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ABSTRACT

This report provides a general description of the mathematical programs pursued by students in Wyoming's public schools, an evaluation of the adequacy of the high school mathematical preparation of college-bound students relative to the occupational aspirations of those students, and a measure of the extent to which students are aware of the adequacy of that preparation. Each set of data was separated according to sex. Data indicate that many discrepancies exist between the mathematics program that students complete and what they actually should complete to insure successful entrance into college programs. Furthermore, they demonstrate that females take fewer mathematics courses, and their poorer preparation severely limits their occupational choices. Also included is an Afterword which suggests sources of information that might be useful in countering the problems revealed in the study. (Author/MK)

MATHEMATICAL PREPARATION VERSUS CAREER ASPIRATIONS: A STUDY OF WYOMING'S 1978 HIGH SCHOOL SENIORS

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PREFACE

The following report is written for use by interested administrators, curriculum coordinators, mathematics teachers and counselors. It is addressed, ultimately, to the students whom they teach and counsel. It provides a description of the current status of mathematical preparation of Wyoming high school seniors. It shows that many discrepancies exist between the mathematics program that students complete in high school and what they actually should complete to ensure successful entrance into college programs. Furthermore, it demonstrates that females take fewer mathematics courses; their poorer preparation severely limits their occupational choices.

As a first reading, the Summary and the Afterword are recommended. The Summary reviews the major findings of the study; the Afterword suggests sources of information which might be useful in countering the problems revealed in the Summary. For an in-depth understanding of the issues raised in the Summary, the reader is then encouraged to turn to the body of the report.

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INTRODUCTION AND PURPOSE

When looking at the information available concerning mathematics learning by male and female students the following "facts" seem to arise.

1. There is a commonly held myth that mathematics is a male domain.
2. Presently, high school girls take fewer mathematics courses than do high school boys.
3. Many occupations require at least four years of high school mathematics.
4. Advanced high school mathematics courses are just as useful for girls as they are for boys.
5. Women cannot enter many occupations because they lack the necessary mathematical background.
6. Boys are more likely than girls to continue taking mathematics classes because they receive encouragement, it is expected of them, they believe it will be useful for them in the future and they are confident of their ability to learn mathematics.
7. Females can learn mathematics as easily as can males.
8. Girls are more likely than boys to stop taking mathematics because they receive little encouragement, they are not expected to continue, they believe they won't need it in the future, and they are not confident of their ability to learn mathematics.

It is the purpose of this study to gather information concerning the status of mathematics preparation of high school seniors in Wyoming and to determine the mathematics necessary for entrance into University of Wyoming programs. The study was conducted by Robert Kansky and Melfried Olson of the Science and Mathematics

Teaching Center and was funded by the Center for Research Services and Publications of the College of Education of the University of Wyoming. In addition to addressing, in part, "facts" 1-5 regarding Wyoming high school students, the study also gathered other useful information relative to the interface between the precollege mathematical preparation of Wyoming students and the occupational aspirations of those students.

THE SAMPLE

Population

At the time of the study, Wyoming had 73 public high schools; the number of seniors enrolled in these schools ranged from 597 to 5[1]. For the purpose of the study, these schools were divided into five types according to the size of the senior class. These five types are defined in Table 1.

Table 1
FIVE SCHOOL TYPES

School Type	Enrollment Range of Senior Class
I	250 - 600
II	150 - 249
III	100 - 149
IV	50 - 99
V	5 - 49

[1] The enrollment data upon which sampling was done was from the Fall 1977 Report of Staff Enrollments (1977 Statistical Report No. 2, Wyoming State Department of Education).

Forty-seven of the 73 schools were selected for inclusion in the study using a modification of the stratified random sampling technique employed by the various studies of the Wyoming Educational Needs Assessment Program. The objective of the technique was to identify a sample which included at least 60 percent of all Wyoming seniors and which was comprised of 60 percent of the seniors in each of the five types of schools. In fact, the sample selected (Table 2) included 70 percent of the senior population. Because "whole schools" were selected and a minimum representation of 60 percent was desired, the actual percents for the five school types ranged from 62 (Type IV) to 76 (Type V).

Table 2

DESCRIPTION OF POTENTIAL SAMPLE BY SCHOOL TYPE

School Type	TOTALS FOR STATE Schools	TOTALS FOR STATE Seniors	TOTALS IN POTENTIAL SAMPLE Schools	Seniors Number	Seniors % of State Total
I	7	2662	5	2023	76
II	7	1368	5	904	66
III	7	818	5	580	71
IV	8	535	5	331	62
V	44	997	27	639	64
TOTALS	73	6380	47	4477	70

For each school selected, the investigators identified a mathematics teacher who had participated in previous leadership activities in cooperation with the University of Wyoming. It was hoped that each such teacher would take the responsibility for the administration of the study's instruments within his school. The investigators then placed a telephone call to the chief administrator of each school in the sample to (a) explain the purpose of the study, (b) obtain permission to include the school in the study and (c) to suggest the participation of the mathematics teacher identified earlier as the study's "school contact". Three of the schools so contacted declined to participate. They were replaced utilizing the sampling techniques described earlier, with no changes in the percents reported in Table 2.

A school's agreement to participate in the study meant that the contact person would complete the School Information Form (Appendix A) and administer the survey instrument (Appendix B) to <u>all</u> seniors in the school using the directions and definitions provided by the Memorandum (Appendix C) and the Directions for Survey Administration (Appendix D). Each administrator was also invited to have the school's contact person place a telephone call (collect) to either of the investigators to discuss the purpose of the survey, the survey instrument and the directions for using/administering the instrument.[2]

It was hoped that the procedures described above would ensure a sufficient return rate to produce a sample including at least 40 percent of the seniors in each of the five types of schools. Returns were received from 40 of the 47 schools[3] and Table 3 shows that the 2010 usable forms returned represented 45 percent of the total sample and 32 percent of the total population of Wyoming seniors. The percent of Wyoming seniors representing each of the five school types ranged from 26 percent to 43 percent. Only Types IV and V came close to the hoped-for proportion in the stratified sample.

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[2] Calls were received from many, but not all, of these persons.

[3] These schools indicated by a '+' in Appendix E.

Table 3

DESCRIPTION OF ACTUAL SAMPLE BY SCHOOL TYPE

TOTALS FOR STATE			TOTALS IN ACTUAL SAMPLE			
School	Schools	Seniors	Schools	Seniors		
				Number of Survey Forms Returned	Percent of Potential Sample	Percent of State Total
I	7	2662	4	701	35	26
II	7	1368	4	472	52	34
III	7	818	4	214	37	26
IV	8	535	5	196	59	37
V	44	997	23	427	67	43
TOTALS	73	6380	40	2010	45	32

Failure to reach the desired sampling rate of 40 percent was due to two conditions. First, seven schools (for various reasons) failed to return any forms. Since the instrument was deliberately administered late in the school year, it was impossible to remedy this loss by the selection of replacement schools. Such "whole school" omissions had a major effect upon the return rates for schools of Types I, II and III. The total return rate was further reduced by local decisions to administer the form to some, but not all, of the seniors.[4]

Instruments

Appendix B is a copy of the survey form completed by each of the 2010 students included in the survey.[5] A first version of this form was administered to a class

[4] Information later obtained from the contact persons indicated that almost without exception, this reduced sample was comprised of seniors currently enrolled in mathematics or science classes.

