COMPARISON OF STUDENTS' ATTITUDE TO THE STUDY STATISTICS AT THE FACULTY OF ECONOMICS AND MANAGEMENT

Jiří Neubauer

***Abstract**: The main topic of the article is the comparison of students' attitude to the study statistics at the Faculty of Economics and Management, University of Defence in Brno. In 2008, second-year students were given a questionnaire aimed at finding out students' opinions on this subject, what had caused them greatest difficulties, how they had prepared for the exam and which software they had used when processing a seminar paper. The same survey was also conducted in 2013. The paper describes the results and comparison of responses from the years 2008 and 2013 by selected statistical methods.*

Keywords: statistics, teaching, questionnaire survey, statistical software

1. Introduction

Almost all university students of economic and technical faculties encounter statistical data processing along with basic knowledge of probability and statistical analysis. This subject is also taught at the Faculty of Economics and Management, University of Defence in Brno. Statistics is a part of the bachelor's degree program curriculum together with subjects such as Mathematics, Economics, Computer Science, Law, etc. The course of statistics contains elementary data processing, foundations of the theory of random variables, basics of theory of estimation and hypothesis testing. In general, Statistics is not one of their favourite subjects, like Mathematics or other exact academic disciplines. The fundamental questions of a lecturer are how to explain the principles of statistics to students, and how to attract students and increase their interest in the subject. It is, therefore, important to obtain student feedback, to know what students think about the subject taught, what causes them the greatest difficulties, how they prepare for lessons or exams, which study materials or software they use when processing a seminar paper, etc. Probably one of the most common ways to obtain this information is a questionnaire survey (see [2], [8]). Second-year students were given a questionnaire aimed at finding out students' opinions in 2008. The same survey was conducted in 2013. Selected statistical methods were used in the evaluation questionnaire; it was especially the χ^2 test of independence in the contingency table, the Wilcoxon test and test of equal proportions (see [1], [6] or [8]).

2. Statistical software

Nowadays, the use of modern computer technology in the teaching process is inevitable. In the case of statistics, an academic discipline that deals with the processing and analysis of data, the need to use computers along with the appropriate software is indisputable.

Not long ago, scientific calculators were used for numerical calculation, and, even today, they are still a helpful tool. However, statistical analysis via computer provides more useful and instant outputs. Besides numerical calculation, we can mention tables and graphs which describe the range of monitored variable characteristics. These outputs help the students understand the "philosophy" of statistics. The computers which entered this area several decades ago are essential for almost all contemporary statistical methods. One can find a great deal of statistical software on the market, such as SPSS, Statgraphics, Minitab, Statistica, SAS, QCExpert, Matlab (statistics toolbox) and so on. These products differ, for example, in a range of offered methods and analysis, in graphical interfaces, in user's accessibility, or in universality. It is necessary to mention the R programming environment which offers a potential alternative to these products. R was created on the basis of a stripped-down version of S language. The code for R was released in 1995 under the GPL (General Public License), which means it can be freely downloaded (http://www.r-project.org/). The basic statistical analyses in R are described, for example, in [3].

