ANALYSIS OF THE EFFICIENCY OF ELECTRONIC MULTIMEDIA EDUCATION AT THE TECHNICAL FACULTY

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Abstract
The article is focused on the determination of the effectiveness of multimedia e-learning of selected subjects of the Czech University of Life Science in Prague, Faculty of Engineering. The author focuses mainly on the quantification of the relationship between student achievement in a given subject and the quality and scope of electronic support. Data from several years of monitoring are statistically processed and relations are sought to quantify the dependence between the student's final evaluation and the electronic support offered. In the conclusion, another possibility of research and the effectiveness of the mentioned e-learning are discussed.

Key words: *education; e-learning; multimedia; efficiency.*

INTRODUCTION

Supporting education and the entire didactic process at any university is a fundamental prerequisite for a high-quality and recognized university. High-quality and well-prepared graduates are the best criterion for evaluating a university with any type of focus. Of course, it is very difficult to evaluate the quality of the teaching process across faculties, disciplines or subjects; however, it is possible, to some extent, to assess the efforts made in the didactic process and to determine a certain degree of effectiveness in the resources spent in this manner. This, of course, primarily impacts supporting the university's didactic process, better acquisition of funds invested in education support, and, of course, as a tool for successfully combating increased failure rates (*Wagner, 2005*). A secondary, but definitely significant argument is the increase in the university's prestige in global rankings (*Vaindorf-Sysoeva, 2018*), (*Gros Salvat, 2018*).

The use of e-learning for all of the above objectives is already relatively broadly developed in academia. At Czech universities, we have been seeing the basic forms of e-learning since the beginning of this millennium (*Čapek, 2015*), although the form and method of implementation varies significantly at individual universities not only in time, but above all with the willingness of guarantors of individual subjects and programs to include these schemes in normal teaching (and in what scope) (*Eger, 2014*), (*Vaněček, 2011*). In addition, stagnation in this area has been evident since about 2014, despite the fact that the technical and technological resources that can be used in e-learning are still being expanded. The prospective means of multimedia e-learning are very difficult to achieve, despite the great interest among students in promoting the aforementioned didactic process. The problem is both the majority approach of teachers and the relatively high reluctance of university management to devote relatively large amounts of funds into the investment of technical equipment, the necessary organizational development and targeted support for this form of teaching. Moreover, there is a fundamental terminological misunderstanding, similarly as when in the past the concept of e-learning itself was misunderstood. Even today, most educators still believe that multimedia e-learning is basically a common form of e-learning supplemented by instructional videos or recordings. It is up to the responsible staff not only at universities, but above all superior components (ministries) to approach multimedia e-learning with full knowledge of this concept and its deployment. Of course, the discussion and definition of the term is not the content of this paper, but it is crucial for any actual implementation.

By analysing data from the real implementation of multimedia e-learning, the aim of the paper is primarily to express the conclusiveness of the assumed hypothesis: "**The implementation of multimedia e-learning increases the success of study in selected subjects**".

Given that this concerns proving the existence of statistically significant correlations between the success of the study of the selected subject (the final grade in the subject) and the intensity of e-learning, more specifically multimedia e-learning (the number and work time of e-learning or multimedia), it is necessary to establish a multi-level comparison, and above all to choose a sufficiently large data set (*Mironova, 2018*). The used inputs and their processing are shown in the next section. When analysing possible processing tools, both classical statistical methods and neural network analysis were considered. Because this is one of the first attempts to determine this dependence, it was finally decided, above all, to use clearer and easier-to-control statistical processing. However, it is evident that analysis using a neural network would ultimately be simpler, but also much more difficult to discuss. However, it is planned as one of the next stages of the ongoing research.

MATERIALS AND METHODS

The first attempts to quantify the effectiveness of multimedia teaching were published in 2015 (*Votruba, 2015*). The results were quite promising, but the fact that the unambiguity of the conclusions had to deal with the high variability of the analyses was evident. It was necessary to significantly increase the number of students and try to refine the own evaluation via a better processing methodology. Therefore, annual data collection has been carried out since 2015. At the moment, a matrix of data from 3 years of teaching (3 semesters of a subject using multi-media e-learning and 3 semesters of a subject where it is not used) is completely available. The data for the analysis is obtained from several independent sources:

a) study information system - ID of the student, final result in the subject (grade), number of attempted exams;
b) LMS system – ID of the student, number of accesses to the system, total time of connection in the system, survey of the student expressing his or her opinion of the subject and e-learning support of the subject;
c) multimedia system – ID of the student, number of accesses to individual records, time of tracking of individual records, total number of accesses, total time of access to the system.

