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INNOVATIVE APPROACH TO EDUCATION AND TEACHING OF STATISTICS

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Abstract

Educational and tutorial programs are being developed together, with the changing world of information technology it is a necessary course to adapt to and accept new possibilities and needs. Use of online learning tools can amplify our teaching resources and create new types of learning opportunities that did not exist in the pre-Internet age. The world is full of information, which needs to be constantly updated. Virtualisation of studying materials enables us to update and manage them quickly and easily. As an advantage, we see an asynchronous approach towards learning materials that can be tailored for the students´ needs and adjusted according to their time and availability.

The specificness of statistical learning lies in various statistical programs. The high technical demands of these programs require tutorials (instructional presentations), which can help students to learn how to use them efficiently. Instructional presentation may be understood as a demonstration of how the statistical software program works. This is one of the options that students may use to simplify the utilization of control and navigation through the statistical system. Thanks to instructional presentations, students will be able to transfer their theoretical statistical knowledge into practical situation and real life and, therefore, improve their personal development process. The goal of this tutorial is to show an innovative approach for learning of statistics in the Czech University of Life Sciences. The use of presentations and their benefits for students was evaluated according to results obtained from a questionnaire survey completed by students of the 4th grade of the Faculty of Economics and Management. The aim of this pilot survey was to evaluate the benefits of these instructional presentations, and the students interest in using them. The information obtained was used as essential data for the evaluation of the efficiency of this new approach. Firstly the knowledge about whether the creation of these tutorials is useful and whether it contributes to better and faster management of work done within the system. The efficiency and benefits of this proposed solution were evaluated through correspondence analysis. Outputs from this multi-dimensional method suggest that interactive manuals are indeed an efficient learning tool. Mostly students with less technical knowledge welcome the benefits of these tutorials.

Introduction

Traditional methods of learning and education are often enhanced with new forms and learning methods, which use electronic technologies. In this regard, internet technology is often used to enhance student's engagement in learning and their academic achievement. (Carle et al, 2009). In addition, student's learning motivation is also a crucial enabler of the success of learning. (Govender, 2009) Sufficient attention must be paid not only to the course design and the learning context, but also to what are in the mind of individual students that motivate their learning process (Law et al, 2010).

Sowey (2001) states that: "The current emergence of interactive demonstrations over the World Wide Web offers particularly attractive presentation possibilities". Interactive materials available on the Internet enrich the traditional learning channels and methods, which usually represent technical literature.

E-learning is not only an complement to the traditional educational process any more. Thanks to the rapid development of technologies, e-learning is becoming an equal alternative. Use a virtual interface during the education process is considered as a challenge. (De Mora et al, 2009)

The efficiency and usefulness of using interactive materials during the education process was verified and published by Aberson et al (2002). In his article he confirms that educational tutorials offer a useful educational tool, which helps students to understand the studied subject better. Law et al (2010) confirmed the efficiency and usefulness of electronic education in his paper.

Under the IGA grant, "The creation of multimedia tutorials for support learning process using statistical program SAS", an e-learning course focusing on the support of work done within the SAS interface was created. The course was designed for all students, who during their studies, or during the preparation of their bachelor's or dissertation thesis, use the statistical software SAS.

The goal of the created electronic support is to extend and enrich the traditional learning methods of statistical subjects, with interactive demonstrations of work done in the user interface of the statistical software SAS. The benefit of the virtual learning materials is the option to approach students asynchronously. Which means that learning materials may be tailored according to the student's needs and according to their time. (Bosom et al, 2007) The created presentations focus on the description of processing of statistical methods. The set of the selected methods is possible to extend. This learning support has been created by using interactive and visually oriented learning tools, focusing on an independent work of each student, as well as on the creation of data relation overview and the complex graphical representation.

Material and Methods

TThe SAS system is one of the most complex statistical systems. It includes a large number of implemented methods and processes focusing not only on the statistical analysis but also on operational analysis, financial management and customer relationship management. The basic module is called the SAS/STAT and offers a wide number of procedures. The SAS/STAT software provides comprehensive statistical tools for a wide range of statistical analyses, including analysis of variance, categorical data analysis, regression and so on.

