Journal on Efficiency and Responsibility in Education and Science
ISSN: 1803-1617

THE IMPACTS OF MULTIMEDIA LECTURES ON STUDENTS' PERFORMANCE IN TWO SPECIFIC SUBJECTS

Milan Houška, Martina Houšková Beránková

Czech University of Life Sciences Prague
houska@pef.czu.cz

Abstract

The objective of the work is to suggest pedagogical, economical and user-oriented criteria to identify benefits of multimedia lectures on mathematical methods in economics. Based on our previous work, we describe them and suggest how to evaluate them including scales and measures, if possible. Then we concentrate on the pedagogical criteria and show their utilization for the efficiency evaluation of the multimedia lectures. For this purpose, we divided the students into two groups based on the frequency of utilizing the multimedia lectures for their study, and used the methods of statistical analysis. In particular, we applied two-sample F-test to know whether the variances of students' results are significantly different or not and an appropriate version of the t-test to know whether mean values of students' results are significantly different or not. The case study is based on the data acquired form the students' performance measurement in two specific subjects taught in the Czech University of Life Sciences Prague in 2010 and 2011.

Key Words

Multimedia lectures, performance, learning outcomes, mathematical methods in economics, operational research methods

ARTICLE INFO

Article type
Full research paper

Article history
Received: November 3, 2011
Received in revised form: December 14, 2011
Accepted: December 15, 2011
Available on-line: December 31, 20111

Introduction

Many researchers have dealt with the analysis of educational effects and learning outcomes in order to define pedagogical efficiency in education. Guan (2009) investigated the effects of multimedia presentations on the efficiency of learning scientific information in the area of basic anatomy of human brains and their functions, the definition of cognitive psychology, and the structure of human memory. In particular, the author dealt with the impact of redundant information on learning outcomes. He found that information per se did not impair learning, which suggested that the redundancy effect could be rather caused by the interference in information processing. According to the results of his another experiment, there is a negative effect of auditory information on learning regardless of the length of the verbal information. No evidence supported the superiority of auditory instructional mode over the visual one.

For the creation of an efficient multimedia lecture, the issue of the lecture interactivity is quite important. Rasch and Schnotz (2009) made the comparison of two learning methods: studying a text with and without interactive elements (pictures) from the viewpoint of learning efficiency. In their specific issue, they found that learning from text only was more successful than learning from text and pictures. In addition, they found that the visualization format affected participants' interaction with pictures, but not the learning outcomes; however this effect was not influenced by interactivity. The results of above-mentioned research allow us to suppose that the element of the lecture interactivity is not crucial and it is not obligatory to include such elements into our lectures.

Windham (1988) developed the Model of Educational Production. He dealt with the definition of educational outputs and especially with the efficiency of the education from the economic point of view. In this case, he understands such efficiency as the maximization of total educational outputs subject to total costs expensed for all educational inputs. This approach is very similar to more general Data Envelope Analysis model known in the area of Operations Research (Charnes, Cooper and Rhodes, 1978).

Yunus and Salim (2008) mention that most works dealing with e-learning are focused on technical matters whereas less attention is given to the pedagogical aspect. Apart from that, unsatisfactory quality of e-learning hinders the learning effectiveness and resulting in no benefit or added value to its users. Thus, they examine the effectiveness of e-learning from the perspective of pedagogy and the criteria which contributes to the effectiveness. The presented scheme includes the following criteria influencing the effectiveness of e-learning from the perspective of pedagogy: individual, knowledge, learning, content and relationship between instructor and learner.

Průcha (1990) summarizes the most common opinions found in more pedagogical works dealing with the efficiency measurement in the educational process. On one hand, he says that the efficiency measurement in education is usually more complex, on the level of the whole educational process and its long-time effects. On the other hand, he does not exclude the possibility to evaluate individual parts of the educational process, such as specific lectures or teaching methods; unfortunately, specific criteria for such an evaluation are not specified there.

