

Vive la Différence: A Comparison of Male-Female Academic Performance[†]

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ABSTRACT

The increase in female participation in University education is a trend that has been obvious for some time. On the basis of the literature on intelligence and achievement testing some of which shows males to be superior in mathematical and scientific areas and females to be superior in humanities and social science areas, it might be expected that performance at the university level would reflect these differential strengths. This expectation should be reinforced as the numbers of males and females in given areas of study become more equal and the effects of selection of the "cream of the crop" are reduced, particularly for women in math-sciences. An examination of data on performance at the University of Alberta gives no support for the expectation of superior performance by males in math-science areas of study.

RÉSUMÉ

La croissance de la participation féminine à la formation universitaire témoigne d'une tendance qui est devenue évidente depuis quelque temps. Selon la littérature sur les tests d'aptitude et de compétence intellectuelles, dont certains indiquent la supériorité des hommes dans les mathématiques et les sciences et celle des femmes dans les humanités et les sciences sociales, la performance à l'université devrait refléter ces mêmes différences. Cette prévision devrait se confirmer à mesure que les nombres d'hommes et de femmes arrivent à égalité dans certains domaines d'études et que les effets de la sélection de la "crème de la société" sont réduits, surtout dans le cas des femmes en sciences et mathématiques. Une analyse

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des données sur les résultats des étudiants à l'Université d'Alberta n'apporte aucun appui à la prévision d'une performance supérieure par les hommes dans les domaines des mathématiques et des sciences.

What are the forces that pull girls away from science? Do they differ in essence, or in strength only, from the forces that steer them away from active involvement in other areas of the working world? How can it be that, despite all the changes in opportunities for and achievements by women today, they still do not do science? (Science Council of Canada, 1982, 7.)

This concern echoes that expressed by the Royal Commission on the Status of Women more than a decade earlier when it observed that "boys predominate in the study of mathematics and science and girls tend to concentrate on social studies" (1970, 167). Although the participation of women in postsecondary education is now nearly equal that of men, females at both the secondary and postsecondary levels are still less likely to specialize in the sciences and mathematics than are males (von Zur-Muehlen, 1982; Science Council of Canada, 1982).

The question of why so few women choose to study science and mathematics has been addressed both in the literature and in a variety of conferences. On the one hand, explanation for the paucity of women in science has been sought in environmental factors. Factors such as female sex role socialization, expectation effects, the absence of appropriate role models, bias in textbooks, bias in the teaching and counselling process, and the absence of support systems for women in science are cited as either discouraging or not encouraging women to enter math-science fields (Fox, 1981; Fox, Brody and Tobin, 1982; Meece, *et al*, 1982; Science Council of Canada, 1982). On the other hand, explanation is sought in sex differences in ability and aptitude for science. Here reference is made to the literature on intelligence and ability testing and on standardized achievement testing which sometimes shows men to perform better on mathematical, spatial, logical reasoning components and women to perform better on verbal components of such tests. Macoby and Jacklin (1974) review much of this literature on male/female differentials in ability and achievement as does Fox (1981). (See also Robitaille and Sherrill, 1979; Sawada, Olsen and Sigurdson, 1981). While the work of Benbow and Stanley (1980, 1984) indicates that males are more likely to be mathematically precocious than females, the existence of differences in ability between males and females as a whole is still a matter on which a conclusive answer cannot be given (Fennema and Sherman, 1977, 1978; Wittig and Petersen, 1979; Fox, 1981).

Despite the fact that it is not clear that females are on average less able than males on mathematical, spatial, reasoning tasks and despite the fact that there is considerable disagreement about what ability and standardized achievement tests measure (Dwyer, 1979, pp. 335-353) the debate about whether the source of any differences between males and females is innate or is the consequence of social factors, continues. Indeed there is a growing debate about how sex linked

differences in chromosomal factors, hormonal levels, brain differentiation and hemispheric dominance may account for male superiority in mathematical and scientific ability. (See for example, Broverman *et al*, 1980; Harris, 1978; Levy, 1974.)

Whether intelligence tests measure intelligence, whether or not sex differences in ability exist; whether whatever differences exist are innate or the product of environment are subject to continuing debate. Emotions and cherished values are at least as important as concrete evidence in this debate.

THE STUDY

Bearing in mind the questions raised above, it is useful to raise some other questions concerning males and females in mathematics and science: Do males outperform females in mathematics and science courses and programs? Do females do better than males in the social sciences and humanities? If there are differences in ability, these ought to be reflected in classroom performance. Perhaps, one reason why fewer women than men study science and mathematics is that they do not do as well in such programs or courses. An examination of these questions should at the very least allow us to see whether those women who enter particular fields are at a disadvantage or advantage relative to men. The intent of this paper, then, is to look at performance of students at the postsecondary level in an attempt to assess sex differentials.

Compared to the considerable literature on performance of males and females on standardized ability and achievement tests, there is relatively little research on course or program performance. Surprisingly, of the studies of school performance (including elementary, secondary and postsecondary levels) reviewed by Maccoby and Jacklin, all show either no sex differences or better female performance both in overall grades and in mathematics and science (1974, 136). Even those studies that combined standardized achievement testing (where boys were superior in mathematics and related skills) with an examination of school grades, girls did as well or better than boys in terms of grades. British data for the secondary level are more consistent but in the opposite direction – “twice as many boys gain passes (at GCE ‘o’ level) in science subjects as do girls, who gain passes in arts subjects instead” (Meighan, 1981, 279).

On the Canadian scene data are sketchy. The Science Council of Canada reports that in Newfoundland in 1973-74 a larger proportion of 11th grade males passed and achieved grades of over 80% in Physics and Chemistry, while females performed better than males in Biology and Algebra (1982, 38). In Ontario (1979), a larger proportion of grade 13 females than males passed physics, chemistry, biology and mathematics (Science Council of Canada, 1982, 41). A similar finding is reported in Saskatchewan, where a larger proportion of 11th and 12th grade females than males obtained passes in mathematics and sciences (Melvin, 1982, 14-15). It should be noted that since fewer females than males enrol in mathematics and physics courses, there may be a selection process operating so

that only the most able females take such courses while male students represent a wider ability range. Studies of performance at the postsecondary level appear to be consistent with secondary school performance. Data from the University of Alberta show that females are less likely to fail and that their average G.P.A. is higher (Mehra, 1978), a pattern that is maintained across faculties including science faculties (Wener and Cairns, 1980). In contacts with twenty-three large Canadian Universities soliciting data on enrolments and performance, only three were able to provide information on performance of males and females in different faculties (Calgary, 1981; Guelph, 1982; Simon Fraser, 1977). This data, like the Alberta information, shows females maintaining higher academic standing than men in both arts and science fields.

In an attempt to examine in more detail the current position of women in University programs, particularly in science, the following study examines data from the University of Alberta over a twelve year period. The data, collected and made available by the Office of Institutional Research and Planning, include information on enrolments, grade point averages, and course failure for science and other faculties for males and females. Also included are performance data for males and females in selected math, science and arts courses. This array of information allows an examination of both the extent to which females and males enter science and other fields as well as an examination of how well they do in various fields and courses. In addition to addressing the question of whether any male-female differences in ability are reflected in differential performance in math-science and arts fields, the possibility of selection factors operating in favor of women in science will be examined. For the most part, the analysis is confined to simple percentaging, frequency distributions and means.