[5] Originally printed on legal-size paper, it has been reduced in size to accommodate this report.

of science students at Laramie High School in February of 1978. The cooperating teacher, Roger Abelson, followed the directions given in a preliminary version of the Directions for Survey Administration (Appendix D). He then discussed the instrument with the students, seeking their suggestions for clarification and format changes with respect to the form. These suggestions were incorporated into the form which appears as Appendix B. Also, the directions to the participating teacher (Appendix D) were rewritten based upon Abelson's comments.

The revised documents (Appendices A-D) were mailed to the cooperating teacher or administrator of each school in the sample during March of 1978. They were administered to the students during early April (the exact date being selected by each school to meet its own scheduling demands) and were returned in a preaddressed, stamped envelope.

The College Program Interview Form (Appendix F) was developed for the purpose of assessing the minimal mathematical entry level skills expected by each of 99 academic programs at the University of Wyoming. Although some of this information appears in University publications, such publications are usually two years behind current thinking of program faculty. Therefore, interviews were conducted with each program director to verify the mathematical expectations listed in the publications and to obtain the directors' opinions regarding the level of preparation of recent program enrollees. The former information was used in this report; the opinion data was not viewed as having sufficient basis to merit reporting here.

ANALYSIS

Sex Distribution in the Sample

The first two items of the survey served to (1) identify the student's sex and (2) determine whether or not the student planned to begin study at a university or community college within the next two years. A summary of the information gathered from these two items, reported by school type, appears in Table 4. The table shows

Table 4

SEX DISTRIBUTION OF SAMPLE

School Type	Group	Number of Seniors in Sample	Percent Females in Sample	Percent Males in Sample
I	college	530	54	46
	non-college	171	58	42
	total	701	55	45
II	college	312	50	50
	non-college	160	48	52
	total	472	49	51
III	college	154	47	53
	non-college	60	37	63
	total	214	44	56
IV	college	138	50	50
	non-college	58	51	59
	total	196	47	53
V	college	281	53	47
	non-college	146	36	64
	total	427	47	53
TOTALS	college	1415	52	48
	non-college	595	46	54
	total	2010	50	50

that the total sample had an even distribution between sexes; moreover, the college-bound group closely approximated this distribution, being 52 percent female and 48 percent male. Only in School Type III and School Type V were there any large discrepancies found in the sex distribution of the sample. In School Type III, 63 percent of the noncollege-bound were male; 64 percent of the noncollege-bound in School Type

V were male. It is also worth noting that over 70 percent of the respondents indicated the preference of going to college.

Terminal Year of Secondary School Mathematics

Item 4 of the survey asked the student to indicate the last year of school in which he/she took a mathematics course. Again, the data was examined across two categories: college-bound and noncollege-bound. Each of these categories was further divided according to sex. The data on college-bound students is reported in Table 5; the data for noncollege-bound students is in Table 6.

Table 5

TERMINAL GRADE OF SECONDARY SCHOOL MATHEMATICS:
COLLEGE-BOUND SENIORS
(As a Percent of College-Bound Seniors in the Sample)

School Type	Subgroup	Sample Size	Terminal Grade for Math		
			7-10	11	12
I	female	284	45	27	28
	*male	246	21	28	50
	total	530	34	28	38
II	female	155	25	37	38
	male	157	21	28	51
	*total	312	23	33	45
III	*female	72	44	29	26
	male	82	32	29	39
	total	154	38	29	33
IV	female	69	33	26	41
	*male	69	20	19	61
	total	138	27	30	43
V	female	149	36	24	40
	male	132	20	19	61
	*total	281	32	22	47
TOTALS	female	729	37	29	34
	male	686	22	27	51
	total	1415	30	28	42

* The sum of the percentages in this row is not 100 due to rounding.

The figures of Table 5 reveal a trend which is typical of the nation as a whole: many college-bound women terminate their study of mathematics much earlier than do college-bound men. The table shows that by the end of Grade 10 an average of 15 percent more women than men end their study of precollege mathematics (For Type I schools, moreover, this difference reached 24 percent.) While nearly equal percentages of men (27 percent) and women (29 percent) take their last mathematics course in Grade 11, the large difference in the Grade 10 termination rates is retained in Grade 12 enrollments. Thus, 17 percent more men than women take mathematics during their senior year. Viewed across school types, this difference in senior enrollments remains highest in Type I schools (22 percent). Thus, in general, the ratio of women to men in senior mathematics classes is about 2 to 3, but in Type I schools it approaches 1 to 2.

It should be noted, furthermore, that the ratios mentioned above are with respect to college-bound students who enrolled in <u>any</u> mathematics course during the senior year. When considered in conjunction with the information of Table 8, which examines the level (i.e., how advanced the content) of the material studied in the senior courses, the difference in termination rates is amplified. It is possible to infer that the ratio of women to men taking <u>advanced</u> mathematics is even smaller than the general ratios already reported. That is, whereas the enrollments of senior men may be characterized as being in advanced mathematics courses, many senior women may be enrolled in career-, consumer- or business-oriented courses in mathematics.

In summary, there are two dimensions to the observed differential in the mathematical preparation of college-bound women: (1) many women terminate mathematical study before men and (2) women who continue the study of mathematics do not elect "advanced" courses as often as do their male counterparts.

The information presented in Table 6 demonstrates that the patterns for terminal grade for the study of mathematics by noncollege-bound students follows the pattern of the college-bound with regard to sex. Specifically: (1) a larger overall percentage of females terminate their mathematics training by the end of Grade 10, (2) about the same overall percentage of males and females terminate their mathematics training in Grade 11, and (3) a larger overall percentage of males continue their mathematics training through Grade 12. It should be noted that the data for School Types II, III and IV does not remain parallel with the patterns for the college-bound; no conjecture is offered as to why this occurred.

Table 6

TERMINAL GRADE OF SECONDARY SCHOOL MATHEMATICS:
NONCOLLEGE-BOUND SENIORS

(As a Percent of Noncollege-Bound Seniors in the Sample)

School Type	Subgroup	Sample Size	Terminal Grade for Math 7-10	11	12
I	female	100	55	30	15
	*male	71	44	30	27
	total	171	50	30	20
II	female	77	31	34	35
	male	83	37	18	45
	total	160	34	26	40
III	female	22	46	21	33
	male	38	53	26	21
	total	60	42	30	28
IV	female	24	46	21	33
	male	34	53	26	21
	total	58	50	24	26
V	female	52	46	21	33
	*male	94	27	29	45
	total	146	34	26	40
TOTALS	female	275	45	28	27
	*male	320	27	29	45
	total	595	41	27	32

* The sum of the percentages in this row is not 100 due to rounding

A casual comparison of the figures of Tables 5 and 6 reveals some curious information about the sample. In general, the pattern of grade-level termination rates of the two groups (college-bound and noncollege-bound) are quite similar. For instance, percent of the total number of noncollege-bound students who terminate before Grade 11 is only 11 percent greater than the percent of college-bound. The percentages terminating study at the end of Grade 11 show only a one percent difference for the two groups, a result which is irrespective of sex. While this might suggest that the decision of when to terminate the study of mathematics is independent of intent to pursue postsecondary education, it should be recalled that many schools administered the survey selectively (i.e., administered it only to seniors enrolled in mathematics classes). On the other hand, this "independence" hypothesis is reasonable for Type V schools where, without exception, almost every senior was surveyed. (Perhaps the limited number of electives in these small schools "encourages" the continued study of mathematics by all students irrespective of postsecondary education plans.)

Levels of Mathematical Preparation

The survey also asked students to describe their precollege mathematical education. Specifically, they were asked to indicate whether they had completed certain specific courses: General Mathematics, First Year Algebra, Second Year Algebra, and Geometry.[6] They also were asked to record the year in which each was taken.