The student's university e-mail was chosen as the ID of the student, under which the student logs into all the above systems. During the course of data processing, it was necessary to significantly simplify the input data, and therefore the following input data were used for the processing:

SIS	LMS	MediaSite
• ID of the student	• ID of the student	• ID of the student
• Final grade	• Number of accesses	• Number of accesses to the subject
• Number of exam attempts	• Student survey	• Time of tracking of the subject

Exports from individual systems were combined into a set, which was subsequently corrected from the perspective of unambiguous identification of the student from all three data sources and subsequently verified in relation to the number of LMS accesses to the number of accesses on MediaSite. Similarly, it was necessary to filter students who completed their studies during the semester. The total number of student records before and after correction is defined in Tab. 1.

Tab. 1 Data counts* before and after correction

year	before correction	after correction
2018	336	267
2017	335	269
2016	340	251

•number of students

The resulting data file structure after correction and connection to several initial data *(with regard to GDPR, the email addresses are hidden)* is specified in Tab. 2.

Tab. 2 Data export structure for evaluation

ID user	ID study	Name	Email	Credit	T1	T2	T3	T4	S-mark	Mediasite - total present.	Mediasite - count of view	Mediasite - time of view	Moodle - count of view	Moodle - time of view
185114	209076			Z	1				1	15	31	9:16:24	223	19:23:00
188157	212425			Z	3				3	7	9	3:02:41	182	12:01:00
180498	199266			Z	4				4	1	1	0:00:00	243	23:57:00
161646	209180			Z	4	4	4		12	3	3	0:02:46	172	13:23:00
180499	199267			Z	4	1			5	2	2	0:01:40	217	15:37:00
180654	199823								0	1	1	0:01:37	112	9:02:00
173495	189220			Z	4	3			7	15	23	7:03:57	166	13:23:00
181420	203201			Z	4	4	2		10	11	26	9:55:33	166	14:38:00
175209	202449			Z	3				3	1	1	0:01:29	124	7:59:00
181416	203194			Z	1				1	2	2	0:43:26	115	8:22:00
180428	199224				4	4			8	3	4	1:49:19	84	7:40:00
180502	199270			Z	4	4	3		11	8	12	0:15:00	202	17:38:00
180657	199826			Z	2				2	4	5	1:13:31	126	10:15:00
185120	209087			Z	1				1	20	46	14:49:48	446	12:37:00

The next step was to verify that the three data files could be merged into one and work could continue with only one (merged) file. The results are specified in Tab. 3.

Tab. 3 Statistical processing of input values

	number of accesses			access time		
	2016	2017	2018	2016	2017	2018
number (n)	251	269	267	251	269	267
average (p)	6,66951567	7,565056	7,270758	3:35:03*	3:03:32*	3:38:44*
standard deviation (σ)	5,83428901	6,196327	6,212452	0,225586	0,176729	0,230928
confidence.t	0,612472865	0,743827	0,734818	0,026683	0,021215	0,027314
finv	1,209985796			1,209447		

*[hh:mm:ss]

Based on the parametric Student's t-test (two selection t-test), the assumption of statistical data consistency with 95% probability was confirmed and data from all three years were still processed collectively. It was thereby possible to work with data from **787 students in two subjects** (full-time and part-time study).

Furthermore, it was necessary to obtain the students' exam results in the monitored subject. This data was exported from the study information system (see Table 2). Since the number of retests, not only the final grade, needs to be taken into account for the evaluation, the resulting grade has been adjusted according to the following formula (1)

$$S = T_1 + T_2 + T_3 + T_4 \tag{1}$$

where S is the final grade of the student for evaluation, T_1 to T_4 are grades (1 – 4) from individual exam attempts.
This completed the data acquisition and verification part, and this could then be followed by the dependency analysis and verification of the defined hypothesis.