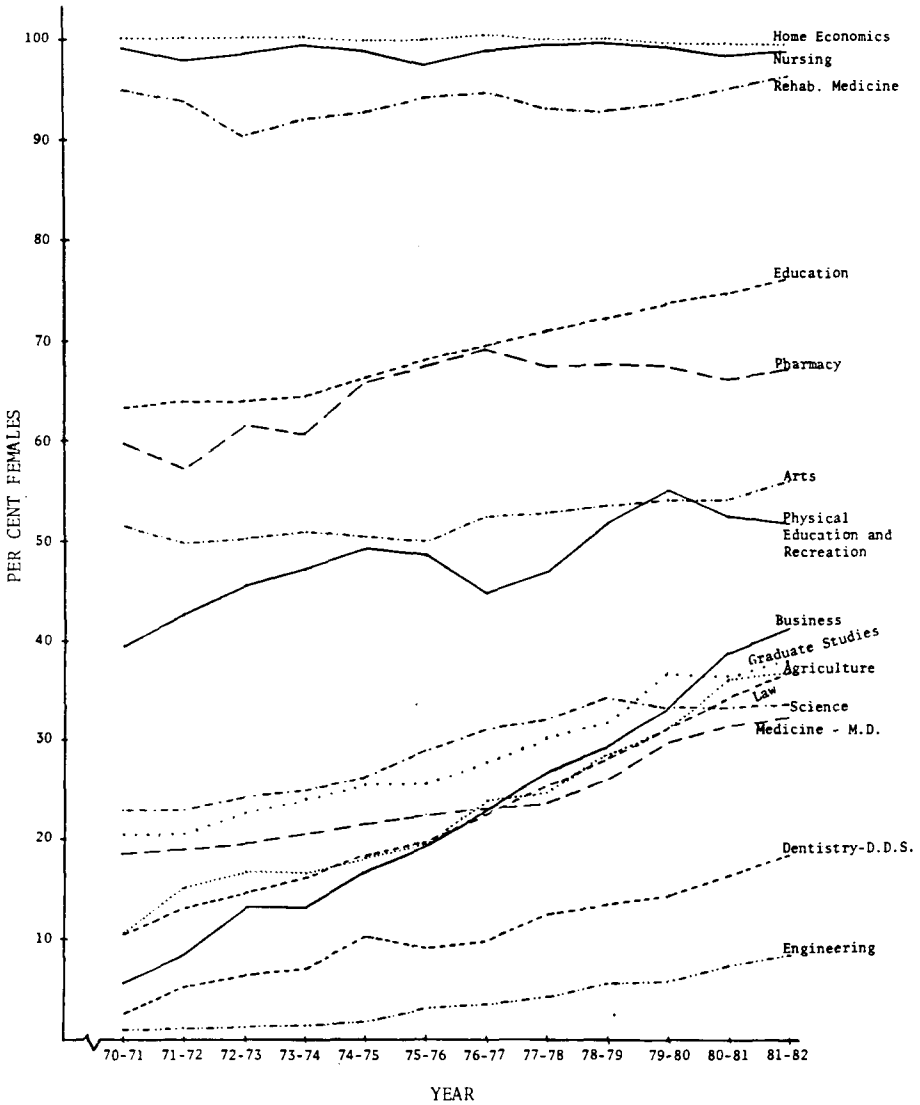
ENROLMENT

After a decade of rapid growth during the 1960's, full-time enrolment at the University of Alberta stabilized. Between 1970-71 and 1981-82 the number of full-time graduate and undergraduate students rose from 18,334 to 19,535. In fact, the latter figure represents a decline from the 1976-77 high point in enrolment of 19,842 full-time students at both undergraduate and graduate levels.

Although the number of students at the University levelled off during this period, shifts in the proportion of males and females attending university continued. In 1960-61 females constituted 31.9% of all full-time students. By 1970-71 this proportion had risen to 38.1% and by 1981-82 females made up 47.5% of the full-time student body at the University.

Not surprisingly, changes in the proportion of men and women at the University were not evenly distributed across all faculties. As Figure 1 shows some traditionally female faculties such as Home Economics, Nursing and Rehabilitation Medicine remained so. The Faculty of Education which early in the decade had a higher proportion of men enrolled than had previously been the case, once more enrolled proportionally more females.

FIGURE 1
FEMALE ENROLMENT AS A PERCENTAGE OF TOTAL ENROLMENT
BY FACULTY, 1970-71 to 1981-82



Other faculties such as Pharmacy and Arts demonstrated moderate increases in the proportion of women enrolled. Here, large increases in the proportion of women had occurred in the previous decade. Between 1970-71 and 1981-82 female students in Arts increased from 51.0% to 55.7% of the total enrolled in

the Faculty. Similarly, in Pharmacy females constituted 59.7% of enrolments in 1970-71 and 66.6% in 1981-82.

The most dramatic changes in male-female enrolments occurred in areas that have long been heavily dominated by male students. This is particularly true of the professional faculties. Foremost among these is the Faculty of Business where female enrolment rose 35.5 percentage points from 5.6% of the total enrolment to 41.1% of the total. As Figure 1 makes apparent, although this is the most dramatic increase, all male dominated professional faculties show increases in the proportion of females enrolled.

While increases in the proportion of females are much smaller in Dentistry and Engineering than in Business, Law, Medicine and Agriculture the proportion of females in Engineering rose from .9% in 1970-71 to 8.2% in 1981-82 and the proportion of females in Dentistry – DDS rose from 2.5% to 18.2%. It should be noted that shifts in proportions of males and females sometimes mask important changes in absolute numbers. For example the rise of 15.7 percentage points in the proportion of women in Dentistry – DDS represents an increase from 5 to 36 women in the DDS program. In Engineering a smaller increase of 7.3 percentage points in the proportion of females represented a large increase in the number of women from 13 to 150.

Increases in the proportion of women occurred also in Graduate Studies and Science. These were not, however, as marked changes as occurred in Business, Agriculture or Law. In the case of Graduate Studies the proportion of females increased by 17 percentage points from 20.9% to 37.9% but the change occurred in areas such as Arts and Education. For example, 34.6% of Master of Education students in 1970-71 were female while by 1981-82, 57.8% were female, an increase of 23.2 percentage points. In Master of Arts a similar picture emerges – 35.4% were women in 1970-71, 54.7% were women in 1981-82, an increase of 19.3 percentage points. Changes in the Master of Science program are not as large. 14.5% of M.Sc. students in 1970-71 were women. By 1981-82 this had increased to 26.5%, an increase of 12 percentage points.

Turning now to the Faculty of Science we see an overall increase in the proportion of women from 22.6% in 1970-71 to 32.6% in 1981-82. Enrolment of men increased from 2190 to 2307 over the period but enrolment of women nearly doubled from 640 to 1115. Again important differences between fields within the Faculty are obscured by the overall trends. Throughout the period women were more heavily enrolled in the life sciences and less heavily enrolled in the physical sciences. For 1970-71 women constituted 34.0% of the honors students in the life sciences and 12.7% of the honors students in the physical sciences. These figures had risen to 36.6% (an increase of 2.6 points in the life sciences) and 16.9% (an increase of 4.2 points in the physical sciences) for 1981-81. Comparable gains in the proportion of women enrolled are evident in four year specialized programs but in each case more women are in life sciences than physical sciences or even computing science. While the data available pertain only to specialized and honors students, it is reasonable to assume that similar patterns obtain for

majors in the General B.Sc. program as well. Similarly in the Faculty of Agriculture and Forestry where women now constitute 36.6% of the students compared to 10.6% in 1970-71; they are more heavily enrolled in Food Science (76.7% of total enrolment) and pre-Veterinary Medicine (61.7%) than in Forestry (25.9%).

