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The implementation of e-learning platforms and Determining the Effectiveness of Multimedia Technologies in Teaching and Learning by Applying Statistical Tests

Wdrożenie platform e-learningowych oraz określenie skuteczności technologii multimedialnych w nauczaniu poprzez zastosowanie testów statystycznych

Streszczenie: W artykule przedstawiono rozwiązania dotyczące poprawy i wzrostu efektywności zarządzania działalności studentów na zajęciach z użyciem narzędzi internetowych. Za pomocą tych rozwiązań studenci mogą mieć zawsze i wszędzie swobodny dostęp w informacji, takich jak: kursy, wirtualne materiały laboratoryjne, opisy badań oraz statystyki. Następnie przedstawiono wybrane wyniki badań i przykłady platform e-learningowych stosowanych w Rumunii. W eksperymencie naukowym zastosowano techniki grup równoległych (4 grupy studentów drugiego roku, 2 grupy tworzące zespół eksperymentalny, dla których były używane kursy multimedialne do procesu szkolenia, i 2 grupy kontrolne). Przeprowadzone badania potwierdziły hipotezę o pozytywnym wpływie realizacji kursów multimedialnych w procesie nauczania grup eksperymentalnych i efektywności stosowanych metod.

Słowa kluczowe: platforma nauczania, e-learning, współczynnik asymilacji, współczynnik automatyki, współczynnik efektywności, funkcja regresji.

Summary: In this article, we presented a solution for improving and rising the management efficiency of the students' activities for the courses in the current semester, using Web Technologies. Moreover, using this solution given by the described application, students of any faculty can have anytime and anywhere access to information such as: courses materials, virtual labs materials, marks given for partial or final tests, statistics regarding the scholar situations. Then, we presented some statistics and examples of e-learning platforms realized in Romania. In this scientific experiment we applied the technique of parallel groups which supposes the implication of 4 groups of second year students, 2 groups forming the experimental team for whom the multimedia courses for training process were used and 2 control groups for whom teaching was made in the traditional system. The application of the statistical methods of processing experimental data attested the hypotheses about the positive impact of the implementation of the multimedia courses in teaching- learning process in the experimental groups and the efficiency of the applied methods to the experimental groups, compared to traditional methods, applied to control groups.

Keywords: e-learning platform, the assimilation coefficient, the automation coefficient, the efficiency coefficient, the regression function.

1. Introduction

The beginning of the third millennium is characterized by a sizable change regarding communication technologies and information and calculus systems. Their potential is able to revolutionize the entire social system. On such terms, the education system should play the promoter role of information technologies, to make them accessible to the entire society.

The society is changing rapidly, and as educators we need to be sensitive to these changes and respond to them in a measured and thoughtful manner. As such, the rules for quality education at a distance are not very different from those that work in a classroom. The most important factor for quality distance education is advanced planning. In distance education strategic planning is not an option but a necessity. The planning process can be summarized in a five-step model:

1. Analyzing the needs of the learner,
2. Designing instructions based on students' learning needs.
3. Developing instructional materials.
4. Implementing instructional sessions.
5. Evaluating the results systematically.

Information technologies are a set of methods of the producing processes and the programmed technical resources joined within a technological chain that provides information accumulation, storage and display, in order to lower the difficulty of using the information resources and to increase its efficiency and security [10].

The impact of the new computing and communication technologies on many aspects of modern life has been dramatic - nowhere more so than in the field of education in general, and higher education in particular.

In recent years, educators have witnessed the rapid development of computer networks, dramatic improvements in the processing power of personal computers, and striking advances in magnetic storage technology. These developments have made the computer a dynamic force in distance education, providing a new and interactive means of overcoming time and distance to reach learners.

The institutional support in adopting a new technology is crucial, for its success or, if not, for its failure, taking into account all the factors involved: institutional or administrative aspects, technology application, teachers' involvement, students' attendance, but also the course contents- if and how these can be applied to the new educational technology.

2. Changes brought by implementing the multimedia technologies in the teaching-learning process

Implementing the multimedia technologies in the teaching-learning process implies an increased attention, amplified volume of conscious information and reduced time for training.

The principles of the new methods and the educational technologies based on using the informational technologies are the following [6]:

a) to accomplish an informational flux (teacher- student), bi-directional, collaborative and inter-disciplinary,
b) the future educational environment must be a virtual one, represented by an electronic campus whose structure will be: administration, teachers' room, course class- laboratory, virtual library,
c) the training must be accomplished individually and must be based on teacher-student team work,
d) the purpose of the teaching process and the education must be to inform, not to memorize passively,
e) the interactive multimedia with its capacity to involve the user is the ideal support for the processes specific to teaching-learning process.

The following list represents the final results from the quality of Internet-based distance education [7]:

Institutional Support

- A documented technology plan that includes electronic security measures (e.g. password protection, encryption, back-up systems) is in place and operational to ensure both quality standards and the integrity and validity of information,
- The reliability of the technology delivery system is as failsafe as possible,
- A centralized system provides support for building and maintaining the distance education infrastructure.

Course Development

- Guidelines regarding minimum standards are used for course development, design, and delivery, while learning outcomes—not the availability of existing technology—determine the technology being used to deliver course content,
- Instructional materials are reviewed periodically to ensure they meet program standards,
- Courses are designed to require students to engage themselves in analysis, synthesis, and evaluation as part of their course and program requirements.

Teaching/Learning

- Student interaction with faculty and other students is an essential characteristic and is facilitated through a variety of ways, including voice-mail and/or e-mail [1],
- Feedback to student assignments and questions is constructive and provided in a timely manner,

- Students are instructed in the proper methods of effective research, including the assessment of the validity of resources.

Course Structure

- Before starting an online program, students are advised about the program to determine if they possess the self-motivation and commitment to learn at a distance and if they have access to the minimal technology required by the course design,
- Students are provided with supplemental course information that outlines course objectives, concepts, and ideas, and learning outcomes for each course are summarized in a clearly written, straightforward statement,
- Students have access to sufficient library resources that may include a "virtual library" accessible through the World Wide Web,
- Faculty and students agree upon expectations regarding times for student assignment completion and faculty response.

Student Support

- Students receive information about programs, including admission requirements, tuition and fees, books and supplies, technical and proctoring requirements, and student support services,
- Students are provided with hands-on training and information to aid them in securing material through electronic databases, interlibrary loans, government archives, news services, and other sources,
- Throughout the duration of the course/program, students have access to technical assistance, including detailed instructions regarding the electronic media used, practice sessions prior to the beginning of the course, and convenient access to technical support staff,
- Questions directed to student service personnel are answered accurately and quickly, with a structured system in place to address student complaints.

