is a very difficult subject would be more likely to have found Grade IX study of internal combustion engines boring, and Grade VII plant study interesting.

Students who have been told that you have to be good in mathematics to be good in physics, and that it is a subject slanted toward boys, would be more likely to believe this than those not so told. They would also be more likely to believe that physics is difficult, and mostly a bunch of formulas.

The very few students who have been told that biology goes with physics would be more likely to accept humorless science teachers and to have enjoyed the Grade IX study of internal combustion engines. The many students who have been told that chemistry goes with biology compared to those not so told would be likely to believe that chemistry does go with biology, and would be more likely to find biology appealing than physics. Students who have been told chemistry goes with physics, compared to those not so told, only differ in degree of disagreement, more,

that the most interesting part of physics is the problem solving and that physics has value in general education.

> Sub-question IId. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high science experiences of the groups who have been counselled in differing ways?

The fewer numbers of differing attitudes between groups revealed by responses to this sub-question (IId), compared to the greater number of differing attitudes revealed by responses to what students have been told by students, teachers, parents, counsellors, etc., suggests that formal counselling is less important in attitude development than what students have been told.

Students who had been advised by their junior high counsellor to take Physics 10, compared to those not so advised, would be more likely to feel that physics is a bunch of formulas, that problem solving is not the most interesting part of physics and that physics is a proper part of general education. Students advised to take Physics 10 would be less likely to expect the science teacher to enjoy the laboratories as much as they do. Students whose choice of Grade X

science was left up to them by their junior high counsellor would be less likely to feel that you learn more from demonstrations than experiments. Students who had been advised by their high school counsellor to take Physics 10 would be more likely to feel that physics deals with things the average person needs to know. Students who have been counselled in different ways would not differ in attitudes toward their junior high school science experiences. Students who were told that they needed two sciences for "matric" would show no differences in attitude compared to those not so told.

> Sub-question IIe. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who did or did not obtain credit in Physics 10, and who selected various reasons for their decision?

The groups who did or did not obtain credit in Physics 10 showed more differences in attitude, and these differences were greater, relative to physics and junior high science experiences, than to science teaching or science teachers.

Students who obtained credit in Physics 10, and those who did not, are the same groups as those who responded "yes" and "no" to item 24, and those who responded "no response" to item 24. They can be expected to and do show similar differences in attitude to the respondents to variables 24a and 24b. All items found to show significant differences between groups responding to variable 15 also showed similar differences for the groups responding to item 24b. Therefore no discussion of variable 15 is reported here.

Students who selected different reasons for not gaining credit in Physics 10 showed little difference in attitude. A student who took biology in preference to physics would be more likely to agree that biology appealed to them more than physics, that chemistry goes with biology, and that studying internal combustion engines in Grade IX was boring. Students not having credit in Physics 10 showed no differences in attitude whether or not they felt that they rejected physics because they did not need it for their career. The students who agreed that they rejected physics

because they needed chemistry would be more likely to agree that chemistry goes with biology, that a good method of teaching science is to write notes on the board, and that Grade XII science teachers should teach for finals for most of the year.

Attitudes of students with credit in Physics 10 (Variables 19-23). Students who had been forced to take Physics 10 showed few differences in attitude, compared to those who had freer choice. The student who believed he had not been given the choice to take physics would be more likely to feel that physics is one of the most difficult high school subjects and that biology is more appealing. Students who took physics because biology did not appeal would be more likely to disagree that chemistry goes with biology, that biology is more appealing than physics, and that one ought to go on field trips often. They would be more likely to agree that they saw a close connection between physics and their choice of career, and that they would expect the science teacher to enjoy the laboratories as much as they did. Students who elected

physics because they had to defer biology and/or chemistry would be more likely to agree that chemistry goes best with biology, that biology appeals more to them than physics, and that the study of plants in Grade VII was interesting. Such students would be less likely to agree that they saw a close connection between physics and their choice of career. Students who said they took Physics 10 because they believed, at the time, that they needed it for their career, would be more likely to agree that physics deals with things the average person needs to know, that the most interesting part of physics is the problem solving, that physics has a close connection with their career, and that a well educated person ought to have taken physics. They would be less likely to agree that biology appeals to them more than physics, or that chemistry goes best with biology.

> Sub-question IIf. What are the differences in attitudes toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups who had credit or were enrolled in Grade XII physics or who did not have credit or were not enrolled in Grade XII physics, and who gave various reasons for their decisions?

Attitudes of physics and non-physics students, both with credit in Physics 10 (Variable 24a). The groups included were the students having credit in, or enrolled in, Grade XII physics, and the students who had obtained credit in Physics 10 but did not have credit in and were not enrolled in Grade XII physics. These groups might be referred to as the group of Grade XII physics students, and those who, after a trial, had dropped the subject. The groups showed no difference in attitude toward science teaching. There was only one difference shown in attitude toward the science teacher. Physics students would not be as strongly likely to agree as would be the drop-outs that the best science teachers explain things simply. Only one difference in attitude was shown by the two groups and this was toward the students' junior high school science experiences. Physics students would be more likely to disagree and the drop-outs to agree that their Grade IX experiences with internal combustion engines was boring.

Seven out of ten attitude items related to physics showed differences between the groups. Students of physics and physics drop-outs would be equally likely

to agree that you have to be good in mathematics to be good in physics, that physics is a course that is slanted toward boys, and that chemistry goes best with biology. Students of physics would be more likely to agree and drop-outs to disagree that physics deals with things the average person needs to know, that the most interesting part of physics is problem solving, that they see a close connection between physics and their career, and that a well educated person ought to have taken physics. Physics students and drop-outs would be likely to agree, but drop-outs would be more likely to do so, that physics is one of the most difficult high school subjects, and that physics is mostly a bunch of formulas. Physics students would be likely to disagree and drop-outs very likely to agree that biology is more appealing than physics.

Attitudes of physics students and students not having credit in Physics 10 (Variable 24b). This variable showed more significant pairs of groups than any other variable. The variable is related to perhaps the most important sub-question of the study, because the

groups are that group comprised of those students who, after obtaining credit in Physics 10, went on to enroll in Grade XII physics, and that group comprised of those students who were not enrolled in Grade XII physics, and who did not have credit in Physics 10.

The largest number of significant pairs of groups, eight out of ten, were found in the items referring to attitudes toward physics. Four out of ten pairs of groups showed significant differences in attitude toward science teaching, and four out of eight groups showed significant differences in attitude toward the science teacher. Three out of seven groups showed significant differences in attitude toward their junior high school science experiences.

Physics students would be more likely to accept, and non-physics students to reject, that there is a close connection between physics and their career, or that a well-educated person ought to have taken physics. The physics students would be more likely to be evenly divided on agreement-disagreement, and the non-physics students to disagree that the most interesting part of physics is the problem solving and that physics deals

with things the average person needs to know. The physics students would be likely to disagree and the non-physics students very likely to agree that biology is more appealing to them than physics. Physics and non-physics students would be likely to agree, but non-physics students somewhat less likely, that physics is mostly a bunch of formulas; that physics is one of the most difficult high school subjects; and that you have to be good in mathematics to be good in physics. It would appear that experience with physics confirms the attitudes held by non-physics students as to the difficulty, mathematics relationship, and formula quality of physics.

In their attitudes toward science teaching, both physics and non-physics students would be likely to disagree, but physics students somewhat less than non-physics students that a good way to teach optics is to use ray diagrams and that you learn more from demonstrations the teacher does than experiments you do yourself. Both physics students and non-physics students would be likely to agree, but physics students less likely, that Grade XII science teachers should teach for finals most

of the year and that one ought to go on field trips often.

In their attitudes toward the science teacher, physics and non-physics students would be likely to agree, with physics students somewhat less likely, that they would expect the science teacher to enjoy the laboratories as much as they do; that the science teachers' main job is to get the students involved in the subject; and that the science teacher ought to remember that at one time he did not know any science. This might be interpreted to mean that physics students are somewhat more likely to accept a remote, depersonalized type of science teacher than non-physics students. Is this attitude caused by physics instruction, or do students having this attitude elect to take physics instruction?

In their attitudes toward their junior high school science experiences, physics students would be as likely to agree as to disagree, and non-physics students to agree that plant study made Grade VII science interesting and that the study of rocks in Grade VIII was enjoyable. However, physics students would be likely

to have found the study of internal combustion engines enjoyable, while non-physics students would be extremely likely to have found it boring.

Attitudes of non-physics students having credit or not in Physics 10 (Variable 24c). As might be expected, differences in attitude were less frequently found between the groups of students who had credit in Physics 10, but who had not enrolled in Grade XII physics (the drop-outs), and the group of students who had had no successful physics experiences in high school. The greatest number of differences in attitude, four out of ten, was found to be related to physics. One out of ten differences was found relative to science teaching, one out of seven relative to junior high school science experiences, and none out of eight relative to science teachers.

Students with credit in Physics 10, compared to students not having credit in Physics 10, would be more likely both to agree, and to disagree, and less likely not to know, that the most interesting part of physics is the problem solving, that physics is mostly a bunch

of formulas, that physics deals with things the average person needs to know, and that chemistry goes best with biology. It would appear that limited experience with physics, as experienced by the "drop-outs," would crystallize both positive and negative attitudes toward physics.

Students with credit in Physics 10 would be more likely to agree, and students without credit in Physics 10 to disagree, that a good way to teach physics is to draw ray diagrams. Both groups would be very likely not to know, but the students without credit in Physics 10 would be much more likely not to know, what to think about this item.

There would be no differences between the two groups in attitudes toward science teachers.

Both groups would be likely to agree that the plant study made Grade VII science interesting, but the group without credit in Physics 10 would be more likely to agree than the other.

Attitudes of students with credit in Physics 10, enrolled or not enrolled in Grade XII physics, who selected various reasons for enrollment or non-enrollment (Variables 25, 26, 27, 28, 29). The groups responding to the various reasons showed only one significantly differing attitude. The group of students who responded "yes," compared to the students who responded "no," to variable 28, "I'm taking physics to fill out my timetable," would be more likely to agree that physics is mostly a bunch of formulas.

> Sub-question IIg. What are the differences of attitude toward physics, toward science teaching, toward science teachers, and toward their junior high school science experiences of the groups of females and males?

More significantly different attitudes were shown by females and males with regard to physics, six out of ten, than to any other attitude object. The groups showed no differences in attitude toward science teaching, two out of eight toward science teachers, and two out of seven toward junior high school science experience.

Both females and males would be likely to disagree, but females would be somewhat more likely to

disagree than males, that they see a close connection between physics and their choice of career, that a well educated person ought to have studied physics, and that physics deals with things the average person needs to know. Females would be more likely to agree, and males to disagree, that biology is more appealing than physics, and that physics is a course that is slanted toward boys. Females and males would be equally likely to agree that physics is one of the most difficult high school subjects, but more males than females would be likely to disagree.

Females and males would likely show no differences in attitude toward science teaching.

Both groups would be very likely to agree that the best science teachers explain things simply, but females would be even more likely to agree than males. Females would be likely to agree, but males to disagree, that science teachers ought to enjoy the laboratories as much as they do.

Females would be likely to agree, males to disagree, that plant study made Grade VII science interesting. Females would be about as likely to agree as to disagree that Grade IX study of internal combustion engines

was boring, while males would be more likely to disagree.

CONCLUSIONS

It has been shown that Grade XII students who elected physics at the Grade XII level did so primarily for reasons related to future education or career. Grade XII students were likely to have been told, and to have believed, negative statements regarding physics. It has been established that Grade XII students were more likely to have made up their own minds regarding enrollment in high school science than to have followed the advice of counsellors. This contrasts with Kruglak's finding, that counsellors' recommendation is one of the two most important influences cited by students. The questionnaire used in the study probably did not include enough choices to establish reasons advanced by students for dropping physics after Grade X.

