Evaluation of eLearning –
A study of Undergraduate Agricultural Economics course

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Abstract: *In this study we evaluate the combination of traditional classroom education with additional content and support provided by an online Learn Content Management System (LCMS). Main focuses are individual learning characteristics and eLearning aspects. Findings are that not all dimensions of eLearning success meet the expected outcomes. Using achieved scores in examinations to measure successful application of eLearning is suitable only to a limited extent. eLearning objectives have to be defined with respect to eLearning's target group.*
Key words: *evaluation methodologies; eLearning process management; teaching / learning strategies*

1 Introduction

Over the last years the usage of electronic learning (eLearning) in university programs has increased rapidly. The term eLearning includes different types of learning, all supported by electronic media. Yaghoubi (2009) find a positive students' perception of eLearning. From student's point of view eLearning can be used to improve education quality. But, Yaghoubi also indicates that universities should focus on students' attitudes regarding eLearning. This goes along with different publications pointing out that learning environment needs to be target-group specific (e.g. Oszkan & Koseler, 2009, Kuechler& Schmidt, 2007). Milliken and Barnes (2002) tried to answer the question of the extent to which new technology aids improving educational quality. They found the need to develop the learning environment of students to ensure that they all had a positive experience.

In this study we analyze the combination of traditional classroom education with additional content and support provided by an online Learn Content Management System (LCMS), so called Blended Learning. Due to the positive link between planning and controlling of the eLearning process and its learning outcomes, an eLearning process management is conducted for implementation and application of the Blended Learning. The eLearning process management consists of four stages: planning, organizing/implementing, controlling and improving the eLearning (Ćukušić, Alfirević, Granić & Garača, 2010). After planning, organizing and implementing the LCMS an evaluation is conducted to measure user satisfaction and outcomes of specific eLearning aspects. In addition, the evaluation should provide detailed target-group characteristics. To improve the eLearning in the fourth stage of process management, collected data analysis is used to customize and enhance the LCMS towards students' needs and usage. Particular emphasis is placed on exploring the different outcomes of specific eLearning aspects related to student's characteristics by means of principal components analysis. The exploration should give insight of how to deal with the, in the above listed publications, claimed consideration of target-group specifics in eLearning evaluation and improvement.

The study is organized as follows. First, the dataset is depicted including data collection and the instruments to measure outcomes of eLearning aspects. Next, the data analysis and used methods are described. Further, the empirical results are reported. Finally, conclusions of this study are summarized.

2 Data & Methods

This section presents course and data description. Data description comprises explanation of the theoretical construct of eLearning success. In the end of the section applied analysis methods are shortly introduced.

2.1 Course description

This course aims to provide students with the opportunity to carry out statistical and econometrical research. All students studying agricultural sciences with a major in agricultural economics and agribusiness are required to undertake this course. By the end of the course students should have

- developed the ability to apply statistical and econometrical methods used in the agricultural market and food industry analysis;
- developed an understanding of using the theoretical foundations;
- developed substantive knowledge in application of statistical software;
- developed the capability to undertake independent research and writing.

Lecture is supported by multimedia applications. Via a tablet PC handwritten notes (Windows Journal), slides (PowerPoint), statistical examples (Open Source Statistic-Software GRETL) and simulations (Excel) are employed. A practical course taking place in the computer lab accompanies the lecture. Students have to submit their own data analyses project in addition to a written examination at the end of the course. Project's mark will be worth 25% of the overall mark.

