Designing an ANOVA Experiment to Estimate the Impact of E-Learning System Upon Students' Performances within the University of Petrosani

CODRUȚA CORNELIA DURA, SORIN MIHĂILESCU
The Economics Department; Mechanical, Industrial and Transportation Engineering Department
University of Petrosani
University Street No. 20, 332006, Petrosani
ROMANIA
codrutadura@yahoo.com, mihailescus@gmail.com

Abstract: The process of shaping the information society is characterized by the massive, broad-based and integrated use of new information technologies and telecommunications in all levels of economic and social life, from material production to services, administration, spreading to education and other cultural and artistic activities. In higher education, the technological progresses open new perspectives for improving teaching - learning – evaluation activities. At the base of new educational methods specific to the information society one can find the approach of assimilation and implementation of e-Learning. The University of Petrosani is one of higher education institutions in Romania which included in its development strategy the assimilation and implementation of a platform for e-Learning, based on raising European funds through a POSDRU strategic project. Following this initiative, the paper employs a bi-factorial ANOVA-type experiment for the identification and the generalization of those teaching technologies which have a significant impact on improving the learning performances of the students. Thus, we have analyzed statistical data regarding the grades obtained by a sample of 6 groups of students (3 from the engineering field and 3 from the economic sciences field) and we have found that e-Learning technologies leads to a higher level of teaching quality within the University.

Key-Words: information society, e-Learning system, the two-way ANOVA experiment, the Fisher test

1 Introduction

At the beginning of the new millennium, the world economy goes through a complex process of transformation that marks the transition from a predominantly industrial society to the information society. The defining feature of the new information society which is in the process of configuration is, without a doubt, the massive, broad-based and integrated use of new information technologies and telecommunications in all levels of economic and social life, from material production to services, administration, spreading to education and other cultural and artistic activities. [29].

As a permanent catalyst of the information revolution, the phenomenon of globalization has put a decisive stamp on the academic education, where the elimination of geographical distances between students and teachers and the registered technological developments open new perspectives regarding the improvement of teaching – learning – assessment activities. At the base of the new educational methods specific to the information society one may find the approach of assimilation and implementation of e-Learning systems.

In a broad sense, e-Learning refers to the educational situations within which we can find a deep involvement of modern means of information technology and communications. According to some definitions in the literature, "*an e-Learning system consists of a planned experience of teaching and learning, organized by an institution that provides educational resources stored on electronic media in a logical sequence in order to be taken in by subjects on their own, without obliging them to do synchronous group activities*" [12]. The core of this system is the Internet which plays a dual role: a place for the distribution of didactic materials and a tool of communication between users (teachers/tutors, students) engaged in the educational activity. In the last period, there were developed a wide range of Web tools able to support and simplify the processes of learning carried out with the help of e-Learning technology: multimedia maps, dictionaries, encyclopedias, videos, pre-sentations in various multimedia formats, e-books, tests, tutorials, simulations, virtual labs etc. [12].

All these confirm a new paradigm in education, namely *the e-Learning educational model 2.0*. The new term e-Learning 2.0 refers to the unique ways of thinking and interacting on the basis of facilities provided by Web 2.0. The term Web 2.0 designates the creation of the second generation of Web designs that is based on advanced approaches in terms of communication, information sharing, interoperability, and collaboration on the World Wide Web. Web 2.0 tools have contributed to the creation and development of Web-based communities that are hosted by services and applications such *as social networking sites, blogs or folksonomies*. These tools facilitate the publishing activity on the Web; virtually, anyone can become a creator of information materials and pass them out on the Internet.

From the perspective of educational processes, there are fantastic opportunities to involve subjects in a proactive learning environment. Thus, the interactions student-information-ideas cannot be limited to the interaction with teachers/tutors, but they also include the communication with other colleagues during the processes of learning and assessment of knowledge. [9].

Becoming more informed and more aware of the advantages of these new technologies for teaching, educational institutions of various types, especially universities worldwide integrate virtual learning as both a self-reliant educational strategy and as an element of support for traditional teaching into their development plans.

2 E-Learning System within the University of Petrosani

The University of Petrosani is an academic education institution from Romania whose beginnings date back in 1948, when the *Coal Institute (Faculty of Mining and Processing of Coal Deposits)* was established at Petrosani, following the release of the Decree no. 175/1948 for education reform. The Jiu Valley was one of the few industrial, highly urban areas in Romania displaying the conditions for hosting such an institution. It was also a strong industrial center with top specialists, which provided a suitable framework for applied education.

The tendency towards the diversification of the domains and study programs, which had become more obvious after 1990, determined important changes in the educational offer of the higher education establishment of Petrosani; simultaneously with the development of technical education, economic education, social and humanistic education, public administration education, informatics and mathematics education have been defined and implemented. The educational offer expanded every year, so that, at the present day, the University of Petrosani develops its didactic and research activity according to curricula designed for day courses and distance learning:

- Bachelor studies for high school graduates who can become students of the University of Petrosani;
- Master studies in the accredited fields and domains for the graduates of higher education institutions;
- Doctorate studies - for research, education, business specialists, after passing an entrance examination;
- Specialized post-graduate studies for production, education, design, and research specialists;
- Training and evaluation programs for the pre – academic teaching staff providing a framework for primary and secondary school teachers to take their tenure, 2nd, and 1st degree examinations.