A comparison between male-female enrolment trends at the University of Alberta and national trends, points to a common pattern. Max von Zur-Muehlen's (1982) analysis of Statistics Canada national data shows similar enrolment patterns. In short, increasing numbers of women are entering science programs, however, the enrolment of females in the physical sciences and engineering remains low.

PERFORMANCE

Among the possible explanations for fewer females enrolling in science programs, are those related to ability and performance. The following analysis addresses the questions raised earlier:

- a. Do males out-perform females in the sciences?
- b. Do females do better in the social sciences and humanities?

In addressing these questions several underlying questions will also be examined.

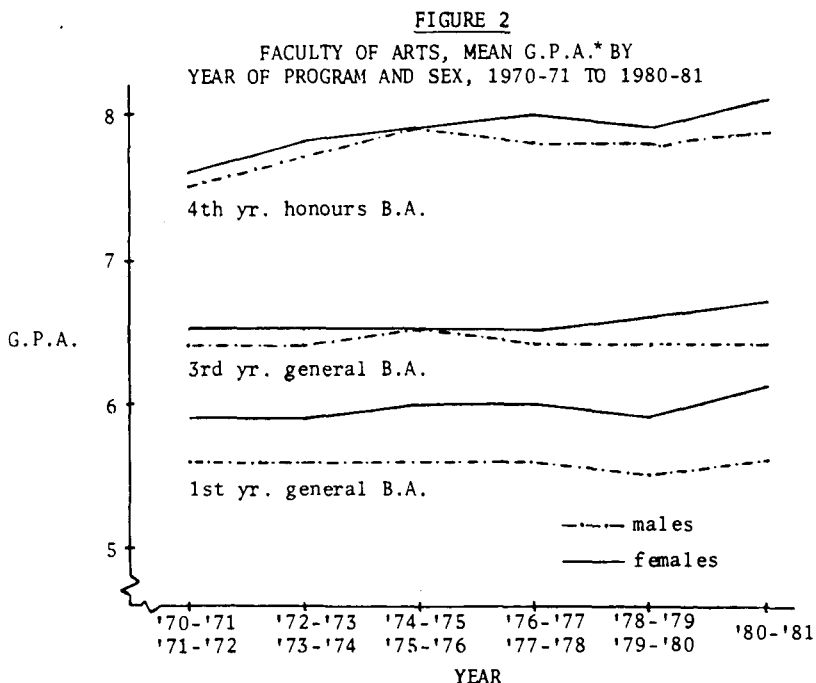
1. Does performance data reflect presumed sex differences in ability?
2. Might lower female enrolment in the sciences be a reflection of poorer performance in some or all science fields?
3. How might selection factors influence possible performance differentials between males and females?

Excluded from this part of the analysis are six faculties: Medicine where G.P.A.'s are not available; Graduate Studies and Research where the large number of pass-fail courses means that up to half of all students do not have G.P.A.'s; Dentistry where there have never been more than 10 female students in any single year of the program and even aggregating, for example, 1st year students for two successive years never yielded an N greater than 16; Nursing, Rehabilitation Medicine, and Household Economics where in contrast to Dentistry there was a shortage of male students. Again even aggregation of students in a particular year of the program over two successive years did not yield N's greater than 20.

MALE AND FEMALE GRADE POINT AVERAGES BY FACULTY

One way of comparing male and female performance in various fields is to examine grade point averages in various faculties. Such a comparison reveals a pattern that is quite consistent from year to year and from faculty to faculty, with female students doing as well or better than male students. This reinforces the findings of earlier analyses by Mehra (1978) and Wener and Cairns (1980).

Data for the Faculty of Arts show females as having mean G.P.A.'s as high or higher than males in all years of the program over the whole time period from 1970-72 to 1980-81. As Figure 2 shows, this difference is greatest in the first year

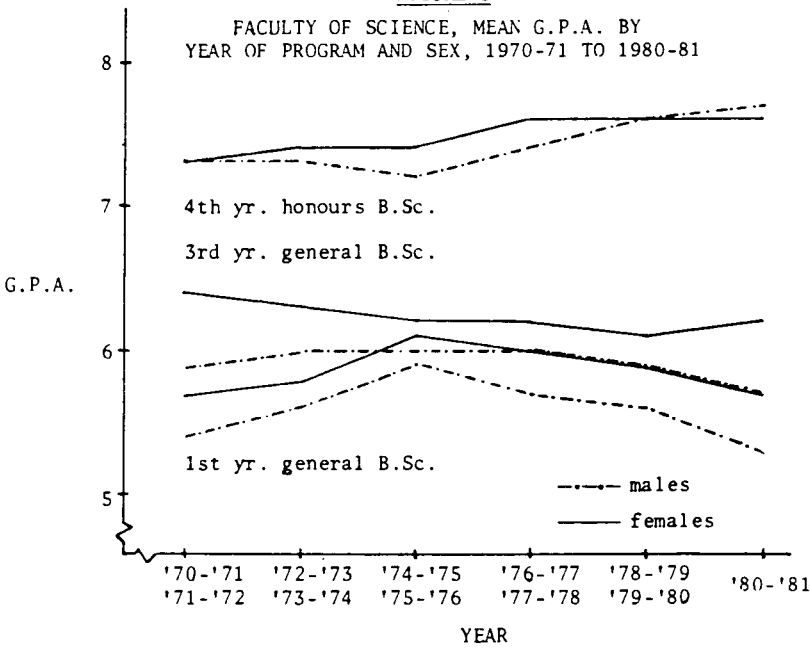


and small in honours programs. Such a finding is, of course, consistent with the observation that the academic strength of females lies in the humanities and social sciences. A similar consistent pattern is evident in the Faculties of Education and Physical Education although the data are not reproduced here. Once more mean G.P.A.'s of females are uniformly higher than those of males.

Figure 3 provides a comparison between male and female mean G.P.A.'s in Science. Although we might expect male mean G.P.A.'s to be higher than those of females, such does not appear to be the case. Indeed for all years, and years of a program, except 4th year honors students in 1980-81, female mean G.P.A.'s are higher than those of males. In no case are the differences large but, as in the case of Arts, a consistent pattern emerges.

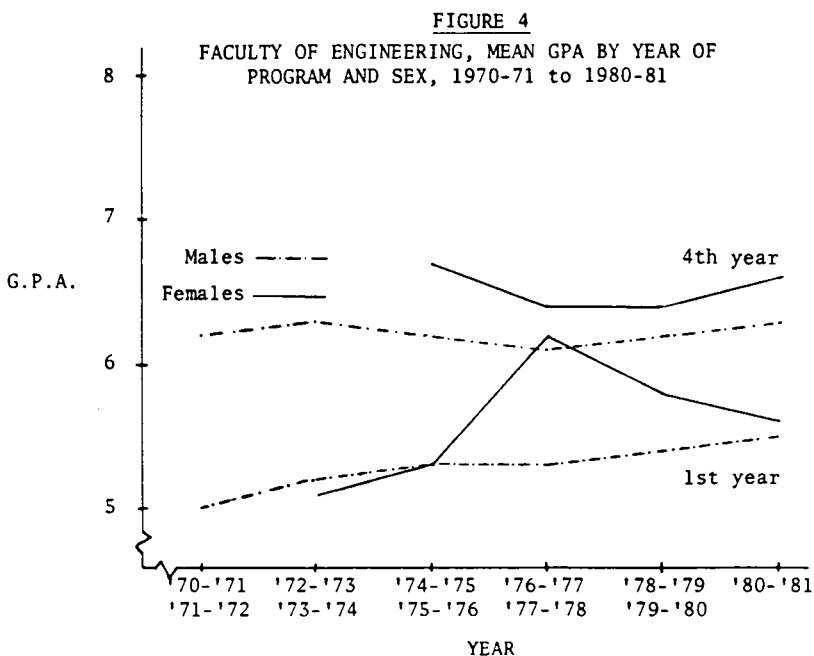
Figures 4, 5 and 6 show mean G.P.A.'s for males and females in first and fourth years of three Science Faculties — Engineering, Agriculture and Pharmacy. Because the number of females in Engineering has been so small until recently, the graphs for that Faculty are incomplete. Even in the 1972-74 period there were only 12 female students in first year Engineering. It is not until 1974-76 for first year students and 1978-80 for fourth year students that there are more than twenty females in each year. Keeping in mind these reservations, in only one case — the 1972-74 first year students did females have a mean G.P.A. lower than that of males. Again, although the data are not graphed, female mean G.P.A. is consistently higher for second and third year students as well.