Additional contents provided by the online LCSM are:

- **Record** of the in classroom used beamer presentation and corresponding voice of the lecturer
- **Forum** to discuss and ask questions regarding the course
- **Material** (Lecture slides, formulary, statistical tables, list of questions as guideline for autonomous learning)
- **Instructions** and **examples** how to realize the data analysis-project independently
- Small **data sets and assignments** (including solutions) for own use of the statistical software GRETL
- Multiple choice **self-tests** covering a wide range of course matters
- **Examples of use** to motivate the subject beyond economics: Quantitative research publications from crop science, animal nutrition, animal physiology, and food science
- **Link list**, bibliographical **references**

2.2 Data description

Student feedback is closest to student experience. Therefore, it is used in the controlling stage of the eLearning process management. To cope with the often emerging low response rate (Jara&Mellar, 2010), the sample was gathered in a practical course session in the computer lab at the end of the semester. The used survey-questionnaire consists of 34 different questions and a multiple-choice test (MCT) concerning course content. It has to be filled out by hand. Survey and multiple-choice test are in students' native language German. 71 students do have access to online content provided by the LCMS. 34 students completed the questionnaire and MCT. In the sample are 20 males and 14 females. The average age is 23. Just over half (53%) of all respondents would like to earn a Master's degree. In contrast,

extrinsic motivation overmatch intrinsic motivation to deal with course matter (Wilcoxon signed-rank test [Alternative: Median *Extrinsic* > Median *Intrinsic*]: V = 483***). We expected a more intrinsic motivation to be well prepared for master's program.

	Mean	Median	Std. Dev.
Progress	1.844	2	0.7761
Encouragement	1.727	2	0.6261
Work	0.8182	1	0.8277
Success	1.031	1	0.5561
Display formats	1.194	1	0.7611
Thesis	-0.2121	0	1.0635
Points	9.647	10	2.0342
Frequency	2.441	3	0.8424
Network	0.5	1	0.7184
Duration of learning	0.9118	1	1.1288
Satisfaction LCMS	1.030	1	0.5040
Satisfaction Lecture	-0.09091	0	1.0080
Satisfaction practical course	0.9091	1	0.7399
Intrinsic	-0.5882	-1	0.8793
Extrinsic	1.059	1	0.9070

Table 1: Objectives of eLearning implementation - Descriptive statistics

High score in an exam not necessarily accompanies satisfaction with the (e)learning environment. Therefore, success of eLearning is a construct of the attainment of didactic functions as well as impartial and subjective learning outcomes, and eLearning aspects, especially how eLearning supports the learning. (Preussler and Baumgartner, 2006) To specify this construct, we are using particular didactic objectives of eLearning implementation, which are theoretically pointed out at the beginning of the eLearning process management. They ought to be the additional benefits from eLearning beside the advantages of overcoming restrictions related to physical location and time of usage. These didactic objectives are: To encourage learning activities, to represent knowledge (organizing and structuring knowledge, depict knowledge by different display formats), and to control and regulate the learning process (Kerres, 1999). Further, we consider that the implementation of eLearning gives impulses to work independently with quantitative methods and helps to achieve high scores in exams. To analyze eLearning success in terms of these different aspects, items listed in table 6 (Appendix) are asked in the survey-questionnaire. The scales are five-point Likert-scales (except points gained in the additional multiple-choice test). The scales are assumed to be equidistant, so interval scale is presumable. Table 1 contains corresponding descriptive statistics.

Impulses to work independently with quantitative methods are measured by *Thesis*. An objective learning success is quantified by the achieved score in the MCT (*Points*). Encouragement learning activities is measured by *Encouragement* and *Work; Display formats* quantifies the support of representation of knowledge through different display formats; *Network* is a parameter to check the structure of the different course offers and how interlocked they are; *Progress* is a variable to detect students' problems in controlling their learning process. Box plots of the mentioned variables are represented in figure 1. On the vertical axes, the corresponding values of the Likert-Scales are written. Figure 1 provides an easy to interpret graphical representation of eLearning success basing on our construct: eLearning success means to have all box plots situated on the right hand side of the scale. We

cannot observe such situation. We have to perceive, the implementation of eLearning is not as successful as expected. Further analyzes is conducted. In the next section employed methods are described.