The mentioned procedures are logically created; each command precisely describes what this or that particular procedure will do and what will be displayed as a result. An important benefit is the availability of wide scope of additional and explanatory commands, which enable the user to perform detailed description, detailed diagnosis of the problem, or other alternative solutions that may be used through the application of other suitable method, etc. However the initial navigation through the large amount of commands may be a difficult task for some students. Therefore, the tutorials offer a useful supporting tool for working in the statistical program SAS.

SAS/INSIGHT software is a tool for data exploration and analysis. With this tool it is possible to explore data through graphs and analyses linked across multiple windows. It is an interactive interface displaying statistical functions numerically and graphically. The INSIGHT module offers an analyze of univariate or multivariate distributions, and fit explanatory models using analysis of variance or regression. This module may be also used for analysis of outputs from other modules.

Time series analysis has been done by using the Time Series Forecasting (TSF) system, which is a part of the SAS/ETS module. The TSF system forecasts future values of time series variables by extrapolating trends and patterns in the past values of the series or by extrapolating the effect of other variables on the series. The system provides convenient point-and-click windows to control the time series analysis and forecasting tools of SAS/ETS software. It is possible to use the system in a fully automatic mode, or to use the system's diagnostic features and time series modeling tools interactively to develop forecasting models customized to best predict your time series. The system provides both graphical and statistical features to help to choose the best forecasting method for each series.This module offers to use a wide variety of forecasting methods, including several kinds of exponential smoothing models, Winters method, and ARIMA (Box-Jenkins) models. It is also possible to produce forecasts by combining the forecasts from several models. (SAS, 2009)

Processing method

Adobe Captivate software was selected for the creation of interactive tutorials, which describe step-by-step how to work and use the statistical software and how to make statistical models. These tutorials enable learners to easily navigate through the statistical software. Therefore, the students have a chance to verify and improve their knowledge gained in the class.

Adobe Captivate is an eLearning content authoring tool that enables virtually anyone to create powerful and engaging simulations, software demonstrations, scenario-based training, and quizzes. It is easy to add any text captions, highlight boxes, audio, mouse paths, and even the captured images. Multimedia or special effects or elements may be also added into the recorded application. Importing of all standard graphical

formats, animations and digital video formats is supported as well as the visual effects such as animated transitions between slides or rollovers. The interface of the program is simple and intuitive.

Contents generated by Adobe Captivate 3 complies with the SCORM 2004 and SCORM 1.2 standards, as well as with AICC rules, including the new PENS specifications (Package Exchange Notification System), which enables easy integration with any learning management system (LMS). (Ceylan et al, 2009)

Screen recording offers three options. The first it is possible to record everything on the screen, or only a window of selected program or lastly, specify the size of the recording window. The automatic recording offers two modes: demonstration and simulation. Instructional presentation means that the program records everything what happens on the screen but only in demonstration mode. Interactive simulation means that the program records the screen in simulation mode. The autor can insert active elements into the final application. These elements react to various actions of the student. There can be add areas, which need to be clicked on, or where texts or numbers need to be inserted. In this way, the student can learn how to use the statistics program - no installing is required. (Digital Media, 2009).

Adobe Captivate enables us to publish the final application on the Internet or as self-executing files. Using Flash format ensures high quality of the output and enables the user to view the application in standard web browser. Before uploading the application on a web page or into the e-learning course it is possible to modify the final size of the display, the appearance of the playback control panel or also protect the entire application with password (Adobe, 2009).

During the work with statistical programs, students may use manuals or any kind of helps. These manuals usually are not illustrative or visual. Therefore, the option to use screen recordings is a welcomed addition to available help features. Using video recordings during e learning courses is very efficient.

Other forms of useful help features are Internet forums (asynchronous online communication). Therefore, within the realized e-learning course, we have established a forum where students and teachers may discuss their experiences or issues relevant to their statistical work or how to use the statistical program. Answers and results from these discussions may be used by other students as a valuable source of information. Advantages of discussion forums and benefits of interaction between other students or teachers, describes Trausan-Matu et al (2009).

Integration of instructional presentations into the learning management system

The final presentations are integrated into the University learning management system (LMS), called the MOODLE. Moodle has reporting, event, course and user management tools that are easily used by learners and teachers (Moodle, 2008). Online learning platforms commonly support a combination of functionalities, including assessment tools; management and administration of course tools; communication and teaching or tutoring materials (Roth et al, 2008). LMS makes it easy to observe how many times the learning object was used, which materials was used, how long was the learners online and reports about evaluations (Ceylan et al, 2009). All information, statistics and used texts, are also available for teachers who based on

these materials may evaluate the efficiency of the relevant study supporting program.

