Survey on Statistics within the Liberal Arts College
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We base this report on a survey of liberal arts college departments of mathematical sciences. The purpose of the survey was to gain basic curricular and pedagogical information about the discipline of statistics within liberal arts colleges.

In 1988 and again in 1993, the Statistics and the Liberal Arts Workshop (SLAW) sent a questionnaire to populations of liberal arts colleges. Tom Moore and Julie Legler sent out a similar survey in August of 2003 (with follow-ups in September, October, and December). The target population was the Carnegie classified liberal arts colleges (N=199). We received 134 responses for a 67% response rate. The 1993 survey used as its target population those classified as "selective liberal arts colleges" by the Carnegie Foundation, a classification that did not exist in 2003. The response rate in 1993 was 77% (108/141).

In this report, we will make some comparisons between 2003 results and results from earlier years. We need to be cautious about not overstating the significance of these differences. Most differences are modest at best and the differences in target populations alone could possibly account for some portion of each difference.

A longer pdf version of this report that also includes a question-by-question summary of the 2003 survey data is available on line at http://www.math.grinnell.edu/~mooret/reports/LASurvey2003.pdf.

Statistical background of faculty at liberal arts colleges

What is the statistical training of faculty who teach statistics courses in math/sciences departments? Figure 1 summarizes the data on this question. Here, "statistics faculty" means faculty within the math/sci dept who teach the statistics curriculum. The categories are: (1) PhD in statistics, (2) Masters in statistics and a PhD in something else, (3) Masters in statistics, but no PhD, and (4) no graduate degree in statistics. A school is placed in the highest category that applies. For example, if the statistics faculty within a math/sci dept has a PhD statistician and a Masters-level statistician with a PhD in math, they would be placed in the top category.

The data suggest that there has been a slight rise in the percentage of liberal arts schools with a Ph.D. in statistics (from 31% to 40%), but this percentage is still not large.

	Educ level	Pct-93	Count-93	Pct-03	Count-03
1	PhD in Stat	31%	34	40%	51
2	MAStat+PhD	9%	10	6%	8
3	MAStat+N0 PhD	4%	4	2%	3
4	No Stat	56%	60	51%	64
	Total	100%	108	99%	126

Figure 1: Percentage of schools with at least one statistics faculty at each level for both the 1993 survey and the 2003 survey.

Figure 2 looks at the number of PhD statisticians that schools have in their mathematical sciences department. The numbers have changed little in 15 years.

No. of PhDs in Stat	1988	1993	2003
0	36 (58%)	45 (57%)	79 (61%)
1	25 (40%)	28 (35%)	40 (31%)
2	1 (1.6%)	5 (6%)	7 (5.4%)
3	0 (0%)	1 (1.3%)	4 (3.1%)
n =	62 (100%)	79 (100%)	130 (100%)

Figure 2: Frequencies of number of PhDs in Statistics: Frequencies by year, with percentages by year in parentheses. The numbers have changed little over 15 years.

The 3 "standard" courses

What percentages of schools teach the standard courses: introductory statistics, with or without a calculus prerequisite, and the probability and math/stat sequence? Figure 3 summarizes results and shows that the probability and statistics course at the upper-level is still the most popular single course taught at liberal arts colleges. This predominance is not as striking as it was in 1993, when 93% of respondent schools taught the course, compared to 81% today. By analyzing the set of 75 schools responding to both surveys, we concluded that about half of this 12% drop is attributable to a real decline in the course and the other half is attributable to the differences between our two samples. (See end note.)

Type of course	Pct-93	Count-93	Pct-03	Count-03
Calc+NonCalc	17%	18	24%	32
Calc only	8%	8	5%	7
NonCalc only	59%	63	59%	79
Neither	16%	17	12%	16
Prob-Stat	93%	99	81%	109
No. respondents		106		134

Figure 3: Standard statistics courses offered for both the '93 survey and the '03 survey. For example, in 1993, 18 of the responding 106 schools offered both a calculus based and a non-calculus based intro course. The prob-stat course is still the most popular course, but fewer schools offer this course today than in 1993. About half of this 12% decline is attributable to schools actually dropping the course; the rest we attribute to different samples for 1993 and 2003.