All told, the University provides 24 bachelor programs, 18 master’s degree programs and 4 doctoral programs. According to the stipulations of the Law of National Education, *Life Long Learning* becomes a core paradigm meant to complete the structure of traditional educational systems. This trend is natural if we consider the latest developments in the knowledge – based society, namely [20]:

- The increasing workforce productivity led to the identification of new important time resources which are used to accumulate further knowledge;
- The increasing life expectancy which, in its turn, provides the individuals new time resources that can be invested in learning activities;
- The increasing complexity of knowledge which determines the necessity to expand the interval dedicated to the assimilation and the use of an ever larger volume of information to be used and processed with social and personal purposes.

The academic curriculum has been recently completed by including new postgraduate study programs in the following specializations: *Occupational Health and Safety Risk Assessment; Automation and Electronics; Computer Science; Electro-mechanics; Technological Education;*

Educational Management; Public Administration Management; Banking Product and Services Management; Mathematics.

Each of these postgraduate courses has in view the needs for continuous professional training and development of target groups of specialists that work in different fields.

Such curricula are defined and implemented within the following academic structures: the Faculty of Sciences, the Faculty of Mechanical and Electrical Engineering, the Faculty of Mining Engineering, the Department for Distance Learning, the Department for the Teaching Staff Training, the Doctorate and Continual Training Center.

The strategy of developing the curricula of the University of Petrosani has started from the need to establish strong connections among the three coordinates of the Bologna type educational system: ***Bachelor studies – Master studies – Doctorate studies***. Curricula have been elaborated with a view to obtaining consistency among the three components; at the same time, the competence given by each component has been structured based on the demands of the local labor market and the implementation of the graduates re-orientation ability required by the adaptation to the deep re-structuring of the Romanian society in general, and of the Jiu Valley area, in particular.

To the effect of meeting the new requirements of the labor market, the University of Petrosani has been involved in a strategic educational POSDRU project - ”*The Development of Human Resources in Higher Education for the Use of the e – Learning System*”. The general objective of the project is the development and modernization of the initial and continuous training system in higher education for a appropriate adaptation to the permanently changing needs in economy and society, by implementing an e-Learning system at the University of Petrosani and the setting up of a data basis in collaboration with the University “Oil and Gases” of Ploiesti. The operational objective of the project is the training of the teaching staff in order to bring in new education and training tools, namely the e-Learning system, by uploading the data basis with teaching materials necessary for the education of students and graduates already working in different fields of economy. The estimated results are the following [36]:

- 240 members of the teaching staff (the target group) from 2 universities situated in different geographical areas, will assimilate knowledge necessary for the use of e-Learning as a modern teaching – learning method;
- 50% of the certified teaching staff will populate the data basis of the system with their courses, under the supervision of the trainers, receiving subventions for these activities;
- the establishment of an e-Learning system (hardware and software) within the University of Petrosani;
- the authorization of the e-Learning training course, which can be subsequently used for other members of the teaching staff;
- the development of competences for the teaching staff in the use of interactive teaching – learning methods and information technologies, by collaborating with other advanced education institutions in Europe, by virtue of collaboration contracts.

In order to achieve these goals, the University uses Trivantis' CourseMill Learning Management System which is worldwide acknowledged due to its scalability, affordability and ease-of-use. The main features of Course Mill for modes of use or roles are as follows [36]:

- students can: view course catalogues and self-enroll; launch enrolled courses, download and submit documents; check progress and results; interact with other students and instructors;
- instructors can manage a course catalogue and content; establish prerequisites; manage grade books and sessions; interact with students; run selective reports for allocated courses;
- administrators can control all aspects of the database, organizations, curricula, users, community features and reports;
- reporters can register students and run reports for selected courses, students and departments.

The main tool for course authoring within the Course Mill platform is Lectora International software. This software product of the same company - Trivantis - is simple to use and allows you to create *html* pages with dynamic content, including templates and wizard. Lectora offers the possibility of publishing practical courses containing texts, images, audio, video, animations etc. using the buttons, menus, dialog boxes, scripts or multimedia files that may be included in the pages created. Being developed especially for solutions of e-Learning, Lectora can be used to create presentations or even Web sites.

Within the University of Petrosani, the Course Mill platform has been operational since 2011 and it supports the process of education for bachelor degrees obtained during distance learning in the following fields: *Management; Accounting and Management Information Systems; Finance and Banks.* In addition, students enrolled in day courses at one of the three faculties – Faculty of Mechanical and Electrical Engineering, the Faculty of Mines and the Faculty of Sciences - have access to the information available on the platform, so that the learning process carried out in different specializations may combine the traditional approach face-to-face type with the new e-Learning technology. In Fig. 1, one may find on the website www.upet.ro the log on window to the Course Mill platform.