Faculty Support

- Technical assistance in course development is available to faculty, who are encouraged to use it,
- Faculty members are assisted in the transition from classroom teaching to online instruction and are assessed during the process.
- Instructor training and assistance, including peer mentoring, continues through the progression of the online course,
- Faculty members are provided with written resources to deal with issues arising from student use of electronically-accessed data.

Evaluation and Assessment

- The program's educational effectiveness and teaching/learning process is assessed through an evaluation process that uses several methods and applies specific standards,
- Data on enrolment, costs, and successful/innovative uses of technology are used to evaluate program effectiveness,
- Intended learning outcomes are reviewed regularly to ensure clarity, utility, and appropriateness.

This new training system is a complementary system, which allows a continuous professional training, more accessible than the classical methods and very beneficial by the elimination of the geographical boundaries, unlimited and equal access for all the users' categories [13]. The possibilities of information personalization offered by e-learning, both as language and contents structure, transform this unit into a powerful instrument for the EU objective of social integration and cultural diversity preservation.

Besides the specific benefits of unlimited access to information, the e-learning training also has long term social and economical effects [5]. This way the citizens are going to become increasingly used to computers and Internet services which in time creates both the trained manpower for producing the information goods in the new economy and the customers for those goods and services as well.

3. Implementing an application to manage the distance learning students' activities

The Web application aims to improve the teacher's work in administrating the students' activity in the courses which they attend in the present semester. By means of the web application, the students have access anytime to the information referring to their activity on a certain course, and the natural errors and the gaps, which could appear because of human mistakes, are completely eliminated.

The main aim of this system is the development of a medium easy to be used both by the students and the teachers. The success of the application depends on the teacher's availability to make known this system provided with a qualitative educational content and with a questions set relevant in number and content [11]. By means of this system, the teachers may offer the students learning unities in digital format as well as questions for self-evaluating.

The created e-learning platform is developed on the Microsoft Active Server Pages (ASP) technology and can be used in any network based on a Windows server. In order to view the created ASP files, an Internet Information Server 5.0 or 6.0 must be installed, and the directory where the ASP file is must be activated with Web Sharing for writing and

scripting. The connection to the database is an operation which is carried out by the system, the user being responsible only for the delivery of the connection parameters (the name of the database, for example IdTests and driver). The database is created with Microsoft Access Application and contains 30 tables and in 16 of them there are different types of relations. The remaining tables are meant to keep information regarding: user names and passwords, grades, general and annual grades, different statistics concerning the passed examinations, the failed ones, the credit points, the numbers of chapters to be given in the online tests for each subject, the date of the last access of the site to warn the students to be attentive during the training process, etc.

As far as the logical structure of the application is concerned, this is organized in 5 modules which communicate with each other, one-way-directed, as one can see in the following figure 1:

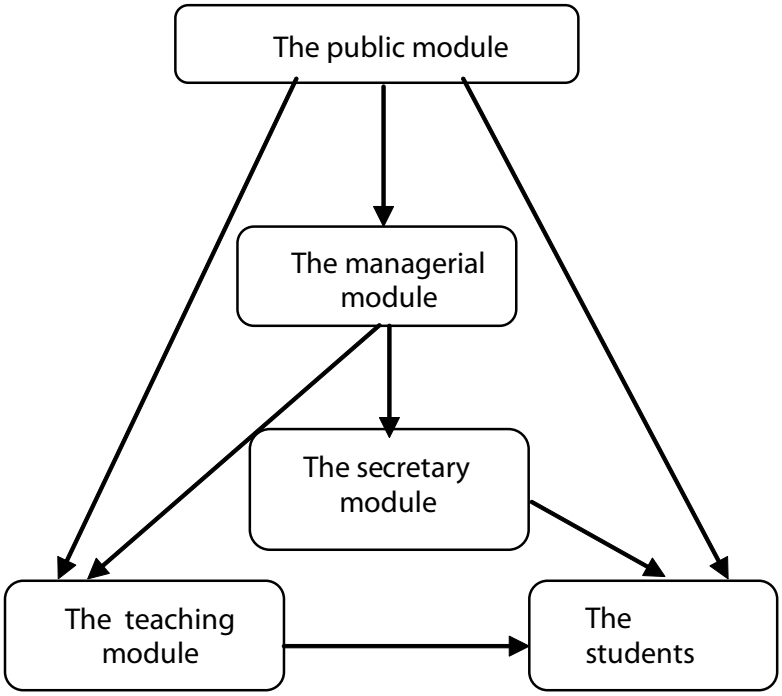


Figure 1. The modular logical structure of the application

For a person to use the managerial module, the teaching module, the secretary module or the students module, he first must authenticate himself using a managerial account, a teaching, a secretary or a student one[account = (name, account, password)]. Similarly, the teaching and the students modules depend on the settings made at the level of the administration module, respectively the secretary module, and the students' module depends also on the settings made at the level of the teaching module.

3.1. The public module

The public module provides information about the educational offer, the enlisting module as well as the guide book. From this module one can find out information about the existing faculties in an University, the existing specializations of each Faculty and the number of places, the study taxes and what has to be done in order to become a student.

Also in this module, there is information to be learned about referring to the study plan of each specialization in an university year or about the enlisted students of learning at a distance program and their final school situations.

Here one can find all the events taking place in the University (conferences, seminaries) and to which the students and the teachers can participate.

The figure 2 presents the logical structure of the public module.