In addition to such "whole course" descriptions, the form specified other mathematical topics which often are part of a mathematics program but which may find themselves under different course names at different schools. Together, this information

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[6] A definition of most of these courses was provided (Appendix D) to the school person administering the survey, along with the written (Appendix C) and oral (telephone) suggestions that these be used to guide student responses.

was used to define the six levels of mathematical preparation found in Table 7.

Table 7

DESCRIPTION OF SIX LEVELS OF MATHEMATICAL PREPARATION AMONG WYOMING SENIORS

Level	Description
1	Algebra I and II; synthetic and analytic geometry; trigonometry; logarithmic functions (common and natural) and their graphs; mathematical induction; algebra of functions; basic operations on matrices; limits, continuity and differentiation of polynomial functions.
2	Algebra I and II; synthetic and analytic geometry; trigonometry; logarithmic functions (including common and natural) and their graphs, mathematical induction; algebra of functions; basic operations on matrices.
3	Algebra I and II; synthetic geometry.
4	Algebra I; synthetic geometry.
5	Algebra I.
6	General mathematics

These six levels are used in this study to classify, from highest (Level 1) to lowest (Level 6), the summative precollege mathematical experience of each college-bound student. This classification, subgrouped on the dimension of sex, is summarized for each school type and for the total sample in Table 8.

Table 8

PERCENT OF COLLEGE-BOUND SENIORS ATTAINING EACH OF SIX LEVELS OF MATHEMATICAL PREPAREDNESS

Level of Mathematical Preparation	Subgroup	School Type I	II	III	IV	V	Combined (I-V)
1	female	12	19	8	22	14	15
	male	34	29	24	26	31	30
	total	24	24	17	23	23	22
2	female	19	20	18	23	24	21
	male	44	32	33	28	33	36
	total	31	26	26	25	29	28
3	female	55	65	49	65	38	54
	male	71	71	63	48	52	64
	total	62	68	56	57	46	59
4	female	75	72	58	78	63	71
	male	85	79	67	71	76	78
	total	80	76	63	75	70	74
5	female	93	91	89	97	93	93
	male	98	94	83	91	93	94
	total	95	93	86	94	93	93
6	female	100	100	100	100	100	100
	male	100	100	100	100	100	100
	total	100	100	100	100	100	100

Table 8 reveals that, for the first three levels of mathematical preparation, there is a decidedly larger percentage of males than females. (There is an exception in School Type IV in regard to preparation Level 3.) In general, the male and female subgroups are equal on Level 6 only; this, of course, reflects the fact that expected completion of Level 6 mathematics is in Grade 8.

Table 8 provides information which refines the observations made with regard to Table 5. For instance, Table 5 indicated that 34% of the females in the total survey population were enrolled in mathematics courses during their senior year; Table 8 reveals, however, that only 15% reach Level 1 of mathematical preparation. Hence only about 44% of these senior women are enrolled in the most advanced mathematics courses. By comparison, Table 5 showed 51% of all male seniors were enrolled in mathematics courses; Table 8 reports that about 60% of these (30% of the total population) have reached Level 1 preparation.

The figures of Table 8 are of particular importance in that they show the populations reaching the highest level of precollege mathematical preparation. For all school types, the ratio of women to men who reach Level 1 is 1 to 2 (i.e. 15% to 30%). This ratio, however, is not uniform across school types. For School Types I and III, this ratio is about 1 to 3.

Mathematical Entry Requirements of University Programs Versus
Precollege Mathematical Preparation of Wyoming Seniors

One study objective was to evaluate students' precollege mathematical studies in terms of the mathematical entry skills set forth by 99 academic programs at the University of Wyoming. An estimate of these entry skills first was obtained by careful reading of University catalogs. These approximations then were revised and brought up to date by means of interviews (using the form in Appendix F) with each program head. These entry-level expectations, subsequently expressed in terms of specific University of Wyoming precalculus mathematics courses (as described in Appendix G), led to the definition of six occupational classes found in Table 9. Each class is defined in terms of the mathematical skills expected of students entering the program; these skills are, in turn, expressed in terms of the courses listed in Appendix G.

TABLE 9

SIX OCCUPATIONAL CLASSES:
DEFINITION IN TERMS OF MATHEMATICAL ENTRY SKILLS

Class	Definition[7]
A	College study should begin with calculus; MATH 303D or MATH 302F and 302G are viewed as deficiency or remedial courses. Students delayed by having to take these courses may be unable to complete program degree requirements in four years.
B	MATH 303D or MATH 302F and 302G are prerequisite to the study of the additional mathematics, statistics or computer science courses required by the programs in this class.
C	MATH 303D or MATH 302F and 302G are specific program requirements. No additional mathematics, statistics or computer science courses are listed as degree requirements.
D	While MATH 302F is not specified as a degree requirement, knowledge of its content is implied by listed program degree requirements in mathematics, statistics or computer science for which knowledge of the content of MATH 302F is a prerequisite.
E	MATH 302F is a degree requirement. No additional work in mathematics, statistics or computer science is specified.
F	No college mathematics is listed as a degree requirement. Neither do the program descriptions indicate that use of any high school mathematics of the level of Algebra I (or above) will be assumed in the courses of the program.

The fact that entry-level skills have been defined in terms of college courses and that students' preparation is expressed in terms of precollege courses needs some explanation. The general points to be made are:

1. The content of the three precalculus courses described in Appendix G is precollege content.

7 Descriptions of the University of Wyoming mathematics courses used in these definitions may be found in Appendix G.

2. The primary purpose of the precalculus offerings is to <u>review and refine</u> the concepts listed and not to introduce them.

In fact, the content of MATH 302F is that of Algebra I; the content of MATH 302G includes all of the major topics of Algebra II in addition to an intensive study of circular, exponential and logarithmic functions. However, it should be understood that these courses are <u>not</u> intended for students who have not studied these topics already. Consider, for example, that the content of MATH 302F is covered in 45 to 48 class sessions (depending upon the semester in which it is taken) of 50 minutes each and is usually taught by persons who are not professional educators. In the high school, this same content would be covered (perhaps at a less sophisticated level) in 180 sessions of 50-60 minutes each by professional educators. A student who avoided this content in high school because of a doubt he could handle it will have little hope of completing the accelerated college version. The content of MATH 302G also is covered in 45-48 sessions of 50 minutes each. In the secondary school, this content may be presented in as many as 270 sessions of 50-60 minutes. MATH 303D (which compresses MATH 302F and MATH 302G into a one-semester offering) meets for 75-80 sessions of 50 minutes each. Compare the latter with the high school time allocation of up to 450 class meetings of 50-60 minutes each.

In summary, the content of the college precalculus courses is precollege content, but the rate of delivery is not similar to that of the secondary school. Clearly, the college treatment is one of review and refinement rather that of introduction. It also should be observed that these college offerings may be quite difficult for a student who has let two or more years lapse between his introduction to those topics in high school and his review of them in the college precalculus. Finally, it should be noted that these observations regarding college precalculus courses and their high school equivalents are not peculiar to the offerings at the University of Wyoming but, rather, are typical of college precalculus offerings in general. The six occupational classes defined in Table 9 were used to classify 99 University of Wyoming academic programs. This classification, displayed in Table 10, may hold a few surprises for persons not familiar with changing University degree requirements. For instance, there is the relatively large number of programs requiring Class B entry skills in mathematics. Specifically, many students are surprised to find business, forestry and wildlife management programs in this category.