It has been shown that Grade XII students displayed many differing attitudes toward physics and their junior high school science experiences, and fewer different attitudes toward science teaching and science teachers. In general, students showed negative attitudes toward physics. Attitudes toward junior high school

science experiences were generally positive toward life science and earth science, but divided toward the physical sciences. Laboratory work and involvement with equipment, as contrasted to a lecture approach, were approved by students.

The picture of student approved methods of science teaching emphasizes involvement by the student in activities, few lectures, in a career-oriented atmosphere. Agreement was shown to be general on the image of the good science teacher. The desired science teacher would be well versed in the subject matter, enthusiastic to involve the student in the subject and laboratory work, have a sense of humor, be forceful and thorough but not strict, be approachable without showing favoritism, and would remember his own lack of science knowledge in the past.

It has been shown that students showed more significantly different pairs of groups with respect to attitude toward physics and toward their junior high school science experiences than toward science teaching or science teachers. It has also been shown that the groups enrolled in Grade XII physics/no credit in

physics 10; credit/no credit in Physics 10; do not need/need physics for university; do not need/need physics for future education; told/not told that physics is a very difficult subject; and female/male show most differences in attitude. Of these groups the most distinctive would be those enrolled in Grade XII physics/no credit in Physics 10 (variable 24b), and female/male.

It has been shown that students who saw a need for physics for their future education or career, compared to those who did not, showed somewhat less but still negative attitudes toward physics. Students who saw a need for physics for their future career had a more positive attitude to their junior high physical science experiences, while the "no" group found it boring. Both groups agreed on the need for student activity in junior high science. Only differences of degree in attitude toward science teaching and science teachers separated the two groups.

It has been shown that students who heard certain negative statements about physics tended to believe those statements, even after experience with physics.

It has been shown that students who were advised by their junior high school counsellor to take physics in high school were more likely to have negative opinions of physics than those not so counselled. It seems likely that this is the same group that was enrolled in Grade XII physics and who held similar opinions. Students whose choice of high school science was left to them showed few differences from those not so counselled. Not unexpectedly, the students who reported free choice showed more agreement with student experimentation as contrasted to teacher demonstration. The only difference in attitude shown by students advised by their high school counsellor to take physics was a more positive attitude toward physics as a subject that deals with things the average person needs to know.

It has been shown that differences between the groups enrolled in Grade XII physics/credit in Physics 10 but not enrolled in Grade XII physics (variable 24a) are primarily with respect to physics and are duplicated, except for item 56, by the groups enrolled in Grade XII physics/no credit in Physics 10 (variable 24b). It has been shown that physics students shared many of the

negative attitudes toward physics that were held by non-physics students. Most especially notable are the attitudes that more physics students held that physics is mostly a bunch of formulas, that it is one of the most difficult high school subjects, and that you have to be good in mathematics to be good at it. Even physics students did not find the problem solving aspect of the subject most interesting, nor were they generally convinced that physics deals with things the average person needs to know. Both physics and non-physics students rejected the lecture-demonstration style of teaching, but physics students were not so opposed as their fellows.

Grade XII physics students were less expectant than non-physics students that Grade XII science teachers ought to teach for finals most of the year and that one ought to go on field trips often. Physics students seemed somewhat more likely than non-physics students to accept a remote, depersonalized style of science teacher. It was not established if this was due to physics instruction or was characteristic of students who sought physics instruction. Physics students

apparently found junior high physical science experiences enjoyable, compared to the non-physics students who found them boring. Physics students were about equally likely to have found junior high life and earth science experiences enjoyable or disagreeable, while non-physics students were very likely to have found them enjoyable.

It was shown that there were few differences in attitudes between students who dropped out of physics and those without any high school physics experience. Students with some experience in physics were shown to have attitudes, both positive and negative, more strongly developed than students who had no high school physics experience.

It was shown that the attitudes of females compared to males were similar with respect to physics and junior high science experiences to that of non-physics and physics students. There was, however, an exception. Females showed agreement, males disagreement with the suggestion that physics is slanted toward boys.

It was shown that attitudes, however gained, may affect the choice to study or not to study physics, and that attitudes toward physics and toward junior high

school physical sciences are generally negative among non-physics students, and fairly evenly divided negative and positive among physics students.

RECOMMENDATIONS

Related to the Study

It seems evident that if the career reasons were removed, that physics enrollment would likely suffer a drop of about half, considering the fairly even division of positive and negative attitudes toward physics of physics students. If physics is worth sustaining in the secondary curriculum, career reasons need to be retained and reinforced, and attitudes toward physics and toward junior high physical science experience need to be improved.

Physics teachers and others concerned about improving physics enrollment ought to ensure that junior high students know the career reasons for enrolling in physics at the high school level.

Physics teachers and others need to play down the difficulty and the mathematics relationship of physics. The close relationship between chemistry and

physics, and any biology-physics relationships, need to be made clear to students at all levels.

Physics teachers and others need to give information to junior high school and other counsellors in order that such counsellors will be more likely to recommend that students take physics in high school. This information should include the facts about the relative difficulty of physics, the level of mathematical power required and about the relationship of physics with chemistry and biology. Counsellors need help to combat the myth about two sciences being needed for "matric"--though success might reduce physics enrollment.

Physics teachers and others, knowing that students tend to believe what they are told about physics, need to convince teachers and counsellors, particularly in the junior high schools, that you do not have to be good in mathematics to be good in physics, that physics is not the most difficult subject, that physics does relate to everyday life, that physics does have value in general education, that physics is not mostly a bunch of formulas, that it is not slanted toward boys, and that it relates more to chemistry than biology does.

Curriculum developers and physics teachers will have to ensure that the physics program, or programs, do not all require high mathematical power, that they not be excessively difficult, that they be shown to relate to everyday life, that they do have value for general education, that they do not appear to be mainly a bunch of formulas, that they are not slanted consciously or unconsciously toward boys, and that connections with the other sciences are explored and exploited.

The emphasis on verbal problem solving is apparently unpalatable to many students who either drop out of physics or who do not enroll at the high school level. As long as Grade XII physics examinations are geared to problem solving and as long as all of a student's final evaluation is established by the final examination, there will be a pressure on students and teachers to make verbal problem solving the core of physics.

The universities, both in their faculties of education and of arts and science, need to look into their operations to find and remedy the reasons why so few well qualified, enthusiastic, activity-and-student-

oriented graduates are being produced in physics. Development of good attitudes toward physics can hardly be left to teachers trained largely in other disciplines. This is especially true at the junior high school level, where attitudes appear to be developed.

Related to Further Research

It is hoped that the questionnaire, "Grade XII Physics: Why Take It? Why Not?" could be used in other Alberta jurisdictions, urban and rural, to see if the results are generally applicable.

There is a need to examine the teaching of physics to see if some of the student attitudes identified with regard to physics are mythological or if they have their beginnings in instructional style.

It might be useful to examine the relationship between such variables as age and I.Q. to the development of attitudes to see if the attitudes relate to some underlying variable.

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BIBLIOGRAPHY

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APPENDICES

APPENDIX A

QUESTIONNAIRE

GRADE XII PHYSICS: WHY TAKE IT? WHY NOT?

A QUESTIONNAIRE

This questionnaire is to be used to gather information from Grade XII students about their reasons for taking, or not taking, Physics 30. It is hoped that this information will be helpful in the design of physics courses. It is also hoped it will help teachers of physics interested in improving the enrollment in their subject. The information is to be confidential. Fill in the other information on the answer sheet, but omit your name, and the name of your instructor.

The questionnaire is in two parts, A and B.

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 (this space has a small number 1 above it.) If the statement is false (F) blacken the corresponding space under F on the answer sheet (this space has a small number 2 above it). If the statement does not apply, or you don't know, blacken the corresponding space with the small number 3 above it on the answer sheet.

PART A

1) I don't need physics for enrollment in university.
2) I need physics for enrollment in an Institute of Technology.
3) I don't need physics for my further education.
4) I need physics for my choice of career.
5) I've been told that physics is a subject for boys.
6) I've been told that physics is a very difficult subject.
7) I've been told that you need to be good in mathematics to be good in physics.
8) My junior high counsellor advised me to take Physics 10.

9) My junior high counsellor left the choice of Grade X science to me.
10) My senior high counsellor advised me to take Physics 10.
11) I've been told that chemistry goes with physics.
12) I've been told that chemistry goes with biology.
13) I've been told that biology goes with physics.
14) I've been told that I need two sciences for "matric."
15) I have credit in Physics 10.

If you do not have credit in Physics 10, answer questions 16 to 18 inclusive, and then go on to Part B.

If you do have credit in Physics 10, skip questions 16 to 18 inclusive and then go on with question 19 and following.

16) I needed biology so I decided not to take Physics 10.
17) I didn't take Physics 10 because I didn't need it for my career.
18) I needed chemistry, so I decided not to take Physics 10.
19) I had no choice, I had to take Physics 10.
20) Biology didn't appeal to me, so I took Physics 10.
21) I couldn't get biology (or chemistry) until Grade XI, so I took Physics 10.
22) I thought I needed physics for my career, so I took Physics 10.
23) I took Physics 10, though I didn't need it for my career.
24) I have credit, or am now enrolled in Physics 30, or 30X, or 32.

If you do not have credit in, or are not enrolled in, Physics 30, 30X, or 32, answer questions 25 and 26, and then go on to Part B.

If you do have credit or are enrolled in Physics 30, 30X, or 32, skip questions 25 and 26 and then go on with questions 27 and following.

25) I don't have room in my timetable for physics.

Continued....

26) I dropped physics when the universities changed their entrance requirements in some faculties from six courses to five.
27) I'm taking physics because I have the prerequisites.
28) I'm taking physics to fill out my timetable.
29) I'm taking physics because my career plans are vague, and I want to keep as many doors open as possible.

GO ON TO PART B

INSTRUCTIONS FOR COMPLETING PART B

There are some statements about physics in this section. There are also some statements about the way science is taught and some about science teachers. There are also some statements about science in junior high. You may agree with some of the statements and you may disagree with others. That is exactly what you will be asked to do.

After you have carefully read a statement, decide whether or not you agree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree, mildly or strongly.

Then, find the number of that statement on the answer sheet, and blacken the space by the

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

Example

00. I would like to have a lot of money.
00. 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.

Continued....

30) You have to be good in mathematics to be good in physics.
31) You have to really know science to teach it well.
32) Science teachers don't have to have a sense of humor.
33) A good method of teaching science is to write notes on the board most of the time.
34) Physics is a course that is slanted toward boys.
35) Physics is one of the most difficult high school subjects.
36) Most of my high school science courses had enough experiments.
37) Physics deals with things that the average person needs to know.
38) In science courses, one ought to go on field trips often.
39) There was too much lab work in my Grade IX science course.
40) Studying internal combustion engines in Grade IX was boring.
41) Science courses ought to be mostly lectures.
42) Science courses ought to prepare you for your career.
43) Science teachers ought to remember that at one time they didn't know any science.
44) Good science teachers are strict in class.
45) Physics is mostly a bunch of formulas.
46) Chemistry goes best with biology.
47) The science teacher's main job is to get the students involved in the subject.
48) You learn more from demonstrations the teacher does than experiments you do yourself.
49) A good way to teach light (optics) is to draw ray diagrams.
50) Grade VIII science was a <u>work</u> course, compared to English, which was a <u>fun</u> course.
51) Most high school science labs seem to relate to the course.
52) The science teacher ought to be friends with the whole class, but not with any one person.
53) Science teachers ought to be forceful and thorough.
54) To me, biology is more appealing than physics.
55) The most interesting part of physics is the problem solving.

Continued....