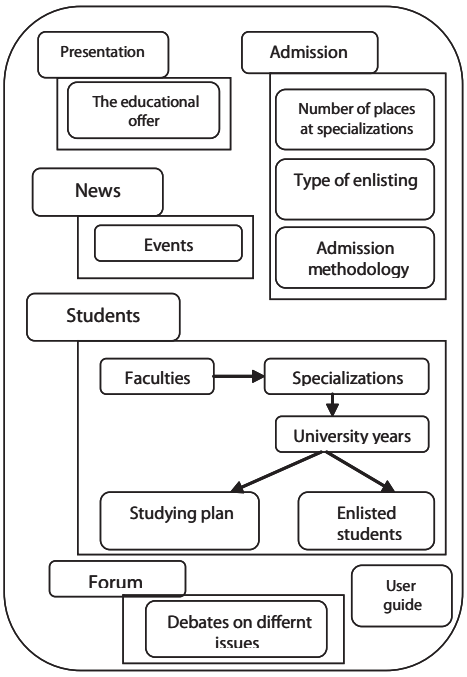


Figure 2. Functionalities provided by the public module

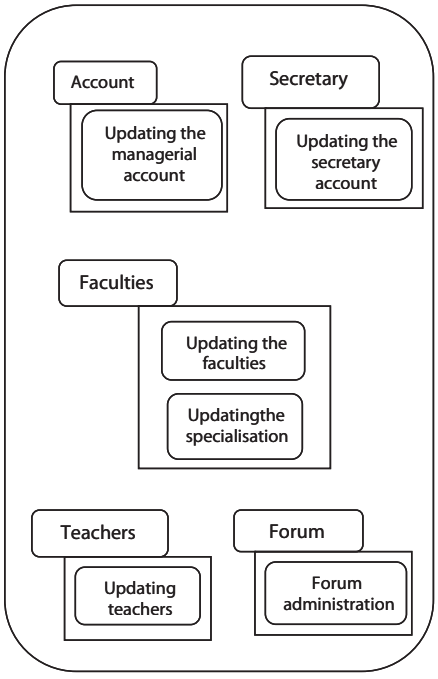


Figure 3. Functionalities provided by the managerial module

3.2. The managerial module

The functions offered by the administration module are very important, because the other modules and functions depend on them (see figure 3). The functions of the administration module may be grouped into the following categories: functions necessary to the organizational chart of the university: faculty updates, profile updates, teacher update; functions necessary to account management: updating the administrator's personal account, updating the teachers' and secretaries' accounts; functions necessary to

communicate: forum administration. The administration panel of the forum is the place where most configurations are made. The administrator controls here the forum and category organization, and may configure the forum names and self cleaning settings.

The administrator having an account for the application may introduce in a form the account name and password, and when clicking OK the application will check if there is such an account and password. According to the testing results made by the application, the administrator will be allowed to access the functions of the respective module corresponding to his/her account, otherwise an error message will be displayed.

We will choose the operation of profile update to exemplify this. The administrator is allowed to do the following operations:

- list the existing profiles;
- add new profiles;
- change a profile;
- delete a profile;
- update the secretary account.

3.3. The secretary module

The secretary module provides functionalities necessary for the administration of the organizing structure of specializations as well as functionalities necessary for the administration of the students' activity (updating of university and learning years, of students and study plan). The functionalities of the secretary module are important because the whole process of studying depends on them (see figure 4). So, at this level, the following stages of evidence of the education system are established:

- The study plan on faculties, specializations, calendar years and study years. The creating of the study plan requires the establishment of the study disciplines of each study year, of the specific credit points, of the evaluating form (written or oral examination), of the semester in each of the disciplines studied, of the entitled teacher and of the tutor.
- The students' details on faculties, specializations, calendar years and study years. Before going to a new calendar year, the secretary must always take into account the "School Situations". The moment the secretary opens this page for each student, the following dates are actualized:
  - the number of passed exams is calculated,
  - the number of re-examinations is determined,
  - the accumulated credit points are calculated,
  - the passing grade of the study year.
- The emphasis on faculties, specializations, calendar and study years. This option is useful to the secretary for visualizing the obtained results of the students as for their listing, too.

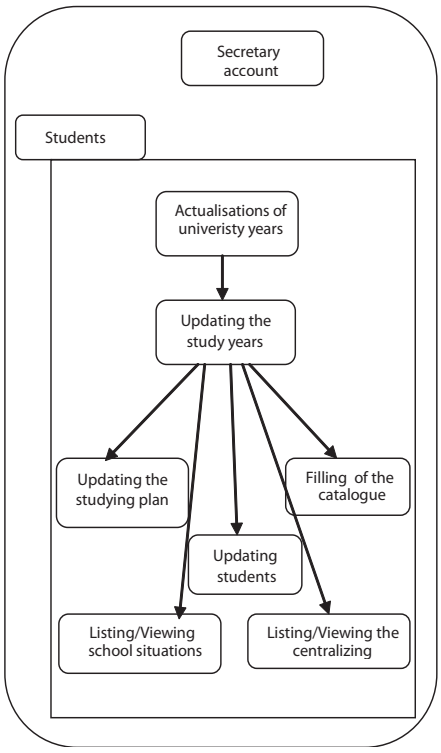


Figure 4. Functionalities provided by the secretary modul

- The School Register of each faculty, specialization, calendar and study year.
- Statistical reports at the request of each faculty, specialization, calendar and study year.

The secretary of a specialization has an account created by the administrator of the application. On the basis of the account and of the password, he can access the web pages through which he realizes all the necessary actions of the secretary. A secretary can access on the basis of the account only the pages specific to the specializations of which he is taking care. To conlcude, the secretary must have training specific to the following responsibilities:

- The enlisting of the candidates for the first year of the study year.
- The closing of the school situations (enlisting, exclusions).
- The students' repartition.
- The underlining of the examinations results.
- Various reports.

3.4. The teaching module

The teaching module provides functionalities necessary for the administration of the organizing structure of the courses (the structuring of the course material on chapters), of the announcements referring to the examination dates, of the evaluating forms as well as functionalities necessary for the administration of the students activity [8]. This module also realizes the communication with students on chat or e-mail.

Functionalities offered by the teacher module are grouped in the following categories (see figure 5):

- functionalities necessary to the administration of the organizing structure of the courses: the transmission of the course materials, presentations of the chapters from the material,
- functionalities necessary to the examination of the students: the establishing of the evaluating form, of the on-line tests of the chapters which come up in the examination [3],

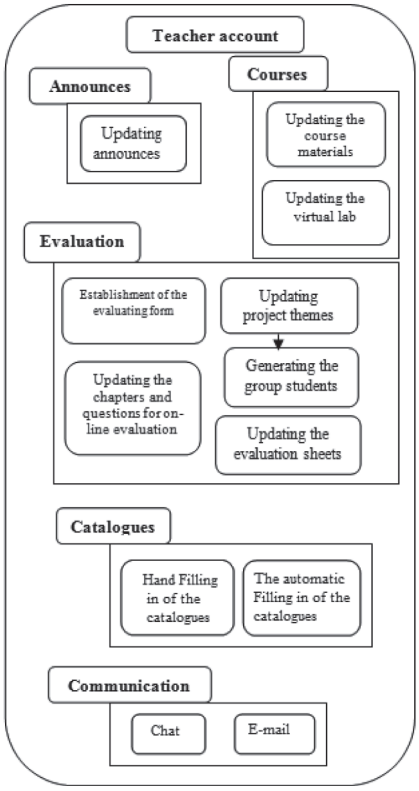


Figure 5. Functionalities provided by the students module

- functionalities necessary to the administration of the students' activity during the courses: recording the students' activity at the examinations,

The titular course teacher or the discipline tutor must provide the enlisted distance learning students with the necessary materials for acquiring knowledge at each discipline

Every tutor has an account and a password, established by the administrator of the application. With these he can realize all the necessary actions in the pages corresponding to the disciplines which he teaches. Thus, a teacher cannot administrate the information about other specializations, study or calendar years.