The tutorials created in Adobe Captivate are mostly valuable by combined students (combined form of studies), where it is not possible to explain all options of the statistical software. An important fact for the use of instructional presentations by the students is a good knowledge of the problem. Without the theoretical knowledge of statistics, it is possible that students will evaluate the analyses incorrectly or make incorrect conclusions.

Figure 1: An example of completed e-learning course

The created presentations are divided into five parts, according to the contents of the studied subjects. The first lesson focuses on demonstrations how to use the SAS programs system. It is an introduction to the SAS program. Next chapters are focused on an explanation analysis (descriptive characteristics, graphical analysis, tests of normality), testing procedures (one or two sample tests and analysis of variance), regression and correlation analysis (simple and multiple regression models, regression diagnostics) and time series analysis (decomposition of time series, trend functions, exponential smoothing models).

The solution of each part has been realized through three selected modules of the SAS system: SAS STAT and SAS/INSIGHT. The time series analysis has been solved by using the TIME SERIES FORECASTING.

Multimedia processing

The SAS user interface, which consists of various modules including the program editor, is not really user friendly. However, Adobe Captivate offers simple way how to create multimedia applications used for demonstrations of how to work in the statistical software. Instructional presentations make easier the basic navigation through each module of the statistical packet. (Jindrová et al, 2009)

The figures below show the demonstrations of how to use the SAS system. The figure 2 shows the programming editor, where the procedures may be entered. The procedure is initiated by clicking the picture icon depicting a running figure (representing the run command), located in the upper part of the menu. One of the tools that may be used in Adobe Captivate is the Zoom Area tool. This tool is used to attract the student's attention to the important part of the slide.
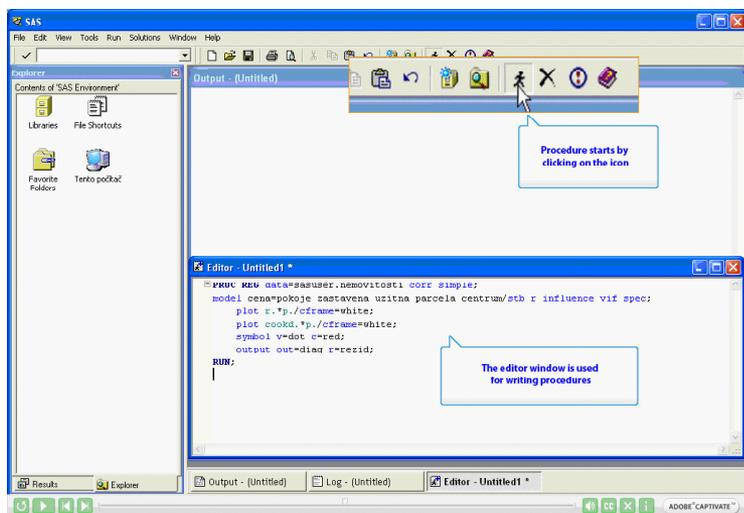
Figure 2: Presentation created in the Adobe Captivate, displaying the REG procedure in the SAS system
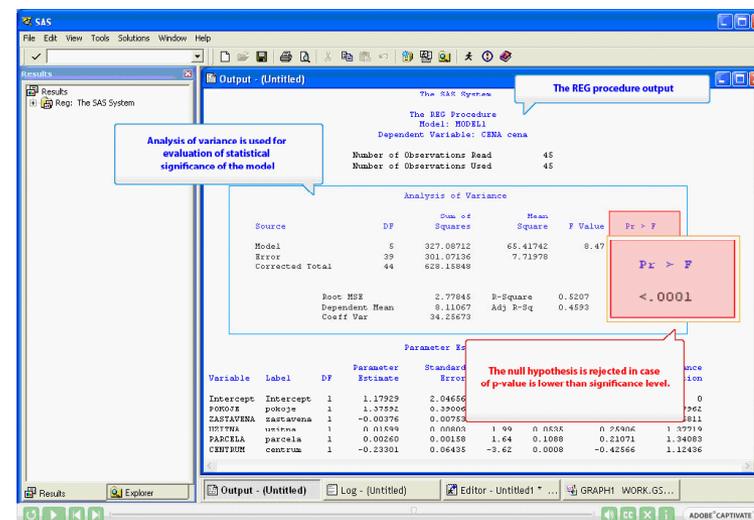

Figure 3: Presentation created in Adobe Captivate, displaying output of REG procedure done in the SAS system.