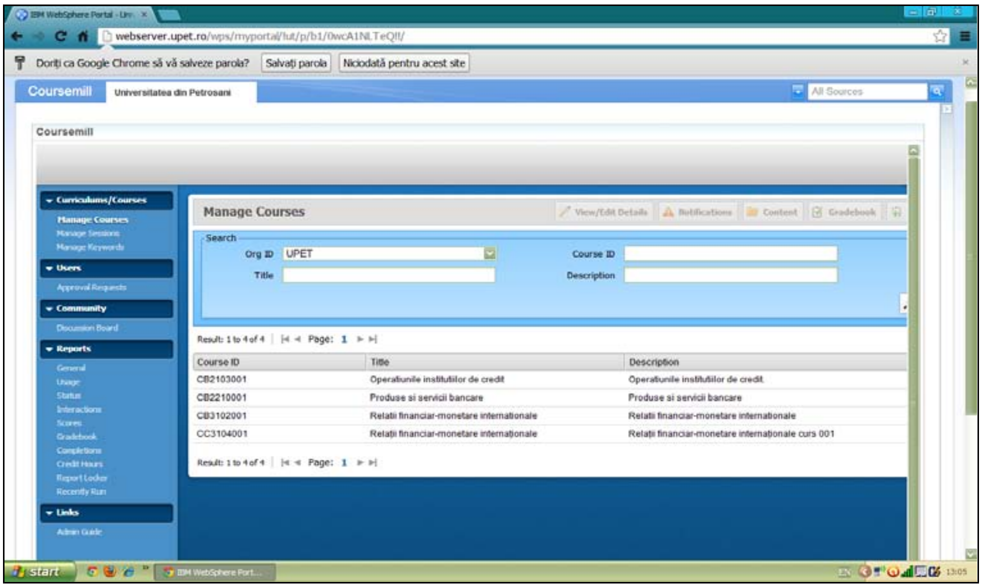


Figure 1: The log on window the Course Mill Platform on the site www.upet.ro

2 Problem Formulation

Nowadays, there are a multitude of factors that influence simultaneously the state and development of phenomena and the social and economic processes which occur on different levels of society. In order to show the extent to which one or more factors or a combination of these determine the development of a resulting variable, statistics provides us a dedicated method - *dispersion analysis or the analysis of a variation* (ANOVA). The ANOVA procedure verifies the extent to which the real values of the accounted characteristic are significantly different from a set of theoretical values (generally determined as average values), as well as the extent to which such deviations are dependent or not on the grouping factor used. Therefore, the dispersion analysis relies on the method of grouping; this method isolates the factors which have a significant influence on the resulting characteristic of random (accidental) factors [1].

The ANOVA model starts from the premise that the average values calculated in relation to the grouping factor represent "typical values" determined at the level of each group $\bar{y}_i$, while the general average $\bar{y}$ is the representative value for the entire population. Real deviations of individual values of the analyzed variables from the average values represent nothing but the effect of associating the examined factors, association which puts its mark on the variation of the resulting characteristic *y*. The assessment of the variation of a variable is usually done through variance. Because variances do not present, in general, the property of additivity, the decomposition of the total variation of the analyzed characteristic uses the sum of squares of the observed values from their average value, known as deviation or variation. By dividing these deviations to the number of corresponding degrees of freedom, we can get the estimates of the variations [1], [19].

Thus, the components of variation are differentiated in relation to the causes that generate it, in two distinct categories: the explained variation (the effect generated by the experimental causative factors) and the experimental error (residual variation) which cannot be assigned explicitly to a specific factor, representing the additive effect of all random factors upon the total variation. For the measurement of the explained component of the variation, which can be made on behalf of one or more factors involved, we can use the variation between groups, while for the error or residual component, the variation within groups is being used [19].

Depending on the number of factors (one, two or more) that can be analyzed in order to explain the variation of the resulting characteristic values, uni-factorial, bi-factorial or multi-factorial dispersion analysis models have been drawn up.

In our paper, we present the design and the use of a bi-factorial ANOVA-type experiment for the analysis of a real decision-making process in the field of education within the University of Petrosani. The main purpose of this study is the identification and the generalization of those teaching technologies, which have a significant impact on improving the learning performances of the students. For this purpose, there was made up a sample of 6 groups of students (3 from the engineering field and 3 from the economic sciences field), and the statistical data collection has led to the following information regarding the grades obtained at the end of an academic year (see the appendix).

Table 1 display the synthesis of the average grades achieved by sampled students, which were classified according to the field of study they the follow and the teaching technology they were exposed to.

We intended to evaluate **whether the two variables** - ***educational technologies*** and ***the field of study*** – **influence** significantly the learning performances.

Table 1: Average grades obtained in learning

	Traditional teaching technologies	**e-Learning technologies**	**Total**
Engineering	6.86 6.22 6.75 Total – 19.83	7.43 7.13 7.21 Total – 21.77	41.60
Economic Sciences	7.02 7.85 8.76 Total – 23.63	9.27 7.92 9.06 Total – 26.25	49.88
Total	43.46	48.02	91.48

3 Problem Solution

We shall use a Two Way ANOVA analysis. This specific model is designed to perform a statistical analysis of a dependent variable Y in relation with two causative factors - A and B. The decomposition of the total variation of the variable Y according to that certain factors which can determine its evolution is shown in Fig. 2.

Let us suppose that the factors A and B are displayed as n and m independent levels in $n \cdot m$ levels of interactions. For each combination between these experimental factors, there are r random experimental units. The total number of observations made within an experiment will be $N=n \cdot m \cdot r$.