Administration. Announcements. The tutor may inform all the students by means of an "announcements" window about the settlement of the partial and final examinations, meetings to discuss certain issues, eventual changes to the school program etc.

Communication. The teacher may contact the students on e-mail or chat. To send an e-mail, the teacher can establish to whom he is sending the e-mail. By means of some validation cassettes, he has the following possibilities:

- to select one student to whom he will send the e-mail,
- to select a certain group of students to whom he wishes to send an e-mail,
- to select all the students.

The Chat LD application is useful for the students and teachers to discuss on-line. Thus, the teacher can simplify the acquiring of knowledge by individual or group explanations of some parts of the course material which haven't been understood.

The evaluation of the students. The teacher may establish the form of evaluation which he wishes to use for evaluating the students. He has the possibility to use the on-line LDTests application or to use the project evaluation form or to combine these two.

In case of on-line situations, the teacher decides that the final mark should consist of one mark obtained at a summative evaluation or as a sum of more marks of different formative and one summative evaluation form.

When using the on-line LdTests evaluation, the teacher is the one who is in charge of managing the test questions which are organized in chapters. Thus, he has the possibility to view and actualize the chapters and the questions of each chapter.

The teacher may choose the project evaluation form. The project begins with defining and understanding the task, with its solving and continues for some days or weeks, the time in which the students have permanent consultations with the teacher. The project can be carried out in groups or individually.

The teacher can update (adding, modifying or deleting) at the beginning of each semester the already proposed project themes. After establishing the themes, the teacher is the one who forms the groups of students for each project. The groups of students are formed at random depending on the number of students for each group.

The hand filling in of the catalogues. Taking into account the groups of students, the teacher can complete the catalogues by introducing the marks on a form. First of all, each student has five spaces for marks (the student can repeat the examination five times). The teacher must first choose the date for the examination and the number of marks of which the final mark is formed (a mark if the teacher chooses only one summative evaluation or more if more examinations are desired).

For each student in a group there are three columns representing the obtained mark, date of examination as well as the possibility of improving the mark. In this last column, after the first passed examination, appears a cassette of validation. If the student asks to improve the mark, the teacher fills this cassette of the respective student, giving him this possibility. This is an important aspect because after the first exam session, the teacher can mark only those students who haven't passed the exam or who have chosen to improve the mark.

At a new examination, the teacher has the possibility to mark only those students who haven't passed the examination or who wanted to improve the mark, if the validation cassette was filled, the teacher thus having a clear situation of the passed examinations and of the re-examinations.

After each exam session, the teacher has the possibility to list the catalogues and to save them in a file on PC.

The automatic filling of the catalogues. The teacher has the possibility to complete the catalogues in accordance with the obtained grade given in the on-line tests at the first exam session or at the re-examination sessions. Thus, after filling in the date of the examination and the number of marks, the teacher must fill in the dates when the examinations took place and the percentage of each mark.

At the first examination, all the students who didn't pass the on-line examination or the missing students will be listed, and at a new examination all will be generated automatically in the catalogue only for those students who haven't passed the examination or asked to improve the grade.

If the student tries to repeat the examination for several times at the established date because he is not satisfied with the grade, all his marks are saved in a table in the data base, and when the catalogue is generated, the obtained mark of the first test is taken into consideration.

3.5. The students module

The students module offers the possibility to receive course materials, information about their activity during the classes in the present study year as well as the possibility to repeat self-evaluating tests at each chapter, to discuss with the colleagues and the tutors by chat or e-mail and to view the project theme which he must do and the group he belongs to.

The students module offers an account for applying the following functionalities (see figure 6):

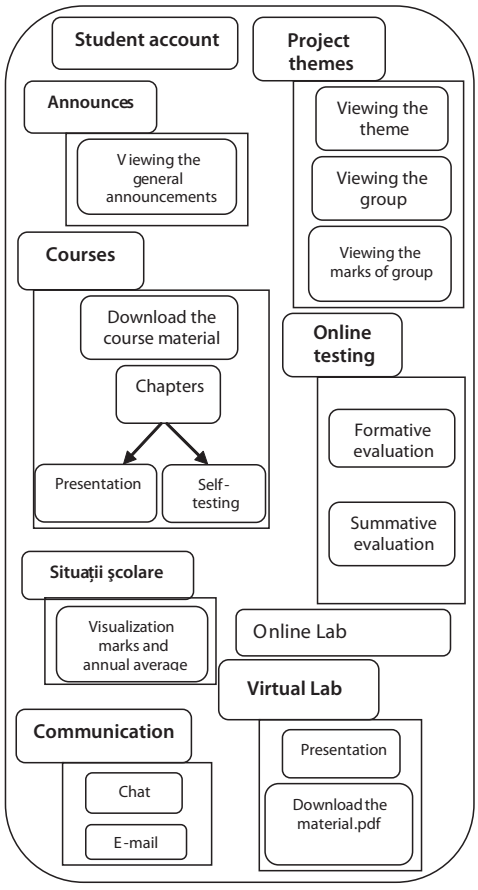


Figure 6. Functionalities provided by the teacher module

- the possibility of accessing the course materials for all disciplines in the present semester, presentations of each chapter at each discipline,
- online testing and self-evaluating at each chapter,
- the listing of final marks of the students for each course in the semester,
- communication with colleagues and the discipline tutor,
- the possibility to access the virtual online laboratories (for certain subjects).

For those subjects provided with laboratories in the mode of traditional education, the distance learning student may have access to virtual laboratories. The student may access the presentations in specialized programs (WinkPortable – for the computer science laboratories, LabView – for the physics laboratories) and files in .pdf format that contains images with presentations and that may be saved in the personal computer.

4. Statistical methods for measuring the results obtained by students in the teaching and learning process

In this chapter we present the results of an experiment made at the Faculty of Economics Sciences. In this scientific experiment we applied the technique of parallel groups which supposes the implication of 4 groups of second year students, 2 groups forming the experimental team for whom the multimedia courses for training process were used and 2 control groups for whom teaching was made in the traditional system. The experimental implementation and the determination of the efficiency of the teaching- learning multimedia technologies were made with the desire to underline the necessities of transformations which self-impose to the educational system, to synchronize it with the general tendencies of the development of the contemporary society.