56) The best science teachers explain things simply.
57) The study of rocks in Grade VIII was enjoyable.
58) Grade IX science seemed to be mostly "read the chapter and make notes."
59) I expect the science teacher to enjoy the labs as much as I do.
60) I see a close connection between physics and my choice of career.
61) Grade XII science teachers should teach for finals most of the year.
62) A well educated person ought to have taken physics.
63) In junior high science, the best part was doing something with equipment.
64) The plant study made Grade VII science interesting.

LAST FIRST MIDDLE DATE AGE SEX M OR F DATE OF BIRTH

CITY GRADE OR CLASS INSTRUCTOR

F TEST PART 1 2

CTIONS: Read each question and its numbered answers. When have decided which answer is correct, blacken the corresponding e on this sheet with a No. 2 pencil. Make your mark as long as air of lines, and completely fill the area between the pair of lines. u change your mind, erase your first mark COMPLETELY. Make tray marks; they may count against you.

IDENTIFICATION NUMBER

SAMPLE

ICAGO is
a country 1-4 a city
a mountain 1-5 a state
an island

SCORES

1 5
2 6
3 7
4 8

	F				T	F				T	F				T	F			
	2	3	4	5	2	1	2	3	4	5	3	1	2	3	4	5	4	1	2	3	4	5
	2	3	4	5	6	1	2	3	4	5	7	1	2	3	4	5	8	1	2	3	4	5
	2	3	4	5	10	1	2	3	4	5	11	1	2	3	4	5	12	1	2	3	4	5
	2	3	4	5	14	1	2	3	4	5	15	1	2	3	4	5	16	1	2	3	4	5
	2	3	4	5	18	1	2	3	4	5	19	1	2	3	4	5	20	1	2	3	4	5
	2	3	4	5	22	1	2	3	4	5	23	1	2	3	4	5	24	1	2	3	4	5
	2	3	4	5	26	1	2	3	4	5	27	1	2	3	4	5	28	1	2	3	4	5
	2	3	4	5	30	1	2	3	4	5	31	1	2	3	4	5	32	1	2	3	4	5
	2	3	4	5	34	1	2	3	4	5	35	1	2	3	4	5	36	1	2	3	4	5
	2	3	4	5	38	1	2	3	4	5	39	1	2	3	4	5	40	1	2	3	4	5
	2	3	4	5	42	1	2	3	4	5	43	1	2	3	4	5	44	1	2	3	4	5
	2	3	4	5	46	1	2	3	4	5	47	1	2	3	4	5	48	1	2	3	4	5
	2	3	4	5	50	1	2	3	4	5	51	1	2	3	4	5	52	1	2	3	4	5
	2	3	4	5	54	1	2	3	4	5	55	1	2	3	4	5	56	1	2	3	4	5
	2	3	4	5	58	1	2	3	4	5	59	1	2	3	4	5	60	1	2	3	4	5
	2	3	4	5	62	1	2	3	4	5	63	1	2	3	4	5	64	1	2	3	4	5
	2	3	4	5	66	1	2	3	4	5	67	1	2	3	4	5	68	1	2	3	4	5
	2	3	4	5	70	1	2	3	4	5	71	1	2	3	4	5	72	1	2	3	4	5
	2	3	4	5	74	1	2	3	4	5	75	1	2	3	4	5	76	1	2	3	4	5
	2	3	4	5	78	1	2	3	4	5	79	1	2	3	4	5	80	1	2	3	4	5
	2	3	4	5	82	1	2	3	4	5	83	1	2	3	4	5	84	1	2	3	4	5
	2	3	4	5	86	1	2	3	4	5	87	1	2	3	4	5	88	1	2	3	4	5
	2	3	4	5	90	1	2	3	4	5	91	1	2	3	4	5	92	1	2	3	4	5
	2	3	4	5	94	1	2	3	4	5	95	1	2	3	4	5	96	1	2	3	4	5
	2	3	4	5	98	1	2	3	4	5	99	1	2	3	4	5	100	1	2	3	4	5
	2	3	4	5	102	1	2	3	4	5	103	1	2	3	4	5	104	1	2	3	4	5
	2	3	4	5	106	1	2	3	4	5	107	1	2	3	4	5	108	1	2	3	4	5
	2	3	4	5	110	1	2	3	4	5	111	1	2	3	4	5	112	1	2	3	4	5
	2	3	4	5	114	1	2	3	4	5	115	1	2	3	4	5	116	1	2	3	4	5
	2	3	4	5	118	1	2	3	4	5	119	1	2	3	4	5	120	1	2	3	4	5
	2	3	4	5	122	1	2	3	4	5	123	1	2	3	4	5	124	1	2	3	4	5
	2	3	4	5	126	1	2	3	4	5	127	1	2	3	4	5	128	1	2	3	4	5
	2	3	4	5	130	1	2	3	4	5	131	1	2	3	4	5	132	1	2	3	4	5
	2	3	4	5	134	1	2	3	4	5	135	1	2	3	4	5	136	1	2	3	4	5
	2	3	4	5	138	1	2	3	4	5	139	1	2	3	4	5	140	1	2	3	4	5
	2	3	4	5	142	1	2	3	4	5	143	1	2	3	4	5	144	1	2	3	4	5
	2	3	4	5	146	1	2	3	4	5	147	1	2	3	4	5	148	1	2	3	4	5
	2	3	4	5	150	1	2	3	4	5												

IBM 1230 DOCUMENT NO. 505 WHICH CAN BE USED IN LIEU OF IBM 805 FORM NO. 1000A 155 AND 1000B 108.

APPENDIX B

ATTITUDE ITEMS GROUPED BY ATTITUDE OBJECT

ATTITUDE ITEMS GROUPED BY ATTITUDE OBJECT

Physics

30) You have to be good in mathematics to be good in physics.
34) Physics is a course that is slanted toward boys.
35) Physics is one of the most difficult high school subjects.
37) Physics deals with things that the average person needs to know.
45) Physics is mostly a bunch of formulas.
46) Chemistry goes best with biology.
54) To me, biology is more appealing than physics.
55) The most interesting part of physics is the problem solving.
60) I see a close connection between physics and my choice of career.
62) A well educated person ought to have taken physics.

Science Teaching

31) You have to really know science to teach it well.
33) A good method of teaching science is to write notes on the board most of the time.
36) Most of my high school science courses had enough experiments.
38) In science courses, one ought to go on field trips often.
41) Science courses ought to be mostly lectures.
42) Science courses ought to prepare you for your career.
48) You learn more from demonstrations the teacher does than experiments you do yourself.
49) A good way to teach light (optics) is to draw ray diagrams.
51) Most high school science labs seem to relate to the course.
61) Grade XII science teachers should teach for finals most of the year.

Science Teacher

32) Science teachers don't have to have a sense of humor.
43) Science teachers ought to remember that at one time they didn't know any science.

44) Good science teachers are strict in class.
47) The science teacher's main job is to get the students involved in the subject.
52) The science teacher ought to be friends with the whole class, but not with any one person.
53) Science teachers ought to be forceful and thorough.
56) The best science teachers explain things simply.
59) I expect the science teacher to enjoy the labs as much as I do.

Junior High Science

39) There was too much lab work in my Grade IX science course.
40) Studying internal combustion engines in Grade IX was boring.
50) Grade VIII science was a work course, compared to English, which was a fun course.
57) The study of rocks in Grade VIII was enjoyable.
58) Grade IX science seemed to be mostly "read the chapter and make notes."
63) In junior high science, the best part was doing something with equipment.
64) The plant study made Grade VII science interesting.

APPENDIX C

WHOLE POPULATION CHOICE DISTRIBUTION BY VARIABLE

TABLE XIII

WHOLE POPULATION CHOICE DISTRIBUTION BY VARIABLE

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
VARIABLE #1, "I don't need physics for enrollment in university."											
	"yes" - 467 subjects					"no" - 284 subjects					
	D_{max} for .01 sig. -.114**					D_{max} for .05 sig. -.092*					
35**	26.6	29.3	23.1	14.3	6.4	21.8	29.6	11.6	21.1	15.8	+.160
37**	5.1	21.2	24.0	30.8	18.6	14.8	31.2	12.0	29.2	12.7	-.198
38*	33.0	37.9	16.7	9.4	2.8	27.8	33.1	20.4	12.7	5.6	+.100
39*	4.1	4.9	16.3	34.9	39.4	4.9	7.4	22.9	27.1	37.7	-.099
40**	22.7	17.3	14.1	25.9	19.3	13.4	11.6	15.8	26.8	32.4	+.150
43**	41.5	25.1	23.6	6.0	3.9	28.9	27.8	31.0	5.3	6.7	+.126
45**	15.4	29.6	35.1	13.9	5.8	19.4	36.3	12.0	18.7	13.4	+.124
46**	28.3	29.3	30.2	8.6	3.2	21.5	21.8	38.4	10.9	7.4	+.143
48*	11.8	15.2	8.8	29.3	34.7	12.0	18.3	9.9	34.2	25.7	-.093
54**	56.1	12.8	12.4	7.9	10.5	21.1	10.2	22.2	14.4	31.0	+.376
55**	6.6	12.4	44.5	18.6	17.6	15.5	26.8	17.3	22.9	16.5	-.233
56**	52.7	27.8	7.3	9.4	2.4	41.2	37.0	10.9	6.0	4.2	+.115
60**	7.7	7.3	15.2	16.7	53.1	29.6	22.5	20.1	12.7	15.1	-.420
62**	6.6	20.1	18.2	22.7	32.1	16.9	27.1	22.9	17.6	14.8	-.220
64**	23.3	28.7	23.3	13.3	10.3	15.8	19.0	28.9	15.1	19.4	+.172

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
VARIABLE #2, "I need physics for enrollment in an Institute of Technology."											
	"yes" - 220 subjects					"no" - 417 subjects					
	Dmax for .01 sig. .127**					Dmax for .05 sig. .097*					
37**	13.2	30.5	20.0	22.3	13.6	7.0	23.3	20.4	30.5	18.9	+.134
39**	5.9	5.5	23.6	37.3	27.3	4.1	7.4	17.5	30.2	40.5	+.131
46*	16.8	27.3	38.2	11.8	5.5	29.0	25.2	31.7	8.9	5.0	-.121
54**	34.1	8.2	19.1	10.0	27.7	46.5	12.9	17.7	9.8	12.5	-.171
55*	10.5	22.7	27.7	22.7	15.5	8.2	14.6	40.3	20.1	16.5	+.104
60**	27.3	20.5	11.8	13.6	26.8	10.3	9.1	18.7	15.8	46.0	+.284
62**	14.1	25.5	23.2	17.7	19.5	7.7	19.4	21.1	20.1	31.4	+.146
VARIABLE #3, "I don't need physics for my further education."											
	"yes" - 502 subjects					"no" - 312 subjects					
	Dmax for .01 sig. .109**					Dmax for .05 sig. .088*					
34*	14.3	36.9	19.3	15.7	13.5	11.5	36.9	13.1	23.7	14.7	+.090
35**	27.7	28.9	25.7	11.2	6.4	18.3	31.1	11.5	24.7	14.4	+.214
37**	3.4	20.1	27.3	30.1	18.9	16.3	33.3	11.5	27.6	11.1	-.261
38**	31.9	39.6	15.7	9.2	3.2	28.8	30.8	21.5	14.1	4.8	+.119
40**	23.7	18.1	13.7	24.7	19.3	13.1	11.2	15.1	28.5	32.1	+.175
45**	15.9	28.1	38.2	12.7	4.6	16.3	36.9	11.2	19.2	16.3	+.178
46**	26.7	28.7	33.1	8.2	3.2	20.8	23.7	36.5	11.2	7.4	+.109
48**	10.6	15.1	9.0	28.9	36.3	11.9	18.9	9.3	34.9	25.0	-.114
50*	6.8	15.9	36.9	21.5	18.9	4.5	11.5	38.8	16.7	27.9	+.096
52*	42.4	30.1	13.7	9.0	4.8	32.7	34.6	19.9	9.0	3.8	+.097