The presentation has several control elements (created automatically), which are inserted into the flash animations and which are used to play or stop the presentation.

Figure 3 displays output of the regression procedure. An advantage of the Adobe Captivate is the option to insert any text captions into presentations. The described area may also be enhanced with the Highlight box tool. Several described areas may be displayed in one window, at different moments with different styles. Each slide may be attached with audio, describing the situation on the screen. Adobe Captivate, enables the user to easily synchronize the audio with the slideshow.

Results and Discussion

The efficiency of the presented tutorials was evaluated by a pilot questionnaire survey completed by students of information technology. The aim of the survey was to find out if the creation of the tutorials, is useful for students and if they use it. 39 students of the Informatics participated in this survey. Most of these students were full-time students. The distribution and collection of questionnaires was done electronically. The questionnaires were available in the Moodle system. The questionnaire consisted of two sets of questions. The first set focused on evaluation of these instructional presentations from the students´ point of view. The second set consisted of detailed questions about taking the advantage of the tutorials. This set of questions was designed in such a way that the student could answer each question (statement) by using scale 1 - 5, where 1 stands for "definitely disagree with the statement" and 5 means "definitely agree with the statement".

Working with the statistical software assumes at least basic knowledge of information technologies, therefore the first question related to IT experiences. Only 13.1% of students consider themselves as pre-intermediate users, 77.7% of students consider themselves as intermediate or advanced users and 9.2% consider themselves as expert users (mostly programmers or administrators).

Nearly 92% of students answered positively to the question that they use the tutorials. The remaining 8% of students answered that they are planning to use instructional presentations in the future. Only one student stated that he does not use instructional presentations, neither he plans to use them in the future.
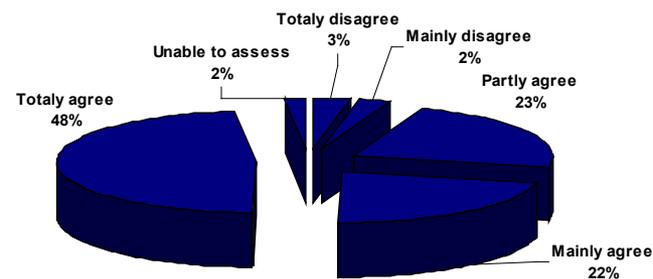

Figure 4: Answers to "IP enabled me to overcome difficulties with the interface of statistical system"

Almost 93% of all students consider using instructional presentation in their class useful and 70% of them confirmed that presentations help them to overcome difficulties with the basic navigation and use of the statistical system.

Most of the students (75.5%) said that statistical presentation represent a valuable form of help and that they prefer these presentations before manuals available in English language (86.6%).

From the teacher point of view, the goal of these presentations is to minimize individual consultations. However, not all students share the same view. Approximately 13% of students do not agree with this opinion, 33% of students partially agree and only half of students agree.

The questionnaire also included two questions asking about home preparation. The goal of these questions was to find out if tutorials enabled students to make their home preparation more efficient and attractive. As you can see on figure 5, more than half

of all participating students (54.7%) positively evaluate the IP as an attractive home preparation. Opinions describing whether home preparation became more attractive are not stable. Of course, this can be explained by aversion of students to study at home. This fact is also confirmed by answers "Can you describe your opinions you have about your studies?", where 62.3% of students answered that they prepare at home only if they have a task or a work that needs to be prepared at home. Almost 20% of students study at home every day and prepare for subjects that they are interested in. 15% of students study at home as little as possible and only if necessary and only 3.8% of students answered that they study and prepare for each class everyday.
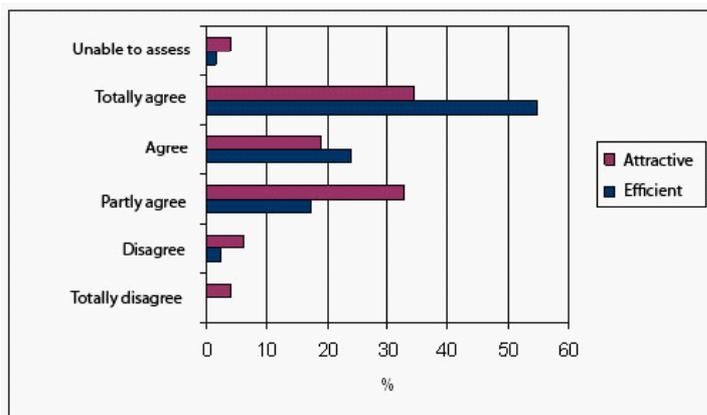

Figure 5: Answers to "IP enabled me to make my home preparation more efficient" and "IP enabled me to make my home preparation more attractive".