The use of software

Are students required to use software in their statistics courses? Table 4 gives percentages by the type of course for the 2003 and the 1993 surveys.

Certainly, the majority of introductory statistics is taught with software (as it was in 1993), but the surprising result is the decrease in the percentage of non-calculus based intro statistics using software, which decreased from 88% to 75% over the decade, and the similar decrease for the prob-stat course. Figure 5 shows that even when we make these comparisons using only the 75 schools that responded to both surveys, the Figure 4 trends persist. It is beyond the scope of our data, but we conjecture that the decrease (at least in the NoCalc course) is due to a few schools going from using software to using the graphing calculator.

	NoCalc 2003	NoCalc 1993	Calc 2003	Calc 1993	Prob-Stat 2003	Prob-Stat 1993
No Software%	25%	12%	26%	35%	45%	31%
Software%	75%	88%	74%	65%	55%	69%
No. respondents	109	81	38	26	99	99

Figure 4: Survey question: "Does the course require the students to use software?" For the calculus-based intro, the percentage has gone up from 1993 to 2003, but for the non-calculus intro and the prob-stat the percentage has decreased. Figure 5 shows that these decreases are evident even when comparing just the sub-sample of schools completing both surveys.

	NoCalc 2003	NoCalc 1993	Calc 2003	Calc 1993	Prob-Stat 2003	Prob-Stat 1993
No Software%	25%	10%	17%	24%	44%	33%
Software%	75%	90%	83%	76%	56%	67%
No. respondents	60	59	24	17	57	73

Figure 5: Comparing software use for the 75 schools common to both surveys. There is still a substantial decrease from 1993 to 2003 in the percentage of NoCalc courses using software (90% to 75%) and there is a similar, but less striking, such decrease for the Prob-Stat course as well.

Which software do instructors use?

Based on the most recent 2003 survey, what software packages are departments using? Figure 6 indicates the favored status of Minitab, although SPSS and Excel are also used heavily. We also note, with interest, the use of Maple or Mathematica in the probability and statistics course.

	NoCalc	Calc	Prob-Stat
Minitab	30(23)	13(10)	16(11)
SPSS	21(12)	4(3)	10(6)
Excel	22(18)	5(1)	8(4)
R,S,SPlus	2(2)	1(1)	5(5)
DataDesk	7(4)	2(1)	3(3)
Mathematica/ Maple	0(0)	5(2)	18(5)
n	89	25	53

Figure 6: Here is software used at the colleges, by the type of course, for the 2003 survey. The question asked respondents to name packages required for students to use, if they required software. Some schools would name a single package and some would name combinations. The outer number counts the number of mentions and the number in ( ) counts the number of citations as a singleton. Thus, for example, the 30(23) in the first cell says that 23 schools named Minitab as the sole package; but 7 others had Minitab in combination with another package.

Student projects

What is the status of student projects in the basic statistics courses? From Figure 7 we see that the percentage of "yes" responses to this question increased between survey years, although this is somewhat compromised by a change in question wording. In 1993, we felt the need to elaborate what we meant by "project," a clarification we felt we could dispense with in 2003.

	No Calc	Calc	Prob-Stat
Yes%-1993	44%	24%	21%
Yes%-2003	69%	67%	48%

Figure 7: This figure compares the percentages of colleges who answer 'yes' to the question: "Does the course involve students doing projects?" But, comparisons are compromised in that the 1993 survey elaborated the question with the parenthetical remark "(collecting their own data, analyzing it, writing reports)".

Statistics outside the department

Finally, what percentage of the school's introductory statistics enrollment is accounted for by departments outside the math/science department? Figure 8 shows that there is almost a uniform distribution of self-reported percentages in response to this question. The mean decreased only slightly from 1993 and is still nearly half.
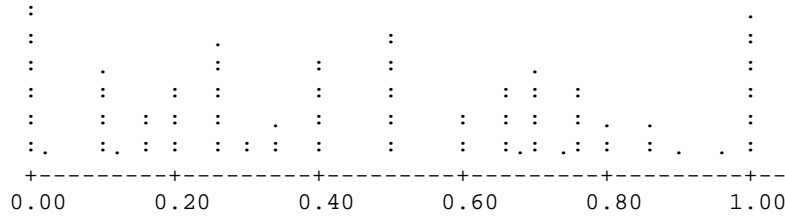
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Figure 8: A dotplot of the self-reported percentage of statistics enrollments taught by courses outside the department of mathematical sciences at responding institutions. The mean is 46%. The 1993 mean was 56%.