TABLE 10

SIX OCCUPATIONAL CLASSES:
CATEGORIZATION OF UNIVERSITY OF WYOMING PROGRAMS
BASED UPON MATHEMATICAL ENTRY SKILLS

Class	Occupational Programs	
A	Computer Science	Physics
	Engineering:	Pre-Dentistry
	Agricultural	Pre-Medicine
	Architectural	Pre-Optometry
	Biological (Electrical)	Pre-Veterinary
	Civil	Statistics
	Electrical	Teacher of Secondary School Mathematics
	Mechanical	
	Mathematics	
B	Agricultural Economics	Industrial Management
	Astronomy	Management
	Botany	Management Information Systems
	Economics	Manufacturing Technology
	Electronics Techology	Marketing
	Engineering:	Medical Technology
	Chemical	Pre-Forestry
	Petroleum	Small Business Management
	General Business	Teacher of Secondary School Physics
	Geology	Wildlife Conservation and Management
		Zoology
C	Agricultural Business	Farm and Ranch Management
	Agricultural Communication	Food Science
	Agricultural Mechanization	General Agriculture
	Animal Science	International Agriculture
	Biology	Microbiology
	Chemistry	Pharmacy
	Crop Science	Range Management
	Dental Hygiene	Soil Science
	Entomology	Teacher of Secondary School Agriculture

TABLE 10
(Concluded)

SIX OCCUPATIONAL CLASSES:
CATEGORIZATION OF UNIVERSITY OF WYOMING PROGRAMS
BASED UPON MATHEMATICAL ENTRY SKILLS

Class	Occupational Programs	
D	Accounting Anthropology Finance Journalism Politics: American Psychology	Teacher of Elementary School Teacher of the Handicapped Teacher of Secondary School Business Chemistry Earth Science Office Administration
E	Dietetics Geography	Speech Pathology and Audiology Teacher of Secondary School Industrial Arts
F	Art Broadcasting Consumer and Family Educational Services Dance English Foreign Language History Home Economics Communications International Studies Music Instrumental Vocal Nursing Philosophy Physical Education: Non-teaching Police Work Public Administration	Recreation and Park Administration Social Work Sociology Teacher of Secondary School Art Biology English Foreign Language Home Economics Journalism Music Physical Education Psychology Social Studies Theater

Elementary school teaching (Level D) is a program in which over 90% of the students are female. A question might be raised as to whether females elect this program with forethought or because their limited preparation in mathematics confines them to this level (or below) while many males can select programs which demand greater entry level skills in mathematics.

While the number of entries in Level F (30 programs) is large, one might consider the employment opportunities available in several of the fields listed. On another note, the large number of secondary school teaching programs that fall into this class may be viewed as indicative of probable attitude toward and importance attached to mathematics by many secondary school teachers. This attitude can surely effect the number of students who select the "advanced" level mathematics courses. One final observation with regard to Table 10 and to the results of this survey is needed. It is important to note that this entire discussion is with regard to minimal mathematical skills needed for a bachelor's-level program in these fields. Advancement in many fields which here show few or no mathematical prerequisites frequently require statistics or computer science. The college student who took little or no mathematics as an undergraduate (and, perhaps, as a high school student) would find such courses to be a barrier of considerable magnitude.

To determine whether or not students' precollege mathematics programs matched their occupational aspirations, the survey instrument asked the student to indicate, in order, his top three choices from among the 99 fields listed. These correspond, of course, to college programs at the University of Wyoming. While some students may enter these occupations without a college degree, many indicated that they planned to take the college preparation route. The analysis which follows is restricted to those college-bound students.

The interaction between the precollege mathematical preparation and occupational aspirations of college-bound students are presented in Table 11. The information is broken down by sex and school type. As a whole, the results indicate that many more males than females aspire to enter occupations in Class A (29 percent male versus 12 percent female) and Class B (33 percent male versus 20 percent female).

TABLE 11

STUDENT CHOICE OF OCCUPATIONAL CLASS:
COLLEGE-BOUND SENIORS
(As a Percent of College-Bound Sample)

School Type	Subgroup	Occupational Class A	B	C	D	E	F
I	female	9	25	8	25	1	32
	*male	32	33	9	10	0	15
	*total	20	29	9	18	1	24
II	female	10	20	6	31	1	32
	*male	27	33	8	12	1	18
	total	19	27	7	21	1	25
III	*female	4	15	7	29	1	43
	male	22	34	17	10	0	17
	total	14	25	12	19	1	29
IV	*female	19	20	4	25	1	30
	*male	19	39	6	17	1	17
	total	19	30	5	21	1	24
V	female	12	14	9	32	1	32
	male	33	27	15	9	2	14
	total	22	20	12	21	1	24
TOTALS	*female	12	20	7	28	1	33
	male	29	33	11	11	0	16
	total	19	26	9	20	1	25

* The sum of the percentages in this row is not 100 due to rounding.

Viewed across school types, moreover, the male/female ratio for selection of Class A occupations ranges from a high of nearly 11 to 3 (School Type I) to 1 to 1 (School Type IV). There is greater homogeneity in the ratio of Class B choices which stand at about 2 to 1 for three school types (III, IV, V) and, roughly, 3 to 2 for School Types I and II. These percentages are singled out because occupations in Classes A and B are those which have high entry level expectations in mathematics.

At the other end of the mathematical expectation spectrum are the occupations of Classes E and F. For these classes, the male/female selection ratios are, generally speaking, the reverse of those observed for Classes A and B. For the total population, the composite ratio is about 1 to 2. Moreover, this is roughly the ratio found for each school type. In all, about 25 percent of the seniors indicated an occupational choice which, at least at the time of this writing, requires at most a knowledge of enough algebra to complete MATH 302F.

Student Awareness of Skill Level

A comparison of the figures in Tables 8 and 11 might suggest that students have made realistic occupational choices. For instance, Table 11 shows that 19 percent of the sample (29% of the males and 12% of the women) aspire to Class A occupations; Table 8 indicates that 22% of the students (30% of the males and 15% of the women) have reached the precollege mathematical preparation Level 1 which is recommended for entry into Class A college programs. Moreover, whereas an additional 26% of the students (33% of the males and 20% of the females) indicated occupational choices in Class B, an additional 37% of the students (39% of the men and 34% of the women) had attained the precollege mathematical preparation level (Level 3) apparently needed for occupations in Class B. However, two further observations quickly darken this rosy picture.

First, it should be noted that precollege preparation Level 2 can be obtained by the end of Grade 10 by students who took Algebra I in Grade 8. Such students will have had two years' lapse in work with mathematics at the time of college entrance. Since mathematical skills atophy quickly, even the "review" nature of MATH 302F, and MATH 302G may present a considerable challenge.

Along the same line, it should be noted that Class B occupations require work with the circular, exponential and logarithmic functions inasmuch as MATH 302G is a required course. Since these concepts were included in the definition of Level 2, <u>but not in Level 3</u>, students who have not exceeded Level 3 preparation will be introduced to these concepts in MATH 302G. The problem here is twofold; (1) again, there is the possibility of a two-year lapse in mathematical practice and (2) the presentation rate for these topics in MATH 302G is that of review, not introduction. The student is faced with a double jeopardy situation.

If one were to take a more conservative stand and insist that students aspiring to enter Class B degree programs should have reached Level 2 of pre-college mathematics, the story is rather depressing. In this case, the additional 26% (33% males and 20% females) who indicated an ambition to enter Class B occupations is mismatched by the 6% (men and women) who reach only Level 2 in precollege mathematics.

