

## Do You Speak Statistics?

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Nearly everybody is concerned with statistics, even in daily life you can see statistics everywhere. So the question arises, if people do understand those basic statistics. Also the difficulties that many students encounter in basic statistic courses are well known and have been widely reported. The results for 2001 and 2003 were presented before, so we can compare the results with the results of the new samples.

### 1. Survey

The data were collected from students of business, economics and social sciences at the University of Linz, Austria, in March 2001 (n = 607), March 2003 (n = 349), March 2005 (n = 204) and March 2007 (n = 319). The samples were no random selection, the students were chosen, because they took part in a basic courses in statistics. Therefore the results are not representative in a strong statistical sense, but still very meaningful. The questionnaire contained eleven questions dealing with mathematics or statistics, most of them multiple choice with six different possibilities of response. The topics were interpretation and calculation (without calculator) of percentages and fractions, interpretation of graphics and (rough) estimation of square roots and percentages.

### 2. Results

The first question about percentages was "How much is 30% of 70%?", the options for response were 3%, 17%, 21%, 30%, 37% and 70 %. The results can be seen in table 1 and 2, the percentages correspond to the numbers of valid cases, which also are presented in the tables.

**Table 1: How much is 30% of 70%? Results of 2001 and 2003**

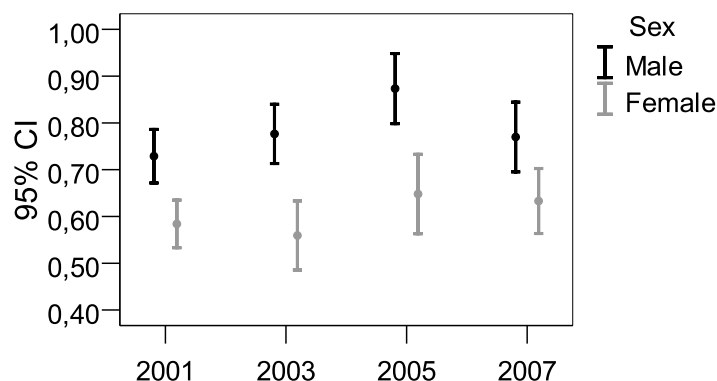
Responses	2001			2003		
	Male	Female	Total	Male	Female	Total
3%	1.3%	1.1%	1.2%	0.0%	1.2%	0.6%
17%	4.2%	4.7%	4.5%	0.6%	3.5%	2.1%
21%	79.7%	73.0%	75.6%	78.0%	71.3%	74.6%
30%	6.4%	10.9%	9.1%	7.7%	8.8%	8.3%
37%	7.6%	10.0%	9.1%	13.7%	14.0%	13.9%
70%	0.8%	0.3%	0.5%	0.0%	1.2%	0.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Cases n	236	359	595	168	171	339

This result ist not satisfactory, only about three-quarter of the samples did choose the right response, female results always below male results, the worst result was in 2005.

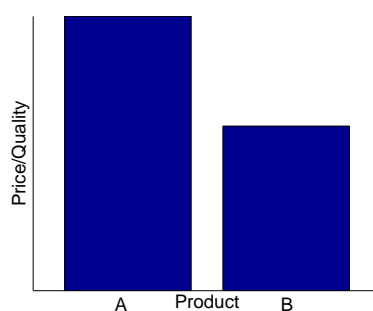
*Table 2: How much is 30% of 70%? Results of 2005 and 2007*

Responses	2005			2007		
	Male	Female	Total	Male	Female	Total
3%	1.3%	0.0%	0.5%	0.0%	1.6%	1.0%
17%	0.0%	5.0%	3.0%	0.8%	3.7%	2.5%
21%	72.2%	64.7%	67.7%	72.4%	68.4%	70.1%
30%	10.1%	15.1%	13.1%	7.1%	13.4%	10.8%
37%	16.5%	12.6%	14.1%	18.1%	11.8%	14.3%
70%	0.0%	2.5%	1.5%	1.6%	1.1%	1.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Cases n	79	119	198	127	187	314

Similar results were found with the question "The fraction  $1/40$  can also be written as ..." with the options 0.40,  $4/100$ , 0.25, 0.040,  $1/25$ , 0.025. Only about two third did know the correct answer. Again there were some differences between the groups of 2001 (64.2% correct), 2003 (66.6% correct), 2005 (73.5% correct) and the group of 2007 (68.8% correct). Figure 1 shows the confidence intervals for the proportion of correct answers in the different samples divided by sex.

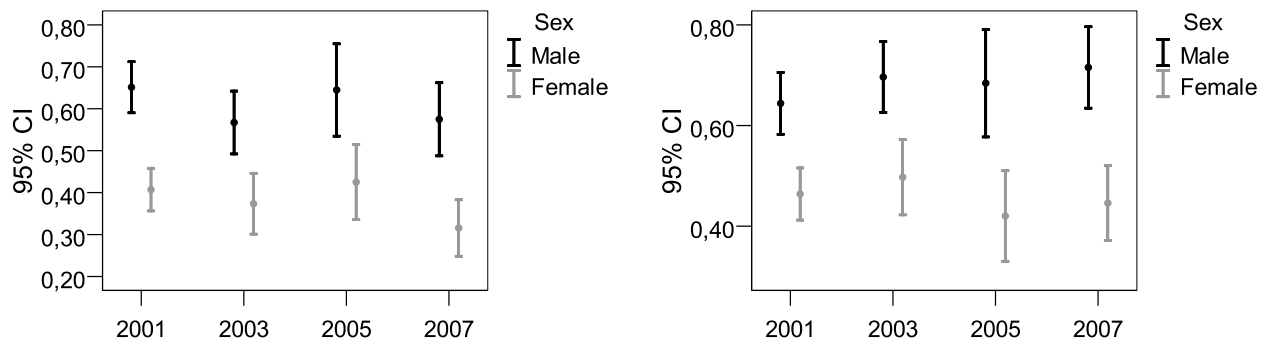
*Figure 1: Fraction  $1/40$ , CI proportion of correct answers*

The result of the question "Figure 2 shows the price-quality-index of two products. Which product would you prefer?" shows us that even majority is not always right. In 2001 38.2%, in 2003 48.4%, in 2005 39.4% and in 2007 34.2% of the corresponding sample voted for product B.