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
54**	54.4	13.9	16.1	7.6	7.8	22.8	7.7	21.5	14.7	32.4	+.378
55**	5.0	11.4	46.8	18.1	18.5	16.7	28.2	17.0	24.4	12.8	-.285
59*	25.3	28.3	23.9	17.3	5.0	16.0	30.4	29.2	15.7	8.7	+.093
60**	3.8	6.4	15.5	16.1	58.2	34.6	23.7	18.9	13.5	9.3	-.515
62**	5.2	16.3	19.5	23.3	35.3	18.3	29.8	20.5	18.9	12.2	-.276
64**	23.3	30.5	21.7	12.9	9.8	15.1	19.9	31.1	16.0	17.0	+.188
VARIABLE #4, "I need physics for my choice of career."											
	"yes" - 270 subjects					"no" - 536 subjects					
	Dmax for .01 sig. .113**					Dmax for .05 sig. .091*					
35**	17.0	29.6	15.9	21.9	15.6	28.0	29.3	22.6	13.2	6.7	-.174
37**	18.9	30.4	14.1	24.4	12.2	3.2	21.8	24.4	32.3	18.1	+.243
40**	13.7	14.8	14.4	24.4	32.6	23.5	16.6	13.8	25.6	20.0	-.122
54**	27.8	7.4	17.4	15.2	31.5	51.3	12.9	16.6	8.0	10.8	-.290
55**	15.2	28.1	18.9	23.7	13.3	7.3	12.1	44.0	18.8	17.4	+.239
60**	38.1	24.1	13.0	12.2	12.6	5.2	7.1	16.8	16.4	54.5	+.499
62**	18.5	27.8	20.4	19.3	14.1	6.2	18.1	20.0	22.4	32.8	+.224
64*	15.9	24.8	25.9	15.9	16.3	22.9	27.2	24.3	12.9	11.2	-.094
VARIABLE #5, "I've been told that physics is a subject for boys."											
	"yes" - 207 subjects					"no" - 581 subjects					
	Dmax for .01 sig. .123**					Dmax for .05 sig. .099*					
34**	28.0	43.0	13.0	10.1	5.8	8.8	34.8	18.1	21.5	16.7	+.274
40*	27.5	17.9	14.0	18.4	22.2	18.9	14.8	14.6	27.7	23.4	+.177

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
45*	16.9	39.1	24.6	12.1	6.8	15.5	28.4	29.9	16.2	9.8	+.121
46*	31.9	25.1	32.4	6.8	3.4	21.5	27.7	34.8	10.5	5.3	+.104
VARIABLE #6, "I've been told that Physics is a very difficult subject."											
	"yes" - 590 subjects					"no" - 250 subjects					
	Dmax for .01 sig. .115**					Dmax for .05 sig. .092*					
30*	30.8	53.4	8.0	5.3	1.4	20.8	54.0	9.2	12.4	2.8	+.100
34**	14.9	39.8	17.1	16.1	11.9	10.4	32.8	17.2	23.2	16.4	+.115
35**	31.4	31.7	20.7	11.9	4.2	8.0	25.2	17.6	28.4	20.8	+.330
37**	6.9	21.4	23.6	30.7	17.5	10.0	33.2	18.0	24.8	13.6	-.149
38*	33.1	36.9	18.0	9.5	2.4	25.6	34.0	18.4	14.4	7.2	+.104
40**	23.6	16.1	12.2	24.7	23.2	10.8	15.6	20.8	26.0	26.4	+.133
45**	15.6	33.4	30.8	13.9	6.1	17.6	26.8	20.8	18.8	15.6	+.146
53*	16.8	34.9	15.1	22.5	10.5	17.2	34.8	14.0	22.4	11.2	-.092
54**	48.3	11.7	15.9	8.5	15.3	27.6	10.0	22.8	14.0	24.8	+.224
55**	7.6	15.4	40.7	19.2	16.8	14.4	21.2	25.2	22.0	16.4	-.126
60**	12.0	10.2	20.2	13.6	44.1	21.6	19.6	14.8	18.4	25.6	-.189
62**	9.5	19.7	20.7	19.8	30.0	10.8	26.8	20.8	23.6	17.6	-.123
64**	21.7	29.2	22.2	13.4	11.7	17.2	21.2	33.6	13.6	14.0	+.125
VARIABLE #7, "I've been told that you have to be good in mathematics to be good in physics."											
	"yes" - 603 subjects					"no" - 222 subjects					
	Dmax for .01 sig. .119**					Dmax for .05 sig. .096*					
30**	34.7	53.4	5.3	4.5	1.0	12.2	53.2	14.0	15.8	4.1	+.227

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
35**	27.7	31.2	18.2	15.4	7.5	16.2	24.3	23.4	20.7	15.3	+.185
39*	3.3	6.3	19.7	35.0	35.3	5.4	5.0	15.8	27.9	45.9	+.102
45**	18.2	33.3	25.4	15.3	7.5	11.7	27.0	32.4	16.2	12.6	+.128
50*	6.3	15.6	37.8	19.2	20.9	5.9	9.0	35.1	22.5	27.0	+.097
51*	24.2	54.4	10.3	8.5	2.7	34.2	43.2	8.6	10.4	3.6	-.100
59*	22.7	31.0	24.5	16.3	5.3	18.0	24.8	31.1	17.6	8.6	+.109
VARIABLE #8, "My junior high counsellor advised me to take Physics 10."											
	"yes" - 206 subjects					"no" - 567 subjects					
	Dmax for .01 sig. .124**					Dmax for .05 sig. .100*					
36*	25.7	30.1	8.7	25.2	10.1	25.6	36.0	12.9	15.9	9.5	-.100
37*	8.3	31.1	11.7	31.1	18.0	6.5	22.0	26.3	29.3	15.7	+.109
40*	14.6	15.0	12.6	25.2	32.0	23.1	16.0	13.4	24.9	22.2	-.103
45**	22.8	38.3	13.1	13.1	12.1	13.9	29.1	33.5	16.0	7.2	+.181
52*	30.1	42.2	13.1	6.8	7.8	42.2	28.9	17.1	8.3	3.5	-.121
54*	35.9	13.1	16.5	12.6	21.4	46.0	10.8	18.5	8.1	16.0	-.101
55**	10.7	23.3	18.0	21.4	26.2	9.0	15.0	43.2	19.6	13.1	-.152
59**	14.1	23.3	29.1	21.4	12.1	23.5	31.7	25.0	14.6	4.9	-.178
62**	11.7	28.2	19.4	21.4	18.9	7.8	19.2	21.5	21.0	30.3	+.129
64*	18.9	20.9	31.1	15.0	12.6	21.0	30.2	21.0	13.4	13.2	-.114

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
VARIABLE #9, "My junior high counsellor left the choice of Grade X science to me."											
	"yes" - 563 subjects					"no" - 239 subjects					
	Dmax for .01 sig. .117**					Dmax for .05 sig. .095*					
48**	8.5	16.9	8.7	31.3	35.5	15.9	19.2	10.9	26.8	27.2	-.119
55*	8.0	16.3	40.3	20.8	13.9	10.0	18.4	26.8	21.3	23.4	+.094
VARIABLE #10, "My senior high counsellor advised me to take Physics 10."											
	"yes" - 146 subjects					"no" - 631 subjects					
	Dmax for .01 sig. .140**					Dmax for .05 sig. .112*					
35*	30.1	34.2	9.6	20.5	5.5	23.1	27.7	23.6	14.9	10.5	+.135
36*	24.7	31.5	6.2	32.2	5.5	26.2	33.6	13.8	16.5	9.7	-.113
37**	13.7	31.5	8.9	26.7	18.5	6.2	23.1	25.2	29.8	15.7	+.159
45*	19.9	36.3	16.4	17.1	10.3	15.4	29.3	32.0	14.7	8.4	+.116
54*	36.3	12.3	15.1	13.7	22.6	45.6	11.4	17.9	7.8	16.6	-.112
55*	9.6	24.0	17.8	25.3	23.3	8.9	15.2	41.0	19.5	14.9	-.137
60*	19.2	17.8	13.7	15.8	33.6	13.2	10.8	19.3	14.9	41.8	+.130
62*	14.4	25.3	17.1	19.9	21.9	7.4	20.1	21.6	21.6	29.2	+.122
VARIABLE #11, "I've been told that chemistry goes with physics."											
	"yes" - 358 subjects					"no" - 457 subjects					
	Dmax for .01 sig. .107**					Dmax for .05 sig. .086*					
35*	23.5	35.2	15.9	16.2	9.2	24.3	25.4	23.4	16.6	10.1	+.090
40*	18.4	14.2	13.1	23.7	30.4	21.4	16.4	15.3	26.3	19.9	+.100

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
45*	17.6	35.2	20.9	16.2	9.5	15.1	28.7	32.6	14.7	9.0	+.090
55**	9.5	17.0	29.1	24.9	19.3	9.8	16.6	40.7	16.8	15.3	-.115
62**	12.8	24.9	18.7	19.8	23.2	7.7	18.8	21.2	22.1	30.0	+.112
64*	20.1	23.2	23.7	13.7	17.0	20.6	29.5	25.8	13.3	10.1	-.089
VARIABLE #12, "I've been told that chemistry goes with biology."											
	"yes" - 466 subjects					"no" - 344 subjects					
	Dmax for .01 sig. .108**					Dmax for 105 sig. .087*					
34*	15.2	39.7	15.0	16.1	13.9	11.6	33.4	19.5	21.5	13.7	+.099
39*	4.7	5.2	17.6	30.0	42.1	3.5	6.1	19.2	37.5	33.7	-.088
46**	36.3	33.3	22.5	4.9	2.8	11.9	18.9	45.3	16.3	7.3	+.388
54**	48.7	14.4	15.2	7.5	13.9	37.2	8.7	18.3	13.1	21.8	+.172
VARIABLE #13, "I've been told that biology goes with physics."											
	"yes" - 54 subjects					"no" - 750 subjects					
	Dmax for .01 sig. .214**					Dmax for .05 sig. .172*					
30*	33.3	31.5	14.8	14.8	3.7	28.0	54.8	7.6	6.9	1.5	-.180
32**	18.5	18.5	22.2	20.4	20.4	7.5	11.3	18.7	27.3	34.9	.217
40**	18.5	25.9	27.8	16.7	11.1	20.5	14.1	13.2	26.3	25.5	+.244
41*	7.4	16.7	13.0	33.3	29.6	4.5	12.4	8.1	25.7	49.1	+.197
48*	13.0	16.7	25.9	22.2	22.2	10.8	16.7	7.9	31.5	33.1	+.202
60*	31.5	13.0	20.4	7.4	27.8	14.1	12.3	17.9	15.5	40.3	+.206
62*	22.2	25.9	18.5	16.7	14.8	9.2	21.5	20.1	21.2	27.7	+.174