The objective of the paper is to suggest pedagogical, economical and user-oriented criteria for the efficiency evaluation of multimedia lectures on mathematical methods in economics. Based on our previous work (Houška, Beránková, 2010), we describe them and suggest ways for their evaluation including

scales and measures, if possible. Then we concentrate on the pedagogical criteria and show how to use them for the efficiency evaluation of the multimedia lectures in two specific courses taught in the Czech University of Life Sciences Prague.

Materials and Methods

Criteria for the measurement of efficiency

Firstly, we have to see the efficiency measurement problem of the multimedia lectures wider, not only from the point of view of the pedagogical efficiency. For such a purpose, we can go out from a general concept for the construction of a criteria hierarchy (Saaty, 1980). It means that the criteria will be ordered into a hierarchy; the hierarchy will include three levels:

- level of the objective;
- level of the criteria groups;
- level of individual criteria under the criteria groups.

The objective level is represented by one formal object – efficiency of the multimedia lectures.

Groups of the criteria are suggested according to general objectives of the courses, because the multimedia lectures will be efficient if and only if they support the achievement of the courses learning outcomes. Moreover, such a support has to fulfill some economical criteria and last but not least, it has to be also user-friendly in order to students will be motivated to use it.

Inspired by Windham (1998) and Yunus and Salim (2008), we can distinguish three groups of evaluation criteria on the second hierarchical level:

Group 1 – pedagogical criteria (P) that are connected with the measuring of learning outputs and inputs on the level of selected courses.

Group 2 – economical criteria (E) that describe the economic efficiency of the multimedia lectures.

Group 3 – user-oriented criteria (U) that reflect a subjective satisfactory of the multimedia lectures users.

Then, criteria level (the third level of the hierarchy) could be as follows:

Pedagogical criteria

P1 – Learning outputs performed by the students in specific courses. We want to evaluate some progress of students, level of their knowledge, etc. This is an objective criterion; we will measure it by results of a didactic test.

P2 – Impact of the multimedia lectures on regular contact teaching (lectures, seminars). This is a subjective criterion; it is evaluated by the sample of teachers who participated on the teaching of Mathematical methods in economics. To obtain the teachers' opinions, we used a free interview method.

P3 – Number of tutorial within the semester. In the frame of the interview for P2, we asked the teachers for the amount of provided tutorials. This is an objective criterion measured by total time of provided tutorials in one semester or by the estimation of such tutorials respectively.

Economical criteria

E1 – Time for the multimedia lectures development. This cost criterion is expressed by total time necessary for the preparation of educational materials, recording the lectures and their editing.

Using the time units, we can compare the time requirements of both multimedia lectures and textbooks.

E2 – Cost for the distribution of the lectures among the students. It is expressed as the sum of staff costs and technical costs.

E3 – Maintenance costs. It calculates all kinds of costs spent within the utilization of the lectures.

User-oriented criteria

U1 – Total time of learning. This is partially objective criterion; it is measured by the estimation of learning time obtained from the questionnaire survey among the students.

U2 – Accessibility of educational materials. This criterion expresses the opportunity of providing the materials through standard shop, e-shop or learning management system.

U3 – Price of the educational material. This criterion is expressed by the amount of money necessary for obtaining the same amount of educational materials in different form.

U4 – General satisfaction of the users with multimedia lectures. This is a subjective criterion we asked the students by a questionnaire.

Complete hierarchy of criteria is shown in figure 1.