The efficient implementation of the multimedia technologies in the teaching- learning process necessitates a scientific underlying, meaning a demonstration of its utility, its pedagogical reason. "The defining of the quality and efficiency categories into the teaching- learning process is possible only through evaluation" [6]. In any field of research, "evaluation means a set of operations through which data resulted from the investigation of phenomena are brought into light, are measured, represented and interpreted" [2].

The contemporaneousness of the investigation topic relies on the fact that in recent years the society made more persistent demands linked to computers: the specialists' training in the implementation of the computer system through the development of the skills of finding, accumulating and understanding the information, of implementing the informational and communicative technologies for its processing, of building virtual models of the objects and actions into the real world. The advances in informational technologies contributed to the motivational rise in the study of some disciplines, which have nothing in common with informatics, because they facilitate learning, due to the fact that the individual particularities of the student are taken into account, also his/ her capacities and preferences, assuring the existence of feedback between the student and program, increasing the efficiency of the learning process.

Thus, the informational technologies are used more frequently in the diversity of spheres of human activities: medicine, finances, mass-media, science and in education.

Bringing these arguments, we can state that the refreshment of the educational process is practically impossible, without the implementation of the advanced informational technologies, including the multimedia technologies.

For the statistical processing we shall examine the results of a test which was applied to two comparative groups: experimental groups for whom the multimedia courses were used for the instruction process and the control groups for whom teaching was realized in the traditional system.

The measurements were done based on the evaluation of the following aspects: the evaluation subsequent to sustaining an ability test and performing a control task, and regarding creative abilities. In order to choose the validation criteria for the experimental results we rely on the following categories: the quantity of assimilated information, the awareness regarding the gained information, the degree to which the subject matter was assimilated. These are part of the student's abilities field and will be applied for the evaluation.

The parameter expressing the quantity of information is calculated based on the number of study elements (*Nes*). In order to determine Nes we will use the logical structure of the "Databases" subject matter. The number of study elements is thirty (*Nes=30*). The value of this parameter is relative and it is established by the author of the multimedia training course. Research has shown that the level of generalization of this course depends on the number of study elements included. If the students assimilate this volume of information, we may consider that the established objectives have been met.

The parameter reflecting the awareness level is determined by applying the assimilated knowledge. The value of this parameter is expressed through the Gc coefficient, which is established by the following definition: "awareness is the intellectual and mental activity, the attention for clarification and understanding" [4]. The author Gremalschi L. proposes an evaluation model for students' knowledge and abilities in which the students' abilities is divided regarding subject matters pertaining to informatics in six categories: knowledge (*Gc=1*), understanding (*Gc=2*), application (*Gc=3*), analysis (*Gc=5*), synthesis (*Gc=5*) and evaluation (*Gc=6*). Based on the particular traits of the awareness level, we will determine the coefficient of subject matter assimilation. Applying these new educational methods and strategies, as well as the new teaching-learning technologies, lead to the realization of the scientific principle, by modernizing the contents and perfecting the level of training.

4.1. Analysis of the degree of assimilating the subject, of the students' performance level and of the teaching methods

4. 1.1. Analysis of the degree of assimilating the subject

The parameter that reflects the quality of learning the subject is expressed by the assimilation coefficient (Ci). For the test we set the awareness coefficient Gc=4, because it determines the students' capacity to "know, understand, apply and analyse" [9] the information.

The control test focused on the students' "creative skills", the awareness coefficient was set at Gc=5, corresponding to the level "creative knowledge" expressed by the "synthesis" criterion.You can see in the following figure 7.

The assimilation coefficient for each student will be determined from the formula: , where:

$$Ci = \frac{ict}{t}$$

it – the number of questions of the test;

itc – the number of correctly solved questions.

Given that the prepared test contains 30 questions, (the value it=30), the questions were chosen according to "the volume of knowledge, included" in the course. The test "contains problems with various difficulty" [2].

Based on the value of the assimilation coefficient we take into account the following cases:

a) If the assimilation coefficient Ci ≥ 0.7, the subject is deemed as assimilated at a high level;
b) If: $0.5 \leq Ci < 0.7$, the subject is deemed partially assimilated;
c) If $Ci < 0.5$, the subject matter is not assimilated (in conclusion it is necessary to review the content of the questions).

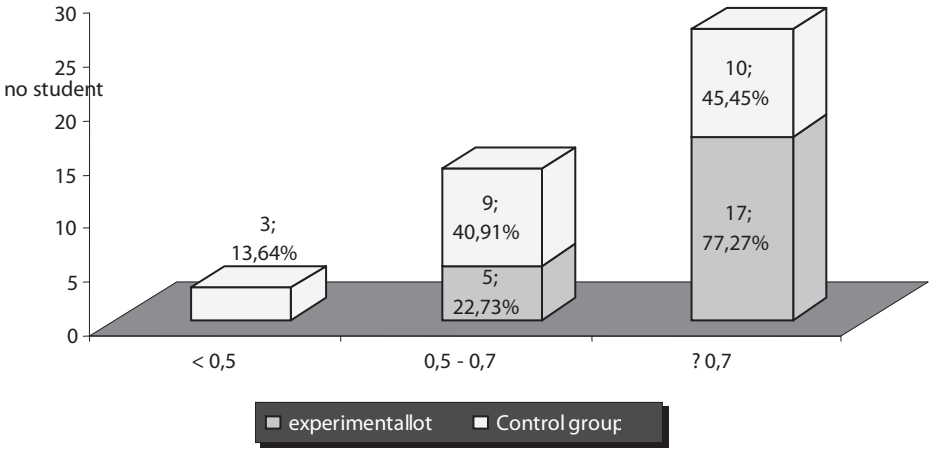


Figure 7. Distribution of students according to the appropriation for the control group and experimental group

For 13.64% (3 students) out of 22 students of the control group, the assimilation coefficient is below 0.5(see figure 7). These students did not assimilate the subject matter appropriately. The subject is deemed partially understood (the value of the assimilation coefficient is between 0.5 ÷ 0.7) by 40.91% (9 students) of all the students in the control group, significantly higher (p = 0) compared to 22.73% (5 students) of the experimental group. The subject is assimilated at a high level (an assimilation coefficient higher than 0.7) by 45.45% (10 students) out of the 22 students of the control group and by 77.27%

(17 students) of the 22 students of the experimental group. The number of students in the experimental group who assimilate the subject at a high level is significantly higher than that of the students of the control group (17 compared to 10 students).