Courses beyond the standard 3

Of the 134 responding schools, only 39 (29%) offer some kind of course or courses beyond the basic three. This is comparable to the 25% (27 of 108) in 1993. Figure 9 shows the relationship between a school having such extra courses and the number of PhD statisticians at the school. The more PhD statisticians at the school, the greater the likelihood the school teaches courses beyond the standard three.

No. PhDs	No	Yes	n	Yes%
0	67	11	78	14%
1	21	19	40	48%
2	2	5	7	71%
3	0	4	4	100%
Totals	**90**	**39**	**129**	

Figure 9: Whether a school teaches courses beyond the "standard 3" is tabled against the number of PhD statisticians at the school. The likelihood of such courses increases with then number of PhDs on the faculty. This is for the 2003 data.

From the 39 schools that listed "other courses" taught beyond the basic three, a total of 69 courses were mentioned. Many of these courses are not statistics courses, per se. Based on the course descriptions and titles given, the statistics courses appear to be concentrated in traditional areas for "second courses" in statistics. Here is a breakdown of the offerings by decreasing popularity (counts in parenthesis):

Regression (11)
Statistical methods, Stat II, Applied Stat, Statistical modeling, Data analysis (14)
Design of experiments or ANOVA (7)
Linear models or Regression-ANOVA (4)
Multivariate statistics (4)
Non-parametric statistics (4)

Others mentioned included biostatistics, probability or applied probability, OR, quantitative methods, games and gambling, latent variables, time series, and miscellaneous others.

Hiring a statistician

We asked respondents to tell us if they had tried to hire a statistician in any of the past three years. Twenty-nine (29) said yes. Of these, 11 were successful the first year, an additional 4 were successful, but not in the first year, and 5 said they were unsuccessful and were still trying to hire. Of the remaining 9, two just said they were unsuccessful, and the rest hired mathematicians (in one case a probabilist with an MS in statistics, in another an applied person with experience teaching statistics), except for one who did not respond.

Conclusions

From the 2003 survey and from comparisons between its results and those of the 1993 survey, we conclude that changes over the past decade have been modest or non-existent. Here are some highlights:

- The "big 3" courses (the two intros and the prob-stat course) are still the courses that predominate. There is a slight decrease in the percentage of schools offering a probability and mathematical statistics course.

- The number of schools with PhD statisticians has increased only modestly during the past decade. Of course, it is not easy to hire a Ph.D. statistician.

- Second courses in statistics are similar to 1993 levels: about one quarter of schools offer such courses (and the subject appears to be traditional for second courses).

- Software use is common, but not universal, in the teaching of introductory statistics.

- There is a slight decrease in the use of software in the non-calculus based introductory course and in the prob-stat course.

- On average, about half of introductory statistics courses at liberal arts colleges are taught outside the department of mathematical sciences.
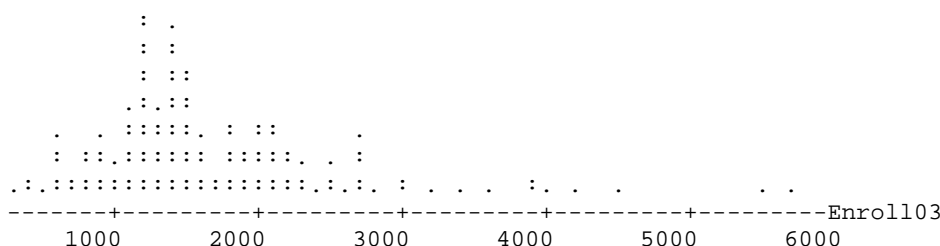
Acknowledgements