RESULTS AND DISCUSSION

On the basis of the aforementioned processing of input data, basic statistical processing of the ascertained values was carried out. Above all, there was no significant change in the number of students in the relevant subject in the ascertained time range, see Fig. 1 (TGT25E is a full-time study, TGT75E is part-time study) (*Votruba, 2015*).

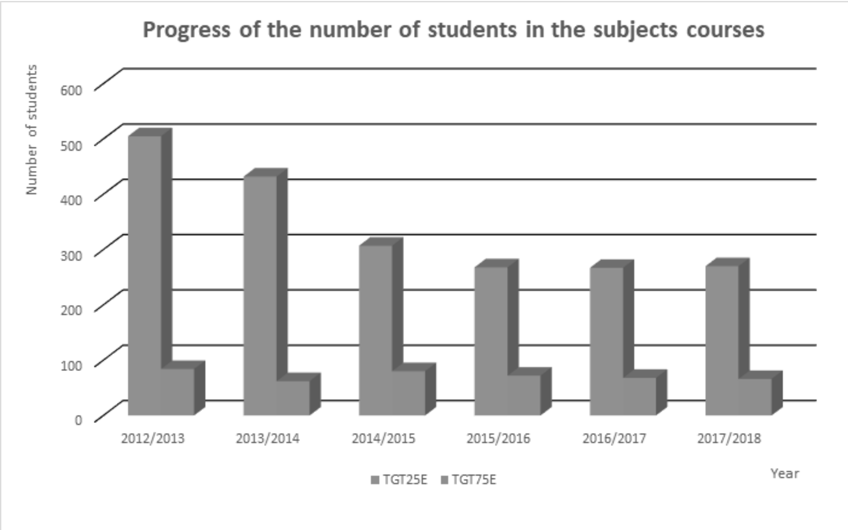

Fig. 1 Development of the number of students in the subject

It is also very interesting to analyse the course of time frequency of access to multimedia support of the relevant subject. It is clear from the graph (Fig. 2) that the maximum monthly number of accesses is achieved both at the end of the semester and in the first half of the exam period. From these values it is possible to conclude that multimedia support becomes the basis for preparation for credit and for preparation for exams, especially for the second and subsequent exam attempts in the subject.