This analysis proves that in the experimental groups, in which modern teaching and learning technologies were applied, the assimilation coefficient is higher, compared to that in the control group, where traditional training methods were applied.

If: $Ni = it*n$; $Nic = \sum_{i=1}^{n} ict_i$, where:

it – number of questions of the test;

n – the number of students in the group;

itci – the number of questions solved correctly by the student i;

Ni – the total number of questions proposed for the whole group;

Nic – the total number of questions solved correctly by the experimental or control group;

We will determine the assimilation coefficient or each group (Ci) using the following formula: $C_i = \frac{Nic}{N_i}$

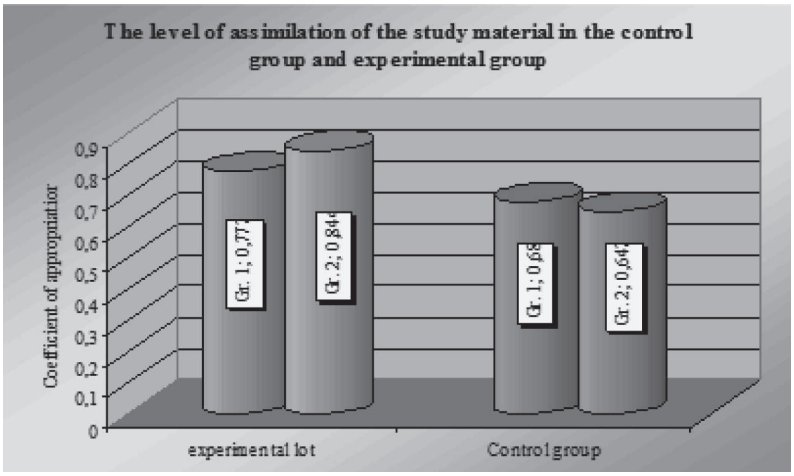


Figure 8. The level of assimilation of the study material in the control group and experimental group

From the analysis of the results obtained we conclude that the required knowledge assimilation level was reached and that the necessary volume of information was assimilated in all the groups(see figure 8).

As we can see in figure 9, in the experimental group the subject assimilation coefficient is higher than that of the control group (*0.81* compared to *0.66* – the average value of the assimilation coefficient for the experimental and control group respectively).

For the analysis of the results of the execution of a control test in the experimental group and in the control group the awareness level of *Gc=5* was set. The value of the test was graded with *10* (*It=10*).

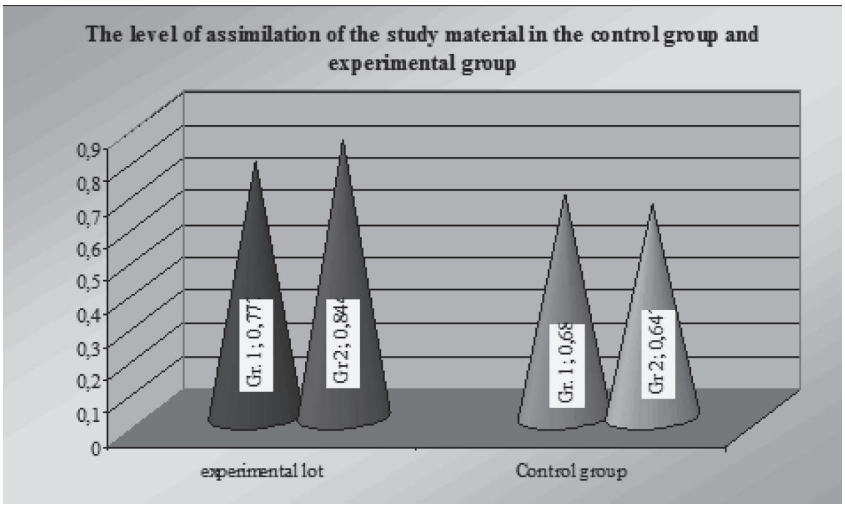


Figure 9. The level of assimilation of the study material in the control group and experimental group

Following the analyses of the results obtained we can say that the subject was assimilated, and the objectives proposed were achieved.

4.1.2. Analysis of the automation coefficient

The students' performance level, in relation to skills concerning the application of the knowledge and the handling of implicit tools, of study processors, will be determined after the time necessary for the completion of the test. The automation coefficient [14.], marked with Ca, will be determined by the ratio:

$Ca = \frac{te}{tp}$, where

tp – the time expected for the execution of the tasks of the paper;

te – the time necessary for the student to perform the given tasks.

If

$Tp=tp*n$, $Te = \sum_{i=1}^{n} te_i$, where:

tp – the time expected for the execution of the task;

tei – the time necessary for the student to perform the given tasks;

Tp – total expected time;

Te – total time necessary to the students to perform the given tasks.

The average automation coefficient, which is the ratio between the total expected time Tp and the total time necessary to complete tasks Te, of each group will be calculated using the formula: C

$$\overline{Ca} = \frac{\sum_{i=1}^{n}}{n*tp} \text{ or } \overline{Ca} = \frac{Te}{Tp}$$

The data indicating the value of the average automation coefficient, calculated in each of the groups of the two compared groups are represented in the following table 1:

Table 1. Average value of the automation coefficients for the experimental group and for the control group

Experimental Group			Control Group		
Group	The average assimilation coefficient	The average automatization coefficient	Group	The avergae assimilation coefficient	The average automatization coefficient
For the test					
E I	0,776	0,8225	CI	0,68	0,9025
E II	0,844	0,825	CII	0,647	0,9083
$\overline{Ca}$	0,82375		$\overline{Ca}$	0,9054	
For the control task					
E I	0,81	0,7325	I	0,58	0,9725
E II	0,875	0,6895	II	0,616	0,975
$\overline{Ca}$	0,711		$\overline{Ca}$	0,97375	

The smaller the ratio between the time spent by the student and the expected time, the more efficient the automation coefficient.

Table.1. shows the values of the average automation coefficient of each group of students, recorded following the test and the completion of the control test. Thus, the calculation of the automation coefficient of each group indicates the following results:

- for the experimental group *Ca = 0,82375* at the completion of the test and *Ca = 0,711* at the control test,
- for the control one *Ca = 0,9054* at the completion of the test and *Ca = 0,97375* at the control test.

Following the analysis of the results in table no.1. we note that the students in the groups with a higher assimilation level (close to 1), also have a more efficient automation coefficient. In the control group almost all the expected time was consumed within papers or tests, showing a rather poor assimilation coefficient. We can conclude that, by applying the new teaching and learning technologies we succeed in providing students with better outlined computer skills, than in the case of applying the traditional training methods.