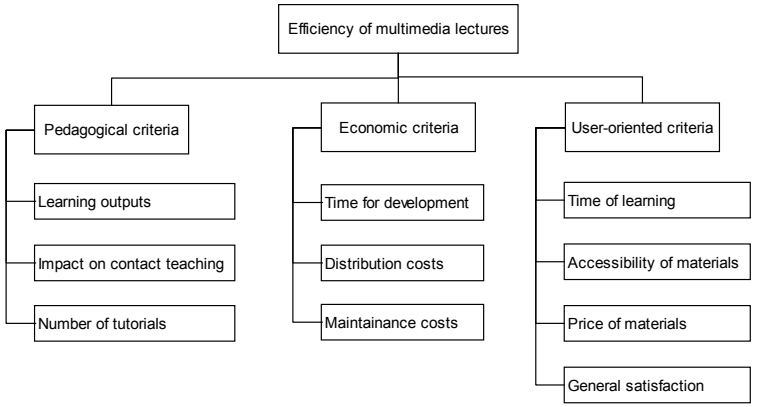

Figure 1: Complete hierarchy of the criteria for multimedia lectures efficiency measurement

Design of the study

The study focuses on the students of Mathematical Methods in Economics I. (MME I., study programmes Economics and Management, and Business and Administration) and Operations Research Methods (ORM, study programme Informatics). They study in a regular form with 2 hours of lectures and 2 hours of seminars per week. Total numbers of students involved into the evaluation of the first didactic test in individual years are in the following table:

Year	MME I.	ORM
2010	370	94
2011	553	91
Total	1364	364

Table 1: Total numbers of students

All data are taken from the learning management system Moodle. We divided the students into two groups:

Group A: The students, who did not intensively use video-lectures for their preparation. It means that they did not utilize the video-lectures at all or in occasion only – 5 times or less from the beginning of the semester to the date of their first evaluation test.

Group B: The students, who prepared with video-lectures intensively, i.e. more than 5 times during the same period.

Based on the above-mentioned segmentation, we formulate the following hypothesis:

Learning outcomes of the Group A were significantly worse than the outcomes of the Group B. We use single measure for the quantification of the learning outcomes; score of the students achieved in a didactic test, we use a cardinal scale from 0 to 50 points.

To reach the maximal objectivity of the study and comparability of received result, we set up the following conditions:

- We consider only the results reached in the regular date of the test. Some students absented in the regular date and tried to pass his/her test later; their results are excluded from the study.
- Moreover, we carefully balanced the hardness of individual variants of the didactic test. Based on results of the students from the previous years, we re-sorted test items among the variants of the tests. After this operation all average test scores did not differ about more than 5% from the total average of all test results.

To compare the learning outcomes between the two groups of students, we use two statistical tests (Freedman, Pisani and Purves, 2007):

- two-sample F-test to know whether the variances of students' results in two groups of students are significantly different or not;
- based on the F-test, an appropriate version of the t-test to know whether mean values of students' results in two groups of students are significantly different or not.

Normal distribution of data is the necessary condition for these tests to be applied correctly. Visually, we can assume the data are distributed normally, see figures 1 and 2.

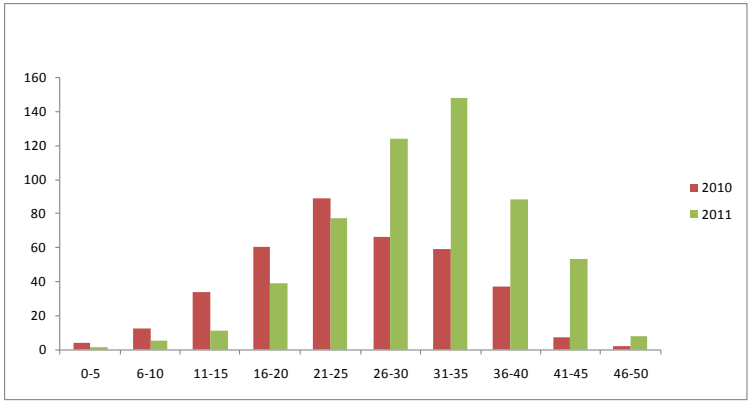

Figure 1: Histograms of students' results in individual years (subject: MME I.)