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
VARIABLE #14, "I've been told that I need two sciences for "matric."											
	"yes" - 667 subjects					"no" - 170 subjects					
	Dmax for .01 sig. .130**					Dmax for .05 sig. .105*					
42*	33.3	37.3	12.5	12.6	3.9	24.1	34.7	15.9	17.6	7.1	+.118
VARIABLE #15, "I have credit in Physics 10."											
	"yes" - 588 subjects					"no" - 279 subjects					
	Dmax for .01 sig. .110**					Dmax for 105 sig. .089*					
30**	25.3	59.5	3.6	8.2	2.4	33.7	39.8	19.4	5.4	.4	+.113
33*	7.8	14.3	8.8	27.4	41.5	8.6	19.7	12.9	18.6	39.8	-.103
35**	24.1	31.6	11.4	20.4	12.2	24.4	24.7	38.0	9.3	3.6	-.200
37**	10.4	29.4	11.9	32.0	16.2	2.9	16.1	42.7	22.6	15.8	+.208
38*	29.6	33.8	19.4	12.6	4.4	33.0	40.5	16.5	7.5	2.2	-.101
40**	15.0	15.0	14.3	28.1	27.4	29.4	16.8	14.7	20.8	17.9	-.183
43*	34.5	25.9	28.9	5.6	5.1	41.6	28.0	19.4	5.7	5.0	-.092
45**	18.5	37.2	12.8	19.2	12.1	11.5	18.3	60.2	7.5	2.2	+.259
48**	11.9	16.7	8.7	34.7	27.9	9.7	16.8	11.5	22.9	39.1	+.201
49**	10.0	28.2	32.7	19.7	9.4	5.4	16.1	54.5	15.4	8.6	+.167
50*	5.4	12.2	37.8	18.7	25.5	6.8	19.0	35.1	22.2	16.8	-.090
52**	33.8	34.2	17.2	9.7	5.1	47.7	28.0	14.7	6.8	2.9	-.139
54**	32.0	10.7	19.0	13.4	24.5	62.7	13.3	16.5	3.6	3.2	-.333
55**	12.4	22.6	18.2	25.2	21.1	3.6	5.7	73.5	10.0	6.8	-.296
57**	9.7	21.3	41.3	15.0	12.6	15.4	29.7	29.7	15.1	9.3	-.141
59**	17.0	27.9	27.7	19.0	8.2	30.5	31.5	22.9	11.5	3.6	-.171

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
60**	19.9	15.3	17.5	17.3	29.9	5.0	7.9	20.4	9.7	57.0	+.270
61**	27.4	26.7	9.9	18.9	16.3	33.3	30.1	12.5	12.5	11.1	-.119
62**	12.8	26.4	19.7	21.3	19.6	3.2	12.9	22.2	20.8	40.5	+.231
64**	14.1	24.7	28.9	14.8	16.2	32.6	30.8	16.8	11.8	6.5	-.246
VARIABLE #16, "I needed biology so I decided not to take Physics 10."											
	"yes" - 105 subjects					"no" - 159 subjects					
	Dmax for sig. .01 .191**					Dmax for sig. .05 .154*					
33*	7.6	27.6	15.2	17.1	32.4	7.5	15.7	9.4	20.1	46.5	+.178
40**	39.0	18.1	12.4	18.1	12.4	22.0	15.7	17.6	23.9	20.1	+.194
46**	37.1	28.6	28.6	3.8	1.9	14.5	27.7	45.9	8.2	3.1	+.235
54**	79.0	11.4	3.8	3.8	1.9	54.1	13.8	24.5	1.9	4.4	+.249
61*	44.8	27.6	6.7	10.5	10.5	26.4	32.7	15.7	13.8	10.1	+.184
62*	1.9	9.5	18.1	21.9	48.6	5.0	15.1	25.2	20.1	34.0	-.158
VARIABLE #17, "I didn't take physics because I didn't need it for my career."											
	"yes" - 205 subjects					"no" - 70 subjects					
	Dmax for .01 sig. .210**					Dmax for .05 sig. .169*					
37*	2.4	13.2	44.4	22.0	18.0	10.0	25.7	30.0	20.0	14.3	-.201
60*	4.4	6.3	21.5	7.3	60.5	11.4	10.0	18.6	17.1	42.9	-.176

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
VARIABLE #18, "I needed chemistry, so I decided not to take Physics 10."											
	"yes" - 97 subjects					"no" - 156 subjects					
	Dmax for .01 sig. .196**					Dmax for .05 sig. .158*					
33**	9.3	30.9	9.3	19.6	30.9	6.4	14.1	14.7	19.9	44.2	+.197
34*	20.6	35.1	26.8	9.3	8.2	12.2	32.1	20.5	23.1	12.2	+.177
46**	34.0	33.0	25.8	5.2	2.1	14.7	26.9	48.7	6.4	2.6	+.254
54*	75.3	11.3	8.2	4.1	1.0	56.4	12.8	22.4	3.8	3.2	+.189
61**	46.4	23.7	8.2	12.4	9.3	25.6	35.9	14.7	12.8	10.3	+.208
62*	2.1	10.3	15.5	19.6	51.5	3.2	14.7	25.0	22.4	34.6	-.178
VARIABLE #19, "I had no choice, I had to take Physics 10."											
	"yes" - 213 subjects					"no" - 380 subjects					
	Dmax for .01 sig. .123**					Dmax for .05 sig. .105*					
35**	32.4	27.7	13.1	19.2	7.5	19.7	34.2	11.6	19.7	14.5	+.127
46*	31.0	27.2	28.6	8.0	4.7	22.6	25.0	35.3	11.1	5.8	+.106
54**	40.8	12.7	17.4	9.4	19.2	29.2	11.1	17.9	14.7	26.6	+.132
62*	12.2	23.9	15.0	22.1	26.8	12.9	26.1	22.9	21.6	16.1	-.108
VARIABLE #20, "Biology didn't appeal to me, so I took Physics 10."											
	"yes" - 178 subjects					"no" - 366 subjects					
	Dmax for .01 sig. .139**					Dmax for .05 sig. .112*					
38**	20.8	32.6	23.0	17.4	6.2	34.7	35.2	15.8	10.4	3.6	-.165
39*	3.4	4.5	19.7	41.0	30.9	4.6	6.3	18.0	27.3	43.4	+.124

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	Dmax
46**	12.9	17.4	46.1	15.2	7.9	33.6	29.5	23.8	8.7	4.4	-.328
54**	11.2	6.7	17.4	20.2	43.8	46.2	12.6	17.5	9.6	13.9	-.410
59**	22.5	30.9	21.9	16.3	8.4	14.2	26.5	31.7	20.5	6.8	+.127
60**	25.8	17.4	21.9	14.6	20.2	16.7	15.6	15.0	17.8	35.0	+.178

VARIABLE #21, "I couldn't get biology (or chemistry) until Grade XI, so I took Physics 10."

	"yes" - 91 subjects					"no" - 451 subjects					
	Dmax for .01 sig. .174**					Dmax for .05 sig. .141*					
35*	38.5	28.6	14.3	13.2	5.5	21.3	33.0	10.6	20.8	14.0	+.172
45*	24.2	44.0	14.3	13.2	4.4	16.9	36.1	12.4	21.5	12.9	+.171
46**	39.6	27.5	22.0	8.8	2.2	23.9	23.7	34.8	11.3	6.0	+.195
54**	56.0	17.6	12.1	3.3	1.1	27.3	10.2	20.0	15.5	26.6	+.361
60**	7.7	8.8	15.4	20.9	47.3	21.3	17.7	19.3	16.4	25.3	-.264
64**	22.0	33.0	26.4	8.8	8.8	11.5	25.1	29.3	16.0	17.1	+.184

VARIABLE #22, "I thought I needed physics for my career, so I took Physics 10."

	"yes" - 279 subjects					"no" - 271 subjects					
	Dmax for .01 sig. .129**					Dmax for .05 sig. .104*					
35*	19.0	36.2	10.0	20.4	14.3	29.5	26.9	13.3	19.6	10.3	-.105
37**	15.3	34.1	10.0	27.2	12.9	5.5	24.7	14.0	37.3	18.5	+.193
44*	7.2	18.3	15.4	32.3	10.0	10.0	21.4	20.3	27.7	20.7	-.108
54**	25.1	8.6	20.1	16.5	29.4	40.2	12.9	17.3	10.3	18.8	-.194
55**	15.8	27.6	13.3	21.1	21.5	10.3	19.2	24.7	26.6	18.8	+.139

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
60**	28.7	22.6	15.4	16.5	16.8	10.7	9.2	19.2	18.1	42.8	+.314
62**	17.2	31.9	21.5	17.9	11.1	8.1	20.3	18.1	25.5	27.7	+.241

VARIABLE #23, "I took Physics 10, though I didn't need it for my career."

	"yes" - 247 subjects					"no" - 279 subjects					
	Dmax for .01 sig. .133**					Dmax for .05 sig. .107*					
37**	6.1	26.7	10.9	38.1	18.2	14.0	31.2	12.2	28.0	14.3	-.137
46**	27.1	31.6	27.5	9.7	3.6	24.4	20.8	35.1	12.5	7.2	+.135
54**	44.1	14.2	13.4	9.7	18.2	22.9	8.6	22.6	15.8	30.1	+.268
60**	7.7	8.1	15.0	18.6	50.6	29.7	22.2	18.3	15.4	14.3	-.394
62**	6.5	23.1	16.2	25.1	28.7	16.1	29.4	21.9	19.7	12.5	-.216
63*	21.5	32.8	26.3	14.6	4.5	29.4	38.0	21.9	7.5	2.9	-.131

VARIABLE #24a, "I have credit, or am now enrolled in, Physics 30, or 30X, or 32."

	"yes" - 403 subjects					"no" - 200 subjects					
	Dmax for .01 sig. .131**					Dmax for .05 sig. .106*					
35**	21.8	33.3	7.7	23.6	13.6	28.5	30.5	19.5	13.0	8.0	-.157
37**	12.7	31.3	9.9	31.3	14.6	5.5	24.0	17.5	32.5	20.5	+.145
40**	10.4	13.2	15.1	30.5	30.8	26.0	18.5	13.5	22.5	18.5	-.209
45**	17.9	38.7	6.5	21.8	15.1	19.5	32.0	29.0	14.0	5.0	-.174
46*	22.3	24.8	36.7	10.4	5.7	31.5	27.0	26.5	10.5	4.0	-.114
54**	20.6	8.9	21.6	17.9	30.8	56.5	15.5	13.0	4.0	10.5	-.425

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
55**	16.4	26.8	10.9	27.0	18.6	4.0	14.5	36.5	19.0	25.0	+.247
56**	41.4	36.5	9.9	7.7	4.0	55.0	25.5	8.5	8.5	2.0	-.136
60**	25.1	18.4	20.6	17.4	18.6	7.0	9.5	15.0	16.0	52.5	+.340
62**	15.6	30.0	21.3	20.3	12.4	6.5	17.5	17.5	23.0	35.0	+.254

VARIABLE #24b, "I have credit, or am now enrolled in Physics 30, or 30X, or 32."

