STATISTICAL LITERACY SURVEY RESULTS: READING GRAPHS AND TABLES OF RATES AND PERCENTAGES

Milo Schield
Director of the W. M. Keck Statistical Literacy Project
Augsburg College Minneapolis, MN 55454

In 2002, an international survey on reading graphs and tables of rates and percentages was conducted by the W. M. Keck Statistical Literacy Project. Respondents included US college students, college teachers worldwide and professional data analysts in the US and in South Africa. The survey focused on reading informal statistics – rates and percentages in tables and graphs. Some high error rates were encountered. In reading a 100% row table, 44% of students misread a description of a single percentage. In reading a pie chart, 65% of data analysts misread a comparison of two slices. In reading an X-Y plot, 81% of college teachers misread a "times more than" comparison. The average error rate was 49% for college students, 44% for data analysts and 28% for college teachers. At the 80th percentile, the error rate was 45% for college students, 20% for data analysts and 10% for college teachers. Using the 80th percentile score for data analysts as a desired goal (80% correct), then only 2% of the students, 20% of data analysts and 43% of these college teachers achieved that goal. Statistical educators should review the survey instrument, the rules used to determine the correct answers and the error rates by group to see if the survey instrument or the rules contributed in any way to the respondent errors. A more detailed analysis of the errors is contained in a separate document.

BACKGROUND

Statistical literacy studies everyday arguments that use statistics as evidence. See Schield 2004a and b. A statistically literate person must be able to read and interpret the data in the daily news or in general trade articles. Typically the data are macro-statistics: summary data presented in tables and graphs. Schield (2000 and 2001) claimed it can be difficult to read tables and graphs of rates and percentages and to identify the corresponding descriptions and comparisons.

To test this thesis an international survey was conducted by the W. M. Keck Statistical Literacy Project in 2002. This survey is available at www.StatLit.org/Survey. The last three demographic questions on the web version (Q70 - Q72) are not part of the original survey.
Of the first 69 questions, the first eight involved respondent demographics, seven questions (13 - 18 and 20) were exploratory (no right answer) to see how people viewed different ways of expressing association versus causation, and the last six questions involved evaluating the survey. Of the remaining 48 questions, 7 involved graphs and 41 involved tables. Since the primary focus of the survey was rates and percentages all of the data sources but one (a scatter plot) involved rates and percentages. This data sources included four graphs (a pie chart, a bar chart and two scatter plots) and five tables (four with percentages and one with rates). The correct answers were determined based on the rules in Schield (2001) for reading tables and the rules in Schield (2000) for describing and comparing rates and percentages. These rules describe US/UK usage of ordinary English so there may be some differences for other cultures or countries.

SCORES FOR DIFFERENT GROUPS

Scores for a group were obtained from the percentage correct for each subject in that group. Classifying subjects by occupation (Q3), the highest overall scores are for college faculty (71%) while the lowest were for K-12 math teachers (45%). Classifying subjects by English proficiency (Q6), the highest overall scores are for native English speakers (57%) while the lowest are for those who are still learning English (48%). See Appendix for details.

For this paper, both low-scoring groups are omitted leaving 169 respondents. Based on the answers to Q4, three groups were formed: college students (85), professional data analysts (47) and college teachers (37). These college teachers and data analysts are very unusual: 81% of college teachers (91% of data analysts) work in fields that are moderately, highly or extremely quantitative (Q3), 78% of college teachers (87% of data analysts) had at least one statistics course and 29% of college teachers (34% of data analysts) had at least two statistics courses (Q7).

RESULTS

The presentation of results involves a figure or table, the question or statement, the correct answer [brackets] and the error rates for the three groups: college students, non-teaching professionals and college teachers. If "Yes" is correct, then "No" and "I don't know" are errors. If the analysis of the questions (not shown in survey) is presented, it is in braces {}. The terms "part" and "whole" refer to the numerator and denominator of a part-whole ratio. See Figure 1.