Correspondence analysis used for detailed evaluation of the questionnaire survey

For the analysis of the questionnaire survey, we have used a graphical multidimensional method - correspondence analysis. The correspondence analysis is an exploratory data analytic technique designed to analyze simple two-way and multi-way tables containing some measure of correspondence between the rows and columns. Exploratory data analysis is used to identify systematic relations between variables when there are no a priori expectations as to the nature of those relations. Correspondence analysis is also a multivariate descriptive data analytic technique. The multivariate nature of correspondence analysis can reveal relationships that would not be detected in a series of pair wise comparisons of variable. Another important feature is the graphical display of row and column points in biplots, which can help in detecting structural relationships among the variable categories and objects (i.e., cases). Finally, correspondence analysis has highly flexible data requirements. The only strict data requirement is a rectangular data matrix with non-negative entries. (Hebák, 2007)

Initially the relationship between students and their studies was monitored and the statement that interactive presentations enabled them to overcome difficulties with the navigation through the statistical system. The correspondence table (table 1) shows the absolute frequency of these inputs.

IP enabled me to overcome difficulties with an interface of statistical system	How conscientiously do you make a school preparation? I prepare...			
	only to interesting subjects	only to projects	as less as possible	Active Margin
Partly agree	9	18	6	33
Mainly agree	7	17	2	26
Definitely agree	14	40	7	61
Active Margin	30	75	15	120

Table 1: Correspondence table of cell frequencies

The maximum number of dimensions for a correspondence analysis solution equals the number of active rows minus 1 or the number of active columns minus 1, whichever is less. The number of categories for both variables is equal to three, so the maximum number of dimensions used in the procedure is two.

The first dimension displays as much of the inertia (a measure of the variation in the data) as possible, the second is orthogonal to the first and displays as much of the remaining inertia as possible From the summary table, it is clear that the first dimension displays 89% of the total variance (inertia) whereas the second dimension displays only 11% of the remaining information. The total inertia is defined as the weighted sum of all squared distances to the origin divided by the total over all cells, where the weights are the masses.

Mass, shown in Table 2, is a measure that indicates the influence of an object based on its marginal frequency. Mass affects the centroid, which is the weighted mean row or column profile. The row centroid is the mean row profile. Points with a large mass pull the centroid strongly to their location. A point with a small mass pulls the row centroid only slightly to its location. Highest mass can be found in the third category, which represents the statement "definitely agree". Category "Preparing only to interesting subjects" represents the highest mass of column variables. The next two columns (Score in Dimension) show the score recorded in the first two dimensions.

The indicator of inertia represents the share of the total information on the profile. The total inertia is defined as the weighted sum of all squared distances to the origin divided by the total over all cells, where the weights are the masses. Rows with a small mass influence the inertia only when they are far from the centroid. Rows with a large mass influence the total inertia, even when they are located close to the centroid.

The diagnostics that measure the contributions of points are an important aid in the interpretation of a correspondence analysis solution. Dominant points in the solution can easily be detected. The contribution of a point to the inertia of the dimensions depends on both the mass and the distance from the origin. (Hebák, 2007)

IP enabled me to overcome difficulties with an interface of statistical system		Score in Dimension			Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
	Mass	1	2	Inertia	1	2	1	2	Total
Partly agree	,275	-,553	,084	,010	,681	,044	,992	,008	1,000
Mainly agree	,217	,366	,331	,005	,235	,548	,777	,223	1,000
Definitely agree	,508	,143	-,186	,002	,084	,407	,626	,374	1,000
Active Total	1,000			,017	1,000	1,000			

a. Symmetrical normalization

Table 2: The row scores

From Table 2 it is evident that the first principal component in the row profile divides students into those who agreed with statement that IP helped them to overcome difficulties with the statistical system, and those who took neutral position (partly agreed). The second principal component splits the first part of students according to how much they agree with the statement.