FIGURE 3
 FACULTY OF SCIENCE, MEAN G.P.A. BY
 YEAR OF PROGRAM AND SEX, 1970-71 TO 1980-81



In Agriculture, as in Engineering the number of female students in any one year of the program does not exceed 20 until the 1974-76 period. The more dependable data after 1974 are once more quite consistent, with females obtaining consistently higher mean G.P.A.'s as Figure 5 illustrates. The Faculties of Engineering, Agriculture, are science based faculties in which males still predominate, particularly so in the case of Engineering. Pharmacy, however, though once a male dominated faculty is now predominantly female. Here a different pattern emerges. While female mean G.P.A. is consistently higher in the fourth year, such is not the case in the first year where females do better for the years 1970-72 to 1974-76 and males have a higher G.P.A. for the years 1976-78 and 1978-80. Once more, trends evident in the years graphed are paralleled in 2nd year which is like 1st year performance and 3rd year which is more like 4th year performance.

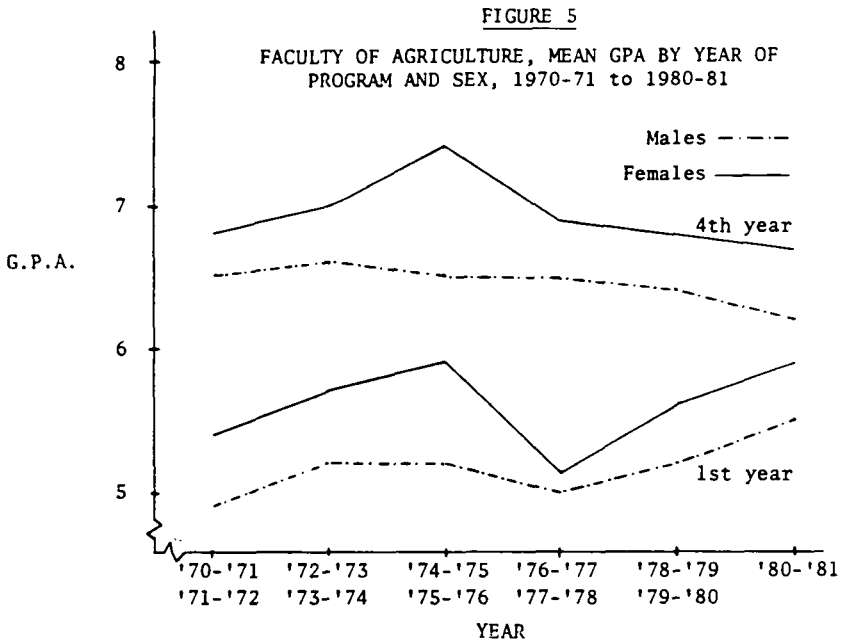
In looking at the performance data reviewed so far, a critic might well point out that it is not surprising that women in Science, Engineering and Agriculture have higher mean G.P.A.'s than men – after all they are highly selected. Even if women on average are less able or less interested in science than men, these women are the “cream of the crop” and so they will out-perform men. If this is the case one would expect that as the proportion of women in a faculty increases, their performance relative to males should deteriorate. Yet this does not appear to occur. Even in Pharmacy where women outnumber men by two to one they do better than men in the third and fourth years of the program over the comparison period and about equally well in first and second years of the program.



One might argue that selection factors ought to work in favour of males in Pharmacy and other faculties such as Arts and Education where male students are in a minority, yet this does not appear to occur.

Turning to Figures 7 and 8, we see the mean G.P.A. of males and females in two professional faculties that until recently enrolled few females. In the case of the Business, females maintain a fairly consistent advantage, though in the case of first year students it appears to narrow as the proportion of males and females becomes nearly equal in recent years. Male-female performance in the Faculty of Law is very similar. Despite the fact that females do as well or slightly better than males, except in the case of first year students in 1980-81, the margin never exceeds .3 grade points. It should be noted that these two faculties; like Engineering, Agriculture and Pharmacy; have had enrolment quotas in effect for at least the period after 1978 and, in the case of Law, much longer. The effect of these enrolment quotas which have no affirmative action components, is to make more uniform the performance and aptitude of all entrants whether male or female. Enrolment quotas, because they eliminate those whose previous academic performance is weak and/or those who perform poorly on standardized entry exams, should diminish the effects of selection. All entrants, male and female, are the "cream of the crop". Despite this, females maintain a performance advantage.

A simple binomial test of significance was used to test whether the probability of the observed frequencies of higher mean female G.P.A., excluding ties, were greater than might be expected by chance. Cases where either the number of males or females in a program were less than twenty per year of program were

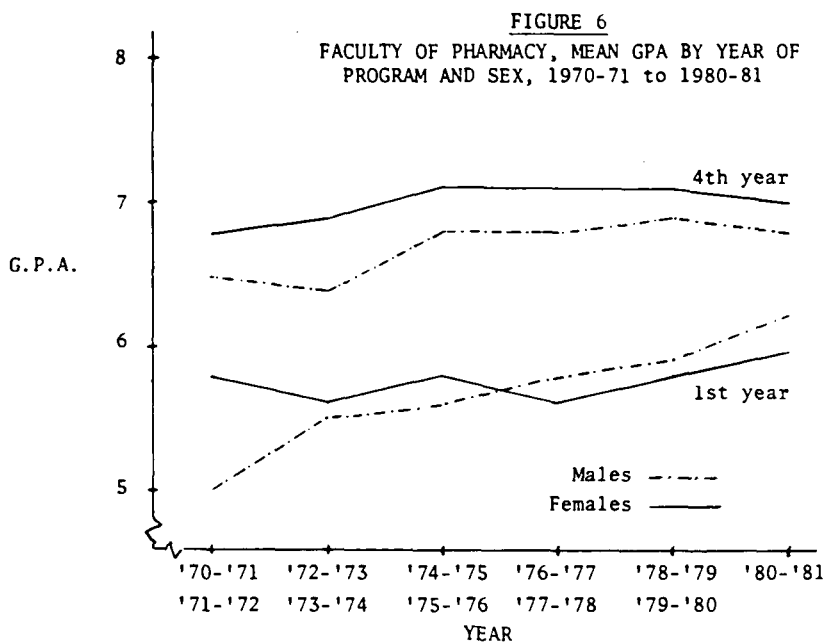


excluded because of their instability. Following this rule of thumb, Agriculture before 1974-76 and Engineering before 1976-78 were not included in this part of the Analysis. Using this simple test of significance (with $\alpha = .05$), the frequency of higher mean female G.P.A. was greater than would be expected by chance in the Faculties of Agriculture and Forestry, Arts, Business and Commerce, Education, Engineering, Physical Education and Science. Only in the Faculties of Law and Pharmacy was there no significant difference.