Appendix

Question-by-question summary of the survey results

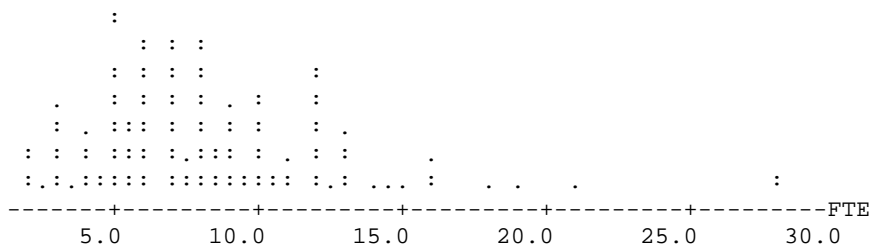The following is a question-by-question summary of the 2003 Survey on Statistics in the Liberal Arts.

Part I: Institutional information

Enrollment of institution. Median=1450; mean=1721; sd=941.

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Name of your department. The question of interest was which disciplines were mentioned in the department title. Overwhelmingly, the two options represented were "mathematics" alone or "mathematics and computer science." More specifically, 64 were departments of Mathematics, 47 were departments of Mathematics and Computer Science, 10 were departments of Mathematical Sciences, 5 were departments of Mathematics and Statistics, and 6 were various other designations.

Number of faculty (FTE) in your department. Median=8; mean=8.4, sd=4.4.

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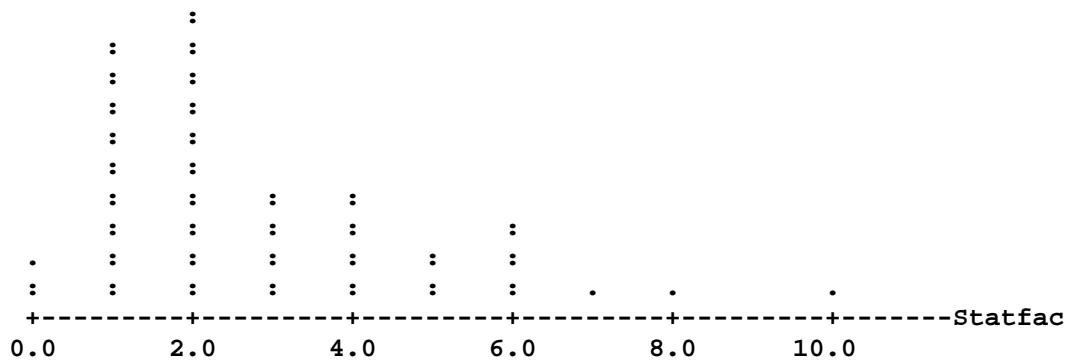
Note: The correlation between FTE and the institution's enrollment is .61.

8

How many individuals in your department were involved in teaching any statistics courses in 2001-02 or 2002-03?

Median=2; mean=2.7, sd=1.95.

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Indicate the number of these statistics instructors at each rank. Here are the means for each rank listed:

Lecturer:	.29
Assistant Professor:	.72
Associate Professor:	.77
Professor:	.89
Other:	.07
Total:	2.74

Indicate the number with each listed statistical background. Here are the means for each level of statistical background listed:

PhD in stat or biostat:	0.51
Masters in stat/bio and PhD in other field:	0.14
Masters in stat/bio, but no PdD:	0.09
PhD in math, but no stat degree:	1.64
PhD in non-math field; no stat degree:	0.12
No stat degree and no PhD in any field:	0.25
Total:	2.75

Part II: Questions about statistics course taught by department.

NON-CALCULUS INTRO

Do you offer introductory course with no calculus prerequisite?