*Figure 2: Which product would you prefer?*

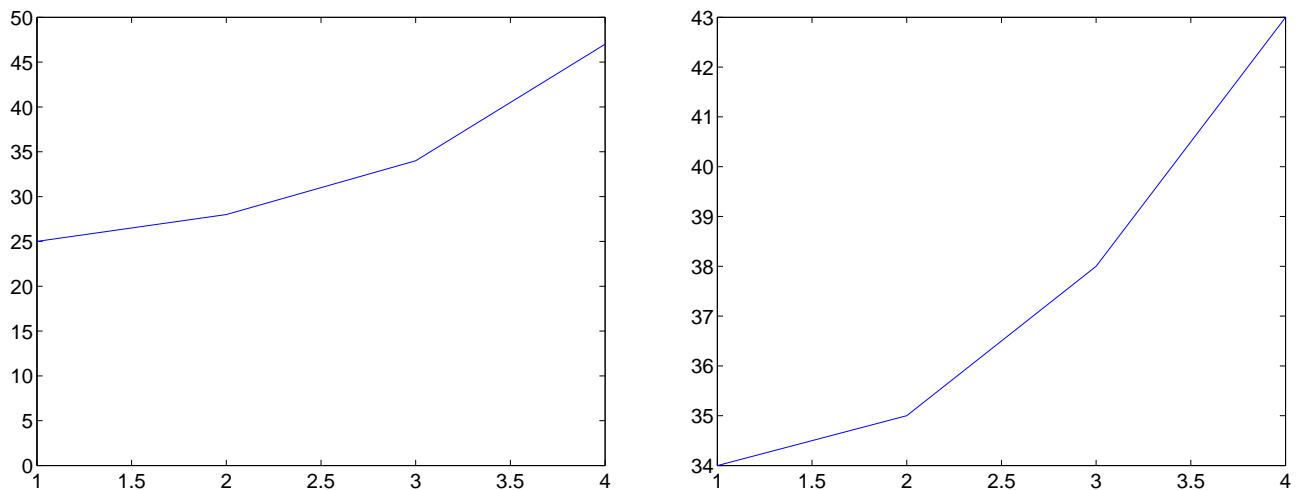
Another bad highlight was the result of the question "The square root of 0.5 is ..." with the options "bigger than 0.5", "equal 0.5" and "smaller than 0.5". In 2007 only 42.0% (2001 50.4%, 2003 47.0%, 2005 51.0%) of the sample chose the right option. So it seems to be very difficult for the students to estimate the square root of a decimal number. Estimating the square root of 14641 with the options 11, 71, 121, 235, 550, 739 was also a big problem (about 55% correct answers). Both results had big differences between male and female students, as can be seen in figure 3.

**Figure 3: CI proportion of correct answers. Left figure  $\sqrt{0.5}$ . Right figure  $\sqrt{14641}$**



At the last question students had to decide on which figure shows a bigger increase (with possibilities "the first", "the second" and "both are equal").

**Figure 4: Which figure shows a bigger increase?**



In the sample 2001 45.3% voted for the correct figure, the results of the samples 2003 and 2005 were a little bit better with 51.2% and 50.3% correct answers, the bad surprise was the result of this year: Male 50.4%, Female 27.2%, Total 36.7% correct answers.

Finally there were eleven questions dealing with mathematics and statistics, two of them concerning graphics. 19.3% of the sample did manage both of the graphical questions, 13.4% did manage all non-graphical questions, and only 4.3% gave correct answers for all eleven questions. Detailed information about the differences in the various samples is given in table 3.

*Table 3: Correct answers in different years*

Part	2001	2003	2005	2007	All
Graphical (2 questions)	18.5%	24.3%	21.5%	13.8%	19.3%
Non-graphical (9 questions)	14.8%	13.5%	16.4%	8.4%	13.4%
All questions	4.2%	5.1%	7.3%	1.9%	4.3%

The results were checked on differences between male and female students.

*Table 4: Correct answers by sex*

Question/Part	Male	Female	Total	Total size
Bigger increase	54.7%	38.9%	45.5%	1454
Product	41.0%	39.1%	39.9%	1451
30% of 70%	76.7%	70.5%	73.1%	1446
Fraction 1/40	76.9%	59.9%	67.0%	1464
40% stands for	92.3%	78.4%	84.3%	1441
$\sqrt{0.5}$	61.1%	38.2%	47.9%	1454
$\sqrt{14641}$	67.8%	46.1%	55.2%	1432
Graphical	24.3%	15.6%	19.3%	1431
Non-graphical	21.4%	7.3%	13.4%	1331
All questions	7.2%	2.2%	4.3%	1314

Table 4 shows results by sex for the questions mentioned above. Some results are very close for men and women, but others differ very much. For example estimating the square root of 0.5 seems to be a bigger problem for women (38.2% correct) than for men (61.1% correct).

### 3. Summary

Do students understand the statistical language? The samples show that most of the participating students have serious difficulties with "statistical" diagrams and also problems in very basic statistics. Especially interpreting diagrams is very important in professional and daily life. So the central points in teaching statistics should be technical skills **and** correct interpretations of results and diagrams.

### REFERENCES

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