4.1.3. Analysis of the efficiency coefficient

Let us determine a new parameter that will illustrate the quality of the training process with the implementation of the multimedia classes, expressed by the efficiency coefficient (*Ce*) of the teaching and learning process.

The relative efficiency coefficient of the assimilation of the subject will be determined by the ratio between the total number of subjects and the expected timeframe.

$$Crv = \frac{Ni}{Tp} = 0,75$$

The real efficiency coefficient will be the coefficient of the assimilation of the subject by each student (i) and will be determined by the ratio between the total number of subjects correctly solved and the timeframe in which the student solved the questions of the test (i).

$Crl = \frac{itc_i}{te_i}$, where:

Ni – number of questions of the test;

Tp – the time expected for the execution of the tasks;

itci – the number of questions solved correctly by the student i;

tei – the time necessary for the student to perform the given tasks.

For the validity of the results we will compare the values of the efficiency coefficients of the teaching and learning process and we will consider the following cases:

If the real efficiency coefficient *Crl ≥ Crv,* (*i.e. Crl ≥ 0.75* then:

a) for *0.8 ≤ Crl < 1* – the results are excellent, therefore the teaching technologies are very efficient;
b) for *0.7 ≤ Crl <0,8* the results are very good, so the applied teaching methods have a high efficiency coefficient;
c) if: *0.6 ≤ Crl < 0.7* – the results are rather good, the efficiency coefficient is close to the targeted;
d) if: *0.5 ≤ Crl < 0.6* – the efficiency coefficient is low, the teaching and learning methods need some changes;
e) if *Crl < 0.5* than the teaching and learning process is inefficient and it is necessary to review the content of the course or to change the teaching technologies.

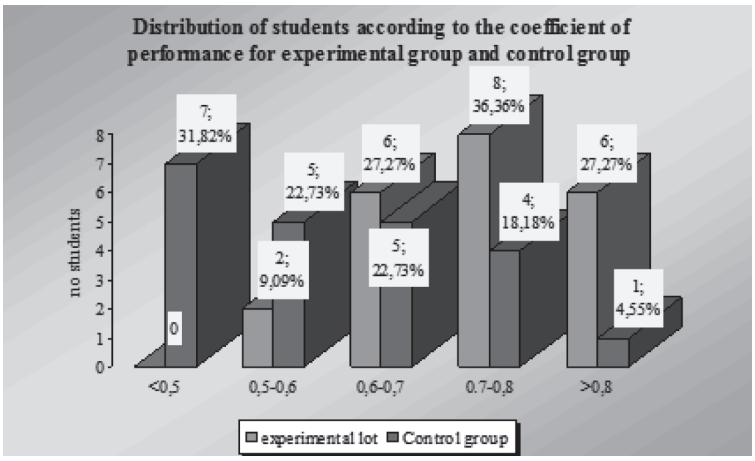


Figure 10. Distribution of students according to the coefficient of performance for experimental group and control group

You can see in the following figure 10 that for *31.82%* (7 students) of all the students in the control group the teaching and learning process is inefficient (the efficiency coefficient is *< 0.5*).

The teaching technologies need some changes (the efficiency coefficient has values between 0.5 and 0.6) for *22.73%* (5 students) of all the students in the control group, whose percentage is higher than the percentage of *9.09%* (2 students) in the experimental group.

Starting with a value of the efficiency coefficient of 0.6, the share of students in the experimental group is higher than that of the students in the control group. Thus for *36.36%* of the students in the experimental group (8 students) the results are very good, so the applied teaching methods have a high efficiency coefficient. We can only say the same thing about *18.18%* of the students in the control group.

We can notice that, in the result of the pedagogic experiment in the experimental groups, the efficiency coefficient of teaching is greater than or equal to *0.75*, so we can deem that the teaching process is efficient. However, in the control groups, the efficiency coefficient of the teaching and learning process is lower: between *0.5* and *0.6*, which shows the inefficiency of the traditional teaching and learning methods. In this case the multimedia courses contain too much information, which cannot be assimilated by traditional methods, in the pre-established time.

The students who have obtained a higher subject assimilation coefficient, obtained, in a shorter time than the one provided for the completion of the tasks, a higher efficiency coefficient. Thus we conclude that by applying the information technologies in the teaching and learning process we receive as a result:

1. an increase in the volume of assimilated information (the assimilation coefficient, the capacity of the memory);
2. a reduction of the timeframe (the automation coefficient) necessary to acquire knowledge and computer skills;
3. an increase in attention, whose parameter is more difficult to measure, but has a great influence throughout the whole teaching and learning activity. With the help of the multimedia effects we can focus our attention on the key elements of the displayed information.

4.2. Central trend and variation indicators

The central trend and variation indicators for the test task in the experimental and control group you can see in the Table 2.

Table 2. The central trend and variation indicators for the test task in the experimental and control group

Experimental group	Value indicators	Control group	Value indicators
Mean	24,40909	Mean	19,86364
Standard Error	1,007889	Standard Error	0,926511
Median	25,5	Median	20
Mode	30	Mode	18
Standard Deviation	4,727418	Standard Deviation	4,34572
Sample Variance	22,34848	Sample Variance	18,88528
Kurtosis	–0,90668	Kurtosis	–0,68347
Skewness	–0,50199	Skewness	–0,04002
Range	15	Range	16
Minimum	15	Minimum	12
Maximum	30	Maximum	28
Sum	537	Sum	437
Coefficient of variation	0,1938	Coefficient of variation	0,2190
Count	22	Count	22

Following the analysis of the results in table no.2, the average score of the *22* students in the experimental group is significantly higher than the average score of the students in the control group (*24.41* compared to *19.86* points).

The standard error is lower in the case of the control group (0.93 compared to 1). Half of the students in the experimental group have a score lower than *25.5* points and for the control group lower than *20* points. Most students in the experimental group have *30* points while most students in the control group have *18* points.

The score of the students in the experimental group deviates, on average, more or less, from the average value of the score by *4.73* points and in the case of the students in the control group by *4.34* points.

The kurtosis of the group can be assessed based on the Kurtosis indicator in such a way as for the control group as well as for the experimental group this indicator has a strictly negative value which reflects a Mezokurtic distribution with a flatter graphic representation compared to the normal distribution curve.

The asymmetry direction is given by the value of the Skewness indicator so that for the experimental group we have a negative or right average intensity asymmetry (*–0.50*) and for the control group we have a right low intensity asymmetry (*–0.04*).