    No: 23
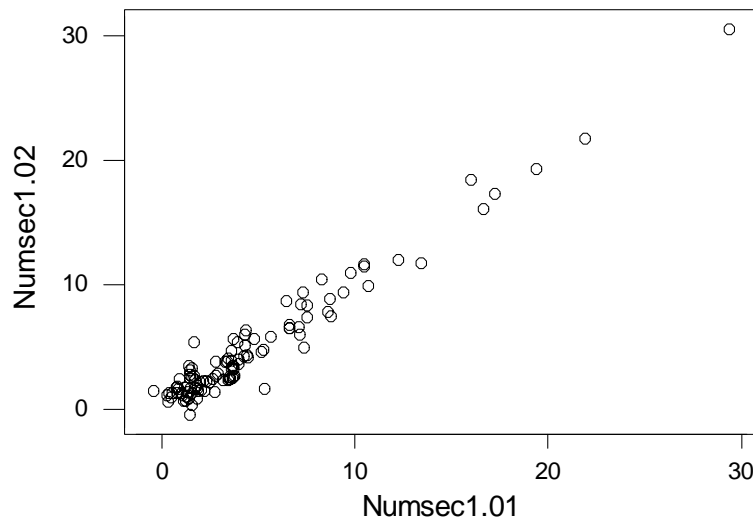   Yes: 111

    If so, give the total number of sections for both 2001-02 and 2002-03:

    mean for 2001-02 (Numsec1.01) = 4.7
    mean for 2002-03 (Numsec1.02) = 4.8
    correlation = .984.
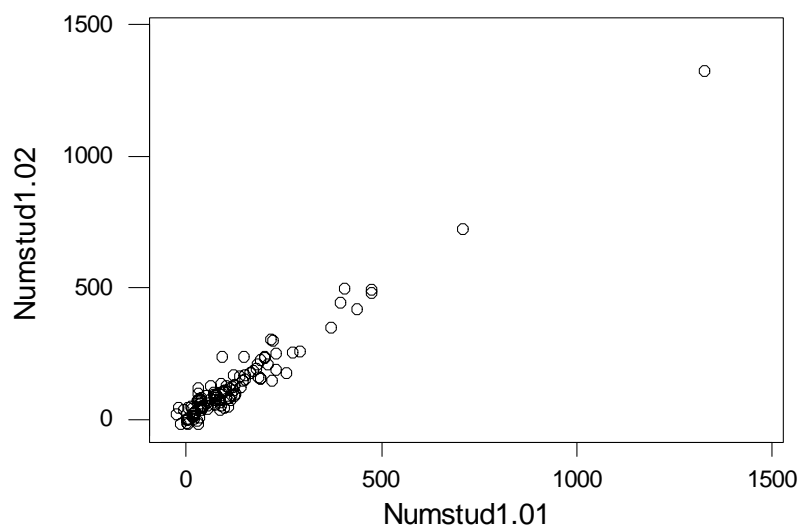   Note: plot has been jittered.

What is the total number of students approximately for 2001-02 and 2002-03?

mean for 2001-02 (Numstud1.01) = 128.9
mean for 2002-03 (Numstud1.02) = 133.9
correlation = .991
Note: plot has been jittered.

What departments do most students in this course come from?

Biology: 48
Psychology: 30
Business, etc: 29
Economics: 22
General ed (all depts):   11
Education: 8
Math: 8
Environ, geology, geog: 8
Health related: 8
other sciences or gen. sci: 13
other soc sci or soc sci: 6

What textbooks were used? We coded up these open-ended responses by the number of mentions. Some institutions mentioned a single text; others more than one. Books by David Moore were clearly most popular.

David Moore texts: Total of 49
    Basic Practice of Statistics (28),
    Intro to the Practice of Statistics (with McCabe)(17),
    Active Practice of Statistics (2),
    Concepts and Controversies (1),
    Business Practice (1).

Mario Triola texts: Total of 15
Freedman, Pisani, and Purves: Total of 7
Utts or Utts and Heckard: Total of 7
Workshop Statistics (some version):   Total of 6
Devore and Peck or Peck, Devore, and Olsen: Total of 5
Bluman   Total of 5
Aliaga and Gunderson: Total of 3
Others: Total of 14

Does the course require software? 27 no's and 82 yes's

If so, which software? The second column below gives the number of mentions for each software package for the intro course with no calculus prerequisite. The third and fourth columns relate to questions to follow later.