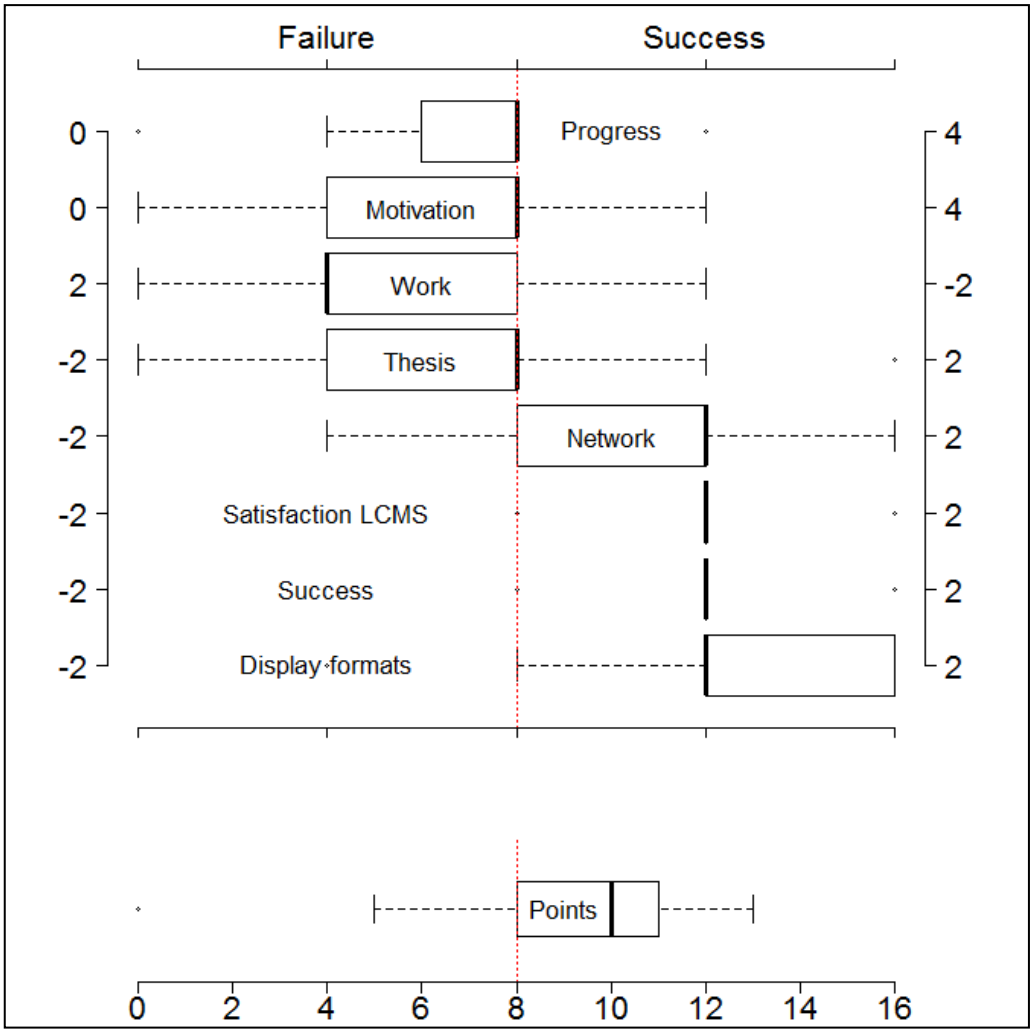


Figure 1: Dimensions of eLearning success

2.3 Methods

To analyze the collected data different methods are adopted. At first a frequency analysis is made graphically: It displays relative usage frequency of an online-content versus the appraisal in terms of how helpful the content is. Further, the parameters of a linear regression model are estimated using linear least squares techniques. Finally, to understand response behavior related to student's characteristics principal components analysis (PCA) is applied. To extract variables for PCA the Anti-Image matrix is consulted. Diagonal elements on anti-image matrix for each variable are a measure of sampling adequacy (MSA). If MSA-value is bigger than 0.5, these variables should stay in the PCA. Before using PCA, Kaiser-Meyer-Olkin Test (KMO) and Bartlett's test of sphericity are executed to test if the chosen variables are suitable for PCA. KMO compares observed correlation coefficients to the partial correlation coefficients. KMO value is in [0 , 1]. If it is bigger than 0.5, PCA is suitable. (Ahmad&Härdle, 2008) Analysis is done in the software environment R.