Figure 1: Pie Chart

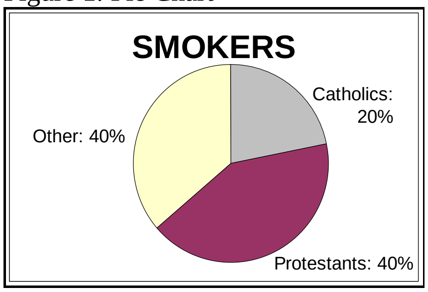


Figure 2: Bar Chart

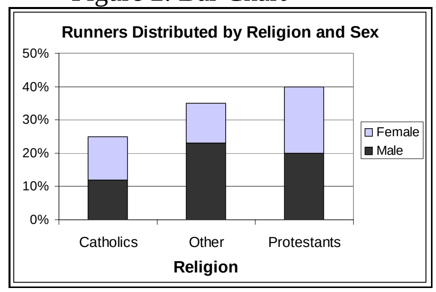


Figure 1. *Do you think the following statements* <u>*accurately describe*</u> *the data shown in this pie chart?* {Correct analysis: Pie (smokers) is whole while slices (religions) are parts.}

Q9. *20% of smokers are Catholic.* [Yes] Error rates: 19%, 0%, 5%

Q10. *Protestants (40%) are twice as likely to be smokers as are Catholics (20%).* [No; Smoker is part in the question.] Error rates: 62%, 65%, 16%.

Figure 2. *Do you think the following statement* <u>*accurately describes*</u> *the data shown in this bar chart?* {Correct analysis: Runner is 100% whole. Religion and sex are parts.}

Q11. *20% of Protestant males are runners.* [No]. Error rates: 68%, 53%, 8%.

Figure 3: Height vs. Weight

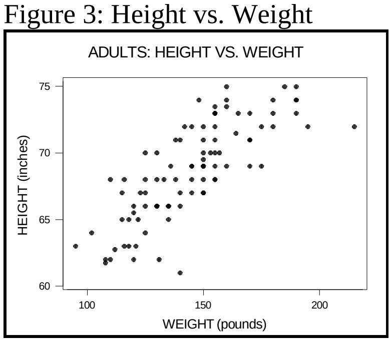


Figure 4: Suicide Rate vs. Protestant Prevalence

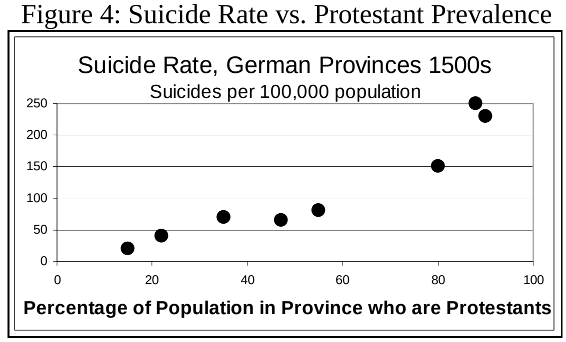


Figure 3. *Do you think the following statements are* <u>*accurate interpretations*</u> *of the scatter graph shown above?* For these exploratory items, the first two percentages are Yes/No for everyone (mode in bold), the modal answer (in bold) and the percentage who selected the modal answer for each group.

Q13. *The more an adult weighs, the taller they tend to be.* **63%**/31%. **Yes**: 65%, 51%, 73%.

Q14. *(Typically) as weight increases, height increases*. **59%**/34%. **Yes**: 68%, 47%, 54%.

Q15 *As adults' weights increase, their heights tend to increase*. 40%/**49%. No**: 44%, 60%, 49%.

Q16. *As an adult's weight increases, their height tends to increase*. 31%/**59%. No**: 52%, 60%, 76%

Q17. *An adult who weighs more will tend to be taller*. **64%**/23%. **Yes**: 66%, 53%, 73%.

Q18. *As an adult weighs more the taller they will tend to be.* **44%**/41%. **Yes**: 51%, 34%, 41%.

Q20. *If weight increases, height will tend to increase.* 15%/**71%. No**: 73%, 64%, 76%

In the following questions, error rates involve students, data analysts and college teachers. [These questions are out of order to allow grouping exploratory questions (13-18 & 20) together.]

Q12. *Adults who weigh more tend to be taller than those who weigh less.* [Yes] Error rates: 25%, 30%, 11%.