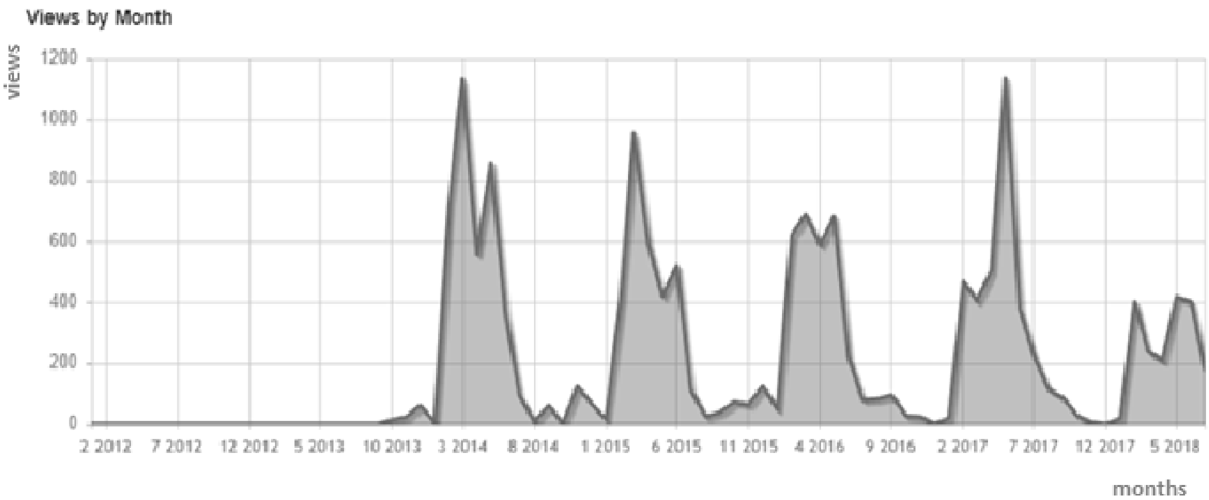

Fig. 2 Peak Connection by Month

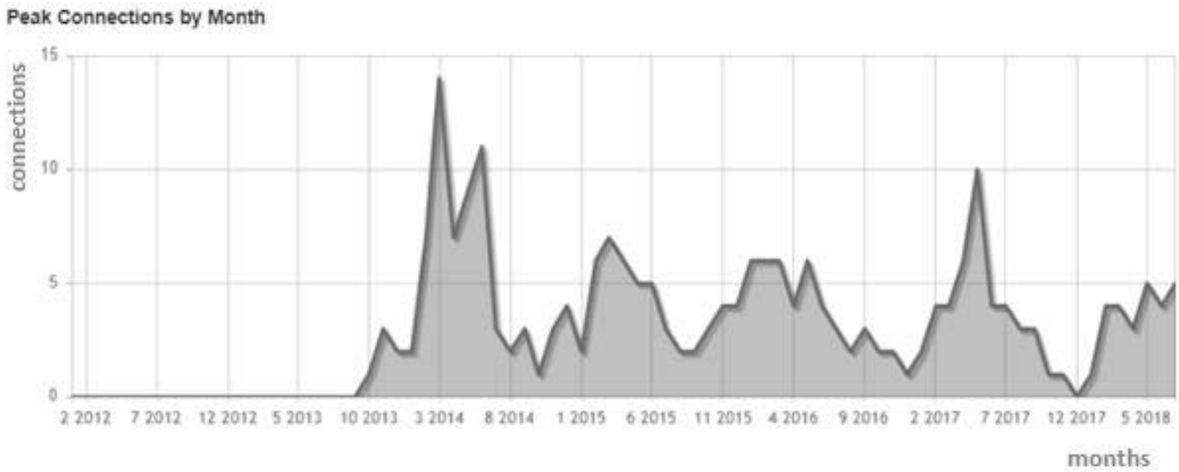

Fig. 3 Views by Month

The subsequent summary table (Tab. 4), together with a summary of the results from the exam via an S-grade, is available after processing input values into a single file and their basic statistical processing.

Tab. 4 Statistical summary of combined input data

	number of accesses	access time	S-grade
number (n)	787	768	768
average (p)	7,0927	3:28:28*	4,8577
standard deviation (σ)	6,0163	0,216245	3,4198

*[hh:mm:ss]

The success of the student (final S-grade) can then be interpreted according to the information system in the subsequent 3 years:

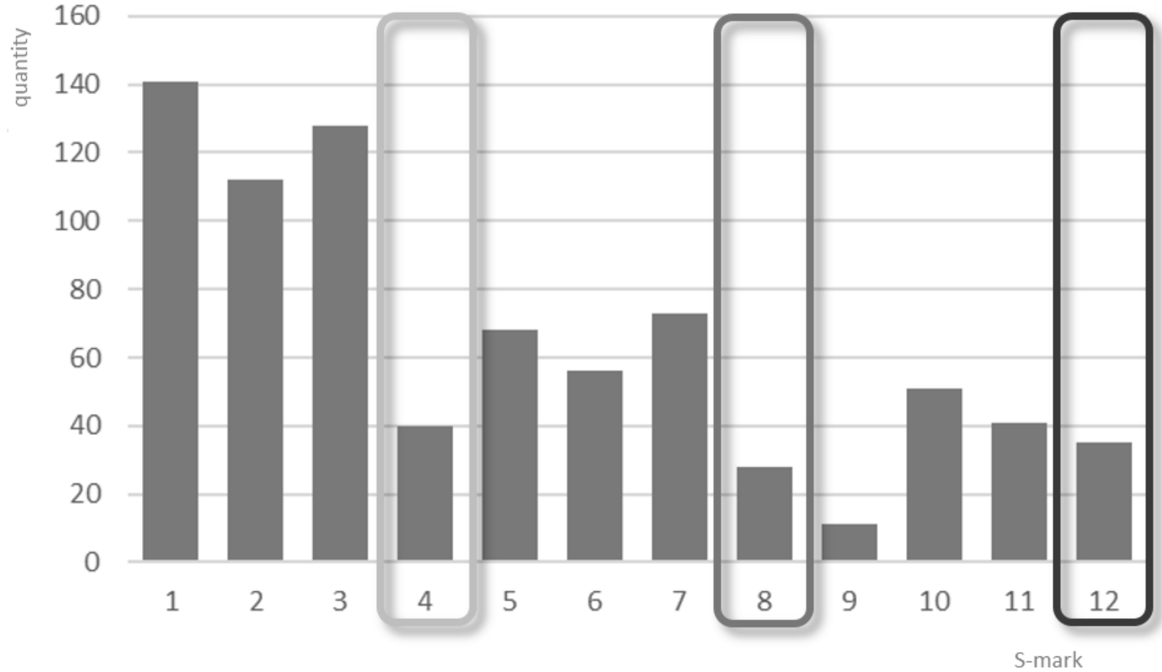

Fig. 4 Success of subject completion

The results shown in Fig. 4 are very interesting, but using a closer analysis, it can be shown that they are somewhat devalued by a systemic error (*Gros Salvat, 2018*). It is obvious that the number of students passing on the second or third attempt is different (lower) than the number of students taking the first exam in the subject in each individual year of study. If this effect and the real number of students recalculated for the given exam are taken into account, the results are significantly more conclusive.

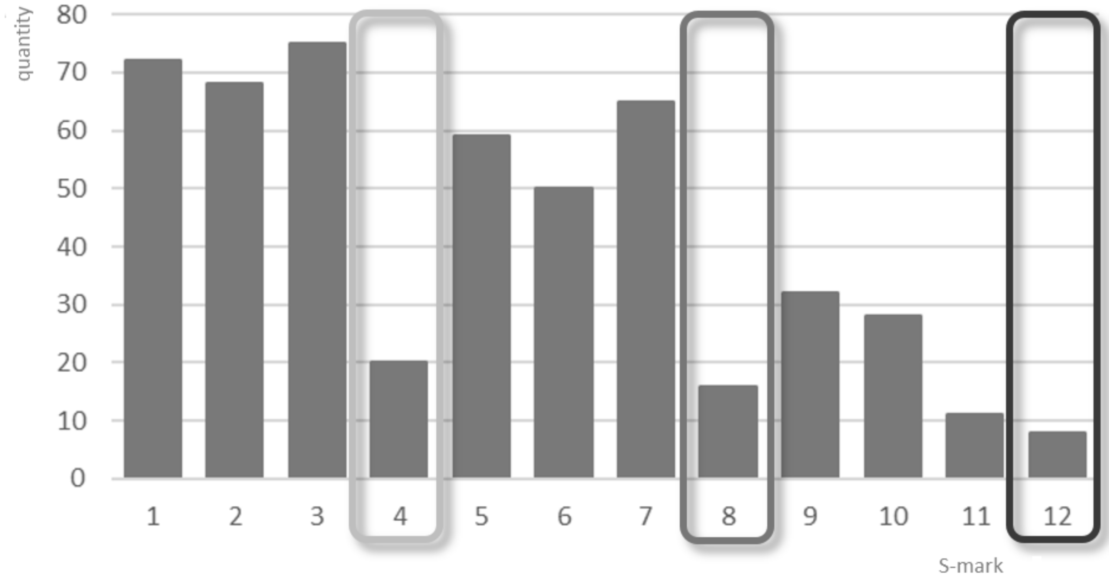

Fig. 5 Success of passing a subject related to the number of students with the relevant grade

It is quite clear from Fig. 5 that multimedia e-learning support is used most by students with a final grade between 1 – 3, the next significant extreme is during a final grade of 3 during the first repetition.

If, for comparison, a subject using only basic e-learning support is processed in a similar manner, the result is demonstrated in Fig. 6.