MALE-FEMALE ENTRY AVERAGES

As was mentioned previously, one explanation for the apparently better performance of females in most years in most faculties, but especially science faculties, might be the self-selection of females whose performance is better prior to entry. It is not possible to determine whether only the best female performers among Alberta high school graduates come to University while male entrants are not as well selected. It is possible to tabulate matriculation entry averages for first year students in various Faculties at the University of Alberta. Although, with the exception of Honours programs in Arts and Science, female matriculation averages are higher than those of males, the data are not reproduced here and any generalization is hazardous. Several factors lie behind this conclusion:

1. There have not been any standardized tests at the high school level since the early part of the period under study, so entry averages do not reflect any common standard.

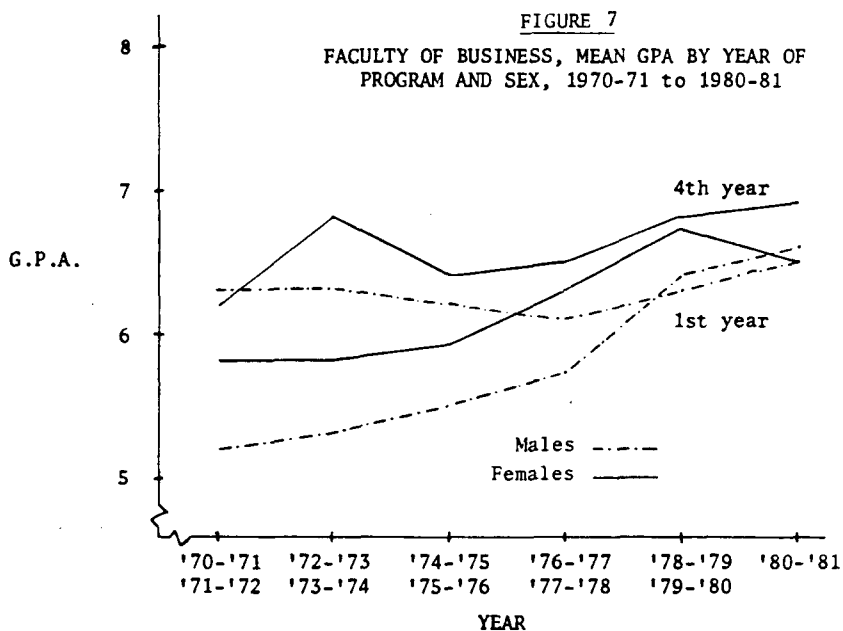


2. In all cases there is a considerable amount of missing data. For professional faculties that admit students with degrees, matriculation averages are missing for most students. For other faculties matriculation averages are not available for up to half of first year students particularly in the period after 1974.

COMPARISON OF FAILURE BETWEEN MALES AND FEMALES

While mean G.P.A.'s give one view of performance, failures give another. Table 1 details the mean percentage of students who fail at least one-half course in any particular year of a program by Faculty. Excluded from the analysis are the same faculties as were excluded in the mean G.P.A. analysis. Instances where male performance is superior to that of females are underlined to facilitate comparison.

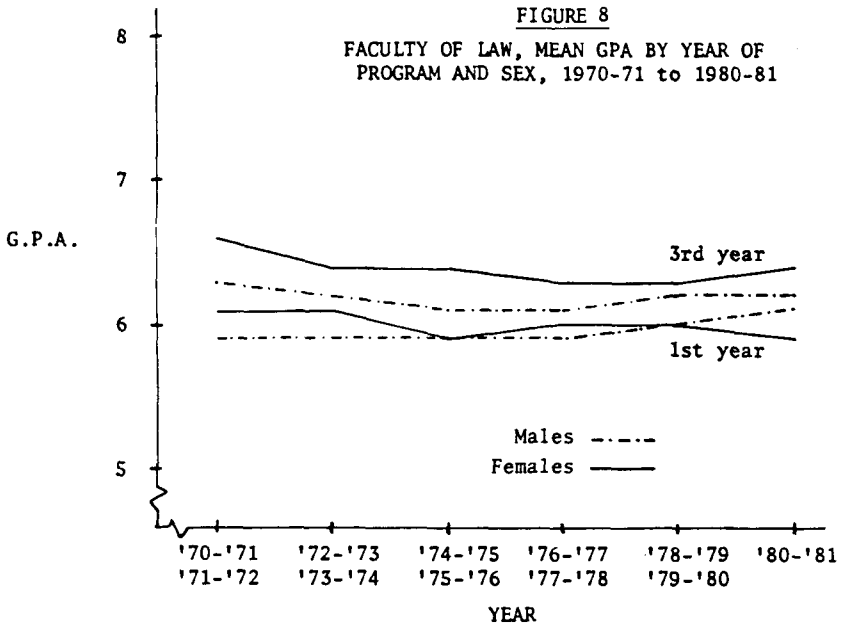
An overview of the data reveals that generally, for both males and females, the proportion of students who fail at least one half-course decreases for each successive year of the program. This is not unexpected since the weakest students in any given year are eliminated. In some faculties this pattern of decline is quite dramatic. Agriculture is a case in point, an average of 51.8% of first year males failed at least one-half course between 1970 and 1982 while 11.6% of fourth year males did so. For females the means are lower, 43.1% in first year and 5.5% in fourth year but the decline is also substantial. The Faculties of Engineering and Physical Education also have high failure rates in the first year of their program but subsequent years do not show as marked a decline in failures as Agriculture. At the other extreme from Agriculture, Science and Law show relatively little change in failure from one year of the program to the next. In Science, for



example, the mean percent failing at least one-half course declines from 38.9% in first year to 33.6% in third year for males and from 29.2% to 24.9% for females.

Turning now to a comparison of males and females, there are fewer females than males who fail at least one course per year in all program years and all faculties except first year Law and second year Pharmacy. This pattern is consistent with earlier observations concerning grade point averages. Unlike other faculties, in Law and Pharmacy, male and female mean G.P.A.'s are most similar. Given this pattern of performance across faculties there is little support in this data for the notion that females do more poorly than males in science.

An examination of the difference between males and females in mean percentage failing at least one-half course per year shows the difference to be greatest in Education (16.6 points different in first year declining to 6.4 points difference in fourth year) and Physical Education (12.9 points in first year and 10.3 points in fourth year). However, the margin of difference between males and females is substantial also in Engineering (12.4 points in first year and 9.6 points in fourth year) and in Business (12.8 points in first year and 4.7 points in fourth year). A perusal of the margin of difference in mean percentage failing in other faculties gives no indication that female academic strength is greater in the humanities and social sciences and smaller in the science based faculties. It should be noted in this connection that though the pattern is not entirely consistent, the margin of difference between the mean percentage of males and females who fail at least one half course per year is generally greatest in the first year of a program and narrower in succeeding years.



Although it is not possible to reproduce the year-by-year data from which the mean percentage of male and females failing were calculated, it is important to point out that the means do not mask trends in the disaggregated data. For example, in the year-by-year data for Arts, Education, and Science fewer females failed in all years between 1970 and 1982 in each year of the program. For Engineering the same is true but the period is shorter, 1976-1982. In Business and Physical Education, only one observation showed fewer males failing. The three faculties, Agriculture, Law and Pharmacy, that had the smallest margins of difference between male and female mean percentage failing were the faculties which some yearly observations showed males failing less often than females. Only in first year Law and second year Pharmacy did half or more of the observations show fewer males failing at least one-half course. These two faculties are the only ones in which the difference between males and females is not significant at the .05 level or better.