The first principal component in the column profile (see table 3) divides group to students who are preparing for their studies and students, who prefer the 'easy way', that means as

less preparation as possible. The second principal component divide students according to how much they are interested in their studies.

How conscientiously do you make a school preparation? I prepare...		Score in Dimension			Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
	Mass	1	2	Inertia	1	2	1	2	Total
only to interesting subjects	,250	-,111	,355	,002	,025	,725	,217	,783	1,000
only to projects	,625	,215	-,099	,004	,235	,140	,931	,069	1,000
as less as possible	,125	-,855	-,216	,012	,740	,135	,978	,022	1,000
Active Total	1,000			,017	1,000	1,000			

a. Symmetrical normalization

Table 3: The column scores

The symmetrical normalization was used to display the correspondence map, it makes easy to examine the relationship. The row and column scores are the coordinates of the row and column points in the biplot. The column scores are related to the row scores via the profiles and singular value (from the inertia per dimension table).

The correspondence analysis offers various diagrams showing the relationship between the categories and variables. The scatterplot demonstrates row and column scores in two dimensions. The symmetric normalization makes the relationship between individual categories of the relevant variables comprehensible.
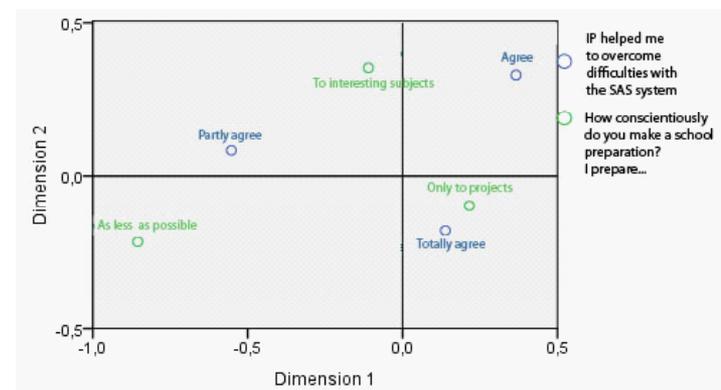

Figure 6: The scatterplot of the row and column scores

Figure 6 shows relations between the selected categories. It is possible to found three separated groups of categories in the diagram. Students who are preparing for interesting classes, agree with the statement ' IP enable me to overcome difficulties with the navigation in the statistical system'. Students who are preparing only on projects, totally agree with the statement because the IP helped them to create their projects. But students who are preparing for their classes as little as possible, agreed with the statement only partially, because they rather use common way of help.

Further, we have scrutinized whether there is a relation between IT experiences of students and their opinions that tutorials make home preparation more efficient. Relative frequencies of each category are shown in the table 4.

IP make my home preparation efficient	IT experiences				Active Margin
	Pre-intermediate user	Intermediate user	Advanced user	Expert	
Partly agree	1	13	5	4	23
Mainly agree	4	16	8	2	30
Definitely agree	11	33	15	6	65
Active Margin	16	62	28	12	118

Table 4: Correspondence table of absolute frequencies

As in the first analysis, even here we used only two dimensions. From the correspondence analysis summary table it is clear that the first dimension explains 88% of the total information and the second dimension explains the 12% of the remaining information.

The first principal component in the row profile divides students into those who agreed that IP helped them make their home preparation more efficient, and into those who took neutral position (partly agreed). The second principal component divides students according to how much they agreed with the statement that the use of interactive presentations made their home preparation process more efficient.

IP make my home preparation efficient		Score in Dimension			Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
	Mass	1	2	Inertia	1	2	1	2	Total
Partly agree	0.195	0.836	0.021	0.023	0.804	0.001	1.000	0.000	1.000
Agree	0.254	-0.174	-0.415	0.004	0.045	0.700	0.323	0.677	1.000
Totally agree	0.551	-0.216	0.184	0.006	0.151	0.298	0.789	0.211	1.000
Active Total	1.000			0.033	1.000	1.000			

Table 5: The row scores

The first principal component in the column profile divides students according to their experiences with information technologies, into users and experts (administrators, etc.) The second principal component divides students into slightly experienced, experienced and advanced users.