Q19. *If an adult increases their weight, they can expect to increase their height.* [No; this question is longitudinal but the graph is cross-sectional.] Error rates: 19%, 28%, 16%.

Figure 4. *Do you think the following statements are <u>accurate interpretations</u> of the scatter graph shown above?* {Correct analysis: The rates are for German provinces as separate wholes.}

Q21. *As the percentage of Protestants increases, the rate of suicides tends to increase*. [Yes] Error rates: 34%, 21%, 32%.

Q22. *Protestants are more likely to commit suicide than non-Protestants (are).* [No; 'Yes' involves a cross-level inference: the ecological fallacy.] Error rates: 45%, 49%, 49%.

Table 1: 100% Row Table

	SEX		
RACE	Male	Female	TOTAL
Black	75%	25%	100%
White	50%	**50%**	100%
Other	40%	60%	100%
TOTAL	50%	50%	100%

Table 2: Two-way half table

PERCENTAGE WHO ARE RUNNERS			
	Non-smoker	Smoker	Total
Female	50%	20%	40%
Male	25%	**10%**	20%
Total	37%	15%	30%

Table 1: *Do the following statements <u>accurately describe</u> the 25% circled above?*

Q23. *25% of females are blacks.* [No] Error rates: 44%, 28%, 11%.

Q24. *25% of blacks are females.* [Yes] Error rates: 13%, 11%, 16%.

Q25. *25% is the percentage of blacks among females.* [No] Error rates: 38%, 28%, 16%.

Q26. *25% is the percentage who are females among blacks.* [Yes] Errors: 21%, 17%, 14%.

Table 1: *Do you think these statements below <u>accurately compare</u> the 25% circled with the 50% immediately below it?* [Correct analysis: Female is common part; the races are wholes.}

Q27. *Whites are two times as likely to be female than are blacks.* [No; this is wrong because of bad grammar: "two times as likely <u>as</u>"]. Error rates: 60%, 53%, 57%.

Q28. *Females are two times as likely to be white as to be black.* [No; 'white' is part in question but 'female' is part in the graph]. Error rates: 44%, 38%, 19%.

Q29. *Whites are two times more likely to be female than are blacks.* [No; either "one time more likely than" or "two times as likely as".] Error rates: 65%, 49%, 46%.

Table 2: *Do you think the following statements <u>accurately describe</u> the 20% circled above?* {Correct analysis: Runner is part while female and smoker are wholes.}

Q30. *20% of runners are female smokers.* [No] Error rates: 55%, 53%, 30%.

Q31. *20% of females are runners who smoke.* [No] Error rates: 53%, 55%, 32%

Q32. *20% of female smokers are runners.* [Yes] Error rates: 62%, 55%, 54%.

Q33. *20% of smokers are females who run.* [No] Error rates: 42%, 36%, 27%.

Q34. *Among female smokers, 20% is the percentage of runners.* [Yes] Rate: 66%, 57%, 51%.

Q35. *Among females, 20% is the percentage of smokers who are runners.* [Yes; Q35 is the semantically the same as Q34.] Error rates: 49%, 51%, 68%.

Table 2: *Do you think these statements accurately compare the circled 20% with the 10% below it?* {Correct analysis: Runner = common part, smoker and sex = whole.}

Q36. *The percentage of runners is twice as much among female smokers as among male smokers.* [Yes.] Error rates: 42%, 47%, 46%.

Q37. *The percentage of smokers who run is twice as much among females as among males.* [Yes.] Error rates: 41%, 55%, 49%.

Q38. *Among these smokers, males are twice as likely to be runners as are females.* [No.] Error rates: 39%, 15%, 22%.

Two statements "MEAN THE SAME THING" if one can <u>always be substituted</u> for the other. *In your opinion, do these two statements mean the same thing?*

Q39. (a) Twenty percent (20%) of high-school dropouts are black. (b) Blacks have a 20% chance of dropping out. [No; part and whole are switched.] Error rates: 14%, 9%, 8%.

Q40. Studies show that television violence (a) is strongly linked with juvenile delinquency. (b) is a cause of juvenile delinquency. [No] Error rates: 22%, 13%, 3%.