In concluding this discussion of course failure, it is interesting to return to a consideration of quota faculties such as Business, Engineering, Law and Pharmacy, where applications for entry have consistently exceeded the supply of places. Since minimum entry standards which are often very high are used, and since the same criteria apply to males and females there being no affirmative action, one would expect students of both sexes to be of comparable potential. In other words, all students represent the "cream of the crop". As suggested before, one might expect that if females are less able than men in math and science, then they should perform more poorly than men in Engineering, Pharmacy or even Business under such selection conditions. This might be particularly so in Business

where the number of males and females enrolled is approaching parity. Inspection of these data and G.P.A. data, however, do not reveal poorer performance amongst women than men although in the case of Law and Pharmacy male-female performance is more comparable.

MALE-FEMALE PERFORMANCE IN SELECTED COURSES

In an attempt to make clearer the comparison between male and female performance particularly in science programs, the following analysis focuses on performance in selected courses. Basic science courses in chemistry, mathematics and physics were selected with courses in English and sociology serving as comparisons in the social sciences and humanities. At the junior level, several chemistry, mathematics or physics courses are combined if they have the same content though course numbers may differ from year to year.

Chemistry

As Table 2 shows, female performance in junior level inorganic chemistry is better than that of males. Mean G.P.A. of females equals or exceeds that of males in all comparison years. In 10 of 12 years females received proportionally equal or greater number of eights and nines than males, and proportionally fewer or equal number of grades of three or less. Although the number of males and females are large in all cases, males outnumber females three or four to one in all years.

The picture that emerges in the junior level organic chemistry is in clear contrast with that above (See Table 3). First, the numbers of males and females enrolled in any given year are more nearly equal, with men in the majority some years, women in the majority other years. Second, the mean G.P.A. of males is higher than that of females in all comparison years. Third, the proportion of males receiving a grade of eight or nine is larger than the proportion of females in all comparison years. Finally, the proportion of males receiving a grade of three or less is equal to or less than that of females in 9 of 12 comparison years.

Although they are not reproduced here, grades for a physical chemistry course were also examined in an attempt to compare male-female performance beyond the introductory level. The pattern of performance was similar to that for inorganic chemistry with women doing as well or better than men in 10 of 12 years but the number of women is small in any given year, ranging from 12-40, and they never constitute more than one-fifth of the total enrolment. The small numerical and proportional enrolment of females which is also evident in physics and mathematics courses beyond the introductory level, clearly demonstrates the low participation of women in these areas of science.

Mathematics

Female performance in elementary calculus (see Table 4) compares favorably with that of men. Mean G.P.A. of women is higher than that of men in all cases. In only 1 of 10 comparison years do a larger proportion of men receive grades of

TABLE 1
 MEAN PERCENTAGE OF FULL TIME STUDENTS FAILING AT LEAST ONE-HALF COURSE PER YEAR
 BY FACULTY, YEAR OF PROGRAM AND SEX, 1970-1982

	FIRST YEAR			SECOND YEAR			THIRD YEAR			FOURTH YEAR		
	Male	Female	M-F	Male	Female	M-F	Male	Female	M-F	Male	Female	M-F
Agriculture*	51.8	43.1	8.7	30.4	26.8	3.6	18.9	16.3	2.6	11.6	5.5	6.1
Arts	33.6	22.5	11.1	25.8	18.5	7.3	17.0	10.9	6.1			
Business	36.9	24.1	12.8	32.3	22.3	10.0	24.7	21.1	3.6	19.2	14.5	4.7
Education	36.5	19.9	16.6	26.2	14.2	12.0	19.5	9.6	9.9	12.0	5.6	6.4
Engineering*	46.9	34.5	12.4	44.2	36.8	7.4	32.6	19.2	13.4	20.6	11.0	9.6
Law [‡]	<u>11.9</u>	<u>13.7</u>	- 1.8	12.5	12.2	0.3	10.3	7.7	2.6			
Physical Education	57.7	44.8	12.9	47.2	28.9	18.3	33.8	20.8	13.0	20.4	10.1	10.3
Pharmacy	32.2	22.8	9.4	<u>20.6</u>	<u>24.8</u>	-4.2	13.1	11.3	1.8	7.8	3.4	4.4
Science	38.9	29.2	9.7	33.4	26.5	6.9	33.6	24.9	8.7			

*Because female enrolment was less than 20 per year of program in the period prior to 1974-76 in Agriculture and 1976-78 in Engineering the earlier data were not included in the calculation of the mean percentage failing.

[‡]Law mean failures reflect the fact that law school entrants must have a degree.

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TABLE 2

MARKS DISTRIBUTORS FOR INTRODUCTORY INORGANIC CHEMISTRY BY SEX 1970-71 TO 1981-82

--Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1970-71	M	4	6	9	15	20	22	12	9	4	1062	5.2	1.9
	F	2	4	5	12	20	24	16	12	5	369	5.7	1.8
1971-72	M	2	8	9	16	17	22	15	9	3	1007	5.2	1.9
	F	1	5	6	12	17	22	20	13	5	349	5.7	1.8
1972-73	M	3	9	6	17	18	18	14	10	5	1110	5.3	2.0
	F	0	5	6	13	23	17	18	14	3	352	5.7	1.8
1973-74	M	2	6	10	16	20	17	14	10	5	1093	5.3	1.9
	F	1	5	8	15	22	21	17	9	3	337	5.4	1.8
1974-75	M	1	5	10	15	20	20	13	9	5	1042	5.4	1.9
	F	1	2	10	17	20	20	14	12	5	321	5.6	1.8
1975-76	M	2	5	8	16	22	21	11	10	5	1235	5.4	1.9
	F	2	5	6	18	18	23	14	10	4	315	5.4	1.8
1976-77	M	2	6	7	16	23	21	12	9	4	1251	5.3	1.8
	F	1	5	7	11	27	20	15	10	4	368	5.5	1.7
1977-78	M	2	5	8	17	22	18	13	9	5	1225	5.4	1.9
	F	2	3	11	12	21	20	14	10	5	349	5.5	1.9
1978-79	M	1	3	9	14	24	20	12	11	5	1197	5.5	1.8
	F	2	4	11	11	22	22	10	8	9	362	5.5	2.0
1979-80	M	1	4	7	16	25	20	15	8	5	1087	5.5	1.7
	F	2	5	5	13	23	20	14	11	6	304	5.6	1.9
1980-81	M	1	3	6	17	26	22	13	9	4	1189	5.5	1.6
	F	1	4	8	15	20	21	14	11	6	338	5.6	1.8
1981-82	M	1	4	6	14	24	20	15	9	6	1335	5.6	1.8
	F	1	4	7	12	21	21	18	9	6	359	5.6	1.8

*The observed frequency of higher \bar{x} female GPA is not significant at the .05 level.

eight or nine and in no case do fewer men receive grades of three or less. The number of females is, however, half or less than that of men. In elementary calculus for students in Business and Engineering, a comparable pattern is evident, however, the proportion of females enrolled is lower (ranging from 11.7% in 1970-71 to 29.9% in 1981-82). Throughout the period, mean G.P.A. of females is substantially higher than that of men, a difference ranging from .3 grade points in 1978-79 to as much as .9 grade points in 1970-71. This pattern in mean G.P.A. is a reflection of lower proportion of grades of three or less and higher proportion of eights and nines among female students.