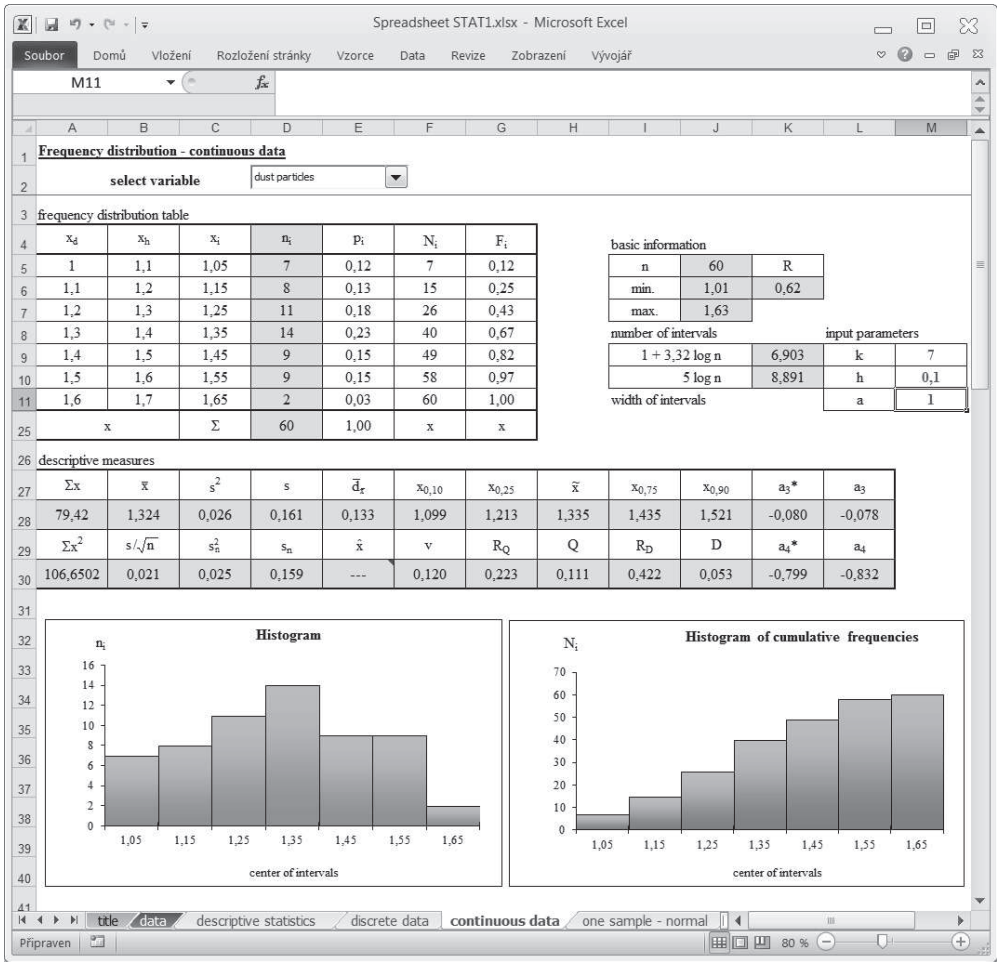

Figure 1: Selected answers from the questionnaires in 2008 and 2013

Selecting the appropriate software for teaching is influenced by many factors. One problem is the accessibility of the chosen software at the university, since the price of the required multi-license is not often low. Another problem is the accessibility of this software to the students, because not only should they be able to use it at the university but they should also be able to use it at their homes or dormitories in order to make their

study more effective. A common disadvantage of these professional products is their limited use of the student's individual work at home. This drawback of statistical software could be solved with freeware (usually in English) or, at least partially, with Excel, which is part of MS Office. An undeniable advantage is that it is widespread among students, and, that computer laboratories are equipped with Excel. It is not special statistical software. Nevertheless, the tabular nature of Excel enables us to utilize several implemented tools and interesting features. We have decided to choose MS Excel for the purpose of statistical teaching and have created the STAT1 spreadsheet (see figure 1, it can be freely downloaded at http://k101.unob.cz/stat1/). This tool contains one-dimensional descriptive statistics with frequency tables and graphs, point and interval estimates and hypothesis tests (selected normality tests, one and two-sample tests of the mean, the variance and the proportions). The aim was to prepare a tool to help students understand the basis of statistics easily and naturally, to succeed in getting into principles of statistics, and not to be afraid of using statistical tools effectively and reasonably. The described tool is a part of the textbook [5] used now in the course of statistics at our faculty.