Q41. *Which study gives better evidence that taking zinc will decrease a nurse's risk of a heart attack?* "In study A, some nurses chose to take supplements containing zinc while others did not. Those nurses who took zinc had 30% fewer heart attacks than those who did not. In study B, half of the nurses were randomly assigned to take zinc; the others got a placebo. Those nurses who received zinc had 10% fewer heart attacks than those who did not." Possible answers: Study A, Study B, Both equal, Can't tell. [Correct Answer: Study B] {Reasoning: Even though study B has lower success rate than A, study B (randomized experiment) is typically better than study A (observational study).} Error rates: 45%, 40%, 8%.}

Q42. *Which study gives better evidence that taking zinc will decrease a nurse's risk of a heart attack?* In study A, some nurses chose to take supplements containing zinc while others did not. Those nurses who took zinc had <u>20% fewer</u> heart attacks than those who did not. In study B, half of the nurses were randomly assigned to take zinc; the others got a placebo. Those nurses who received zinc had <u>20% fewer</u> heart attacks than those who did not. Possible answers: Study A, Study B, Both equal or Can't tell. [Correct answer: Study B.] {Reasoning: Even though both studies have the same success rate, study B (a randomized experiment) is better (ceterus paribus) than study A (an observational study).} Error rates: 41%, 36%, 8%.

Q43. *In 2000, a research hospital had a higher death rate than a rural hospital. Each patient's condition was classified as either "poor" or "fair." Is it possible that in 2000, this research hospital had a lower death rate than this rural hospital for those patients in "poor" condition AND for those patients in "fair" condition?* Possible answers: Yes, possible. No, impossible. Don't know. [Yes, possible. This is Simpson's Paradox.] Error rates: 44%, 68%, 41%.

Table 3: Percentage of Smoking Prevalence

Year	All	Male	Female		White	Black
1955	--	56.9	28.4		--	--
1965	42.4	51.9	33.9		42.1	45.8
1980	33.2	37.6	29.3		32.9	36.9
1990	25.5	28.4	22.8		25.6	26.2

Table 4: Low Birth Weights

Percent of Births with Low Birth Weight			
State	**1990**	**1995**	**1996**
U.S.	7.0	7.3	7.4
Alabama	8.4	9.0	9.3
California	5.8	6.1	6.0

Table 3: *Do the following statements accurately describe the 26.2% circled above?* {Correct analysis: The ALL margin values are averages so Sex and Race are wholes. Years delimit the whole. "Smoking" is countable and modifies "prevalence" so it is part.}

Q44. *In 1990, 26.2% was the percentage of smokers who were black*. [No; smoking is the part in the table but a whole in the question.] Error rates: 72%, 64%, 27%.

Q45. *In 1990, 26.2% of blacks were smokers*. [Yes] Error rates: 60%, 43%, 19%

Q46. *In 1990, 26.2% of smokers were black.* [No] Error rates: 72%, 62%, 32%.

Q47. *In 1990 26.2% was the percentage of black smokers*. [No] Error rates: 71%, 62%, 22%

Q48. *In 1990, 26.2% was the percentage of blacks who were smokers*. [Yes] 51%, 47%, 22%.

Table 4: *Do you think the following statements accurately describe the 6.0 circled above?* {Analysis: US margin values are averages, so each state delimits a whole. There is no margin for the years, so each year delimits a whole. The countable whole is "births;" part is "low weight."}

Q49. *In the US in 1996, 6% of low-weight births were in Calif.* [No] Errors: 60%, 43%, 19%.

Q50. *In the US in 1996, the percentage of California births among low-weight births was 6%.* [No] Error rates: 66%, 68%, 30%.

Q51. *In the US in 1996, 6% of Calif. births were low-weight*. [Yes] Errors: 39%, 36%, 11%.

Table 4: *Do you think this statement accurately compares the 6.0% in California (CA) with 9.3% in Alabama (AL)?* {Correct analysis: Births is common whole, low-weight is common part. States are whole delimiters that are being compared.}

Q52. *In the US in 1996, there were more low weight births in Alabama (AL) than in California (CA)*. [No] {Comparison of counts – not rates} Error rates: 66%, 68%, 30%.

