Head for Figures and Mathematical Comprehension

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Do students have a head for figures, do they have mathematical comprehension? The samples show that most of the participating students have serious difficulties in interpreting "statistical" diagrams and also problems in very basic mathematics. In my opinion especially interpreting diagrams is very important in professional and daily life. Therefore I think we have to focus not only on technical skills in statistics, but also in correct interpretations of results and diagrams.

1 The Sample

The data were collected from students of economics and social science at the University of Linz, Austria, in March 2001 (n = 607), March 2003 (n = 349) and January 2004 (n = 259). The samples were no random selections, the students were chosen, because they took part in basic courses in statistics. Therefore the results are not representative for any really interesting population, 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 results at university were not very glorious. Even majority is not always right, as shown in some examples. The first part of this chapter shows results for the different samples (2001, 2003 and 2004), the second part differentiates the results for male and female students.

The first question about percentages was "How much is 30 % of 70 %?", the options for response were 3 %, 17 %, 21 %, 30 %, 37 % and 70 %. Only 75.6 % of the whole sample (all percentages refer to valid cases only) did manage this question, there were hardly any differences between the sample 2001 (75.7 % correct), the sample 2003 (74.6 % correct) and the sample 2004 (76.8 % correct).

Even worse was the result of the question "The fraction 1/40 can also be written as …" with the options 0.40, 4/100, 0.25, 0.040, 1/25 and 0.025. Only about two third (66.3 %) did know the correct answer. Again there were hardly any differences between the group of 2001 (64.2 % correct), the group of 2003 (66.6 % correct) and the group of 2004 (70.8 % correct).

The result of the question "Figure 1 shows the price-quality-index of two products. Which product would you prefer?" (see Figure 1) shows us that even majority is not always right. The figure shows the ratio price to quality, so product A would be more expensive for the same quality as product B, but only 40.3 % of the students chose product B. There were differences in the various years (2001: 38.1 %, 2003: 48.4 % and 2004: 34.4 %), but majority was wrong in each year.

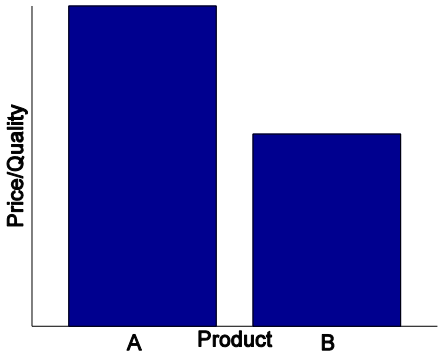

Figure 1: Which product would you prefer?

There were better results for the question "40 % stands for …" with the possibilities "every fourth", "one out of forty", "four out of ten", "one fourth", "1/25" and "ten out of four hundred". 86.1 % of the sample were able to find the right interpretation. This seems to be a good result, but on the other hand this means, that about 14 % of the students do not understand anything about percentages, so how could they manage probability?

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". Only 50.7 % of the whole sample chose the first option, 1.0 % voted for the option "equal" and 48.3 % voted for the last response. 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 (56.9 % correct answers).

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

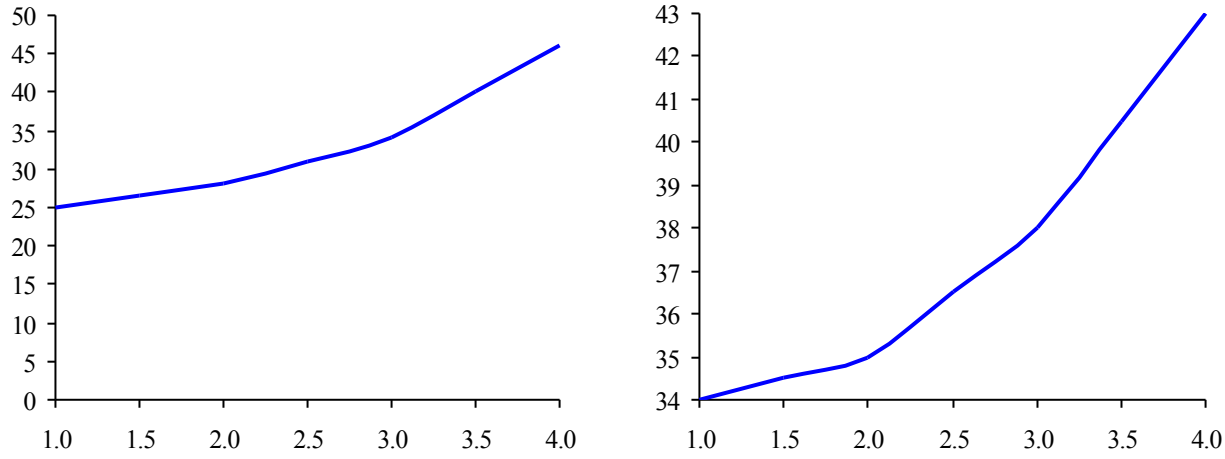

Figure 2: Which figure shows a bigger increase?

In the sample 2001 only 45.4 % voted for the correct figure, the result of the sample 2003 was a little bit better with 51.2 % correct answers, in the sample of 2004 again only 45.9 % chose the correct figure. This result is disappointing, because one of the topics in basic courses in statistics is how to look at figures.

There were eleven questions dealing with mathematics and statistics, two of them concerning graphics. 19.9 % of the sample did manage both of the graphical questions, 15.3 % did manage all non-graphical questions, and only 4.5 % gave correct answers for all eleven questions. Detailed information about the differences in the various samples is given in Table 1.

Part	2001	2003	2004	All
Graphical (2 questions)	18.5 %	24.3 %	17.4 %	19.9 %
Non-graphical (9 questions)	14.8 %	13.5 %	19.0 %	15.3 %
All questions	4.2 %	5.1 %	4.7 %	4.5 %

Table 1: Correct answers in different years

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

Question / Part	Male	Female	Total	Total size
Bigger increase	54.2 %	42.1 %	47.1 %	1205
Product	38.5 %	41.7 %	40.3 %	1190
30% of 70%	78.8 %	73.3 %	75.6 %	1188
Fraction 1/40	76.4 %	58.9 %	66.3 %	1203
40% stands for . . .	92.3 %	81.6 %	86.1 %	1195
$\sqrt{0.5}$	62.1 %	42.4 %	50.7 %	1202
$\sqrt{14641}$	66.9 %	49.7 %	56.9 %	1195
Graphical (2 questions)	22.1 %	18.4 %	19.9 %	1183
Non-graphical (9 questions)	22.9 %	9.8 %	15.4 %	1120
All questions	7.0 %	2.7 %	4.5 %	1103

Table 2: Correct answers by sex

Table 2 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 (42.4 % correct) than for men (62.1 % correct). As a matter of fact only the question about the product-price-index was a smaller problem for women (41.7 %) than for men (38.5 %).

3 Summary

The samples show that most of the participating students have serious difficulties in interpreting "statistical" diagrams and also problems in very basic mathematics. In my opinion especially interpreting diagrams is very important in professional and daily life. Therefore I think we have to focus not only on technical skills in statistics, but also in correct interpretations of results and diagrams.

References

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