3 Results

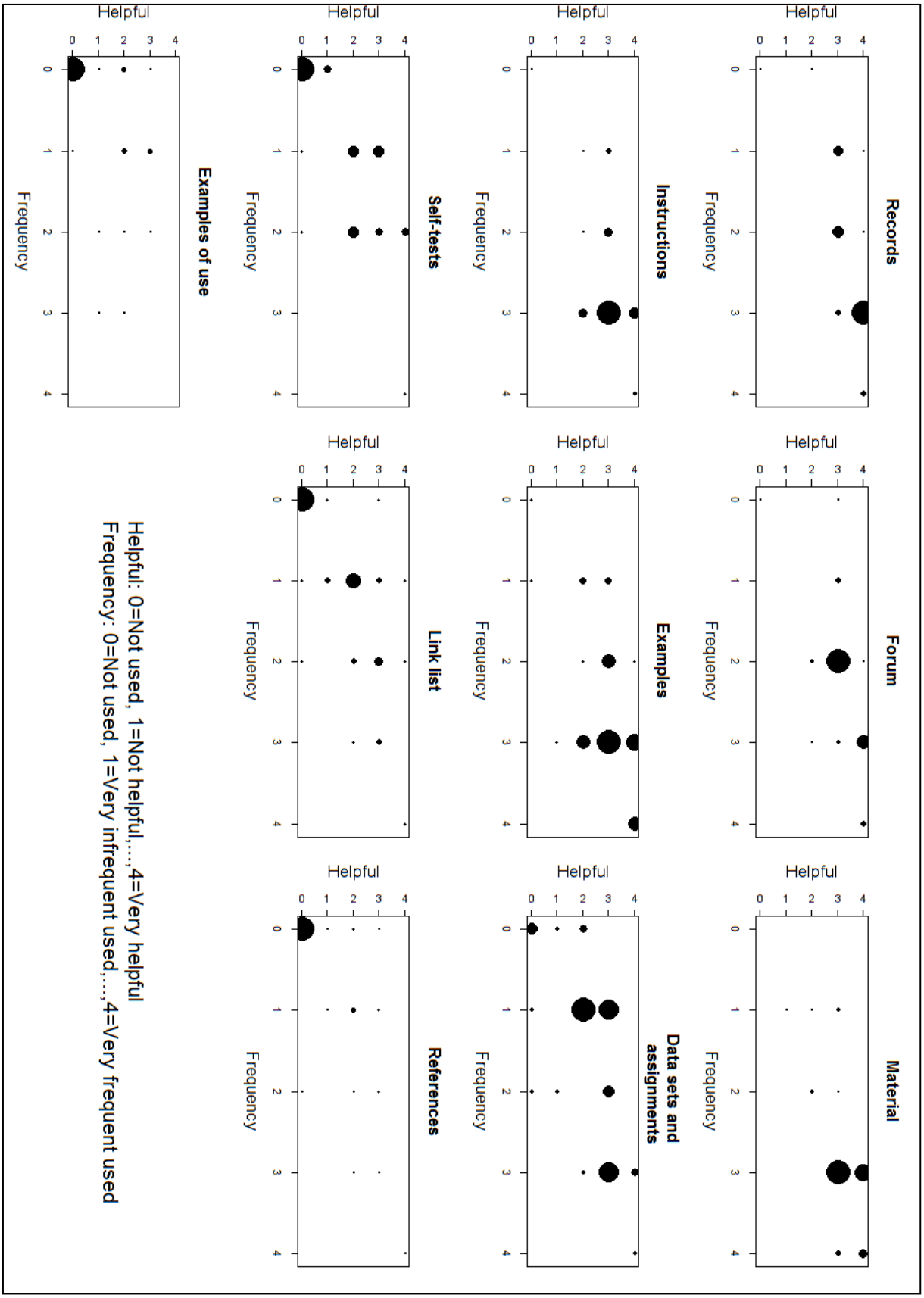
Figure 2 shows the frequency analysis. Self-test, link list, references, and examples of use are relative often not used. Instructions for the project work, examples of such project works, but also small datasets including practical assignments and solutions are more frequent used. Students appraise records, forum, and lecture material to be most helpful, in relation to the other offered content, and use it frequently. We assume that this usage pattern results from the fact to be an obligatory course. Presumably, most students only want to pass the exam. Self-test, link list, bibliographical references, and practical examples of use exceed subject matter, which is asked in the examination or needed in project work.