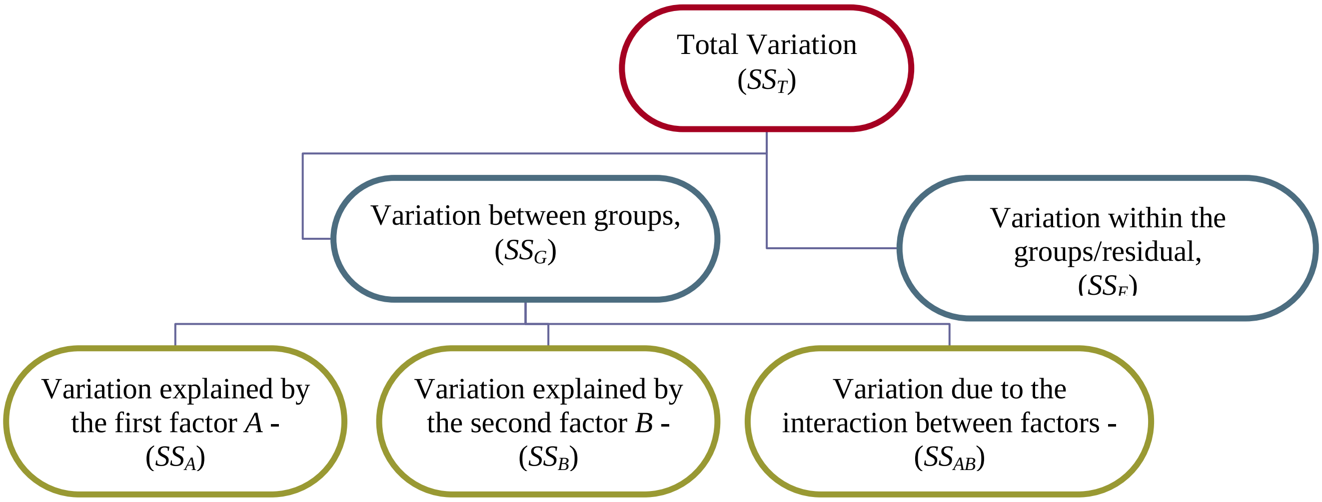


Fig. 2: The decomposition of the total variation of the resulting variable within a bi-factorial ANOVA model

The two experimental factors are A - the field of study in which the student is enrolled within the University of Petrosani, and B – the teaching technology used. Each of these two factors has two levels: the fields of study within the branch of Engineering and Economic Sciences for the factor A and classical teaching tools and e-Learning technologies for the factor B, respectively.

Considering the fact that the conducted experiment is a selective research, in the sense that it is carried out on a sample consisting of only 6 groups of students which compare the two types of teaching methods for a certain subject from the curricula, it is obvious that the result obtained will have a relative value. Thus, it is possible that the data do not coincide with those regarding the total population (consisting of all the groups of students who are studying that subject), and moreover, one cannot know with certainty which is the difference between the two sets of data, since the condition of the total population is generally unknown. The mathematical theory of probability provides procedures for evaluating the results of selective studies, allowing an estimate in terms of probability, of the maximum error that can be admitted by using the values of variables estimated with the help of a sample, instead of the real values which would characterize the overall population [10].

Therefore, the researcher cannot issue confidence judgments regarding the population characteristics evaluated by means of a selective approach, but he can make certain assumptions that bear the name of statistical hypotheses. For a statistical hypothesis that is to be tested we can use the term *null hypothesis*. Particularly, in our case, the null hypothesis can be stated as follows:

- H_{0A} – the teaching technology has no main effect upon the learning performances (for the experimental factor *A*);
- H_{0B} - the field of study in which the student is enrolled has no main effect upon the students' results (for the experimental factor *B*);
- H_{0AB} – there are no significant interactions between the experimental factors *A* and *B*.

Testing statistical hypothesis means subjecting the assumptions to some tests, called statistical tests, operation in which the hypothesis is either rejected or accepted. Such a decision is always based on the calculation of the confidence interval corresponding to a threshold of significance. In order to facilitate practical operations, statistical tests indicate as a rule, the concrete procedure which consists, mainly, in the calculation of a specific test value, denoted by *F* in our case, with the help of research data (*F* comes from the Fisher test). The real value is then compared with the "critical" value from a theoretical table, and, in the final phase, the researcher decides whether the initial hypothesis is rejected or not.

Determining the results of the experiment is done by comparing the calculated values of the Fisher test with the values tabulated for V_1 degrees of freedom in the numerator and V_2 degrees of freedom in the denominator, corresponding to a level of significance α. Accordingly, a value $F_{theoretical}$ is determined and, when comparing it with F_A, F_B and F_{AB} one can distinguish the situations presented in Table 2.

Table 2: Decision rules for the rejection/acceptance of null hypothesis

Fisher Test	Rule of rejection	Rule of acceptance
Factor A	H_{0A} is rejected if $F_{A\ computed} > F_{theoretical\ (n-1);nm(r-1);\alpha}$	H_{0A} is accepted if $F_{A\ computed} \leq F_{theoretical\ (n-1);nm(r-1);\alpha}$
Factor B	H_{OB} is rejected if $F_{B\ computed} > F_{theoretical\ (m-1);nm(r-1);\alpha}$	H_{0B} is accepted if $F_{B\ computed} \leq F_{theoretical\ (n-1);nm(r-1);\alpha}$
Interaction AB	H_{0AB} is rejected if $F_{AB\ computed} > F_{theoretical\ (n-1)(m-1);nm(r-1);\alpha}$	H_{0A} is accepted if $F_{A\ computed} \leq F_{theoretical\ (n-1)(m-1);nm(r-1);\alpha}$