If one takes the liberal view that persons having Level 3 precollege mathematics are prepared to enter Class B college programs, Table 12 indicates that 72% of the students in the sample had at some time in their secondary school career been exposed to the minimal mathematics required by the programs they wish to pursue. In fact, this rate is uniform across the five school types. While these figures certainly account for the majority of the college-bound students, the 25 to 29 percent who are not prepared constitute a large minority.

TABLE 12

COLLEGE-BOUND STUDENTS MEETING ENTRY-LEVEL MATHEMATICS REQUIREMENTS OF THEIR OCCUPATIONAL CHOICE

School Type	Percent Meeting Minimal Requirements*
I	72
II	75
III	71
IV	71
V	72
TOTAL	72

*Of the total sample, this is the percent of seniors who have completed a high school mathematics program which would provide at least the minimal mathematical skills required by the occupational class selected.

To ascertain how well informed students are of their mathematical preparedness (or unpreparedness, as the case may be), the survey instrument included the question:

> Do you feel that the mathematics you have taken in high school has prepared you adequately to begin training in your chosen occupational field(s)?

Table 13 shows that about one-third of the students are misinformed--that is, are either underprepared or (if such is possible) overprepared mathematically for the fields they wish to enter. This figure is relatively constant across school types and for both males and females.

TABLE 13

COLLEGE-BOUND STUDENTS MISINFORMED REGARDING THE ADEQUACY OF THEIR PRECOLLEGE MATHEMATICS PROGRAM

(As a Percent of the Sample Size of Each Group)

	Female		Male		Total	
School Type	Sample Size	Percent Misinformed	Sample Size	Percent Misinformed	Sample Size	Percent Misinformed
I	284	35	246	34	530	35
II	155	32	157	39	312	36
III	72	38	82	24	154	31
IV	69	41	69	39	138	40
V	149	35	132	33	281	34
TOTALS	729	35	686	34	1415	35

Table 14 considers only those students identified as unprepared. It reveals that about 2: percent of these students are unaware that they have chosen college programs for which they do not have entry level mathematical skills. While this group of students who know-not-and-know-not-that-they-know-not, constitutes only about 6 percent (21% of 28%) of the total sample, it is an important group. It is faced with a high probability of disappointment in the college pursuit of a particular career. Moreover, the figure is a minimum in view of what constitutes preparation for Class B occupations.

TABLE 14

COLLEGE-BOUND STUDENTS WHO BELIEVE THAT THEY HAVE PURSUED AN ADEQUATE PRECOLLEGE MATHEMATICS PROGRAM BUT HAVE NOT
(As a Percent of the Sample Size of Each Group)

School Type	Female		Male		Total	
	Sample Size	Percent Misinformed	Sample Size	Percent Misinformed	Sample Size	Percent Misinformed
I	284	15	246	21	530	18
II	155	18	157	29	312	24
III	72	21	82	20	154	20
IV	69	25	69	32	138	28
V	149	19	132	25	281	22
TOTALS	729	18	686	25	1415	21

SUMMARY

This study was made in response to a concern often expressed to the authors by students at the University of Wyoming. Students from a broad range of fields of study reported that the mathematics courses required for completion of their college programs were posing serious obstacles. These students had terminated their study of precollege mathematics as early as possible on the assumptions that (1) no mathematics was required for the fields they wished to enter or (2) college mathematics courses were available wherein they could correct any mathematical shortcomings. For many students, both assumptions had proved erroneous. In conclusion, they asserted that "someone should have told us we'd need so much mathematics."

Was the problem reported by these students all that widespread or were these the complaints of a vocal few? Was the University remiss in providing adequate career information relative to the mathematical expectations of its many (99) programs? Were high school students uninformed or misinformed? We decided to find out.

In this study, we sought paired information regarding both the precollege mathematical preparation and the occupational aspirations of students entering the University of Wyoming. (Since over 70 percent of the University's students are graduates of Wyoming high schools, the study was confined to that population.) Using that paired information, we have been able to provide

* a general description of the mathematical programs pursued by students in Wyoming's public schools,
* an evaluation of the adequacy of the high school mathematical preparation of college-bound students relative to the occupational aspirations (99 fields) of those students, and

* a measure of the extent to which students are aware of the adequacy of that preparation.

Each set of data was broken out along the dimension of sex.

A stratified, intact-group sampling procedure was used. Having divided Wyoming's 73 public high schools into five groups based upon senior class size, 47 were selected for inclusion in the study. The students in these 47 schools represented 70 percent of the total senior population and over 60 percent of the senior population at each of the five levels of school size. It was hoped that instrument returns would include at least 40 percent of the senior population at each level.

The 2010 instruments completed represented 32 percent of the total senior population. Returns by school size ranged from 26 percent to 43 percent. As a result, the data for the state as a whole includes disproportionate subpopulations of (a) students from schools with senior class enrollments below 100 and (b) students enrolled in a mathematics course at the time of the study. Thus it becomes important to examine the data for each size of school. It is also important to keep in mind that the problems suggested by the data may be, in fact, much more serious because the data is skewed by the disproportionate subpopulation of mathematically better-prepared students.

To define the mathematical entry-level skills required for a variety of college programs, the implicit and/or explicit mathematical expectations of 99 programs of the University of Wyoming were used. The requirements of each program were verified through an interview of the program directors. These requirements were further expressed in terms of the content and pace of the University of Wyoming precalculus courses specified by those programs and were then related to the content and pace of precollege courses.

With the reported limitations in mind, the results which we consider most worthy of note are listed below. The person interested in more detail should consult the body of the text.

1. Seventy percent of the seniors responding indicated they were planning to begin study at a university or community college within the next two years. The female to male ratio was 52 to 48 percent for the college-bound students and 46 to 54 percent for the noncollege-bound.
2. Considering college-bound seniors, a much larger percent of females than males (37 to 22 percent) terminates study of precollege mathematics in Grade 10 while a much larger percent of males than females (51 to 34 percent) terminates study of precollege mathematics in Grade 12. While this trend was found in all school types, the percentages were greatest in the largest high schools.
3. Considering noncollege-bound seniors, the results reported in Item 2 above were the same for the total subpopulation, but varied by school types.
4. Of the 99 University of Wyoming programs, 15 expect students to begin their mathematic study with the calculus. The study of precalculus mathematics is viewed as remedial; it could delay graduation by as much as a year. Another 20 programs assume that students completed Algebra II in high school and, at most, will require only the acceleration review and extension of precalculus concepts before entering balanced courses in mathematics.
5. Of the remaining 64 programs, 18 expect students to complete both of the rapid-paced precalculus courses; another four require the completion of the first of the two courses.
6. Finally, 42 programs list no explicit requirement of precalculus mathematics. However, a required facility with Algebra I may be inferred

from other coursework in the 12 programs of Class D. Only the 30 programs of Class F appear to assume no use of mathematics at or above the level of Algebra I.

7. The results in Items 4 and 5 above serve to distinguish the occupational choice limitations imposed by the extent of the mathematical skills (or lack of same) of a person entering the University. It should be no surprise to realize that the "male dominated" professions are described in Item 4 while "female dominated" professions are described in Item 6. In the college-bound population of this study, 32 percent of the females and 62 percent of the males made choices from among the occupations described in Item 4; on the other hand, 62 percent of the females and 27 percent of the males made occupational choices from among those occupations demanding entry-level mathematics of Algebra I or below.
8. Of the college-bound students, 72 percent had pursued a high school program which met the entry-level mathematics requirements of their occupational choices. About 35 percent were misinformed regarding the adequacy of their precollege mathematics program. (Some took more than necessary, but most took too little.)
9. Of the students in the total college-bound sample, 21 percent believed they had completed a precollege mathematics program which would provide the entry-level skills required by the college program they intended to pursue, <u>but in fact, had not completed an adequate program</u>. This figure was smaller in schools having senior class enrollments of 250 - 600, but this was probably influenced by a sampling failure in which instruments were completed only by seniors currently enrolled in mathematics courses. Generally speaking, the percent of students who were unaware that they were inadequately

prepared rose with the percent of the school population completing the survey instrument. For the largest schools, only 35 percent of the seniors in the sample completed the instrument; of these, 18 percent of the college-bound students were unaware of inadequate preparation. For schools with senior class enrollments below 100, an average of 62 percent of the seniors in the sample completed the instrument; about 27 percent of the college-bound students in this group were unaware of inadequate preparation.