Software	No-calc	Calc-based	Prob-stat
Minitab	33	13	17
SPSS	27	4	11
Excel	25	5	9
Data Desk/ActivStat	10	2	3
JMP	3	1	3
SAS	1	1	1
R/S	2	0	5
StatView	3	0	0
Mathematica/Maple	1	6	18

Does the course require a graphing calculator? 84 no's and 26 yes's

Does the course involve students doing projects? 33 no's and 75 yes's

CALCULUS-BASED INTRO

Do you offer an introductory course with some calculus as a prerequisite?
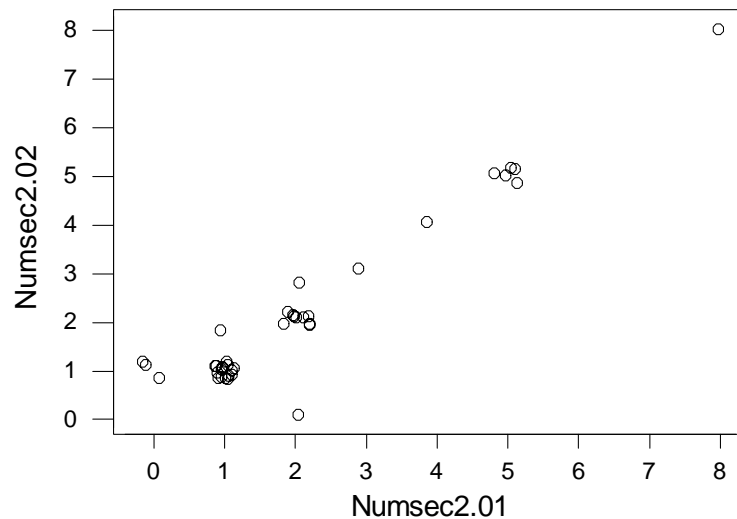
    No: 95
    Yes: 39

If so, give the total number of sections for both 2001-02 and 2002-03:

    mean for 2001-02 (Numsec1.01) = 2.0
    mean for 2002-03 (Numsec1.02) = 2.1
    correlation = .961.
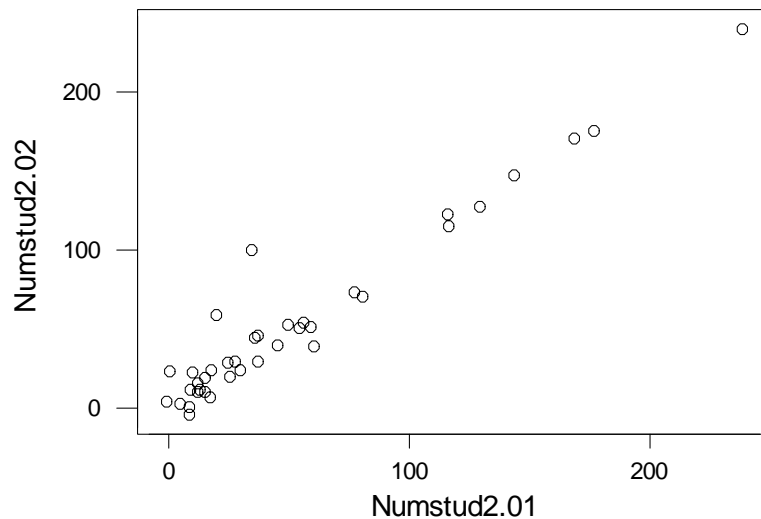   Note: Plot has been jittered.

       What is the total number of students approximately for 2001-02 and 2002-03?

mean for 2001-02 (Numstud1.01) = 128.9
mean for 2002-03 (Numstud1.02) = 133.9
correlation = .991
Note: plot has been jittered.

What departments do most students in this course come from?

Whereas the non-calculus introductory course is dominated by biology, psychology, business, and economics students, the calculus-based course is more slanted toward the mathematics majors and physical and natural science majors. Here are tallies for the top departments:

Mathematics:	16
Economics:	11
Sciences:	9
Computer sciences:	8
Biology:	8
Psychology:	5
Business:	3
other sciences:	9
other soc. sciences:	3

What textbooks were used? Moore and McCabe's Intro to the Practice of Statistics earned 10 mentions; Devore's Prob and Stat for Engineering Science earned 4, Tamhani and Dunlop earned 3, and Walpole, Myers, and Myers earned 3. No others were mentioned more than once.