In order to process the data contained in table 1, the following steps are performed [6], [12]:

1. The total sum of squares deviations (SS_T) is determined using the relationship:

$$SS_T = \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{r} x_{ijk}^2 - \frac{T^2}{n \cdot m \cdot r} \quad (1)$$

where: n – the number of levels corresponding to the experimental factor *A* (*n=2*); *m* – the number of levels of experimental factor *B* (*m=2*); *r* – the number of experimental units tested within each subgroup (in the case study there are two subgroups of experimental units – that of the students who study the engineering field and that of the students who study in the economics field, each of these subgroups comprising 3 groups of students, therefore *r=3*); x_{ijk} - the dependent variable represented by the learning results achieved by the students in the fundamental field *i*, who experience teaching method *j* and belong to group *k*; *T* - the grand total of the contingent table.

$$SS_T = \left(6.86^2 + ... + 9.06^2\right) - \frac{91.48^2}{2 \cdot 2 \cdot 3} = 10.337$$

This total variation breaks down into two components: *the sum of squares deviations among the groups* (SS_G) and *the sum of square deviations within the groups* (also referred to as the sum of square deviations due to experimental error - SS_E). Therefore:

$$SS_T = SS_G + SS_E \quad (2)$$

2. The sum of the square deviations among the groups (SS_G) is calculated with the relationship:

$$SS_G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} T_{ij}^2}{r} - \frac{T^2}{n \cdot m \cdot k}, \tag{3}$$

where $T_{ij} = \sum_{k=1}^{r} x_{ijk}$, represents the total of cell *ij*.

$$SS_G = \frac{19.83^2 + 21.77^2 + 23.63^2 + 26.25^2}{3} - \frac{91.48^2}{12} = 7.485$$

3. We can determine **the variation due to random factors SS_E** as the difference:

$$SS_E = SS_T - SS_G = 10.337 - 7.485 = 2.853 \tag{4}$$

In its turn, the sum of square deviations among experimental groups breaks down into:

- the variation due to the factor A, SS_A;
- the variation due to the factor B, SS_B;
- the variation due to the interaction of the two factors, SS_{AB}:

$$SS_G = SS_A + SS_B + SS_{AB} \tag{5}$$

4. The sum of square deviations due to the factor *A* (SS_A) is being calculated:

$$SS_A = \frac{\sum_{i=1}^{n} T_i^2}{m \cdot r} - \frac{T^2}{n \cdot m \cdot r}, \tag{6}$$

where $T_i = \sum_{j=1}^{m}\sum_{k=1}^{r} x_{ijk}$ - the total of the row *i*.

$$SS_A = \frac{(19.83 + 23.63)^2 + (21.77 + 48.02)^2}{2 \cdot 3} - \frac{91.48^2}{12} = 1.733$$

5. The sum of square deviations due to the factor *B* (SS_B) is calculated with the relation:

$$SS_B = \frac{\sum_{j=1}^{m} T_j^2}{n \cdot r} - \frac{T^2}{n \cdot m \cdot r}, \tag{7}$$

where $T_j = \sum_{i=1}^{n}\sum_{k=1}^{r} x_{ijk}$ - the total of the column *j*.

$$SS_B = \frac{(19.83 + 21.77)^2 + (23.63 + 26.25)^2}{2 \cdot 3} - \frac{91.48^2}{12} = 5.713$$

6. The variation due to the interaction of factors *A* and *B* (SS_{AB}) can be determined as the following difference:

$$SS_{AB} = SS_G - (SS_A + SS_B) \tag{8}$$

$$SS_{AB} = 7.485 - (1.733 + 5.713) = 0.039$$

7. Testing the significance of the results obtained with the help of Fisher statistical test and determining the results of the experiment:

In order to verify the statistical significance of the three effects due to experimental factors and the interaction among them, the three values of *F* can be determined with the relations:

- for the first experimental factor:

$$F_{n-1;nm(r-1);\alpha} = \frac{SS_A}{(n-1)} \div \frac{SS_E}{n \cdot m \cdot (r-1)} \tag{9}$$

- for the second experimental factor:

$$F_{m-1;nm(r-1);\alpha} = \frac{SS_B}{(m-1)} \div \frac{SS_E}{n \cdot m \cdot (r-1)} \tag{10}$$

- for the random factors (experimental error):

$$F_{(n-1)(m-1);nm(r-1);\alpha} = \frac{SS_{AB}}{(n-1)(m-1)} \div \frac{SS_E}{n \cdot m \cdot (r-1)} \tag{11}$$

In order to verify if the influence of the first factor - the field of study - upon the average grades is significant, we must calculate the value of *F*:

$$F_{(2-1);2\cdot 2\cdot(3-1);0.05} = \frac{1.733}{2.853} \times \frac{2 \cdot 2 \cdot (3-1)}{(2-1)} = 4.859$$

Since the theoretic value of *F* for 1 degree of freedom at the numerator and 8 degrees at the denominator ($F_{1;8;0.05}$), for a level of significance of 5% is, according to the table, 5.320, it means that **the field of study has no main effect on the learning results achieved by students**.