3. Questionnaire survey

It is undoubtedly beneficial to identify possible links among students'study results. For example, the article [9] analyses relationship between results in English language test and the Learning potential test at the Faculty of Economics and Management. (These two tests are parts of the entrance exam.) The basic objective of our survey was to determine the attitudes and opinions of students on the subject of statistics and analysis of changes. The first questionnaire survey was carried out in 2008; the survey was answered by a total of 64 respondents. The same questionnaire was given to 73 students in 2013. The first part of the questionnaire is focused on comparison of study results in selected subjects of the curriculum, particularly in Statistics, Mathematics, Economics and Computer Science. For the purpose of comparison, we used the old grading scale from 2008 (grades 1, 2, 3 and 4). Therefore, the results from 2013 were converted to the old scale in following manner: A, B = 1; C, D = 2; D = 3 and F = 4. It should be noted that only successful students of Statistics responded to the questionnaire. When evaluating the exam results of the subjects observed, we are not surprised. Better results occurred in Computer Science and Economics, but worse in Mathematics and Statistics. Results are summarised in table 1. It contains basic descriptive statistics of grades in 2008 and 2013; the last two columns show the results of the grades comparison using the Wilcoxon rank test (see [1], [6] or [8]). Continuity correction was applied when calculating the Wilcoxon rank test. At significance level 0.05, we can see the change in the grades in Mathematics (p-value is less than 0.05), at significance level 0.10, we can see the change in the grades in all subjects except for Statistics.

Table 1 Descriptive statistics and grades comparison in 2008 and 2013 – Wilcoxon test

	2008			**2013**			**Wilcoxon test**	
	mean	**median**	**st.dev.**	**mean**	**median**	**st. dev.**	**statistic**	**p-value**
Mathematics	2.141	2	0.870	2.452	3	0.708	1898.0	0.03848
Comp. Science	1.828	2	0.767	2.082	2	0.777	1922.0	0.05758
Economics	1.922	2	0.762	2.164	2	0.707	1928.0	0.05876
Statistics	2.203	2	0.800	2.384	3	0.757	2046.5	0.17404

More interesting, however, are the results of the relationships between Statistics and other subjects which the following analysis brings (table 2). These relationships were analysed by χ^2 test of independence (see [1], [6] or [8]). The tests were conducted in such a manner that conditions of good approximation were fulfilled. In contrast to the results from 2008, when it was shown that there is dependence between the results of the subjects of Mathematics – Computer Science, Mathematics – Statistics and Computer Science – Statistics (at significance level 0.10 also between Mathematics and Economics), in 2013, independence was rejected for the subjects of Mathematics – Computer science and Mathematics – Statistics (at significance level 0.10 also between Computer Science and Statistics). If we look at student evaluations (marks) in each year, we find that the results in Mathematics and Statistics are generally worse than in Computer Science and Economics (see table 3). Results in Mathematics and Statistics are comparable, as expected. Similarly, according to the Wilcoxon test it is not possible to say that the achievements in Computer Science and Economics are different. The required statistical analyses were calculated in R, where the significance level of the tests was 0.05.

Table 2 Tests of grades independency – χ^2 test

	2008		**2013**	
	statistic	**p-value**	**statistic**	**p-value**
Mathematics-Computer Science	14.225	0.00081	14.812	0.00061
Mathematics-Economics	5.930	0.05156	0.564	0.75441
Mathematics-Statistics	8.916	0.01159	9.711	0.00779
Computer Science-Economics	7.749	0.02077	1.720	0.42322
Computer Science-Statistics	15.268	0.00048	5.754	0.05631
Economics-Statistics	4.257	0.11902	1.563	0.45764

Table 3 Grades comparison – Wilcoxon tests

	2008		**2013**	
	statistic	**p-value**	**statistic**	**p-value**
Mathematics-Computer Science	2465.5	0.03498	3363.5	0.00309
Mathematics-Economics	2351.5	0.12553	3270.5	0.00974
Mathematics-Statistics	1982.5	0.73968	2775.0	0.62906
Computer Science-Economics	1909.0	0.48011	2520.5	0.54595
Computer Science-Statistics	1525.0	0.00823	2091.5	0.01581
Economics-Statistics	1646.0	0.04190	2190.5	0.04446

The second part of the questionnaire deals with the study of statistics. We can say that 60 % of the students encounter statistics at our faculty for the first time. The rest of them had had awareness of statistics before attending the course of statistics (a secondary school or another university). What is slightly surprising is that after finishing the course, 57 % of university students perceive statistics as an academic discipline almost identical or very similar to mathematics, using the same or similar way of thinking (50 % in 2008). We can identify no change in the proportion. This result points to the ongoing lack of understanding of the difference between mathematics and statistics.