	"yes" - 403 subjects Dmax for .01 sig. .120**					"no response"- 268 subjects Dmax for .05 sig. .097*					
30**	25.8	61.3	1.7	8.2	2.5	33.2	39.6	20.1	4.9	.4	+.143
33*	7.4	14.1	9.4	25.8	42.9	9.0	19.4	12.7	19.0	39.6	-.102
35**	21.8	33.3	7.7	23.6	13.6	24.6	22.4	38.8	10.1	4.1	-.230
37**	12.7	31.3	9.9	31.3	14.6	3.0	16.4	42.9	22.8	14.9	+.246
38**	27.3	33.3	19.4	14.6	5.5	33.2	40.3	16.0	7.8	2.2	-.129
40**	10.4	13.2	15.1	30.5	30.8	29.1	16.8	14.6	20.5	18.7	-.223
43**	31.8	25.8	31.3	5.5	5.7	42.9	26.9	19.8	5.2	4.9	-.122
45**	17.9	38.7	6.5	21.8	15.1	11.2	19.4	59.7	7.1	2.2	-.272
47**	37.5	41.2	8.7	7.9	4.5	49.6	30.2	7.5	9.7	2.6	-.121
48**	12.2	18.4	9.4	34.2	25.8	9.7	16.8	11.9	22.0	39.6	+.138
49**	8.9	29.0	31.5	21.8	8.7	5.6	16.4	53.4	16.0	8.6	+.159
50*	4.7	10.4	38.7	18.9	26.8	7.1	18.3	34.7	22.8	17.2	-.103
51*	29.0	53.6	5.7	8.9	2.7	26.1	46.3	17.2	8.2	1.9	+.102
52**	30.3	36.5	18.9	9.9	4.5	49.3	26.9	14.9	6.3	2.6	-.190
53*	13.9	35.7	13.6	25.6	10.9	19.0	36.9	17.9	18.7	7.5	-.106

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
54**	20.6	8.9	21.6	17.9	30.8	62.7	12.7	16.8	3.7	3.4	-.459
55**	16.4	26.8	10.9	27.0	18.6	3.7	5.2	73.1	10.8	6.7	+.343
57**	8.4	19.9	41.4	17.4	12.9	15.3	29.5	29.5	14.9	10.1	-.165
59**	15.4	27.3	27.5	19.9	9.7	30.6	31.3	22.8	11.6	3.7	-.192
60**	25.1	18.4	20.6	17.4	18.6	6.0	7.5	18.3	10.1	58.2	+.396
61**	26.1	27.8	7.7	20.8	16.6	34.0	29.5	12.7	12.3	11.2	-.146
62**	15.6	30.0	21.2	20.3	12.4	3.4	13.1	22.0	20.5	40.7	+.291
64**	12.4	23.1	31.0	16.1	16.1	33.2	31.0	16.4	11.2	6.7	-.287

VARIABLE #24c, "I have credit, or am now enrolled in, Physics 30, or 30X, or 32."

	"no" - 200 subjects Dmax for .01 sig. .142**					"no response" - 268 subjects Dmax for .05 sig. .114*					
32*	7.5	13.5	25.5	24.0	29.5	7.5	9.3	16.4	29.1	37.3	+.133
35*	28.5	30.5	19.5	13.0	8.0	24.6	22.4	38.8	10.1	4.1	+.120
37**	5.5	24.0	17.5	32.5	20.5	3.0	16.4	42.9	22.8	14.9	-.153
45**	19.5	32.0	29.0	14.0	5.0	11.2	19.4	59.7	7.1	2.2	+.209
46**	31.5	27.0	26.5	10.5	4.0	22.0	29.1	38.8	6.7	3.0	+.164
49**	11.5	25.0	38.5	14.5	10.5	5.6	16.4	53.4	16.0	8.6	+.145
55**	4.0	14.5	36.5	19.0	25.0	3.7	5.2	73.1	10.8	6.7	-.270
59*	21.0	29.0	29.0	16.5	4.5	30.6	31.3	22.8	11.6	3.7	-.119
64**	17.5	28.0	25.5	12.5	15.0	33.2	31.0	16.4	11.2	6.7	-.187

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
VARIABLE #25, "I don't have room in my timetable for physics."											
	"yes" - 79 subjects					"no" - 120 subjects					
	Dmax for .01 sig. .220**					Dmax for .05 sig. .177*					
37*	7.6	30.4	22.8	24.1	15.2	6.7	19.2	16.7	39.2	18.3	+.181
61*	36.7	27.8	12.7	11.4	10.1	21.7	23.3	20.0	16.7	18.3	+.195
VARIABLE #26, "I dropped physics when the universities changed their entrance requirements in some faculties from six courses to five."											
	"yes" - 24 subjects					"no" - 155 subjects					
	Dmax for .01 sig. .333**					Dmax for .05 sig. .268					
35*	41.7	37.5	8.3	8.3	4.2	23.2	27.1	26.5	13.5	9.0	+.289
VARIABLE #27, "I'm taking physics because I have the prerequisites."											
	"yes" - 223 subjects					"no" - 114 subjects					
	Dmax for .01 sig. .175**					Dmax for .05 sig. .141*					
No significant data											
VARIABLE #28, "I'm taking physics to fill out my timetable."											
	"yes" - 76 subjects					"no" - 255 subjects					
	Dmax for .01 sig. .198**					Dmax for .05 sig. .160*					
45**	28.9	44.7	5.3	14.5	6.6	14.9	34.5	8.2	25.1	17.3	+.242
50*	3.9	14.5	48.4	11.8	21.1	3.5	7.5	38.8	19.6	29.8	+.173
60*	10.5	17.1	22.4	17.1	32.9	28.2	18.4	21.2	17.3	14.9	-.190

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
VARIABLE #29, "I'm taking physics because my career plans are vague, and I want to keep as many doors open as possible."											
	"yes" - 219 subjects					"no" - 113 subjects					
	Dmax for .01 sig. .176**					Dmax for .05 sig. .142*					
37*	14.2	33.3	10.5	29.2	12.8	9.7	25.7	7.1	38.1	18.6	+.155
VARIABLE. Female/male											
	"Female" - 213 subjects					"Male" - 217 subjects					
	Dmax for .01 sig. .146**					Dmax for .05 sig. .118*					
34**	20.0	42.0	15.0	13.0	10.0	7.0	37.0	15.0	26.0	15.0	+.180
35**	27.0	27.0	27.0	16.0	4.0	20.0	32.0	11.0	23.0	14.0	+.180
37**	5.0	19.0	30.0	31.0	15.0	11.0	32.0	11.0	27.0	19.0	+.190
40**	29.0	15.0	16.0	22.0	17.0	10.0	16.0	14.0	29.0	31.0	+.199
45*	12.0	27.0	43.0	13.0	5.0	20.0	33.0	15.0	18.0	14.0	-.140
52*	40.0	32.0	18.0	5.0	5.0	28.0	33.0	22.0	12.0	6.0	+.120
54**	59.0	15.0	10.0	9.0	7.0	25.0	13.0	20.0	12.0	30.0	+.360
55*	8.0	12.0	48.0	19.0	14.0	9.0	25.0	21.0	27.0	18.0	-.140
56**	54.0	31.0	8.0	6.0	1.0	35.0	41.0	12.0	8.0	3.0	+.190
57*	13.0	27.0	34.0	17.0	9.0	8.0	18.0	41.0	17.0	16.0	+.140
59**	25.0	31.0	23.0	16.0	3.0	13.0	28.0	26.0	20.0	12.0	+.150
60**	5.0	11.0	19.0	15.0	50.0	22.0	14.0	24.0	16.0	24.0	-.260
62**	5.0	14.0	19.0	24.0	38.0	12.0	28.0	23.0	20.0	18.0	-.240

TABLE XIII (continued)

Item & Sig.	Percentage Distribution "yes" 1	2	3	4	5	Percentage Distribution "no" 1	2	3	4	5	D_{max}
VARIABLE. Female/male (continued)											
	"Female" - 213 subjects					"Male" - 217 subjects					
63*	20.0	34.0	25.0	16.0	3.0	29.0	39.0	24.0	4.0	3.0	-.140
64**	29.0	33.0	20.0	11.0	6.0	12.0	20.0	35.0	12.0	20.0	+.300

Note: Significant choice distribution percentages of responses for items 30-64 inclusive of questionnaire "Grade XII Physics: Why Take It? Why Not?" for 32 pairs of variables.
Data of print-outs II and III.

APPENDIX D

SIGNIFICANT CHOICE DISTRIBUTIONS BY VARIABLES AND ATTITUDE OBJECT

TABLE XIV

SIGNIFICANT CHOICE DISTRIBUTIONS BY VARIABLES AND ATTITUDE OBJECT

Variable	Attitude Object Physics										Attitude Object Science Teaching									
	30	34	35	37	45	46	54	55	60	62	31	33	36	38	41	42	48	49	51	61
1			**	**	**	**	**	**	**	**				*			*			
2				**		*	**	*	**	**										
3		*	**	**	**	**	**	**	**	**				**			**			
4			**	**			**	**	**	**										
5		**			*	*														
6	*	**	**	**	**		**	**	**	**				*						
7	**		**		**														*	
8				*	**		*	**		**			*							
9								*									**			
10			*	**	*		*	*	*	*			*							
11			*		*			**		**										
12		*				**	**													
13	*								*	*					*		*			
14																*				
15	**		**	**	**		**	**	**	**		*		*			**	**		**
16						**	**			*		*								*
17				*					*											
18		*				**	*			*		**								**
19			**			*	**			*										
20						**	**		**					**						
21			*		*	**	**		**											

TABLE XIV (continued)

Variable	Attitude Object: Physics										Attitude Object: Science Teaching									
	30	34	35	37	45	46	54	55	60	62	31	33	36	38	41	42	48	49	51	61
22			*	**			**	**	**	**										
23				**		**	**		**	**										
24a			**	**	**	*	**	**	**	**										
24b	**		**	**	**		**	**	**	**		*		**			**	**	*	**
24c			*	**	**	**		**										**		
25				*																*
26			*																	
27																				
28					**				*											
29				*																
F/M		**	**	**	*		**		*	** **										

Variable	Attitude Object: Science Teachers								Attitude Object: Jr.H.School Science Experiences							
	32	43	44	47	52	53	56	59	39	40	50	57	58	63	64	
1		**					**		*	**					**	
2									**							
3					*			*		**	*				**	
4										**					*	
5										*						
6						*				**					**	
7								*	*		*					
8					*			**		*					*	

TABLE XIV (continued)

Variable	Attitude Object: Science Teachers								Attitude Object: Jr.H.School Science Experiences							
	32	43	44	47	52	53	56	59	39	40	50	57	58	63	64	
9																
10																
11										*						
12									*						*	
13	**									**						
14																
15		*			**			**		**	*	**				
16										**					**	
17																
18																
19																
20								**	*							
21																
22			*												**	
23																
24a							**							*		
24b		**		**	**	*		**		**						
24c	*							*		**	*	**			**	
25															*	
26																
27																
28																
29											*					
F/M					*		**	**		**		*		*	**	

Note: ** - differences significant at .01 level or less
* - differences significant between .05 and .01 level

APPENDIX E

DETAILED ANALYSIS OF RESPONSES RELATED TO
SUB-QUESTION II-a
SUB-QUESTION II-b
SUB-QUESTION II-c
SUB-QUESTION II-d
SUB-QUESTION II-e, VARIABLES 16, 17, 18
SUB-QUESTION II-e, VARIABLES 19, 20, 21, 22, 23

1. Detailed Analysis of Responses Related to Sub-Question II-a

Total group attitudes toward physics. Unless otherwise stated, all items and percentages are shown in Table V. Greatest unanimity of attitude was shown for Item 30, "You have to be good in mathematics to be good in physics," with 81% agreement. This compares with 69.2% (Item 7, Table III) of the subjects who had been told that "You need to be good in mathematics to be good in physics." The next largest D_{max} was shown for item 46, "Chemistry goes best with biology." This item showed 50.9% agreement, which did not fully account for the large D_{max}, others, item 30 and item 60 for example, showing higher percentages of agreement and disagreement. The high percentage of "don't know" responses for item 46, 35.0%, may account for the differences. Item 12, "I've been told that chemistry goes best with biology," had 53.5% agreement. Very few subjects appeared to disagree with what they have been told about the relationship of chemistry and biology.

Item 60, "I see a close connection between physics and my choice of career," had the highest negative

response, with 38.6% strongly disagreeing, 14.8% mildly disagreeing, and only a total of 28% agreement. This could be compared with the positive response to item 4, "I need physics for my choice of career," of 31.0%. This may be also compared to the response to item 24 (Table III), where it was shown that 46.3% of the subjects had credit in, or were enrolled in, Grade XII physics. Few physics students take the subject for reasons not attributable to career needs. Item 62, "A well educated person ought to have taken physics," and item 34, "Physics is a course that is slanted toward boys," have the distinction of having the lowest D_{max}'s in this attitude object group. More students disagree (47.3%), or don't know (20.7%) for item 62 than agree (31.7%). This item also produced 13 of the pairs of groups having significant differences at the .01 level in Table XIV (Appendix D). The percentage of agreement with item 34 was 50.3, and this item showed a significant difference at the .01 level for choices of girls vs. boys. This agreement of 50.3% compared with item 5, Table III, where only 23.8% of the respondents had been told that physics was a subject for boys.