Moreover, since:

$$F_{(2-1);2\cdot 2\cdot(3-1);0.05} = \frac{5.713}{2.853} \times \frac{2 \cdot 2 \cdot (3-1)}{(2-1)} = 12.016$$

and the theoretical value of $F_{1;8;0.05}$ is 5.320, it means that **the teaching technologies have the main effect upon the learning performances of students.**

However:

$$F_{(2-1);2\cdot 2\cdot(3-1);0.05} = \frac{0.039}{2.853} \times \frac{2 \cdot 2 \cdot (3-1)}{(2-1) \cdot (2-1)} = 0.108$$

while the theoretical value of $F_{1;8;0.05}$ is 5.320. There results that **the interaction of the two experimental factors has an insignificant influence upon the results of the experiment**.

4 Conclusion

The results of the calculations made and the decision of accepting or rejecting the null hypothesis H_0 are summarized in table 3 [23]. It turned out that the teaching technologies had a substantial effect upon the learning performances of students while the field of study does not influence significantly these performances.

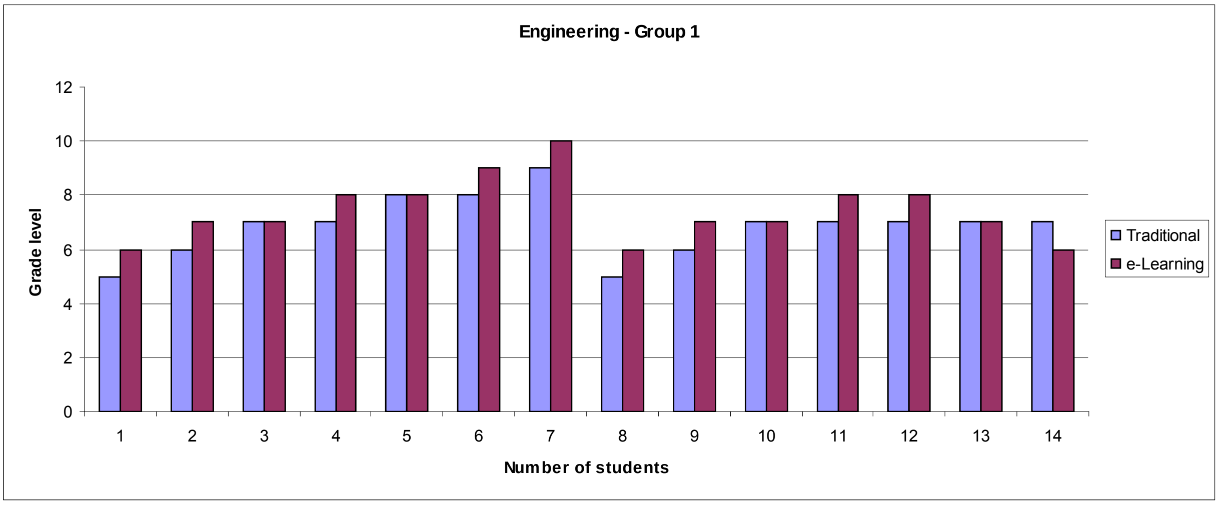
The analysis of statistical tables of the theoretical values of *F* reveals that the conclusion according to which the teaching technology used significantly influences the learning performances of students can be supported with a higher degree of confidentiality. Thus, for α=1%, $F_{theoretical\ 1;8;0.01}$= 11.26, which means that the previous assertion is correct in 99% of the cases.

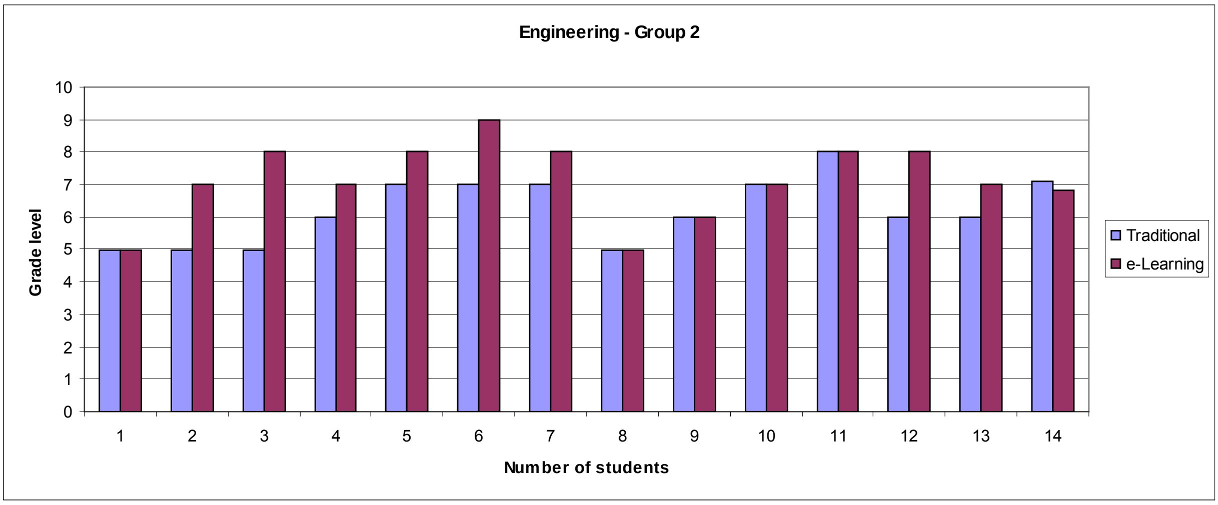
The ANOVA experiment designed in our paper encourages the implementation of the project which aims at assimilating and using e-Learning teaching technologies in all the fields of study in which the University has developed study programmes for various learning cycles. By its importance and expected results, this project contributes to the reassertion of the University of Petrosani as a major educational center, whose main objective is to materialize the concept of life – long learning.