The results reported in Items 1 - 9 above raise serious concerns regarding the mathematical preparation of Wyoming high school students planning to enter college. The results demonstrate that amount of mathematics taken and level of mathematics accomplished varies with sex, with males taking more and achieving higher levels. This, in turn, limits the future occupational choices available to most females.

While the results of the study are somewhat grim, the reader should realize that those results probably paint a rosier picture than is justified. In fact, the actual situation may be a good bit worse than reported here. Specifically, five modifying conditions should be noted:

1. The sample contains a disproportionate subpopulation of Wyoming's mathematically able students. This is due to the fact that the survey instrument was often administered only to those seniors enrolled in mathematics classes rather than to all seniors (as intended).
2. The mathematical entry-level skills expected by programs at the University of Wyoming do not represent an upper-level extreme nationally. Although increasing gradually, they still may be viewed as modest as compared with a large number of universities.

3. The University of Wyoming still offers precalculus courses, but the pace and extended content of these courses makes them, in practicality, inaccessible to students who terminated precollege mathematics before Algebra II and/or who have not studied mathematics for two or more years before enrolling in these college courses.
4. Due to rising mathematical requirements in all occupations, enrollments in college mathematics classes are increasing rapidly. The resources (instructors and classroom space) needed to meet this tide are expanding slowly or not at all due to financial constraints. College mathematics departments (including the one at the University of Wyoming) can no longer afford the luxury of offering "remedial" courses. As a result, two actions are being taken which will magnify the problems reported by this survey. First, noncredit college courses in general mathematics are being dropped entirely. Secondly, the content of precalculus and calculus courses is being "revised upwards". Many topics previously reviewed in these precalculus courses are being deleted in order to concentrate on the refinement of advanced skills. Students will be expected to pass course-specific entrance examinations covering these deleted topics before being permitted to register for such precalculus and calculus courses. Since remedial courses will no longer be available within the universities, students failing these entrance examinations will be forced to seek the help of private tutors or leave their chosen fields of study for ones with lesser mathematical requirements.
5. The study focused upon the mathematical preparation and occupational aspirations of college-bound students. This was done because it was relatively easy to define the entry-level mathematical skills associated with

college programs. However, noncollege-bound students seeking certification by union, trade or government agencies comprise an equally important population which will be confronted by similar mathematical requirements, usually in the form of examinations.

AFTERWORD

Based upon the results of this study, the authors agree with the students who led them to undertake it. That is, they agree that high school students need more and better information regarding the mathematical expectations for entry into and advancement within the occupational fields to which they aspire. To this end, the following minimal suggestions are offered.

1. The college-bound student should contact the appropriate program director within each institution he is considering requesting an up-to-date program description and a copy of the institution's undergraduate catalog. This should be done as early as possible in the student's high school career.
2. College-bound and noncollege-bound students should contact the professional, trade or union groups associated with their fields of interest requesting information about mathematical requirements of those fields.
3. Mathematics teachers and counselors should have access and be familiar with general information regarding the mathematical requirements of several occupational fields. In this regard, some useful resources are:
   * The National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091. Ask for information about their package of posters and brochures entitled "Mathematics and Careers." Also ask for the NCTM Guidance/Counseling Position Statement (free).
   * University catalogs from universities of interest to students in your school. Have the students identify the universities and construct a letter, but have the letter typed on school stationery.

* Bibliography on Careers in Mathematics and Related Fields. Society for Industrial and Applied Mathematics, 33 South 17th Street, Philadelphia, PA 19103. 1976. 2pp., free.
* Careers for Women in Mathematics. Association for Women in Math, c/o Wellesley College, Wellesley, MA 02181. 7pp., free. (Self-addressed, stamped envelope must accompany request.)
* Careers in Statistics. American Statistical Association, 806 15th St., NW, Washington, DC 20005. 1974. 23pp., free.
* Career Mathematics: Industry and the Trades. Houghton Mifflin Co., One Beacon St., Boston, MA 02107. 1977. 436pp., $6.99.
* Employment Outlook in Mathematics Occupations--Mathematicians, Statisticians. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. (BLS Bulletin No. 1785-78) 1974-75. 12pp., 35¢.
* Occupational Information Monograph - Mathematician. Guidance Centre, Faculty of Education, University of Toronto, 1000 Yonge St., Toronto, ON, Canada M4W 2K8. 1973. 3 pp., 58¢. Quantity discounts available on request. (Other mathematics-related career briefs also available.)
* Professional Opportunities in Mathematics. Mathematical Association of America, 1225 Connecticut Ave., NW, Washington, DC 20036. 1974. 35pp., 50¢. (40¢ each for orders of five or more.)
* Why Not Mathematics? Chronicle Guidance Publications, Inc., Moravia, NY 13118. 1971. 4pp., 65¢. Reprint from the MATHEMATICS TEACHER, NCTM, January, 1971.
* So You're Good at Math. Society of Actuaries, 208 South LaSalle St., Chicago, IL 60604. 12pp., free.

4. Female students and students revealing anxiety about mathematics need special attention.

* School personnel within Wyoming should contact the Science and Mathematics Teaching Center, Box 3992 University Station, Laramie, WY 82071 (Phone: 766-6381).
* Other sources of information in this area can be obtained by contacting the Dissemination Center, Women's Educational Equity Act Program, c/o Education Development Center, 55 Chapel Street, Newton, MA 02160. Simply ask for information about WEEA products, especially those dealing with mathematics.

In reviewing such information, students should be cautioned on at least three counts. First, published requirements are often out of date. Minimal requirements in the area of mathematics are increasing within many fields; a personal interview with program directors is advised if current information is to be obtained and projected to the time when the student will enter the program. Second, the mathematical skills needed to gain entry to a program may not be sufficient to advance within the field. Third, skills in mathematics atrophy quickly. The student electing to complete only the minimal precollege mathematics required by his chosen field should consider completing these requirements late in his high school career. If completed early, the ensuing time interval between course completion and required application on the job or in further study may make those skills inaccessible.

APPENDICES

APPENDIX A

SCHOOL INFORMATION FORM

Please complete each item on this form and return it (use the enclosed envelope) along with the completed Student Mathematics Program Survey form by 5 May 1978.

1. Name of School: ______________________________

   Mailing address of school: ______________________________

   ____

   ZIP

   School phone number: ______________________

2. Name of person completing this form: ______________________

3. Number of seniors enrolled in school at the time the Survey form was used: ____________

4. Number of seniors actually completing the survey form: _____

APPENDIX B

STUDENT MATHEMATICS PROGRAM SURVEY

1. Sex (circle one) - M F

2. Do you plan to begin study at a university or community college within the next two years? (Circle one) - - - - - - - - - - - - Yes No

> If you responded 'NO' to Item 2, skip Item 3 and go directly to Item 4. If you responded 'YES' to Item 2, complete Item 3 before going on to Item 4.