A similar pattern of female advantage is evident in intermediate calculus — an equal or higher mean G.P.A. (11 of 12 years), an equal or smaller proportion of grades of three or less (10 of 12 years); an equal or higher proportion of eights

TABLE 3

MARKS DISTRIBUTIONS FOR INTRODUCTION ORGANIC CHEMISTRY BY SEX 1970-71 TO 1981-82

-- Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1970-71	M	2	8	9	11	14	19	16	12	8	335	5.6	2.1
	F	1	6	12	12	16	21	14	13	5	440	5.5	2.0
1971-72	M	3	7	7	11	16	21	17	14	5	436	5.6	2.0
	F	3	7	8	14	19	21	16	10	3	416	5.3	1.9
1972-73	M	4	5	9	12	14	20	18	13	5	357	5.5	2.0
	F	3	6	9	17	18	21	13	8	4	375	5.2	1.9
1973-74	M	3	4	6	16	16	20	17	12	7	455	5.7	1.9
	F	3	6	10	17	20	22	12	6	3	420	5.1	1.9
1974-75	M	1	4	7	12	19	21	16	13	7	497	5.8	1.9
	F	1	5	8	13	21	21	16	10	6	463	5.6	1.8
1975-76	M	1	3	6	13	19	24	15	14	5	472	5.8	1.7
	F	1	4	8	16	21	23	16	7	4	427	5.4	1.7
1976-77	M	1	2	8	15	21	21	17	10	6	368	5.7	1.7
	F	1	3	8	16	21	24	15	9	4	392	5.5	1.7
1977-78	M	3	5	11	13	12	17	17	14	8	334	5.6	2.1
	F	3	5	8	15	19	21	15	9	5	391	5.4	1.9
1978-79	M	2	1	6	12	23	23	16	13	5	333	5.8	1.7
	F	2	3	6	14	20	24	15	11	4	436	5.6	1.8
1979-80	M	2	2	6	14	24	18	15	11	7	265	5.7	1.8
	F	2	2	5	17	25	22	17	8	3	373	5.5	1.6
1980-81	M	1	6	6	14	22	20	16	11	5	244	5.6	1.8
	F	2	3	5	14	24	25	16	7	4	338	5.5	1.7
1981-82	M	1	4	6	11	22	22	16	10	9	271	5.8	1.8
	F	3	4	5	17	22	21	17	8	3	354	5.4	1.8

*The observed frequency of higher \bar{X} male GPA is significant beyond the .001 level.

and nines (9 of 12 years), and smaller proportions of females enrolled (female enrolment does not exceed 30% of total in any year).

Physics

Despite increases in the number of women who take introductory general physics, women still constitute only 35.3% of the total enrolled. Here, as Table 5 shows, mean G.P.A. of females equals or exceeds that of males in 11 of 12 years. The proportion of female students who receive grades of three or less is smaller than that of men in all but one year, however, the proportion of males who receive grades of eight or nine equals or exceeds that of females in 7 of 12 years.

Although the data are not reproduced here, comparisons of male and female performance in junior level physics for engineers show a pattern of performance

TABLE 4

MARKS DISTRIBUTIONS FOR ELEMENTARY CALCULUS BY SEX 1972-73 TO 1981-82

-- Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1972-73	M	5	6	8	14	16	17	14	13	8	814	5.5	2.2
	F	2	5	10	10	14	15	19	15	10	304	5.8	2.1
1973-74	M	3	7	9	13	14	18	15	12	10	851	5.6	2.1
	F	2	4	5	12	12	19	20	16	10	273	6.0	2.0
1974-75	M	2	5	8	11	15	17	17	14	11	846	5.9	2.1
	F	1	3	7	12	14	17	16	20	11	313	6.2	2.0
1975-76	M	3	7	8	13	16	17	16	13	7	701	5.6	2.1
	F	2	4	7	9	14	22	20	17	5	310	5.9	1.9
1976-77	M	4	5	8	11	18	20	15	11	8	707	5.6	2.1
	F	3	6	6	11	20	18	16	15	7	372	5.7	2.0
1977-78	M	4	6	9	15	16	17	14	12	7	841	5.4	2.1
	F	2	3	8	12	15	20	18	13	9	405	5.9	1.9
1978-79	M	4	8	9	14	15	17	16	11	6	829	5.3	2.1
	F	3	4	8	11	16	20	17	13	8	421	5.8	2.0
1979-80	M	4	7	9	16	15	17	16	12	5	925	5.3	2.1
	F	2	5	9	14	15	19	20	10	6	459	5.6	2.0
1980-81	M	4	8	8	13	15	21	15	9	6	1108	5.3	2.1
	F	2	7	6	16	19	20	15	11	4	567	5.4	1.9
1981-82	M	4	7	8	16	16	16	14	11	6	1642	5.3	2.1
	F	4	6	9	16	13	18	17	11	8	742	5.5	2.1

*The observed frequency of higher \bar{x} female GPA is significant at the .001 level.

like that evident for general physics. At the intermediate level so few females enrol in physics courses that no comparison was undertaken.

Sociology and English

Tables 6 and 7 give distributions for introductory English and introductory sociology. Both are frequently taken by students from a variety of faculties. As even a brief perusal indicates female performance is better than that of men whether in terms of mean G.P.A. the proportion with grades of 8 or 9 or the proportion with grades of 3 or less. One notable difference from the math-science areas, is the more nearly equal numbers of male and female students enrolled.

What conclusions might one draw from the data on course performance of males and females? At the very least, it would appear that females enrolled in science courses, except organic chemistry, do as well as men, perhaps better. It may be that selection factors operate which favor women currently enrolled in science courses. Nothing in this course data either confirms or refutes this possibility.

TABLE 5

MARKS DISTRIBUTIONS FOR INTRODUCTORY GENERAL PHYSICS BY SEX 1970-71 TO 1981-82

-- Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1970-71	M	1	3	4	18	20	21	14	12	6	378	5.7	1.8
	F	-	2	-	15	15	30	23	11	4	84	6.0	1.5
1971-72	M	1	4	2	8	16	25	20	14	9	366	6.2	1.8
	F	1	1	1	9	9	20	21	19	19	80	6.7	1.8
1972-73	M	1	4	2	16	20	19	18	13	7	332	5.9	1.8
	F	3	-	4	10	12	15	27	16	12	78	6.4	1.9
1973-74	M	-	3	2	11	17	24	23	13	7	340	6.2	1.6
	F	-	3	3	23	17	29	18	19	-	78	6.0	1.5
1974-75	M	-	3	2	7	16	25	24	15	8	276	6.3	1.6
	F	-	-	3	8	11	32	25	17	3	63	6.3	1.4
1975-76	M	-	2	1	8	18	24	21	18	7	255	6.3	1.6
	F	-	-	1	7	8	22	34	20	8	76	6.7	1.3
1976-77	M	-	1	4	9	20	21	24	15	6	256	6.2	1.6
	F	-	2	1	10	16	23	25	18	7	102	6.3	1.6
1977-78	M	-	5	3	11	14	21	19	18	9	687	6.2	1.8
	F	1	1	3	10	15	26	23	14	7	380	6.2	1.6
1978-79	M	1	4	3	9	14	25	23	16	7	763	6.2	1.7
	F	1	2	4	9	16	22	24	16	7	414	6.2	1.7
1979-80	M	1	2	4	11	17	23	20	14	9	827	6.1	1.7
	F	-	1	3	10	19	23	22	17	3	375	6.1	1.5
1980-81	M	1	2	5	13	15	21	22	14	6	854	6.0	1.7
	F	1	2	2	10	17	23	24	14	6	456	6.1	1.6
1981-82	M	1	4	5	11	16	21	19	16	8	933	6.0	1.9
	F	1	3	6	9	18	24	22	12	5	509	5.9	1.7

*No significant difference

CONCLUSION

Looking at the overall performance data examined here it is clear that females do at least as well or better than males. Comparisons between mean male and mean female grade-point averages show superior female performance in the Faculties of Agriculture, Arts, Business, Education, Engineering, Physical Education and Science. In the Faculties of Law and Pharmacy male-female performance is more equal over the comparison years with male mean G.P.A. higher in some years and female mean G.P.A. higher in other years.