Item 35, "Physics is one of the most difficult high school subjects," showed 53.5% agreement compared to item 6, Table III, in which 67.7% of the respondents had been told that physics is a very difficult subject. "Physics is mostly a bunch of formulas," item 45, showed 47.4% agreement, with a substantial percentage, 28, who refused to commit themselves. Table XIV, Appendix D, shows that at least 10 pairs of groups differed significantly in their response to this statement. For item 54, "To me biology is more appealing than physics," 41.8% strongly agreed, plus 11.6% who agreed mildly, and only 28.0% disagreed. This may be compared to the 46.3% (item 24, Table III) of the population who were enrolled in or had credit in Grade XII physics. Apparently many students, even though enrolled in physics, found biology preferable. Item 55, "The most interesting part of physics is the problem solving," showed 35.9% (highest in this attitude object group) who didn't know, the remainder being divided 26.9% agreeing and 36.6% disagreeing. This item (55) shows 11 pairs of groups who differ significantly (at this .01 level) in their responses (Table XIV, Appendix D).

Item 37, "Physics deals with things the average person needs to know," shows 33% agreement, 45% disagreement, and 13 pairs of groups differing significantly (at the .01 level) in their responses (Table XIV, Appendix D).

Total group attitudes toward science teaching. Unless otherwise stated, all items and percentages refer to Table V. As previously stated, the average D_{max} for this attitude object group was found to be the highest for the four groups. This can be interpreted to mean that greater unanimity of opinion can be expected toward these attitude statements. The highest D_{max} (.514) for all the 35 statements of this attitude portion of the questionnaire was found for item 31, "You have to really know science to teach it well." Of the respondents, 71.4% agreed strongly, and 16.5% agreed mildly with only 7.8% expressing disagreement. It would seem that students expect teachers of science to be well grounded in their subject matter. Next highest D_{max} (.377) in this group was for item 51, "Most high school science labs seem to relate to the course," with 77.7% of the respondents expressing

agreement. Items 31 and 51 showed no significant differences (at the .01 level) between any of the 32 groups identified (Table XIV, Appendix D). Lowest D_{max}'s were for item 49 (.125), "A good way to teach optics is to draw ray diagrams" and item 61 (.169), "Grade XII science teachers should teach for finals most of the year." Agreement with item 49 amounted to 32.7%, disagreement 27.5%, and a very high 39.8% didn't know. As could be expected, three pairs of groups differed significantly at the .01 level on this item (Table XIV). Responses to item 61 were 56.9% agreement, 31.6% disagreement, and 3 pairs of groups differed significantly (at .01 level) in their responses (Table XIV). Sixty-five point six percent of students rejected writing notes on the board as a good method of teaching science (item 33). It is interesting to speculate why 8% of the respondents agreed strongly with this statement. Students also rejected even more strongly the lecture method of instruction (item 41) with 73.3% disagreeing with the statement. Though 62.5% of the respondents disagreed that you learn more from demonstrations the teacher does than from experiments you do yourself, a surprising 28%

of the subjects agreed (item 48). In item 38, "In science courses, one ought to go on field trips often," 66.9% of the students agreed. Item 42, "Science courses ought to prepare you for your career," received 68.1% agreement. "Most of my high school science courses had enough experiments," item 36, drew 59.% of agreement.

Total group attitudes toward science teachers. This group of attitude object responses had an average D_{max} (.248) that was second highest of the four, indicating considerable unanimity of opinion. This was confirmed by the low number of significantly different groups revealed by Table XIV, Appendix D.

Item 47, "The science teacher's main job is to get students involved in the subject," had 42% strongly agree, 36.7% mildly agree, and only 11.8% disagreement. Equally strong concurrence (47.2% + 32.4%) was found with item 56, "The best science teachers explain things simply." Next in frequency of positive response was item 52, "The science teacher ought to be friends with the whole class, but not with any one person," with 38.2%

of the subjects agreeing strongly, 32.0% agreeing mildly, only 13.1% disagreeing. Strong agreement was registered for Item 43, "Science teachers ought to remember that at one time they didn't know any science," with 36.7% and 26.5% agree responses. Least unanimity was shown for item 53, "Science teachers ought to be forceful and thorough," with 52% agreement, 32.8% disagreement. This was general, though, with no groups differing significantly in strength of agreement (Table XIV). More students disagreed (53.7%) that "Good science teachers are strict in class" than agreed (29.3%) (item 44).

It is interesting to speculate what it might mean to approve of teachers being forceful and thorough, but to disapprove of them being strict. Sixty point nine percent of the respondents disagree that "Science teachers don't have to have a sense of humor" (item 32), while 50.3% agree that they expect the science teacher to enjoy the labs as much as they do (item 59). More subjects did not know (26.4%) how they reacted to item 59, than to any other item in this attitude object group.

Total group attitudes toward junior high school science experiences. This group of attitude object responses showed least unanimity of opinion overall, though some individual items had high unanimity. The D_{max} average was .169. The high number of significantly different groups (except for items 58 and 63) confirm this (Table XIV). This attitude object group showed most uniformly large "don't know" responses. One explanation would be that memory of junior high school experiences has dimmed for many students.

Item 58, "Grade IX science seemed to be mostly 'read the chapter and make notes,'" with .066, had the distinction of having the lowest D_{max} of any of the 35 items. With item 31 it shared the distinction of revealing no significantly different groups at either the .05 or the .01 level (Table XIV): 46.6% of respondents agreed with the statement and 34.4% disagreed. Item 39, "There was too much lab work in my Grade IX science course," elicited strongest negative response in this attitude object group, 71.4% disagreement. Greatest percentage of agreement responses was to item 63 (62.1%), "In junior high science, the best part was

doing something with equipment." Item 50, "Grade VIII science was a work course, compared to English, which was a fun course," drew 42.5% negative response, compared to 20.4% positive response. This appeared to be a uniformly distributed feeling--there were no significant differences between groups at the .01 level (Table XIV). A slightly higher percentage (35.5%) of the respondents found the study of rocks in Grade VIII enjoyable (item 57) than found it disagreeable (26.5). Thirty-seven point seven percent, the largest number in this attitude object group, reported no opinion. Perhaps they could not remember. Is rock study most forgettable? "Studying internal combustion engines in Grade IX was boring," (item 40) had the second lowest D_{max} in this group, with 35.2% agreement and 49.8% disagreement. It also had the largest number of significant differences between groups, 10 (Table XIV). Item 64, "The plant study made Grade VII science interesting," an item that will be returned to later in the study, called forth 46.6% agreement, 26.8% disagreement, and also had a large number of significantly different groups (8) as shown in Table XIV.

2. Detailed Analysis of Responses Related to sub-question II-b

Attitudes toward physics. All groups responding "yes" to needing physics for further education or career showed a lower percentage agreeing with item 54, "To me biology is more appealing than physics," than those groups responding "no." For example, with reference to variable 4, those who agreed that they needed physics for their choice of career, 35.2% agreed that biology appealed more to them than physics. Of those who responded that they did not need physics for their choice of career, 64.2% agreed that biology appealed more than physics. Not surprisingly, all groups responding "yes" to need for physics for career or further education showed a higher percentage of agreement with item 60, "I see a close connection between physics and my career," than those responding "no." All four groups responding "yes" to need for physics showed a higher percentage of agreement with item 62, "A well educated person ought to have taken physics," than those responding "no" to need for physics. However, none of the groups, either needing or not needing physics, showed as much as 50%

agreement with item 62. Item 37, "Physics deals with things the average person needs to know," showed all four groups who needed physics for career or further education showing a higher percentage of agreement than those not needing physics; but as with item 62, no group exceeded 50% agreement with item 37. Item 35, "Physics is one of the most difficult high school subjects," drew a greater percentage of agreement from those who did not need physics than from those who needed it. However, all groups showed agreement rather than disagreement with this item.

For item 55, "The most interesting part of physics is the problem solving," it appears that if a group needed physics for further education or career they showed a higher percentage agreeing (and lower percentage not knowing) than those not needing physics. All groups showed higher percentage disagreeing with item 55.

Item 45, "Physics is mostly a bunch of formulas," drew differing percentage distributions for variables 1 and 3. It is notable that those needing physics for further education and career showed 55.7% and 53.2% agreement, and 12% and 11.2% "don't know," while those

not needing physics showed 45.0% and 44.0% agreement, but 29.6% and 38.2% "don't know."

Not unexpectedly, those students needing physics did not show as high a percentage agreeing with item 46, "Chemistry goes best with biology," as those not needing physics. The figures were 43.3% and 44.5% agreement with item 46, for those needing physics, 57.6% and 55.4% agreement for those not needing physics.

Attitudes toward science teaching. Significantly differing percentage distributions of responses in items related to attitudes to science teaching were two in number, to items 38 and 48, and only showed for variable 3. The group needing physics for their further education showed a lower percentage of responses agreeing with item 38, 59.6% ("In science courses, one ought to go on field trips often"), than those not needing physics, 71.5%. This will be discussed further in the analysis of variable 24b. The group needing physics for their further education showed a lower percentage of responses disagreeing with item 48, 59.9%, "You learn more from demonstrations the teacher does than experiments you do

yourself," than those not needing physics, 65.2%.

Attitudes toward science teachers. Significantly differing percentage distributions of response in items related to attitudes toward science teachers were two in number, items 43, 56, and only showed for variable 1. The group not needing physics for enrollment in university showed a slightly higher percentage of responses agreeing with item 43, 66.6%, "Science teachers ought to remember that at one time they didn't know any science," than those needing physics, 56.7%. The group not needing physics showed a very slightly higher percentage of responses, 80.5%, agreeing with item 56, "The best science teachers explain things simply" than those needing physics, 78.2%.

Attitudes toward junior high school science experiences. Significantly differing percentage distributions of responses in items related to attitudes toward junior high school science experiences were three in number, items 40, 64 and 39. Item 40 drew differing percentage distributions from variables 1, 3 and 4. The group not needing physics generally showed

a higher percentage of responses agreeing with item 40, "Studying internal combustion engines in Grade IX was boring," than those not. The percentage distributions from variable 3 are illuminating. For those not needing physics, 41.8% agree with item 40, 44.0% disagree, and for those needing physics 24.3% agree with item 40, and 60.6% disagree. The group not needing physics tended to show a higher percentage of those agreeing with item 64, "The plant study made Grade VI interesting," while those needing physics tended to show a lower percentage of agreement. The group needing physics for enrollment in an Institute of Technology showed a lower percentage disagreeing that there was too much laboratory work in their Grade IX science course, 64.6%, than those not, 70.7%.

3. Detailed Analysis of Responses Related to Sub-question IIc

Attitudes toward physics. Those responding "yes" to item 6, variable 6, "I've been told that physics is a very difficult subject," had a higher percentage agreeing with items 34, 35, 45 and 54 than those responding "no" to item 6. The group who responded "yes" to item 5

"I've been told that physics is a subject for boys," also showed a higher percentage who agreed with item 34, than those who said "no." The group who responded "yes" to item 7, "I've been told that you have to be good in mathematics to be good in physics," also showed a higher percentage who agreed with items 35 and 45 than did those who responded "no" to item 7.