3. A list of several occupational fields is given on the back of this sheet. In the boxes at the right, list the number that corresponds to the field that you wish to enter. (You may list as many as three fields or as few as one. The order in which you list them should indicate your order of interest in them.)

   1st [ ]
   2nd [ ]
   3rd [ ]

4. Circle one number at the right to indicate the last year of school in which you took a mathematics course. 7 8 9 10 11 12

5. Do you feel that the mathematics you have taken in high school has prepared you adequately to begin training in your chosen occupational field(s)? Yes No

* *

Below is a list of mathematics courses and topics. Read each item on the list. If you took a given course (or studied a given topic) as part of your mathematics program (Grades 7-12), so indicate by drawing a circle around the year (grade) in which you took that course (or studied that topic).

(a) 7 8 9 10 11 12 General Mathematics (Circle the <u>last</u> year in which you studied this)

(b) 7 8 9 10 11 12 First Year Algebra (Algebra I)

(c) 7 8 9 10 11 12 Second Year Algebra (Algebra II)

(d) 7 8 9 10 11 12 Geometry

(e) 7 8 9 10 11 12 Trigonometric functions and their graphs

(f) 7 8 9 10 11 12 Trigonometric identities

(g) 7 8 9 10 11 12 Inverse trigonometric functions and their graphs

(h) 7 8 9 10 11 12 The common logarithm function (base 10)

(i) 7 8 9 10 11 12 The natural logarithm function (base e)

(j) 7 8 9 10 11 12 The algebra of functions (composition, inversion, addition, etc.)

(k) 7 8 9 10 11 12 Mathematical induction

(l) 7 8 9 10 11 12 Analytic (Coordinate) geometry (lines, parabolas, circles, hyperbolas, ellipses)

(m) 7 8 9 10 11 12 Matrix addition, subtraction and multiplication

(n) 7 8 9 10 11 12 Inverse and determinant of a matrix

(o) 7 8 9 10 11 12 Concept of a limit

(p) 7 8 9 10 11 12 Continuity

(q) 7 8 9 10 11 12 Differentiation of polynomial functions

(r) 7 8 9 10 11 12 Differentiation of trigonometric functions

(s) 7 8 9 10 11 12 Differentiation of exponential and logarithmic functions

(t) 7 8 9 10 11 12 The Chain Rule for differentiation

(u) 7 8 9 10 11 12 Maxima and minima problems

(v) 7 8 9 10 11 12 Integration of polynomial functions

(w) 7 8 9 10 11 12 Integration of trigonometric functions

(x) 7 8 9 10 11 12 Integration of exponential and logarithmic functions

(y) 7 8 9 10 11 12 Computer programming (BASIC language)

(z) 7 8 9 10 11 12 Computer programming (FORTRAN language)

OCCUPATIONAL FIELDS

ARTS AND SCIENCES

01 Anthropology
02 Art
03 Astronomy
04 Biology (combined study of plants and animals)
05 Botany
06 Broadcasting (radio and TV)
07 Chemistry
08 Computer Science
09 Dance
10 English
11 Foreign Language
12 Geography
13 Geology
14 History
15 International Studies (politics, culture, economics: not just language)
16 Journalism
17 Mathematics
18 Music: Instrumental
19 Music: Vocal
20 Philosophy
21 Physics
22 Police Work
23 Politics: American
24 Pre-Forestry
25 Psychology
26 Public Administration
27 Recreation and Park Administration
28 Social Work
29 Sociology (study of the structure of human society)
30 Theatre
31 Wildlife Conservation and Management
32 Zoology

AGRICULTURE

33 Agricultural Business
34 Agricultural Communications (journalism and broadcasting)
35 Agricultural Economics
36 Agricultural Mechanization (technology applied to agriculture)
37 Animal Science (production of meat, dairy products, wool, etc.)
38 Consumer and Family Educational Services
39 Crop Science
40 Dietetics (dieticians)
41 Entomology (insects and insect control)
42 Farm and Ranch Management
43 Food Science (processing, storage and distribution of food)
44 General Agriculture
45 Home Economics Communications (journalism and broadcasting)
46 International Agriculture (world trade in agricultural products)
47 Microbiology
48 Pre-Veterinary Medicine
49 Range Management
50 Soil Science (soil properties as related to crop production)

VOCATIONAL/TECHNICAL

51 Electronics Technology (non-engineering careers in electronics)
52 Manufacturing Technology (non-engineering careers in manufacturing industries)

COMMERCE AND INDUSTRY

53 Accounting
54 Economics
55 Finance (bank management, investment management, etc.)
56 General Business
57 Industrial Management (combines business and engineering)
58 Management (planning, directing and controlling operations of a large organization)
59 Management Information Systems (combines accounting or management with computer science)
60 Marketing (merchandising, product research, retailing, advertising, etc.)
61 Small Business Management
62 Statistics

EDUCATION

63 Elementary School Teacher
64 Physical Education (non-teaching: athlete, trainer, journalist, broadcaster, etc.)
65 Teacher of the Handicapped

Secondary School Teacher of:
66 Agriculture
67 Art
68 Biology
69 Business
70 Chemistry
71 Earth Science
72 English
73 Foreign Languages
74 Home Economics
75 Industrial Arts
76 Journalism
77 Mathematics
78 Music
79 Office Administration (secretarial science)
80 Physical Education
81 Physics
82 Psychology
83 Social Studies

ENGINEERING

84 Agricultural (improving plant & animal environments, processing, storage, etc.)
85 Architectural
86 Biological (electrical engineering applied to biological studies)
87 Chemical
88 Civil
89 Electrical
90 Mechanical
91 Petroleum

HEALTH SCIENCES

92 Dental Hygiene (not dentistry)
93 Medical Technology (paramedic)
94 Nursing
95 Pharmacy
96 Pre-dentistry
97 Pre-medical
98 Pre-optometry
99 Speech Pathology and Audiology

APPENDIX C

M E M O R A N D U M

TO: Persons Assisting with the "Needed Mathematics" Survey of Wyoming High School Seniors

FROM: Bob Kansky
Box 3992 University Station, Laramie, Wyoming

RE: Use and Return of the Student Survey Form

Thank you for helping us to complete this study. We hope that the information which it will provide (the report will be printed and mailed in early October) will be of value to you and your students.

We ask that you do three things with regard to this study. The details on each are given below.

/__/ 1. Complete each line of the attached (yellow) School Information Form.

/__/ 2. Have each senior (insofar as possible) complete a copy of the enclosed Student Mathematics Program Survey (white). In doing this, please consider the suggestions given on the attached Directions for Survey Administration (green sheet).

/__/ 3. Please return the (yellow) School Information Form and the completed Student Mathematics Program Survey forms to me by 5 May 1978. Use the addressed envelope which is enclosed.

Should you have any questions, phone me person-to-person collect at my office (766-6381) or home (742-3903).

Attachments: School Information Form
Directions for Administration of Survey

Enclosures: Copies of Student Survey Form
Envelope addressed to Kansky

APPENDIX D

DIRECTIONS FOR SURVEY ADMINISTRATION

The Student Mathematics Program Survey form should be administered to each senior in your school. We realize, of course, that we may have to settle for less than that. However, please try to reach as many seniors as possible.

The form could be administered to all seniors at one time (as in a senior assembly) or to groups (as in classrooms). It need not be administered to all persons on the same day. In pilot testing, it took about 15-20 minutes to administer this survey to a group of high school seniors.

The form should be administered to <u>seniors only</u>.