Does the course require software? 10 no's and 28 yes's.

If so, which software? (See the table above for the non-calculus based course.)

Does the course require a graphing calculator? 24 no's and 10 yes's

Does the course involve students doing projects? 12 no's and 24 yes's

THE PROBABILITY AND MATHEMATICAL STATISTICS COURSE

Do you offer a course or course sequence in probability/mathematical statistics?
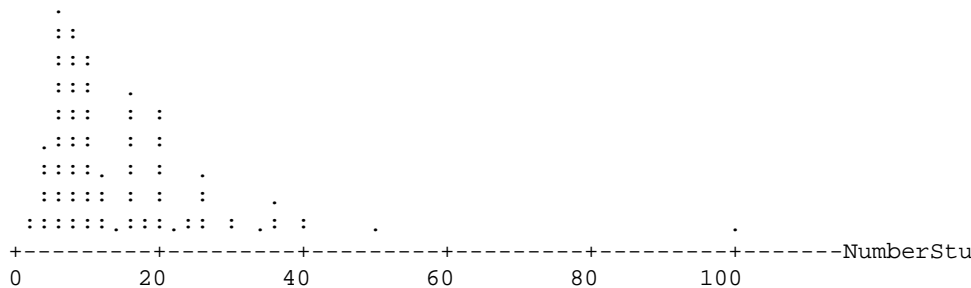
    No: 25
    Yes: 109

How many terms or semesters comprise the course? 33 are one term or semester, 68 are two-terms, and 1 is three-term.

Is the course taught every year or alternate years (or some other frequency)? 31 are taught every year, 65 are taught in alternate years, and 10 have other frequencies.

What is the total number of students completing the course or course sequence (approximately) the last time taught?

median=10; mean=14.3, sd=12.8

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Is linear algebra a prerequisite? 81 no's and 23 yes's.

Please list any prerequisites (other than calculus): 15 explicitly answered "none," 10 answered multivariate calculus, 4 answered discrete math, and 3 answered some statistics course.

What departments do most students in this course come from? Holy smokes! Believe it or not, Mathematics was listed more than any other discipline. But here is a tally of mentions of the various departments.

Mathematics:	89
Economics:	16
Physics:	14
Statistics (concentrations, minors, etc):	9
Computer Science:	12
Science:	5

Others: Chem (3), Engin (3), Bio (2), Math Ed (2)
Several others at 1.

What textbooks were used? Respondents mentioned both probability texts, combined probability and statistics texts, and a few statistics only texts. Unlike the previous two courses, there was no overwhelming favorite here.

Probability and statistics texts:

Wackerly, Mendenhall, and Scheaffer:	18
Freund's Mathematical Statistics (Miller&Miller):	13
Larsen and Marx:	11 (continued)

Hogg and Tanis:	11
Hogg and Craig:	3
Mendenhall and Sincich:	3
Walpole, Myers, Myers:	2
Degroot and Schervish:	2
(several at 1)	

Probability texts:
Ross's First Course in Probability:	6
Ghahramani:	2
(others at 1)	

Statistics texts:
Nolan and Speed:	2
Moore/McCabe:	1
Statistical Sleuth:	1

Does the course require students to use software? 45 no's and 54 yes's.

If so, which software? See the software question under the non-calculus intro course. We found it interesting that Maple or Mathematica are getting pretty heavy use in this course.

Does the course involve students doing projects? 50 no's and 47 yes's

Part III: OTHER STATISTICS COURSES

Describe any other statistics courses your department offers beyond the 3 courses mentioned above.

From the 39 schools that listed "other courses" taught beyond the basic three, a total of 69 courses were mentioned. Based on the course descriptions and titles given, here is a breakdown of the offerings by decreasing popularity (counts in parenthesis):