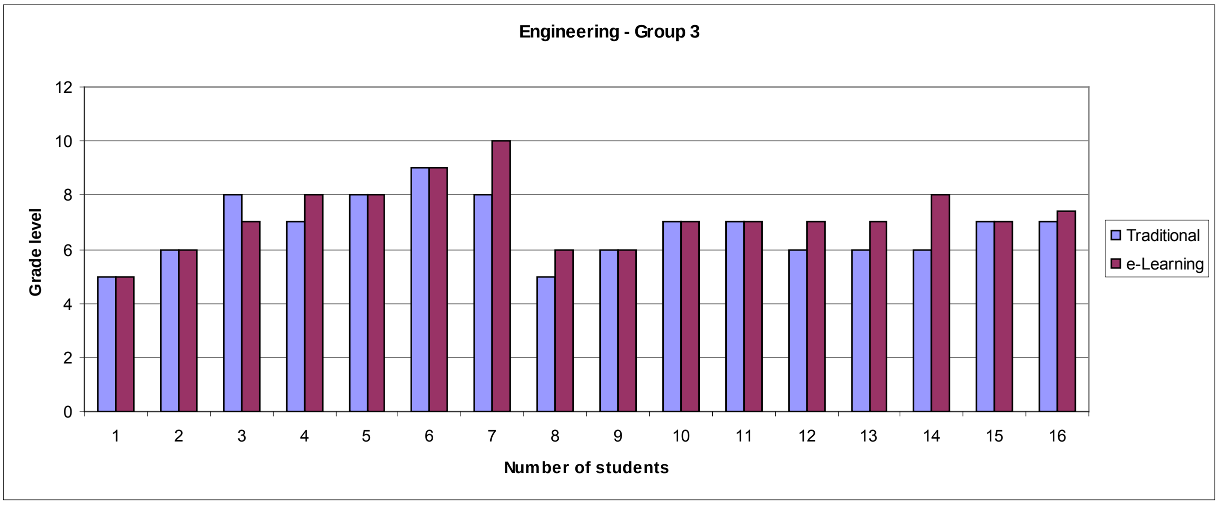
Table 3: The results of the experiment

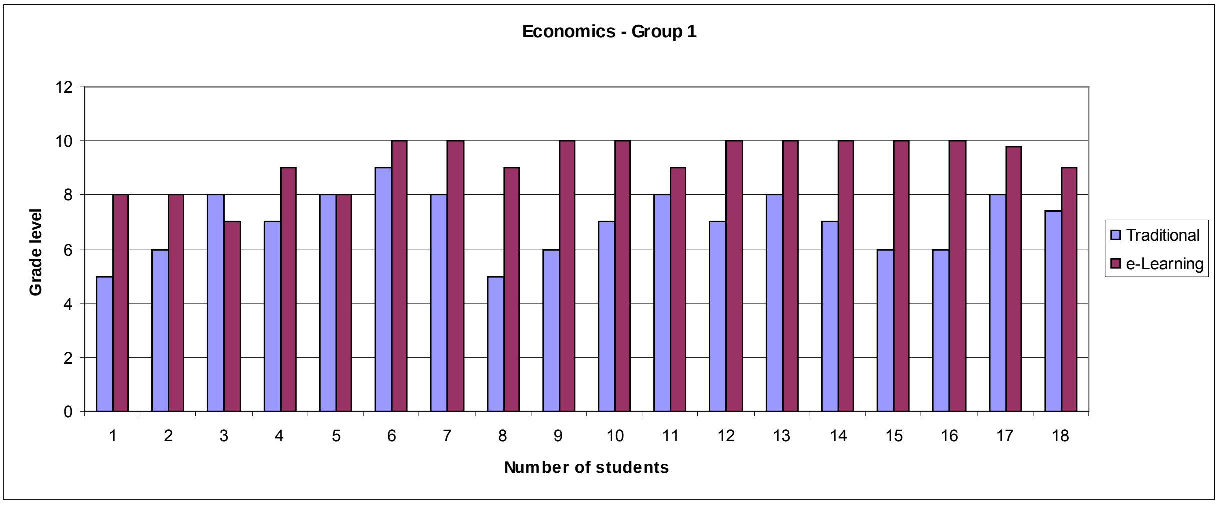
The source of variation	**No. of degrees of freedom**	**Sum of square deviations (variation) *SS***	**Mean square (dispersion) *MS***	**Fisher test *F***
Experimental factor *A*	$(n-1) = 1$	$SS_A = 1.733$	$MS_A = 1.733$	$F_A = 4.859$
Experimental factor *B*	$(m-1) = 1$	$SS_B = 5.713$	$MS_B = 5.713$	$F_B = 12.016$
Interaction between factors *AB*	$(n-1)\cdot(m-1) = 1$	$SS_{AB} = 0.039$	$MS_{AB} = 0.039$	$F_{AB} = 0.108$
Experimental error	$n\cdot m\cdot(r-1) = 6$	$SS_E = 2.853$	$MS_E = 0.475$	-
Total	$m\cdot n\cdot r-1 = 11$	$SS_T = 10.337$	-	-
The final decision	$\boldsymbol{H_{0A}}$ **is accepted** because $F_{A\ computed}$ (4.859) < $F_{theoretical\ 1;8;0.05}$ (5.320)			
	$\boldsymbol{H_{0B}}$ **is rejected** because $F_{B\ computed}$ (12.016) > $F_{theoretical\ 1;8,0.05}$ (5.320)			
	$\boldsymbol{H_{0AB}}$ **is accepted** because $F_{AB\ computed}$ (0.108) < $F_{theoretical\ 1;8;0.05}$ (5.320)			