Table 5: Percent of Women, 15 to 44, who Received Selected Medical Services

Age	HIV	Pregnancy	Pap
15-19	14.6	16.1	33.5
20-24	20.0	27.4	68.7
25-29	25.6	25.3	70.9
30-34	18.5	17.4	69.5
35-39	14.2	8.1	62.9
40-44	10.0	4.3	62.7
ALL	17.3	16.0	61.9

Table 5: *Do you think the following statements accurately describe the circled 10.0%?* {Analysis: Since the margin values for ALL are averages, the rows (Ages) are wholes. Medical services (tests) are not exclusive, so they can be either parts or wholes. A part is needed. The title indicates "medical services" may be part. There are no other candidates, so it is a part.}

Q53. *10% of the women who received an HIV test were 40-44.* [No] Errors: 78%, 55%, 19%.
Q54. *10% of these women 40 to 44 received an HIV test.* [Yes] Errors: 66%, 68%, 30%.
Q55. *Among those women who received an HIV test, the percentage of those 40-44 was 10%.* [No; Age is not part.] Error rates: 60%, 60%, 30%.
Q56. *Among these women 40-44, the percentage who received an HIV test was 10%.* [Yes]. Error rates: 38%, 30%, 14%.

Table 5: *Do you think the following statements accurately compare the 10% and the 20% circled above?* {Analysis: HIV test is part, ages are whole delimiters; women is whole.}
Q57. *Women 40-44 were twice as likely to have an HIV test as were women 20-24.* [No; the correct response is “half as likely”.] Error rates: 32%, 26%, 14%.
Q58. *HIV tests were twice as likely to be administered to women 20-24 as to women 40-44.* [Yes] Error rates: 35%, 62%, 46%. {Decoding “to be administered to women” is not easy. “To be administered” refers to the HIV test as part; “to women” does not make women part.}
Q59. *Women 20-24 were two times more likely to have an HIV test than women 40-44.* [No; either two times as likely as” or “one time more likely than”]. Error rates: 82%, 60%, 81%.

Table 6: Death Rate by leading cause

No. 143. Death Rates, by Leading Cause--States (Top 5 and Bottom 5). Source: 1998 US Statistical Abstract
[Deaths per 100,000 resident population estimated as of July 1.]

STATE 1995	Total	Heart disease	Cancer	Cerebro-vascular dis-eases	Accidents and adverse effects	Motor vehicle acci-dents	Chronic obstructive pulmonary diseases	Dia-betes mellitus	HIV	Suicide	Homicide
United States	**880.0**	**280.7**	**204.9**	**60.1**	**35.5**	**16.5**	**39.2**	**22.6**	**(NA)**	**11.9**	**8.7**
D.C.	1,244.2	302.4	267.2	66.8	34.8	12.3	24.2	39.5	117.8	7.0	56.8
West Virginia	1,107.0	378.9	259.4	67.9	40.4	21.2	60.0	32.8	0.0	15.1	5.5
Florida	1,081.3	351.6	263.5	69.9	38.1	19.8	52.9	26.0	30.8	15.3	8.8
Arkansas	1,075.1	339.8	244.7	91.5	48.8	26.3	45.0	22.4	6.8	14.5	11.6
Pennsylvania	1,059.2	359.7	250.7	68.6	35.3	13.1	43.9	28.2	11.5	12.1	6.5
Missouri	1,021.9	345.3	230.7	72.9	43.5	20.6	46.1	23.4	8.8	13.5	8.9
California	709.8	216.3	162.8	51.4	29.3	14.1	34.2	16.2	20.4	11.7	11.6
Colorado	667.6	172.1	145.9	42.7	39.8	18.6	42.3	14.3	10.9	17.5	5.7
Hawaii	643.1	196.0	156.4	51.5	27.6	12.0	20.4	14.2	10.4	12.0	4.9
Utah	560.6	148.1	108.6	39.9	32.4	17.2	24.1	21.3	4.8	14.8	3.9
Alaska	423.0	90.6	95.1	24.0	56.2	16.1	17.7	9.3	5.0	17.1	8.9

Table 6: *Do you think the following statements* *<u>accurately describe</u>* *the 16.1 circled above?* {Analysis: US rates are averages so states are wholes. Totals are sums so the columns are parts. “Death” modifies “rate” so “death” is a part along with the particular column heading.}