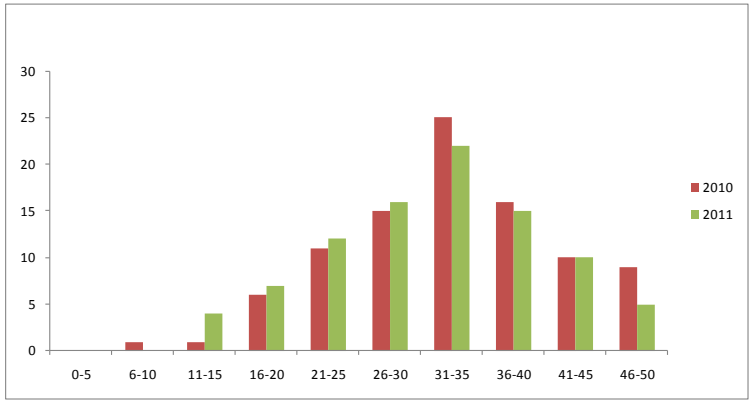

Figure 2: Histograms of students' results in individual years (subject: ORM)

Results

We concentrate to the group of the pedagogical criteria and demonstrate their application for the evaluation of two specific courses on mathematical methods in economics:

- Mathematical methods in economics I. (MME I.) for the students of the study programme Business and administration and
- Operations research methods (ORM) for the students of the study programme Informatics.

These courses are very suitable for the purpose of the case study, because we can simply compare two different instances of such courses: current courses with the support of the multimedia lectures and last courses without such a support. Moreover,

- number of students in these courses is high, results from some statistical surveys are statistically significant;
- within these two years, there are no significant changes in courses structure, contents, teachers, testing methods, etc., no new textbook was provided to the students;
- multimedia lectures cover both lectures and seminars and so the students can use them for both theoretical knowledge and practical skills improvement;
- multimedia lectures are available to the students since the beginning of the semester and information about the availability of such lectures is generally known among the students.

Firstly, we investigated the impact of the multimedia lectures on the pedagogical criteria. Table 2 summarizes basic information about the courses that are involved in the case study. All data were acquired from LMS Moodle.

Number of students	MME I.	ORM
School year 2009/2010	370	94
School year 2010/2011	553	91
Multimedia support	3 lectures, 3 examples	4 lectures, 6 examples
Course topics covered by the support (in % of coverage)	86%	90%

Table 2: Basic information about the courses

For the evaluation of the criterion P1, we used the results of the first didactic test and analyzed them by statistical methods. We divided the students into two groups subject to the utilization of the multimedia lectures. In the first group, there were the students who used the lectures extensively (no utilization or up to 5 times of utilizations); in the second one, there were the

students who used the lectures more than 5 times. Data for the statistical analysis are in the following table (the maximum test score is 50 points).

Utilization intensity	Number of students		Average test score		Standard deviation	
	MME I.	ORM	MME I.	ORM	MME I.	ORM
2010						
No or up to 5 times	250	83	24.20	33.99	8	9.1
More than 6 times	120	11	27.07	37.27	9.29	10.26
All students	370	94	25.13	34.37	8.53	9.25
2011						
No or up to 5 times	384	81	30.30	32.01	7.98	10.00
More than 6 times	169	10	31.56	34.02	7.00	8.56
All students	553	91	30.68	32.25	7.42	8.87

Table 3: Average test score in relation to the intensity of multimedia lectures utilization

The above given data were tested on the equivalency of means. Separately in individual courses, the hypothesis that the mean value of the test score is higher for the students who used the multimedia lectures more intensively was tested. For such a purpose, the two-sample t-test was used. The appropriate version of the t-test depends on the equality of variances determined by the F-test. Its results are in the following table:

	MME I.		ORM	
	0-5 lectures	6+ lectures	0-5 lectures	6+ lectures
2010				
Mean value	24.20	27.07	33.99	37.27
Variance	63.96	86.34	82.84	105.22
Observations	250	120	83	11
Common variance	--- [1]	α = 0.05	85.27 [2]	α = 0.05
t-test value	-2.90		-1.11	
t-critical value	1.65		1.66	
2011				
Mean value	30.30	31.56	32.01	34.02
Variance	63.71	49.03	100.04	73.29
Observations	384	169	81	10
Common variance	59.23 [2]	α = 0.05	--- [1]	α = 0.05
t-test value	-1.78		-0.74	
t-critical value	1.65		1.78	

Table 4: Statistical analysis of learning outputs in individual courses

[1] two-sample t-test for different variances

[2] two-sample t-test for equal variances

As results from Table 3, there are no differences between the results in individual years. There is a significant difference of mean values for the students from the course MME I. On the contrary, the difference is not statistically significant for the students from the course ORM. To explain that, we have to return back to the comparison of both courses and describe their relevant differences:

1. The authors of the multimedia lectures are not involved in the teaching of the MME I.; on the other hand, they cover about 33% of the teaching of the ORM. It means that the multimedia lectures are an original study support for the MME I. students, but the students of the ORM are used to hear very similar way of explanation in their contact lectures like in the multimedia ones.
2. In contrast to the MME I. students, the ORM students could use any support during the testing (textbooks, notes from lectures, seminars, etc.), except communication with their neighbors or third persons. These factors explain an absolute value of differences (that is about 10 points) in average scores of both groups of students. On the other hand, if the student can use the support during the test, the role of his/her theoretical knowledge acquired from the multimedia lectures becomes marginal.

Discussion

We also describe shortly the multimedia lectures evaluation subject to other pedagogical criteria. For interest we summarize and present here information received from our several colleagues; we discussed with them whether and how they had noticed the existence of the multimedia lectures and their utilization by the students. Because of a subjective nature of these criteria, it is worth making the comparison of situations in teaching with and without multimedia support.

The teachers mostly evaluated the criterion P2 (the impact of the multimedia lectures on regular contact teaching) in a positive way. They told us that the multimedia lectures allow them to make their contact lessons more continuous. Before the multimedia support, they had to always stop the lecture, when at least one student had not understood the explanation and repeat it again. Now, it is possible to refer the student to the specific multimedia lecture and/or a clearly performed solution of an example.

The teachers' evaluations of the criterion P3 (a number of tutorial within the semester) are very similar. Amount of time spent by the tutorials before the support and now is approximately the same, but level of asked questions significantly increased. The teachers concluded that the students are really able to use the multimedia support to find answers to their problems and they asked their teachers for the tutorial in case of difficult problem only.

Based on the observations, we are going to design a new systematic research aimed at the pedagogical criteria P2 and P3 as well as the user-oriented criteria U1 – U4.

Conclusion

The evaluation of learning outputs is a complex process. The efficiency measurement of individual teaching methods is very difficult, because there are many factors, which influence such efficiency together; it is practically impossible to extract the impact of one specific factor and analyze it separately. We proved a statistical significance of the difference of learning outputs measured by a didactic test score in specific course with and without the support of the multimedia lectures. Despite this fact, we cannot conclude that the difference is fully caused by the existence and utilization of such lectures by the students. There is no way how to disprove the assumption about the strong dependency between a study effort of a student and her/his propensity to the utilization of all available study support including multimedia lectures.

On the other hand, we registered a significant improve of some subjectively evaluated efficiency criteria. The utilization of the multimedia lectures had a positive impact on contact teaching and the contents of tutorials provided to the students within the school year. Finally, we have to note very positive informal feedback from our students. Regardless of measurable efficiency, the best award for the multimedia lectures authors are the compliments from the students and their wishes and demand of more and more such lectures that make their studies easier.

Acknowledgements

The paper is supported by the grant project of the Ministry of Education of the Czech Republic No. MSM6046070904 – "Information and Knowledge Support of Strategic Management".

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