IT experiences		Score in Dimension			Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
	Mass	1	2	Inertia	1	2	1	2	Total
Pre-intermediate user	0.136	-0.822	0.385	0.017	0.541	0.322	0.925	0.075	1.000
Intermediate user	0.525	0.093	-0.075	0.001	0.027	0.047	0.805	0.195	1.000
Advanced user	0.237	-0.094	-0.259	0.001	0.012	0.256	0.262	0.738	1.000
Expert	0.102	0.837	0.480	0.014	0.420	0.375	0.892	0.108	1.000
Active Total	1.000			0.033	1.000	1.000			

Table 6: The column scores

Figure 7 shows relations between the selected categories. On this diagram there can not be found clearly separated groups of categories as we could see in the previous diagram. However, generally, it is possible to say that the less experienced user totally agrees that using interactive presentation made his home preparation more attractive. Mostly more experienced users will agree with this statement, however expert users agree with this statement partially. The results support the intention of the authors, as they focused mostly on less experienced users, who usually have more troubles with the navigation. Advanced users and programmers, probably do not have any problem with the navigation through new programs, or if necessary, they can found necessary information in sources available on the Internet or in help features.
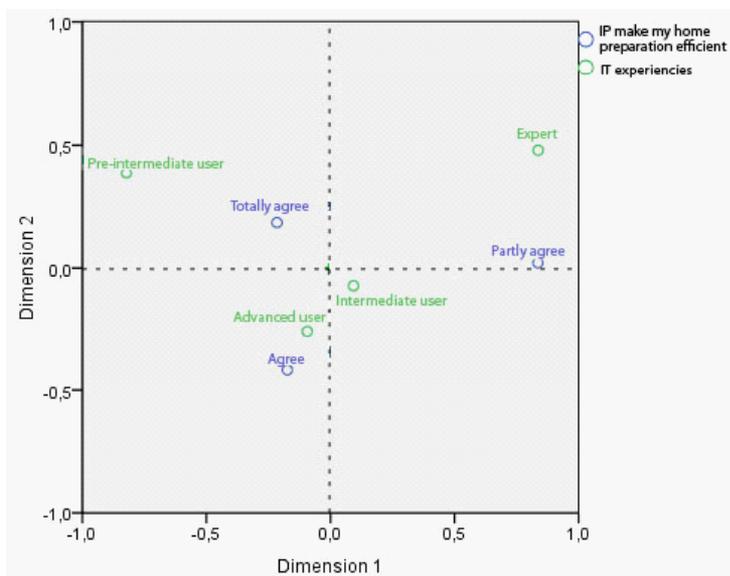
Figure 7: The scatterplot of the row and column scores

Conclusion

In order to make the teaching of statistics in statistical program systems more efficient, visual tutorials demonstrating how to work in SAS system, were created. Tutorials enable to describe the work process and familiarize the procedures to users. The intention of authors was to help students to work in the statistical system SAS easier.

The goal of the pilot questionnaire survey was to determine whether these tutorials are considered by students as a supportive study material. Whether the use of these presentations positively affects their home preparation, and whether this preparation became more efficient and attractive. And of course whether the students, using these demonstrations, are able to understand the process of statistical analysis in the SAS system.

From the questionnaire survey it is clear that user who knows statistical methods, may understand the process of statistical analysis in the program software SAS by using these tutorials. The survey confirms that instructional presentation is a helpful tool for teaching students, who have different experiences with the SAS system. Each user may watch these presentations in his free time in case he needs.

Based on the results obtained from the survey we can say that multimedia presentations can make the teaching process of statistical classes more efficient. Therefore, students are able to understand how to work and use statistical software faster and easier. Using these presentations at home during the preparation process makes the preparation more efficient. These tutorials are contributive for teachers, who can spend more time in the class by explaining the statistical methods instead of concentration on the software.

From the analysis it is clear that students who are preparing at home with higher intensity, more appreciate the existence of demonstrative tutorials. These tutorials help them to overcome problems with navigation through the statistical system SAS. Further, it was found out that less experienced users of information technologies, mean that tutorials made their home preparation more attractive. The results support the aim of the authors, as they focused mostly on less experienced IT users, who usually have more troubles with navigation in program systems.

The described multimedia presentations are available at: https://projekty.czu.cz, in the course called Electronic support for work in the SAS program. These demonstrations

are not used only by students of the statistics classes, but also by students, who use the statistical software SAS within the writing of their bachelor's or diploma thesis.

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