Q60. *In 1995, the death rate due to motor vehicle accidents was 16.1 per 100,000 Alaskans.* [Yes] Error rates: 20%, 17%, 8%.
Q61. *In 1995, for those in motor vehicle accidents, the death rate was 16.1 per 100,000 Alaskans.* [No; “Motor vehicle accidents” is not a whole.] Error rates: 60%, 53%, 16%.
Q62. *In 1995, the rate of motor vehicle accidents was 16.1 per 100,000 Alaskans.* [No; the question omits the word “death.”] Error rates: 60%, 32%, 30%.
Q63. *In 1995 for Alaskans who were in motor vehicle accidents, the death rate was 16.1 per 100,000.* [No; “vehicle accidents” is not a whole.] Error rates: 67%, 66%, 19%.

Please give your evaluation of this survey: Percentages shown are for “strongly agree,” “moderately agree,” “moderately disagree” and “strongly disagree.” The modal answer is in bold.
Q64. *This survey was much more difficult than I thought it would be.* 25%, **50%**, 20%, 5%
Q65. *This survey was much more subtle than I thought it would be.* 21%, **43%**, 32%, 4%
Q66. *This survey was unnecessarily tricky.* 24%, 27%, **36%**, 14%
Q67. *I felt considerable discomfort in taking part or all of this survey.* 10%, 29%, **34%**, 28%
Q68. *These tables and graphs are the kind I need to be able to read.* **53%**, 37%, 7%, 4%.
Q69. *College students should be able to read these tables and graphs.* **63%**, 29%, 5%**,** 2%.

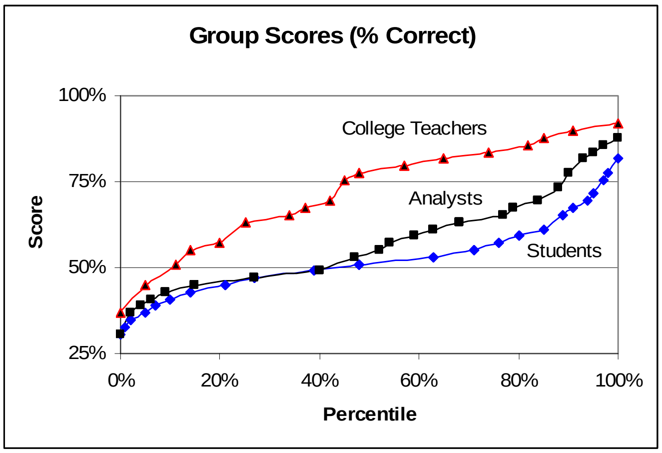
RESPONDENT COMMENTS

"*The subtleties in the English language is frustrating for a 2nd language speaker…*" "*Interestingly, the various shadings of many of the graph questions involve many of the clumsy wordings my fellow journalists use to describe data.*" "*Whew! I learned a lot about subtleties of language while doing this! Thanks.*"

SUMMARY

The distribution of overall scores by group is shown in Figure 1. Among the respondents, the average scores are 51.2% for students, 56.4% for data analysts and 71.8% for college teachers (many of whom teach statistics). The interquartile ranges are 10.2 percentage points for these students, 19.4 percentage points for these data analysts and 20.4 percentage points for these college teachers.

Figure 1: Distribution of Overall Scores by Group



The average error rate was 49% for college students, 44% for data analysts and 28% for college teachers. At the 80th percentile, the error rate was 45% for college students, 20% for data analysts and 10% for college teachers. Using the 80th percentile score for data analysts as a desired goal (80% correct), then only 2% of the students, 20% of data analysts and 43% of these college teachers achieved that goal.

Schield (2006) analyzed the results of this survey in more detail and made recommendations for teachers who want to help students be statistically literate.

CONCLUSION

In reading a pie chart (Q9), 19% of students misread a description. In comparing two slices within a pie chart (Q10), the error rate was 62% for students (65% for data analysts). In a 100% row table, 44% of students (28% of data analysts) misread a description while 46% of college teachers misread a "times more" compare (Q29). In comparing two percentages (Q59), the error rate for college teachers (81%) was about the same as for students (82%) but higher than for data analysts (60%). The possibility of Simpson's paradox (Q43) was not recognized by 68% of data analysts and 41% of college teachers. In reading a table of rates (Q61), the error rate was 60% for students and 53% for data analysts.