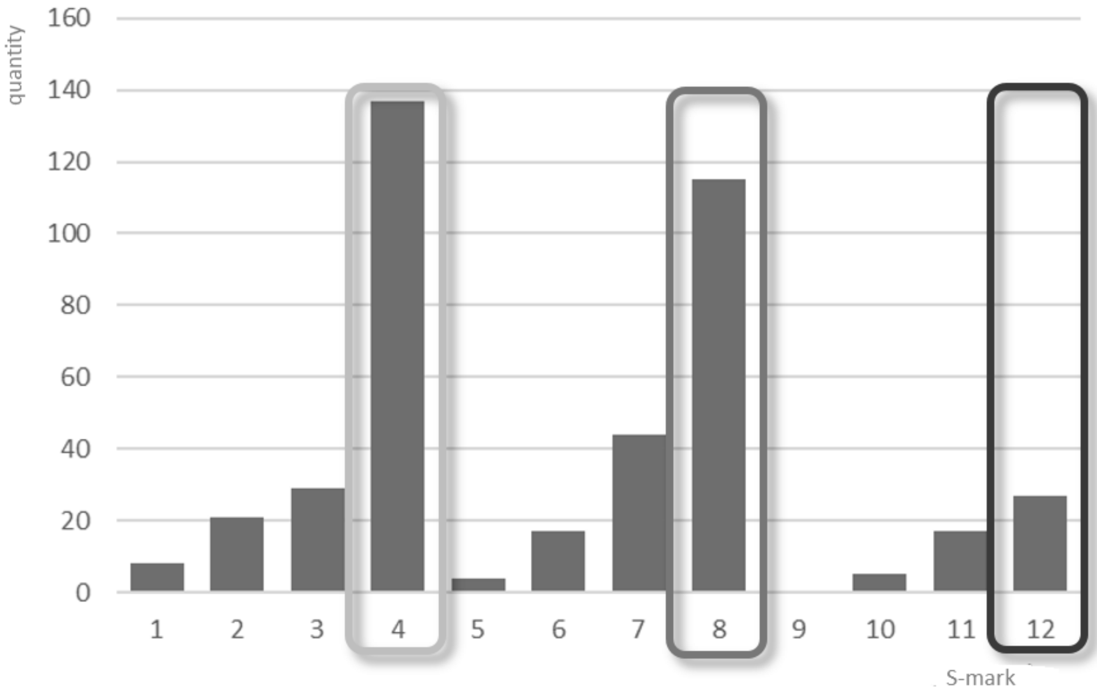

Fig. 6 The success of passing a subject related to the number of students with the relevant grade – control sample

Given the obvious difference between the control sample of the study results and the results discussed in this report, an analysis of statistically significant differences between the compared samples was omitted (*Trilaksono, K.; Santoso, H. 2017*).

CONCLUSIONS

It is possible to formulate the conclusions of this testing on several levels. Above all, it has been statistically confirmed that the results of two different subjects taught in three consecutive semesters are statistically identical. The impact of multimedia e-learning thus manifested itself similarly in various subjects on different groups of students. This is one of the key test conclusions, proving the universal validity of the findings.

Another confirmed conclusion was the verification of the conclusiveness of the impact of multimedia e-learning on a student's final grade (see Fig. 5 and Fig. 6). In this case, the striking difference in the frequency shift of the result "failed" towards the frequency of the result "good", and a certain shift in the frequency of the result "good" towards the frequency of the result "very good" can be seen. In order to unambiguously quantify this result, it will be necessary to expand the monitoring, in particular in the area of "***teaching without e-learning***" and "***teaching with e-learning without multimedia support***", in order to independently assess the impact of e-learning and the impact of multimedia support. Above all, in this monitoring, it is necessary to exclude the influence of the teacher and the subject (topic) area. Therefore, it would be ideal to **have the same teacher teach the subject for various groups of students** with multimedia e-learning, and for a different group without multimedia e-learning, and then in the third group only with classic e-learning support.

From the existing testing, by comparing the results of the specified two groups of students, it can be unequivocally deduced that the use of e-learning shifts the final grade by about **0.4 to 0.7 grade levels** from the subject to a better result, in particular for students around the overall expected result of the S-grade of 3 – 4 and 7 – 8. On the contrary, it is apparent that the impact is **not particularly significant for students repeating an exam for the second time**. Of course, it is not possible to confirm this impact for students with grades from 1 to 2. In any case, the validity of the defined hypothesis that multimedia e-learning has a positive impact on the study results in the given subject has been confirmed.

The survey conducted annually among students shows that the popularity of multimedia e-learning is very high, mainly as a basis for preparation for an exam, and amongst of part-time study students (Fig. 7). The usual claim that multimedia support reduces real participation of students in a lecture is therefore not true.

Fig. 7 Graph of the results of the survey among students on the usefulness of multimedia e-learning (536 respondents)

Without preparing a more detailed analysis, it is interesting to note that the students attach relatively much greater importance to the lecture record than to multimedia support of seminars.

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