For item 34, "Physics is a course that is slanted toward boys," 71.0% of the group responding "yes" to item 5 agreed with item 34, 43.6% of those responding "no" to item 5 agreed with item 34. The percentage of subjects agreeing with item 34, who responded "yes" or "no" to item 6, were 54.7% and 43.2%, respectively. Sixty-three point one percent of the subjects who responded "yes" to item 6 agreed with item 35, "Physics is one of the most difficult high school subjects," only 33.2% of those who responded "no" to item 6 agreed with item 35. The corresponding percentages for those subjects responding "yes" or "no" to item 7 were 38.9% and 40.4%. Item 45, "Physics is mostly a bunch of formulas," drew 49.0% of agreement from the group who had been told that physics is a difficult subject (item 6) and 51.5%

agreement from those told that you have to be good in mathematics to be good in physics (item 7). The percentages of agreement for those responding "no" to items 6 and 7 were 44.4% and 49.0% respectively. Sixty percent of those responding "yes" to item 6 agreed that biology was more appealing than physics (item 54) with 37.6% of agreement from those saying "no" to item 6. Sixty percent of subjects who had been told that chemistry goes with biology ("yes" to item 12) agreed with item 54. Forty-five point nine percent of subjects responding "no" to item 12 agreed with item 54.

Subjects responding "yes" to item 6 showed a lower percentage of agreement with items 37, 55, 60 and 62 than did the subjects responding "no" to item 6. Item 37, "Physics deals with things the average person needs to know," brought agreement from 28.3% of subjects answering "yes" to item 6 and from 43.2% of subjects answering "no" to item 6.

Item 55, "The most interesting part of physics is the problem solving," elicited 23% agreement from subjects who had been told physics was a very difficult subject ("yes" item 6), and 35.6% agreement from

those who had not been so told ("no" item 6). It would seem that if you have not been told that physics is difficult you are more likely to enjoy the problem solving. Almost the same percentage, 26.5%, 26.4%, of those who had or had not been told that chemistry goes with physics ("yes," "no" item 11) agreed with item 55. However, 44.2% of those who had been told that chemistry goes with physics ("yes" item 11) disagreed with item 55, as compared with 32.1% of those who responded "no" to item 11.

"I see a close connection between physics and my choice of career" (item 60) called forth agreement from only 22.2% of those subjects who responded "yes" to item 6. Forty-one point two percent of those who had not been told physics is a very difficult subject agreed with item 60.

Item 62, "A well educated person ought to have taken physics," brought 29.2% agreement from subjects responding "yes" to item 6, and 37.6% agreement from those responding "no."

It would seem that if you have been told that physics is a very difficult subject you are more likely

to feel that it has little place in general education. Thirty-seven point seven percent of those subjects who had been told chemistry goes with physics ("yes" item 11) agreed with item 62, compared to 26.5% who agreed with item 62, who responded "no" to item 11.

Not surprisingly, 88.1% of those who had been told that you have to be good in mathematics to be good in physics ("yes" item 7) agreed with item 30, "You have to be good in mathematics to be good in physics," and so did 65.4% of those who had not been so told ("no" item 7).

Again it should not surprise that 69.6% of those subjects who had been told that chemistry goes with biology ("yes" item 12) agreed with item 46, "Chemistry goes best with biology," but only 30.8% of those responding "no" to item 12 agreed with item 46.

Attitudes toward science teachers. Only variable 13, "I've been told that biology goes with physics," produced a significant difference in the percentages of subjects responding to an item related to the science teacher, item 32, "Science teachers don't have to have a

sense of humor." From the very small group, 54 subjects --Table XIII, Appendix, who had been told that biology goes with physics ("yes" to item 13), 37% agreed with item 32, compared with 18.8% agreement from the much larger group (750 subjects, Table XIII Appendix) who said "no" to item 13. It is interesting to speculate why those students who have been told that physics goes with biology should also be more ready to accept a humorless science teacher. Maybe it's the group reporting that they were told that physics goes with biology who have the sense of humor!

Attitudes toward junior high school science experiences. Items 40 and 64 drew differing percentages of agreement from the groups "yes" or "no" of variable 6, and item 40 also produced differing percentages of agreement from the groups responding "yes" or "no" to variable 13. The percentages of subjects who had or had not been told that physics is a difficult subject, "yes" "no" to item 6, who agreed with item 40, "Studying internal combustion engines in Grade IX was boring," was 39.7% and 26.4% respectively. Forty-four point four percent of the subjects who had been told that biology

goes with physics, "yes" to item 13, agreed with item 40, compared to 34.6% of agreement from those answering "no" to item 13.

Finally, 50.9% of subjects responding "yes" to item 6 agreed with item 64 ("The plant study made Grade VII science interesting") while 38.4% of those responding "no" to item 6 agreed with item 64.

4. Detailed Analysis of Responses Related to Subquestion IId

Attitudes toward physics. Forty-five point two percent of subjects who reported that they had been advised by their high school counsellor to take Physics 10, "yes" item 10, showed agreement with item 37, "Physics deals with things the average person needs to know," as compared with 29.3% who agreed having responded "no" to item 10. Sixty-one point one percent of subjects who reported that their junior high counsellor had advised them to take Physics 10, "yes" to item 8, agreed that physics is mostly a bunch of formulas, item 45, while only 43.0% of those not so advised, "no" to item 8, agreed with item 45. Does experience

with physics convince students that it is "mostly a bunch of formulas"? This question will be considered again in the analysis of variable 24b. Those responding "yes" to item 8 showed 34.0% who agreed with item 55, "The most interesting part of physics is the problem solving," compared to 24.0% agreement from those who responded "no" to item 8. Thirty-nine point nine percent of those responding "yes" to item 8 agreed that a well educated person ought to have taken physics (item 62) compared to 27.0% of those responding "no" to item 8.

Attitudes towards science teaching. Twenty-five point four percent of subjects who reported that choice of Grade X science had been left up to them by their junior high counsellor ("yes" to item 9) agreed that you learn more from demonstrations the teacher does than from experiments you do yourself (item 48), compared to 35.1% of agreement from those reporting "no" to item 10. Students who were given decision responsibilities by their counsellor in junior high seem to be more likely to want to find out for themselves in later science experiences.

Attitudes toward the science teacher. Of the subjects who responded "yes" to item 8, 37.3% agreed that they expect the science teacher to enjoy the labs as much as they do (item 49), compared to 55.2% who agreed with item 49, who said their junior high counsellor had not advised them to take Physics 10 ("no" to item 8). This will be referred to again in consideration of responses to item 24b.

5. Detailed Analysis of Responses Related to Subquestion IIe, Variables 16, 17, 18

Sixty-five percent of the group who responded "yes" to item 16, "I needed biology, so I decided not to take Physics 10," agreed that "Chemistry goes best with biology," item 46, compared with 42.2% agreement of the group who responded "no" to item 16. This compared with the agree percentages of responses of those who needed or did not need chemistry ("yes" item 18, or "no" item 18) of 67.0% and 41.6%, respectively. A percentage of 92.4% of subjects who responded "yes" to item 16 agreed that biology was more appealing to them than physics, item 54, compared to 67.9% of those responding "no" to item 16. That is, 67.9% of those who did not

take physics, and did not do so because they needed chemistry, agreed that biology was more appealing than physics.

The only pair of groups of the 32 who significantly differed in response to item 33, "A good method of teaching science is to write notes on the board most of the time," were those responding "yes" and "no" to item 18, "I needed chemistry so I decided not to take Physics 10." The respective percentage agreements with item 33 were 40.2% and 20.5%. Why should twice as high a percentage of students who dropped physics in order to take chemistry be accepting to a note-writing style of instruction, compared to those that dropped physics for some other reason? This same group who responded "yes" to item 18 had 70.1% of agreement with item 61, "Grade XII science teachers should teach for finals most of the year," compared to 61.5% of those who responded "no" to item 18.

Fifty-seven point one percent of those responding "yes" to item 16, "I needed biology, so I decided not to take Physics 10," agreed with item 40, "Studying internal combustion engines in Grade IX was boring," compared with 37.7% who responded "no" to item 16.

6. Detailed Analysis of Responses Related to Sub-question IIe, Variables 19, 20, 21, 22, 23

Subjects who responded "yes" to item 19, "I had no choice, I had to take Physics 10," as compared to those who responded "no" to item 19, agreed 60.1% and 53.9% with item 35, "Physics is one of the most difficult high school subjects." Those who responded "yes" to item 19 showed 53.5% agreement with item 54, "Biology is more appealing than physics," compared to 40.2% agreement from those who responded "no" to item 19. Item 20 reads, "Biology didn't appeal to me, so I took Physics 10." Subjects who responded "yes" to item 20, as compared to those who responded "no," showed 30.3% and 63.1% agreement with item 46, "Chemistry goes best with biology." The percentages were 17.9% and 58.8% for agreement with item 54, "To me, biology is more appealing than physics." Two explanations suggest themselves why there is even 17.9% agreement, one, either unwitting or deliberate falsification of response, two, a changeover in attitude between Grade X and Grade XII. Subjects who responded "yes" to item 20 showed 43.2% agreement with item 60, "I see a close connection

between physics and my choice of career," as compared to 32.3% agreement by those who had responded "no" to item 19. Those who responded "yes" to item 20 showed 53.4% agreement with item 38, "In science courses, one ought to go on field trips often," compared to 69.9% agreement for those who responded "no" to item 20. Perhaps those responding "yes" to item 20 saw fewer opportunities to relate field trips to physics than to biology. Fifty-three point four percent of those who responded "yes" to item 20 agreed with item 59, "I expect the science teacher to enjoy the labs as much as I do," compared to 40.7% agreement with item 59 of those who responded "no" to item 20.

Subjects who responded "yes" to item 21, "I couldn't get biology or chemistry until Grade XI, so I took Physics 10," showed 67.1% agreement with item 46, "Chemistry goes best with biology," compared to 47.6% agreement from subjects who responded "no" to item 21. Responses to item 54, "To me, biology is more appealing than physics," were 73.6% and 37.5% agreement, respectively. Responses to item 60, "I see a close connection between physics and my choice of career," were 16.5%

and 39.0% agreement respectively. Responses were 55.0% and 36.6% respectively to item 64, "The plant study made Grade VII science interesting."

Responses to items 22 and 23 will be considered together. Item 22 reads "I thought I needed Physics 10 for my career, so I took Physics 10" and item 23 reads "I took Physics 10, though I didn't need it for my career." One could expect that the response patterns would be mirror images--that is those responding "yes" to 22 ought to respond "no" to 23. In the case of responses to items 27, 54, 60 and 62, which appear as significantly different pairs of percentage responses under both variables, this is substantially true. However, one item, 55, appears in the distributions of variable 22 but not in those of variable 23. The reverse is true for the distributions of item 46--it appears under variable 23 but not under variable 22. Forty-nine point four percent of those responding "yes" to item 22 agreed with item 37, "Physics deals with things the average person needs to know," compared to 30.2% agreeing who responded "no" to item 22. Corresponding percentages of agreement to item 54, "To me biology is

more appealing than physics," were 33.7% and 53.1%. For item 60, "I see a close connection between physics and my career," the percentages were 51.3% and 19.9%. The low percentage of subjects, 51.3%, who agreed that they saw a close connection between physics and their career, who all took Physics 10 because they thought they needed it for their career, may be accounted for by change in career plans over 3 years of high school. Forty-nine point one percent of subjects who said "yes" to item 22 agreed with item 62, "A well educated person ought to have taken physics," compared to 28.4% of subjects who responded "no" to item 22. Forty-three point four percent of subjects who said "yes" to item 22 agreed with item 55, "The most interesting part of physics is the problem solving," compared to the 29.5% of those who said "no" to item 22. Fifty-eight point seven percent of those responding "yes" to item 23 agreed with item 46, "Chemistry goes best with biology," compared to 45.2% of those who said "no" to item 23.