The question about the difficulty of statistics has not brought any surprises, 51 % (50 % in 2008) expressed the fact that statistics is rather difficult for them, 23 % (34 % in 2008) consider statistics as a subject reasonably challenging with the need to think

more. Only 23 % (14 % in 2008) said that statistics is very difficult and hard to understand. This fact is also confirmed by teachers. Comparing results from 2008 and 2013, we can identify no significant changes in answers. With regard to the fact that students consider statistics rather difficult, we wanted to find out what caused them such problems. 59 % (56 % in 2008) of the students saw the biggest problem in finding links among different parts of statistics, such as the descriptive statistics, the probability and the inductive statistics. Another difficulty in the study of statistics was a new language and a new way of thinking which is used (25 %, resp. 28 % in 2008). The subsequent question revealed that 33 % (42 %) of the students in their view understood the nature of the subject matter at home when doing their homework or later during revision which indicates a significant decrease. However, 45 % (38 %) of the students reported that they understood the principles in the study for the test, and 8 % (6 %) even thought that they basically misunderstood. A deeper analysis demonstrates that understanding the studied subject matter is associated with the exam evaluation.

The use of computers is likely to affect students' views on the practical application of technical means. The third part of the questionnaire is focused on the use of computers during study. According to the students, 84 % of them have access to a computer at home and at the university, 18 % only at home (84 % and 18 % in 2008). The survey also shows that 67 % of the respondents can work with a computer completely independently and without any problems and 29 % of them occasionally need help (48 % and 40 % in 2008). As we can see, there is a significant increase in computer literacy. This result can be considered quite satisfactory; the use of computers in the study of statistics plays an increasingly important role. Nevertheless, the link between the results of the examination and students' computer skills were not proved.

In the last part, the students answered questions connected with their study of statistics. A relatively large proportion of students, a total of 73 %, said that they did not understand the new subject matter after the lecture, or their level of understanding was very low (similar results as in 2008 – 72 %). The situation changed after the seminars. However, the increase of understanding in 2008 was not significantly greater than in 2013. In this context, it should be noted that the STAT1 spreadsheet was used during the seminars (the descriptive and the inductive statistics) which saved time in the numerical calculations and this reserve could be used by teachers for the commentaries and explanations of the results obtained. With regard to the opinion on STAT1, 88 % of the respondents consider it a very good tool and 11 % quite a useful tool (64 % and 33 % in 2008). There is a positive increase in popularity of this tool (a significant rise in the proportion). This opinion corresponds to the use of this spreadsheet, because 82% of the students used it when preparing for all or some of the seminars, 17 % up to 2 times, but only 1 % had not used STAT1 at all. In 2008, we obtained proportions of 50 %, 33 % and 17 % which indicates a very significant shift in the use of this tool, not only in schools but also at home. The link between students' opinions on the usefulness of this tool and the use for the statistical computation during the course was also proved. The following question focused on the use of different parts of the STAT1 spreadsheet: 68 % of students used it for descriptive statistics, 77 % for normality tests, 77 % for the computation of point and interval estimates and 80% for hypothesis testing. None of the respondents answered that he did not used it for any part of the statistics analysis. The previous survey gave results of 61 %, 69 %, 63 %, 47 % and 6 % (did not use of STAT1). The results obtained demonstrate the increasing popularity of computer data processing. We are also interested in their opinions about computer-aided study of this subject. 68 % (45 % in 2008) of the students considered the current version of STAT1 to be sufficient, 23 % (28 % in 2008) of them would appreciate an enlarged version of

the spreadsheet. 7 % (25 % in 2008) of the respondents required professional statistical software, and approximately 1 % (2 % in 2008) believed that computer support was not needed. We can see and prove that there is a change in the opinions on the use of statistical software in teaching.