Regression (11)
Statistical methods, Stat II, Applied Stat, Statistical modeling, Data analysis (14)
Design of experiments or ANOVA (7)
Linear models or Regression-ANOVA (4)
Multivariate statistics (4)
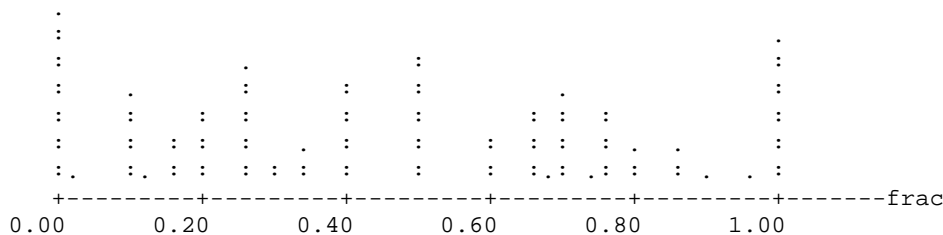Non-parametric statistics (4)

Others mentioned included biostatistics, probability or applied probability, OR, quantitative methods, games and gambling, latent variables, time series, and miscellaneous others.

Part IV: Miscellaneous other questions

Please list those departments (other than yours) that offer an introductory statistics course. Then estimate the total percentage of your school's introductory statistics enrollment accounted for by these other departments. The departments most mentioned as teaching their own introductory statistics course were:

Psychology: 84
Economics: 44
Business or Management: 27
Sociology: 26
Biology: 14
Political Science: 10
Anthropology: 5
others at 1 or 2

Here is a dotplot of the estimated percentage of introductory statistics enrollments at each college taught in these courses outside the mathematical sciences department. The mean is .46=46%

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  0.00      0.20      0.40      0.60      0.80      1.00
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Does your department require at least one statistics course for the mathematics major? 95 no's and 34 yes's.

Are the following program options available at your institution? If so, give approximately the total number of students who have completed that program during the past two academic years.

A concentration in statistics: 115 no's and 15 yes's. The mean number of students was 9.4, ranging from 0 to 40.

A minor in statistics: 116 no's and 13 yes's. The mean number of students was 5.8, ranging from 0 to 16.

A major in statistics: 125 no's and 3 yes's. Of the 3, only two reported a total number of students; the values were 0 and 10.

Has your department tried to hire a PhD statistician in the tenure track in any of the past 3 years, beginning in 2000-01? If "yes," then which of the following options best describes the outcome of your search:
> **We were successful the first year.**
> **We were successful, but not in the first year.**
> **We were unsuccessful, and are still trying to hire.**
> **Other; please explain.**

Twenty-nine (29) of our respondents said "yes," they had tried to hire a PhD statistician within the past 3 years. Of these, 11 were successful the first year, 4 were successful, but not in the first year, and 5 said they were unsuccessful and were still trying to hire. Of the remaining 9, 2 just said they were unsuccessful, and the rest hired mathematicians (in one case a probabilist with an MS in statistics, in another applied people with experience teaching statistics), except for one who did not respond.

What is your department's policy on granting placement or credit to students entering with an AP Statistics score?

Of those responding; 10 said they gave no credit for the AP statistics exam; 21 said they had no policy, in some cases because they had not run across any such students; and 19 said they gave some kind of credit for the AP statistics exam, without specifying their precise policy.

Of those stating their policy, the credit given was most often for the lowest level introductory statistics course, but it could also be generic college credit, or exemption for some math or statistics requirement. Of this group, 12 stated credit was given for an AP score of 3 or better, while 48 gave credit for a score of 4 or 5, and 3 required a score of 5. A couple of schools gave differing amounts of credit depending on the score.

Questions about the survey may be addressed to Tom Moore, Grinnell College, mooret@grinnell.edu.

(March 30, 2005)

End note:
We investigated this drop of 12% by looking at the set of schools that responded to the Prob-Stat question on both the 1993 and 2003 surveys. There were 74 such schools. Of these, 64 offered the course both years and 1 offered it neither year; thus 65 of the 74 schools had unchanged status on this course between the two survey years. Of the 9 schools whose status changed, 8 taught such a course in 1993, but do so no longer, while only one school that did not teach it in 1993 was teaching it in 2003. This represents a net drop in the teaching of this course between the two survey years and 7 of 134 would represents about 5.2% of the 12% drop, or nearly half. Thus it seems fair to conclude that about half of the 12% decline in the offering of the prob-stat course is due to a real decline in the course and half is attributable to the differences in our two samples.