Points	**Estimator**	**Std. Dev.**	**p-value**
Intercept	5.97	1.24	3.68e-05 ***
Frequency	1.27	0.49	0.014 *
Examination	0.83	0.89	0.35
F-Statistic (2,31) = 4.925 p-Value = 0.01389		R^2: 0.24 adj. R^2: 0.19	

Table 2: Linear Model explaining points gained in Multiple Choice Test. Examination is dummy-variable (=1 if student is registred for the 1st examination date and therefore probably already preparing and learning for examination).

Results for the estimated linear model are summarized in table 2. Our findings highlight significant positive relation between frequency of usage LCMS and gained points in MCT. Beside the poor Goodness-of-fit, the effect of *Frequency* might be overestimated. We have to consider the positive link between frequency using the LCMS and general interest in quantitative methods. *Frequency* is a measure of relative time spent on the LCMS. The group of students who is particular interested in quantitative methods is likely to use the LCMS more often. Also, this group is likely to achieve in general better test results independent of the LCMS. Altogether, we receive first impression of eLearning's impact: Either the objective learning success is positively concerned by usage-frequency, or at least the group of interested students receives an additional support by LCMS content.

To be able to identify relationships between variables in the data-set, e.g. patterns in students' characteristics and reported survey specifications, PCA is used in the last part of data analysis. The values on the diagonal of the anti-image correlation matrix are a measure of sampling adequacy (MSA). Based on these MSA-values, variables are excluded from PCA. The remaining variables are: *Duration of learning*, *points*, *extrinsic*, *satisfaction LCMS*, *work*, *success*, *frequency*, and *thesis*. The KMO value of these variables is 0.64 (Table 3). It is an acceptable value to continue PCA. The accomplishment of PCA is also supported by Bartlett's test of sphericity. The hypothesis that the variables are uncorrelated in the population has to be rejected (Table 3: Significance p-value=0.00).



Figur 2: Relative usage frequency of an online-content versus the appraisal in terms of how helpful the content is.

	Value
KMO Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.64
Bartlett's Test of Sphericity Approx. Chi-Square	110.46
df	28
Significance	0.00

Table 3: Kaiser-MeyerOlkin Measur of Sampling Adequacy and Bartlett's Test of Sphericity

For PCA the correlation matrix is used. Four principal components are extracted. They explain nearly 80% of variation in the total data. To present the components in a more meaningful configuration, orthogonal varimax rotation is applied. Table 4 shows rotated loadings. The loadings express the correlation of the respective variable with the principal component. The variability in the original variables is almost retained, shown by the communalities in table 5.

Variables	Component 1	Component 2	Component 3	Component 4
Duration of learning	-0.76			
Points	0.52			
Extrinsic	0.83			
Satisfaction LCMS		0.54		0.55
Work		0.61		
Success		0.88		
Frequency			-0.94	
Thesis				0.94
Rotation Sum of Squared Loadings	*1.91*	*1.73*	*1.35*	*1.32*
% of variance	*23.9*	*21.6*	*16.9*	*16.5*
Cumulative %	*23.9*	*45.5*	*62.4*	*78.8*

Table 4: Rotated component matrix. Rotation Method: Varimax with Kaiser Normalization. Values lower than 0.50 are not presented.