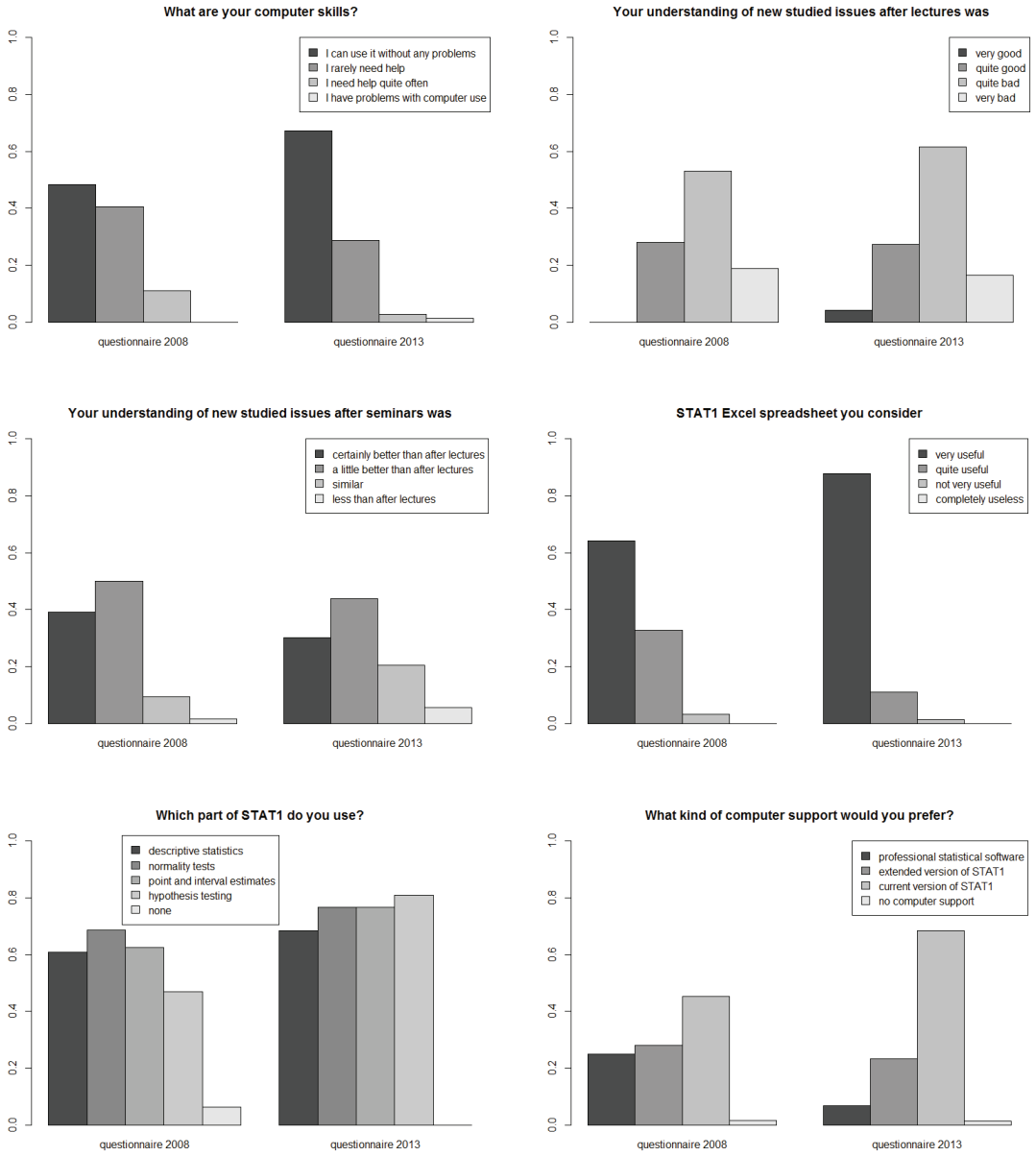

Figure 2: Selected answers from the questionnaires in 2008 and 2013

4. Conclusion

Let us summarize the results obtained from both questionnaire surveys. It can be said that from 2008 to 2013 there was deterioration in student evaluation (grades) in Mathematics, Computer Science and Economics. This trend was not significant only in the case of Statistics. Regarding the relationships between the subjects due to the resulting exam evaluation, we have not reached any surprising conclusions. Grades in Statistics are related to grades in Mathematics and Computer Science. The link between grades in Statistics and Economics has not been proved. When comparing "average" grades we can say that students achieve better results in Economics and Computer Science than in Statistics. On the other hand, we can identify no difference between

Mathematics and Statistics. These conclusions are valid for both survey years. According to our findings, students consider Statistics more or less difficult. Its popularity is comparable with Mathematics. The main reasons may be the difficulty in finding connections between different parts of statistics and a new language and a new way of thinking. Comparing the student computer skills in 2008 and 2013, we conclude that computer literacy has increased. This finding can be considered quite satisfactory because the use of computers in the study plays an increasingly important role. We can see a positive rise in popularity of the STAT1 spreadsheet. The advantage of this tool is that it contains only methods studied within the course. Professional software enables users to perform a number of statistical analyses. However, we can use only a fraction of the available options for teaching purposes. This complexity may be a