The average error rate was 49% for college students, 44% for data analysts and 28% for college teachers. At the 80th percentile, the error rate was 45% for college students, 20% for data analysts and 10% for college teachers. Using the 80th percentile score for data analysts as a desired goal (80% correct), then only 2% of these students, 20% of these data analysts and 43% of these college teachers achieved that goal.

Statistical educators should review the survey instrument, the rules used to determine the correct answers and the error rates by group to see if the survey instrument or the rules may have contributed to the respondent errors.

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APPENDIX:

SURVEY SUBJECTS:

The names of those surveyed were not requested except for those students taking it as part of a course in which case they took the survey twice: once at the beginning of the course and once at the end. Data obtained from students after they had studied these materials in a course (Worksheets F, G, P, Q and R) were not included in this analysis. The resulting dataset was named “All New” and included all 240 entries in data sets A, C, I, K, L, M, N, W and X. The handling of blanks or non-entries is problematic. It seems inappropriate to treat those who left an answer blank because they got tired the same as those who left it blank because they didn’t know after trying. In the interim worksheets, responses (records) were eliminated if they had any blanks (non-responses) for questions Q9-Q63.

For the 191 respondents, here are some highlights. Q1. 36% have discomfort with formal statistics. Q2. 19% have discomfort with informal statistics. Q3. 95% have quantitative occupations. Q4. 41% are students. Q6. 29% are not native speakers of English. Q7: 21% have taken at least 4 courses in statistics.

For the 191 surveys, the percentage scores range from a low of 22% to a high of 94% with a median of 51%, a mean of 56% (27 of the 48 questions) and a standard deviation of 15.6 percentage points. The quartile percentages were 45% (first) and 65% (third). There was no adjustment for guessing. One explanation for low scores is that the answers are wrong. Perhaps the descriptive rules formulated by Schield (2000 and 2001) are in error or perhaps there was a mistake in their application.

In the ICOTS worksheet, answers to Q4 were modified in 23 cases. Of these, 12 involved reclassifying known adult students as students rather than by their profession, 7 involved classifying known data analysts (dataset K) as “Other profession” rather than as “Other” or as “students” and 4 involved reclassifying known Augsburg staff members as “Other Professions” (data analysts) rather than “Other.” Henceforth Q4* designates these modified values.

OMITTED SUBGROUPS

Table 7 presents the count and Table 8 the average score for subgroups formed by the intersection of answers to Q4* and Q6 respectively.

Table C: Count by Questions 4 and 6.

COUNT	**English**			
Q4* Q6	Native speaker	Learned as child	Adult Learner	ALL
13+ Student	80	5	2	87
K-12 Teacher	4	6	1	11
13+ Teacher	27	10	2	39
Professional	24	23	7	54
ALL	135	44	12	191

Table D: Score by Questions 4 and 6.

SCORE (%)	**English**			
Q4* Q6	Native speaker	Learned as child	Adult Learner	ALL
13+ Student	51%	53%*	37%*	51%
K-12 Teacher	53%*	37%*	59%*	**45%**
13+ Teacher	71%	73%	62%*	71%
Professional	61%	52%	46%*	55%
ALL	57%	55%	**48%**	56%

* Less than 10 subjects in cell.

By column or row, the highest scores are for college faculty (71%) and native English speakers (57%); the lowest are for K-12 teachers (45%) and for those who learned English after childhood (48%). For this introductory paper, both low-scoring groups are omitted leaving 169 respondents. Based on the modified answers to Q4, three groups were formed: college students (85), college teachers (37) and professional data analysts (47).

SURVEY SUBJECTS’ ATTITUDES

Subjects were asked two questions about their attitudes toward statistics.

Q1. What best describes how comfortable you are in dealing with formal statistics (e.g., chance, probability, sampling distributions, confidence intervals, etc.)?