We would make the following suggestions with regard to the use of the form with a group.

1. Let the students know why the survey data is being gathered. To this end, you could read them the following statement of purpose:

   PURPOSES OF THIS STUDY (Please read to students)

   Comments of faculty and undergraduate students at the University of Wyoming have suggested that <u>high school students</u> (especially women) are not pursuing a high school mathematics program consistent with their career goals. The purposes of this study are (1) to find out if that suggestion is correct and (2) to provide high school students, teachers and administrators with current information regarding the mathematical requirements of a wide variety of occupations. By completing this survey form, you will help meet the first of these purposes; a report will then be issued to the schools to satisfy the second purpose and, hence, to help in counseling of future students.

2. Make certain that students understand each of the first five items. (Without this information, the survey form is worthless.) You might consider taking these items one at a time.

3. If you're not a mathematics teacher yourself, HAVE A MATHEMATICS TEACHER READ THE LIST OF MATHEMATICS COURSES AND TOPICS! It would be a good idea to have notes indicating
   (a) which courses or topics are <u>not</u> part of your school curriculum, and
   (b) for those topics which are in your curriculum, the course in which each topic is developed.

   The latter is important since we have found that many students who have studied a topic do not recognize its description on this survey and some students misinterpret technical terms (e.g., they take 'differentiation of' to mean 'distinguishing among' and indicate that they studied 'differentiation of trigonometric functions' in Grade 10).

4. Have a mathematics teacher handy in case a student has questions about the items on the list of courses and content.

5. As a guide to your mathematics faculty, the courses entitled First Year Algebra (Algebra I), Second Year Algebra (Algebra II) and Geometry are defined as follows:

   <u>Algebra I</u> would include the study of operations on signed numbers, linear equations, systems of linear equations, integer exponents and special products such as $(a \pm b)^2$, $(a \pm b)^3$ and $(a+b)(a-b)$.

   <u>Algebra II</u> would include the study of quadratic equations (including the method of completing the square), polynomial functions, graphs of functions, fractional exponents, common and natural logarithms, arithmetic series, geometric series and the binomial theorem.

   <u>Geometry</u> would include the study of the basic properties of geometric figures in two and three dimensions as well as the application of formulas for perimeters, areas (plane and surface) and volume.

6. If you have any questions, please call Bob Kansky person-to-person collect at the Teaching Center (766-6381) or his home (742-3903).

APPENDIX E

SCHOOLS SELECTED FOR STUDY: CLASSIFIED BY SIZE OF SENIOR CLASS

School Type	Senior Class Enrollment Range	High Schools Selected	Senior* Enrollment
I	250-600	Natrona County	597
		+ Cheyenne East	457
		+ Kelly Walsh	404
		+ Laramie	286
		+ Campbell County	279
II	150-249	+ Rock Springs	237
		+ Lander	189
		Cody	167
		+ Powell	157
		+ Rawlins	154
III	100-149	Star Valley	126
		+ Worland	124
		+ Jackson	113
		+ Converse County	112
		+ Newcastle	105
IV	50-99	+ Hot Springs County	85
		+ Buffalo	79
		+ Glenrock	65
		+ Platte Valley	52
		+ Kemmerer	50
V	5-49	+ Sundance	49
		+ Big Piney	44
		Pine Bluffs	40
		+ Pinedale	38
		+ Wind River	36
		+ Basin	36

APPENDIX E (concluded)

SCHOOLS SELECTED FOR STUDY: CLASSIFIED BY SIZE OF SENIOR CLASS

School Type	Senior Class Enrollment Range	High Schools Selected	Senior * Enrollment
		+ Mountain View	34
		+ Lyman	32
		+ Tongue River	31
		+ Dubois	29
		Medicine Bow	29
		+ Guernsey/Sunrise	27
		Jeffrey City	24
		+ Big Horn	22
		+ Hulett	21
		+ Meeteetse	20
		+ Cokeville	16
		+ Morrow (Baggs)	15
		+ Byron	14
		+ Burlington	13
		Clearmont	12
		+ Goshen Hole	12
		Albin	10
		+ Manderson/Hyattville	10
		+ Glendo	9
		+ Chugwater	8
		+ Farson/Eden	8

* Figures are from the Wyoming SDE publication Fall 1977 Report of Staff/Teachers/Pupils/Schools Enrollments, October, 1977.

\+ Indicates those schools that returned the survey.

APPENDIX F

COLLEGE PROGRAM INTERVIEW FORM

BACKGROUND (To be explained to person to be interviewed):

Informal comments of faculty and students at the UW have suggested that high school students (especially women) are not being given proper counseling with regard to mathematical preparation for college. The Science and Mathematics Teaching Center, therefore, is conducting a study with two purposes: (a) to identify any discrepancies between the specific college plans of Wyoming high school seniors and the high school mathematics programs pursued by these seniors and (b) to provide Wyoming's high school counselors, administrators and mathematics teachers with current information regarding the minimal high school mathematical preparation assumed of students entering various UW programs. The report also will be made available to all UW program directors.

The purpose of this interview is to identify the mathematical expectations of the program(s) you direct.

* *

Name of person interviewed: ______________________________

Office address: ______________________________

Campus phone: ______________

Name of specific undergraduate program: ______________________________

1. Does completion of this program (above) require that the student take

   /__/ MATH 302F?
   /__/ MATH 302G?

   Check the one(s) required.

2. If completion of the program requires any UW mathematics course otner than 302F of 302G, what is the first such mathematics course required?

   MATH ______________

3. For what portion of the students who enter the program has completion of the required mathematics courses been a stumbling block?

   none (0%)
   few (1-25%)
   many (26-50%)
   most (over 51%)
   all (100%)

4. In general, are you and your faculty satisfied with the mathematical preparation of students entering this program?

   /__/ yes
   /__/ no

5. Is there any comment that you wish to make with respect to the high school mathematical preparation of persons wishing to enter this UW program?

APPENDIX G

DESCRIPTION OF THE PRECALCULUS MATHEMATICS COURSES AT THE UNIVERSITY OF WYOMING*

MATH 302F: Precalculus Algebra

Three 50-minute class meetings each week; 45-48 meetings during the semester. A total of 38-40 clock hours of instruction and testing.

Reviews and/or extends work with real number operations and properties, operations on polynomials and rational expressions, linear equations and inequations, quadratic equations and inequations, powers and roots (both integral and rational), analytic geometry (lines and conic sections), graphing of equations and inequations (one and two dimensions), absolute valuing in first degree equations and inequations, systems of linear equations, direct and inverse variation, functions and relations, polynomial functions, theory of equations, polynomial functions, theory of equations, exponential and logarithmic functions, determinants, basic operations on matrices, and problem solving.

MATH 302G: Precalculus Trigonometry

Three 50-minute class meetings each week; 45-48 meetings during the semester. A total of 38-40 clock hours of instruction and testing.

Reviews and/or extends work with exponential and logarithmic functions, right angle trigonometry, the distance formula, angular velocity, circular functions (emphasizing radian-measure arguments) and their graphs, trigonometric identities, trigonometric equations, Law of Sines, Law of Cosines, universe trigonometric functions and their graphs, polar coordinates, complex numbers and problem solving.

MATH 303D: Precalculus Mathematics

Five 50-minute class meetings each week; 75-80 meetings during the semester. A total of 63-67 clock hours of instruction and testing.

Intended for students needing only a very quick review of precalculus algebra and trigonometry, this course covers the combined content of MATH 302F and MATH 302G (as described above).

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* These descriptions are based upon the 1978-79 course syllabi filed in the Department of Mathematics.