disadvantage because the elementary analysis in this environment is sometimes complicated for beginners. Another advantage is, of course, that it is free and freely accessible. In the coming years we will continue with the teaching statistics using the STAT1 spreadsheet, which will be continually supplemented by other tools.

References

[1] ANDĚL, J. *Základy matematické statistiky*. Praha: Matfyzpress. 2005. 358 s. ISBN 80-86732-40-1.

[2] ČECHOVÁ, I., BERÁNKOVÁ, J., ZERZÁNOVÁ, D., NEDOMA, R., a H. HRDLIČKA. Military Professionals and their Language training: research projects' finding. *Economics and Management.* 2012, 2012/1, p.15-24.

[3] NEUBAUER, J. Selected Statistical Methods in R. In: *XXIX International Colloquium on the Management of Educational Process*. Brno: UO. 2011. 239-249. ISBN 978-80-7231-780-6.

[4] NEUBAUER, J., SEDLAČÍK. M. a O. KŘÍŽ. Aplikace STAT1. 2012. http://k101.unob.cz/stat1/

[5] NEUBAUER. J., SEDLAČÍK. M. a O. KŘÍŽ. *Základy statistiky: aplikace v technických a ekonomických oborech*. Praha: Grada. 2012. 236 s. ISBN 978-80-247-4273-1.

[6] OLOFSSON, P. *Probability. Statistics. and Stochastic Processes*. Hoboken: John Wiley & Sons. 2005. ISBN 978-0-471-67969.

[7] R Development Core Team, *R: A language and environment for statistical computing*, R Foundation for Statistical Computing, Vienna, Austria, 2009, http://www.R-project.org.

[8] ŘEZANKOVÁ, H. *Analýza dat z dotazníkových šetření*. Praha: Professional Publishing, 2011. 223 s. ISBN 978-80-7431-062-1.

[9] SEDLAČÍK, M., ČECHOVÁ, I. a L. DOUDOVÁ. "Be Born as Successful Mathematics or Language Learner: Myths, True or False", *Journal on Efficiency and Responsibility in Education and Science*. 2013, 6(3), p. 14-25. ISSN 1803-1617. [on-line] www.eriesjournal.com/_papers/article_219.pdf [2013-09-30].