Q2. What best describes how comfortable you are in dealing with informal statistics (e.g., reading and interpreting tables and graphs that use rates and percentages)?

Answers for Q1 and Q2: 1 are. “very comfortable” (VC), 2. “somewhat comfortable” (SC), 3. “somewhat uncomfortable” (SU), and 4. “very uncomfortable” (VU). Here are the results.

Table A: Attitude toward Formal Statistics

Count	Q1				
Q4*	1 VC	2 SC	3 SU	4 VU	All
Student		39	39	7	85
Data Analyst	14	23	8	2	47
Professor	21	10	3	3	37
ALL	35	72	50	12	169

Table B: Attitude toward Informal Statistics

Count	Q2				
Q4*	1 VC	2 SC	3 SU	4 VU	ALL
Student	6	52	24	3	85
Data Analyst	29	13	4	1	47
Professor	28	9			37
ALL	63	74	28	4	169

Table A: "Very comfortable" "in dealing with formal statistics" was cited by 0% of students, 30% of data analysts and 57% of college professors. Table B: "Very comfortable" with informal statistics" was cited by 7% of students, 62% of professional data analysts and 76% of college teachers. Table C: 54% (92/169) of the respondents felt equally comfortable with formal and informal statistics, 7% (12/169) felt more comfortable with formal than informal statistics while the remaining 38% (65/169) felt more comfortable with informal than formal statistics.

Table C: Count by Attitude: Formal/Informal

Q1\Q2	1 VC	2 SC	3 SU	4 VU	ALL
1 VC	30	4		1	35
2 SC	25	41	6		72
3 SU	6	24	19	1	50
4 VU	2	5	3	2	12
ALL	63	74	28	4	169

Table D: Scores by Attitudes: Formal/Informal

Score	* indicates less than 10 in that cell				
Q1\Q2	1 VC	2 SC	3 SU	4 VU	ALL
1 VC	70%	68%*		31%*	69%
2 SC	58%	53%	47%*		54%
3 SU	66%*	52%	50%	55%*	53%
4 VU	82%*	58%*	45%*	47%*	57%
ALL	65%	54%	49%	45%*	57%

Table D: While correlating scores (percentage correct) with ordinal measures is not generally meaningful, in this case it may be useful in making a comparison for the same group. The 0.97 correlation between scores and Q2 (attitude toward informal statistics) is much higher than the 0.66 correlation between scores and Q1 (attitude toward formal statistics).

MARGIN OF ERROR:

If this were a random survey, and if the population error rate were 50%, then using the normal distribution the 95% margin of error for the three groups (students, data analysts and college professors) in Q4* would be ±10.7, ±14.4, or ±16.2 percentage points respectively (± 6.4, ±8.6, or ±9.7 percentage points for a 10% population error rate). If the population error rate were 1%, then using the binomial distribution the upper-end of the 95% confidence intervals would be 3.5%, 4.3% or 5.4% respectively. A sample error rate of 0% would be the lower end of the 95% confidence interval for population error rates of 4.2%, 7.5% or 9.5% respectively.

WRONG ANSWERS:

It is possible that some answers are wrong. One way to check this is to compare the modal answer with the correct answer. If they agree, it is difficult to say that the correct answer is wrong. The modal answer was correct for 61% (29) of the 48 questions. For the 19 questions where the modal answer disagreed, the wrong-right ratio was typically 1.3 or less indicating the opposition to the correct answer was not very strong.

One way to view this survey is to look at the questions where the group with the lowest error rate (college teachers) had the highest error rates. High error rates may reflect problems in the questions, the answer key, or the subject's misunderstanding. Over half the college teachers missed the right answer for the following questions.

- Q 59. 81% error rate. The question was, "20% is 2 times more than 10%?" Equating "2 times as much as" with "2 times more than" is a common error – even for college teachers.
- Q35. 68% error rate. This comparison involved reading a two-way rate table and the question had part and whole reversed.
- Q27. 57% error rate. "Two times as likely than" is not proper English for a ratio compare.
- Q32. 54% error rate. Respondents may not realize that a combined whole (female smokers) can be expressed in difference ways (Q32 and Q35).

Based on Schield (2000 and 2001), these high error rates are not due to a wrong answer.