Considering the loadings of the rotated components, the first principal component is highly correlated with *Duration of learning* and *Extrinsic*, and it is moderately correlated with *Points*. This indicate, that high score in an exam not necessarily accompanies satisfaction with the eLearning environment. Instead, high score in an exam is attended by extrinsic motivation to achieve a good mark in the final exam and effort to learn continuously. Keyword for interpretation component 1 is ***Effort.*** This finding confirms our approach to treat success of eLearning as a construct of different aspects, not only objective test-results. The second component is strongly correlated with *Success* and it is correlated with *Work* and *Satisfaction LCMS*. This result can be associated to ***Encouragement***, with regard to encourage the passive working student through the LCMS. The overall success of a passive working student is positively influenced by the LCMS. The variable ***Frequency*** determines the third component. It indicates that *Frequency* is nearly uncorrelated to other components as well as variables. Component 4 is strongly correlated with *Thesis* and moderately correlated with *Satisfaction LCMS*. Here, satisfaction of the LCMS is attended by conceiving a thesis, which is likely to be written using the learned quantitative methods. This might concatenates with ***Econometrical Interest***.

	Communalities
Duration of learning	0.68
Points	0.89
Extrinsic	0.76
Satisfaction LCMS	0.73
Work	0.73
Success	0.90
Frequency	0.84
Thesis	0.80

Table 5: Communalities: proportion of variable's variance explained by the four components.

4 Conclusion

This study investigates success of eLearning. Success of eLearning is constructed by different aspects. A survey including a multiple-choice test was conducted to quantify this construct. First result is that the implementation of eLearning is not as successful as expected. Not all dimensions of eLearning success meet the expected outcomes. The insufficient aspects of the course must be corrected. According to the analyses of relative usage frequency of an online-content versus the appraisal in terms of how helpful the content is, students appraise organizing knowledge functions to be most helpful, in relation to the other offered content, and use it more frequent. Content, which exceed subject matter asked in the examination or needed in project work, is not used by students. Our assumption is that this usage pattern results from the fact being an obligatory course.

As an empirical finding, there is a significant positive relationship between LCMS usage frequency and achieved points in the multiple-choice test. The fitted linear model has limitation due to lack of exact knowing latent influence on the variable *frequency*. Usage frequency might be influenced by general interest in quantitative methods. Students with this interest tend to gain higher score in tests than students without this interest. Therefore, to explore variables correlation, PCA is employed. It shows that points achieved in the MCT come along with effort and extrinsic motivation. Hence, using *Points* to measure successful application of eLearning is suitable only to a limited extent. Further result of PCA is joint appearance of satisfaction with LCMS with either econometrical interest or passive learning-attitude towards offered content.

Back to the initial question how to deal with the consideration of target-group specifics in eLearning evaluation and improvement: Students with econometrical interest are satisfied with LCMS as well as passive working students. Therefore, we have to reassess aims of implementing eLearning. Success is not only encouraging active learning attitude. Being an obligatory course, success is also to spend satisfaction with the learning environment in terms of LCMS, although there is only passive learning attitude. The different objectives within the construct of eLearning success have to be weighted by target-group specifics. Our conclusion is that we want to improve LCMS for a more active learning-behavior. But, to support passive learning we decide to improve the knowledge organization, still providing the existing content of LCMS. At least, this might help students without econometrical interest to pass the course satisfied within learning environment. With this, we try to fulfill Miliken and Barnes (2002) conclusions, to meet individual learner's need.

Jara and Mellar (2010) mention student representation amongst others to gain student feedback. But, they also constrain the approach because of problems finding proper student representation in eLearning courses with only few class attendances. Our findings from PCA

suggest arbitrary choice for student representation needs to be avoided. Otherwise, the impact of student characteristics on eLearning success distorts the results. Solution of this problem might be weighting student representation according to their characteristics to be representative. For this, future research is needed. Moreover, an identical research where the course is elective should be conducted to see if there is any difference in the result. Also, further research should cover more courses in the sample. The group of student which clearly benefits from eLearning needs to be identified.