The data examined here do not provide any support for the commonly held belief that males are better in sciences, while females are advantaged in the social sciences and humanities. One might suggest that if selection factors favor women in science fields, they ought to favor men studying Education or Nursing. Such

TABLE 6

MARKS DISTRIBUTIONS FOR INTRODUCTORY ENGLISH BY SEX 1970-71 TO 1980-81

-- Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1970-71	M	2	3	9	23	27	21	10	4	1	1610	5.0	1.5
	F	—	1	2	10	21	30	22	10	4	951	6.0	1.4
1971-72	M	1	4	8	24	28	21	9	4	1	879	5.0	1.5
	F	1	2	3	9	26	29	22	6	2	578	5.8	1.4
1972-73	M	5	4	7	22	30	18	9	4	1	698	4.8	1.6
	F	2	2	4	13	23	29	18	7	2	554	5.6	1.6
1973-74	M	5	4	9	21	24	18	12	5	1	591	4.9	1.8
	F	1	2	4	12	28	25	19	8	1	478	5.6	1.5
1974-75	M	4	4	10	19	26	21	12	3	1	647	4.9	1.6
	F	1	1	4	17	26	26	17	7	1	501	5.5	1.4
1975-76	M	2	3	5	23	33	19	10	4	1	441	5.1	1.4
	F	1	1	4	10	25	24	22	11	2	486	5.8	1.5
1976-77	M	3	3	5	19	26	25	14	4	1	533	5.2	1.5
	F	1	1	4	13	24	25	20	11	1	539	5.8	1.5
1977-78	M	1	2	6	15	25	30	13	6	2	481	5.4	1.5
	F	—	—	4	9	23	30	21	11	2	577	5.9	1.4
1978-79	M	3	2	6	16	31	24	11	6	1	562	5.2	1.5
	F	1	1	4	10	28	26	21	8	1	520	5.7	1.4
1979-80	M	3	4	6	14	26	23	18	5	1	552	5.3	1.6
	F	1	1	3	11	23	32	20	8	1	665	5.8	1.4
1980-81	M	5	3	4	14	25	23	18	6	2	610	5.3	1.7
	F	2	1	2	10	20	29	24	11	1	690	5.9	1.5

*The observed frequency of higher \bar{X} female GPA is significant at the .001 level.

does not appear to be the case in Education, and too few men enter Nursing to permit such an analysis.

These observations with regard to mean grade-point averages are reinforced by data on the proportion of students who fail at least one-half course per year. Again in all but two of the faculties examined, females were significantly less likely to fail one-half course than were males. Only in the Faculties of Law and Pharmacy were males and females relatively comparable in this aspect of performance.

If there is any merit to the argument that women do well in fields where they are highly selected, then one would expect this advantage to decline as proportion enrolled in a field increases. For example, one would expect women in Science to compare less favorably to men as their enrolment in Science increased but such is not the case. In the same vein, one would expect that in Faculties such as

TABLE 7

MARKS DISTRIBUTIONS FOR INTRODUCTORY SOCIOLOGY BY SEX 1970-71 TO 1980-81

-- Percentage Frequency Dist of Numeric Marks --

SESSION	SEX	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	N	Mean*	S.D.
1970-71	M	1	3	3	10	21	31	21	8	2	785	5.7	1.5
	F	—	1	1	4	15	29	31	17	2	1062	6.4	1.3
1971-72	M	—	1	4	15	27	27	16	7	3	814	5.6	1.4
	F	—	—	1	8	20	31	25	12	3	962	6.2	1.3
1972-73	M	2	2	3	10	21	31	20	9	2	894	5.8	1.5
	F	1	1	2	5	18	31	26	14	2	917	6.2	1.4
1973-74	M	2	2	4	13	23	26	17	9	4	983	5.7	1.6
	F	—	1	2	8	20	29	25	13	2	1006	6.1	1.4
1974-75	M	1	3	3	15	22	24	19	10	3	851	5.7	1.6
	F	—	1	4	11	17	26	24	14	3	1006	6.1	1.5
1975-76	M	1	2	2	12	21	29	18	12	3	788	5.9	1.5
	F	1	2	1	9	17	29	23	14	4	966	6.2	1.5
1976-77	M	1	3	2	11	17	30	20	12	4	605	5.9	1.6
	F	—	1	2	7	16	27	27	15	5	1048	6.3	1.5
1977-78	M	—	1	4	11	23	25	23	10	3	517	5.9	1.5
	F	—	2	1	7	19	29	25	14	3	773	6.2	1.4
1978-79	M	1	1	3	13	22	24	21	11	4	409	5.9	1.6
	F	1	1	1	7	17	27	27	15	4	695	6.3	1.4
1979-80	M	1	2	3	10	21	25	20	12	6	333	6.0	1.6
	F	1	1	1	8	16	29	22	16	6	649	6.3	1.5
1980-81	M	—	3	3	9	18	25	25	14	3	277	6.0	1.6
	F	—	1	2	9	15	28	26	15	4	563	6.3	1.4

*The observed frequency of higher \bar{x} female GPA is significant at the .001 level.

Agriculture, Business and Engineering where enrolment is limited and where entry standards have been controlled since the mid 1970's, there should be no selection advantage in favor of females. Yet, in each of these cases females are consistently less likely to fail than males.

The final type of performance data examined — performance in specific courses — shows females to be poorer performers in only one case. Males consistently out-performed females in the junior level organic chemistry courses. In inorganic chemistry, in math, in English and in sociology; female mean G.P.A. was consistently higher than that of males. In physics courses, on the other hand, there was less consistency in the pattern of female advantage. It is worth noting in conclusion that the increase between 1970-71 and 1980-81 in the number of students enrolled in mathematics and physics courses does not appear to affect their average performance relative to men. Again, if selection factors favor women their performance relative to men ought to decline but does not.

An argument related to the idea of selection is that females may more often withdraw or change programs and in that way reduce failure and hence G.P.A.'s. The present study presents no data in this regard. It is worth noting, however, that an earlier study at the University of Alberta showed females to be less likely to withdraw or change programs than males (Mehra, 1978).

To return to the literature reviewed at the outset of this paper, the performance data analysed above give no indication that females are at a disadvantage in mathematics fields. If it is the case that males are more able in these fields as the intelligence and standardized achievement testing literature sometimes suggest, then males' superior ability is not translated into performance. It is also possible either that there are no innate ability differences, or that whatever differences there may be are the products of environment and/or testing, the differential effects of which are diminishing. Certainly, nothing in the data analysed here suggests that low female enrolment in the sciences is the product of lower ability or poorer performance among women.

One final point needs to be made in conclusion. An anecdotal observation, it is that of several dozen male and female colleagues who have seen the data in various stages of analysis, all but one were surprised. They did not expect females to perform better, especially in science programs. This general expectation, however common, receives little empirical support, for there are few such studies. As indicated in the literature review, in contacts with twenty-three large Canadian Universities soliciting data on enrolments and male-female performance, only three were able to provide information on performance. None of the information received from the University of Calgary (1981), Simon Fraser University (1977), and University of Guelph (1982) is as detailed as the data presented here but it is consistent with it.

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