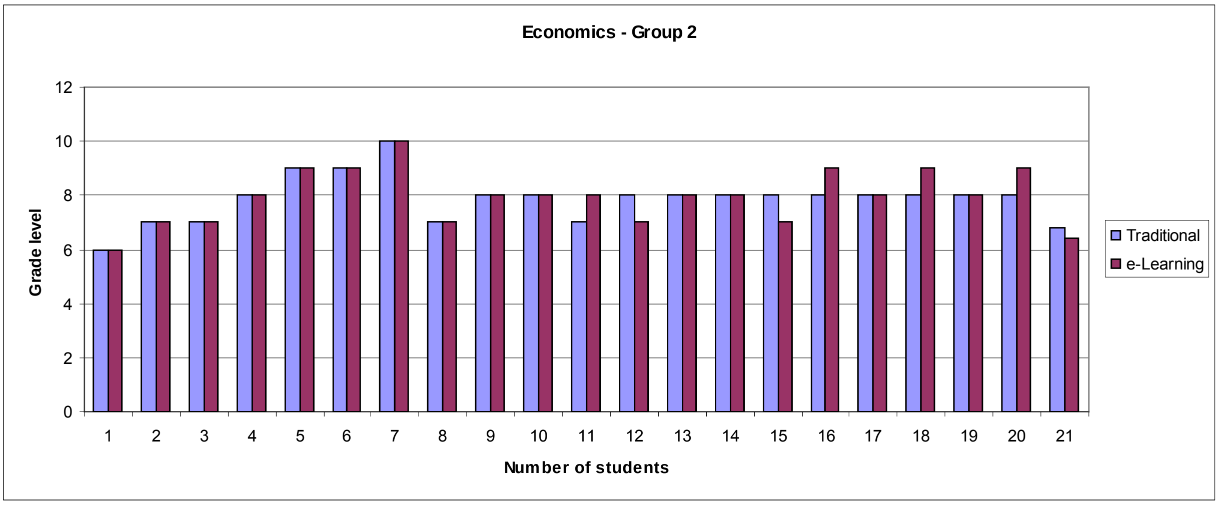
Appendix:

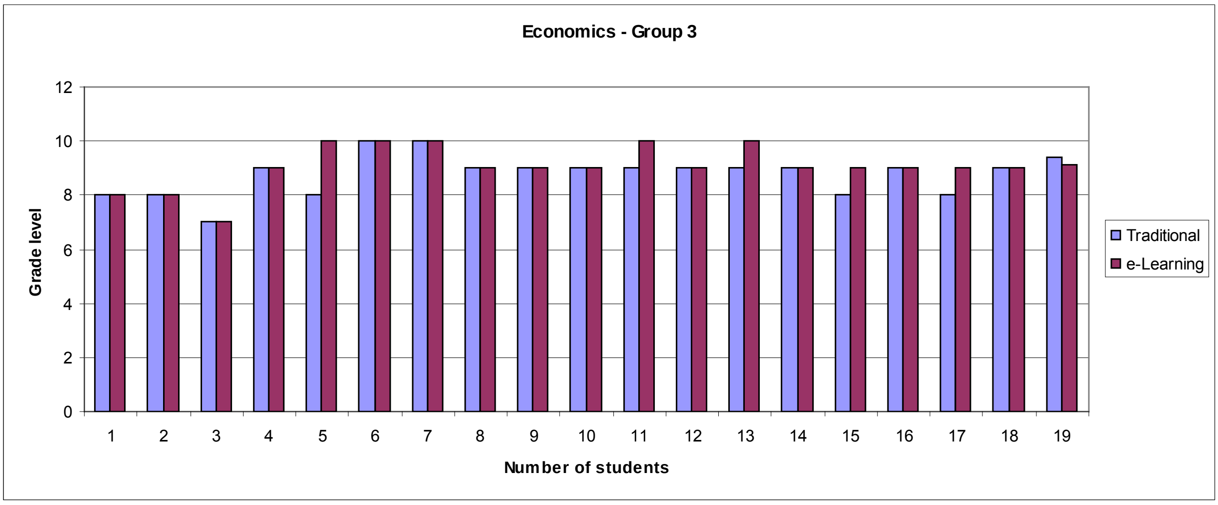





Engineering - Group 3
Grade level
Number of students
Traditional
e-Learning


Economics - Group 1
Grade level
Number of students
Traditional
e-Learning


Economics - Group 2
Grade level
Number of students
Traditional
e-Learning



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