References

Ahmad, T. & Härdle, W. (2008). Statistics E-learning Platforms Evaluation: Case Study. SFB 649 Discussion Paper 2008-058. Humboldt-Universität Berlin. Berlin.
Source: http://sfb649.wiwi.hu-berlin.de/papers/pdf/SFB649DP2008-058.pdf
Last access: 13th January 2011

Ćukušić, M., Alfirević, N., Granić, A. & Garača, Z. (2010). E-Learning process management and the e-learning performance: Results of a European empirical study, Computers&Education. 55. 554-565.

Jara, M. & Mellar, H. (2010). Quality enhancement for e-Learning courses: The role of student feedback. Computers&Education. 54. 709-714.

Kerres, M. (1999). Didaktische Konzeption multimedialer und telemedialer Lernumgebungen. HMD - Praxis der Wirtschaftsinformatik. 205. 9-21.

Kuechler, T. & Schmidt, K. (2007). From e-Learning to integrated learning architectures: a novel approach to learning management in corporate and higher education contexts. Management&Marketing. 2(4). 27-34.

Milliken, J. & Barnes, L.P. (2002). Teaching and technology in higher education: student perceptions and personal reflections. Computers&Education. 39. 223-235.

Özkan, S. & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation. Computers&Education. 53. 1285-1296.

Preussler, A. & Baumgartner, P. (2006). Qualitätssicherung in mediengestützten Lernprozessen – zur Messproblematik von theoretischen Konstrukten. In: Qualitätssicherung im E-Learning. Hrsg.: A. Sindler, C. Bremer, U. Dittler, et al. Waxmann. Münster. 73-85.

Yaghoubi, J. (2009). Assessment of agricultural extension and education graduate students' perceptions of e-Learning in Iran, Procedia Social and Behavioral Sciences. 1. 1914-1918.

Appendix

Items		Scale		
Progress	To what extent does work with the LCMS help to appraise the own progress in learning and level of knowledge?	4	…	0
		Appraising the learning progress is very good practicable.	…	No help for appraising the learning progress.
Encouragement	Does the LCMS encourage you to deal with the content of the course?	4	…	0
		Very strong encouraging.	…	Not encouraging at all.
Work	How do you work with the content provided by the LCMS?	2	…	-2
		Passive work (watching missed lectures, reading offered solutions, quick scanning examples of projects).	…	Active work (controlling correctness of notes from lecture by watching the records, using self-tests for self-control, communicating in the forum for solving any problems).
Success	Taken all together, does the LCMS influence your success in the course positively or negatively?	2	…	-2
		Positive influence.	…	Negative influence.
Display formats	Does the combination of different display formats in the LCMS support you or bewilder you in your learning process?	2	…	-2
		Supporting display formats.	…	Bewildering display formats.
Thesis	Can you imagine writing your bachelor or master thesis using the learned quantitative methods?	2	…	-2
		Very well imaginable.	…	Not at all imaginable.
Frequency	In relation to the total time, how frequent do you use the LCMS?	4	…	0
		Very frequent.	…	Do not use it.
Network	Do you agree with the statement, the different offers (Lecture, LCMS, practical course) are well networked?	2	…	-2
		Strong agreement.	…	Strong disagreement.

Items		Scale		
Duration of learning	How do you describe your own duration of learning?	2	…	-2
		Learning on the verge of the examination.	…	Steady learning over the whole semester.
Satisfaction LCMS	How do you appraise your satisfaction concerning the LCMS?	2	…	-2
		Very satisfied.	…	Very unsatisfied.
Satisfaction Lecture	How do you appraise your satisfaction concerning the lecture?	2	…	-2
		Very satisfied.	…	Very unsatisfied.
Satisfaction practical course	How do you appraise your satisfaction concerning the practical course?	2	…	-2
		Very satisfied.	…	Very unsatisfied.
Intrinsic	Do you agree with the statement, the matter of lecture encourages me to learn for the subject?	2	…	-2
		Strong agreement.	…	Strong disagreement.
Extrinsic	Do you agree with the statement, a good mark in the examination encourages me to learn for the subject?	2	…	-2
		Strong agreement.	…	Strong disagreement.
Points	Points gained in the Multiple Choice Test	Maximum score: 16		

Table 6: Main items measuring success of eLearning implementation