The experimental group is more homogenous than the control one because the value of the variation coefficient for the experimental group is lower than that of the control group (*0.1938* compared to *0.2190*).

Table 3. The central trend and variation indicators for the control test in the experimental and control group

Experimental group	Value indicators	Control group	Value indicators
Mean	8,454545	Mean	6
Standard Error	0,277022	Standard Error	0,308607
Median	8,5	Median	6
Mode	8	Mode	5
Standard Deviation	1,29935	Standard Deviation	1,447494
Sample Variance	1,688312	Sample Variance	2,095238
Kurtosis	-0,79096	Kurtosis	1,313756
Skewness	-0,39191	Skewness	0,829019
Range	4	Range	6
Minimum	6	Minimum	4
Maximum	10	Maximum	10
Sum	186	Sum	132
Coefficient of variation	0,1529	Coefficient of variation	0,2417
Count	22	Count	22

As we can see in *table 3,* the average score, at the control test, of the students in the experimental group is significantly higher that the average score of the students in the control group (*8.45* compared to *6* points).

The standard error is lower than in the case of the experimental group (*0.277* compared to *0.309*). Half of the students in the experimental group have a score lower than *8.5* points and for the control group under *6* points. Most students in the experimental group have *8* points while most students in the control group have 5 points.

The score of the students in the experimental group deviates, on average, more or less, from the average value of the score by *1.299* points and in the case of the students in the control group by *1.45* points.

The kurtosis of the group can be assessed based on the Kurtosis indicator in such a way as for the control group as well as for the experimental group this indicator has a strictly negative value which reflects a Mezokurtic distribution with a flatter graphic representation compared to the normal distribution curve.

The asymmetry direction is given by the value of the Skewness indicator so that for the experimental group we have a negative or right average intensity asymmetry (-0.39) and for the control group we have a left high intensity asymmetry (*0.83*).

The experimental group is more homogenous than the control one because the value of the variation coefficient for the experimental group is lower than that of the control group (0.1529 compared to 0.2417).

5. Analysis of the correlation between the score and the time required for the response

We are further analysing the dependence of the score, deemed an endogenous variable, against a potential influence factor i.e. the time, an exogenous variable.

The regression function [12] that describes the relationship between the two variables is given by the formula: $y = a + bx + \varepsilon$, in which:

y – is the score obtained by each student,

x – is the necessary work time,

ε – random variable (residual or disturbing),

a – and, b – the parameters or coefficients of the model(see figure 11).

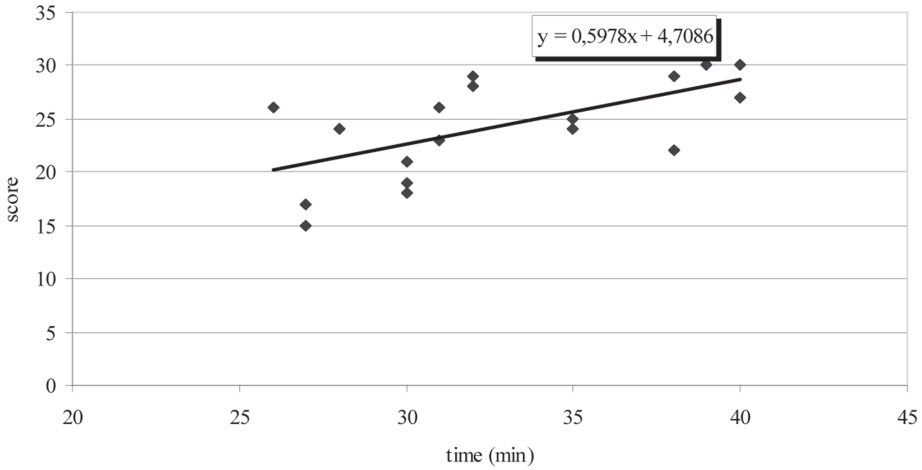
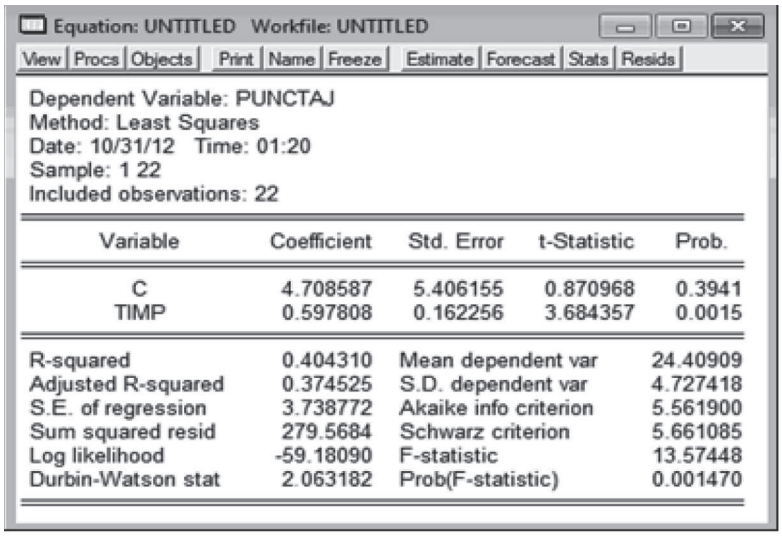


Figure 11. Correlation between the scores obtained and working time

The theoretical values of variable Y: $\hat{Y} = \hat{a} + \hat{b}x$, in which: $\hat{a}, \hat{b}$ – the values of the parameter estimators.

The parameters of the econometric model are assessed by means of the ordinary least squares (OLS) method (see figure 12):



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Dependent Variable: PUNCTAJ
Method: Least Squares
Date: 10/31/12 Time: 01:20
Sample: 1 22
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.708587	5.406155	0.870968	0.3941
TIMP	0.597808	0.162256	3.684357	0.0015

R-squared	0.404310	Mean dependent var	24.40909
Adjusted R-squared	0.374525	S.D. dependent var	4.727418
S.E. of regression	3.738772	Akaike info criterion	5.561900
Sum squared resid	279.5684	Schwarz criterion	5.661085
Log likelihood	-59.18090	F-statistic	13.57448
Durbin-Watson stat	2.063182	Prob(F-statistic)	0.001470

Figure 12. Estimarii model results using regression method in EViews program

No. of observations: *22*

R-squared – the determination coefficient *0.4043* which means that approx. 40% of the variation of the scores obtained by the students is due to the influence of time.

AIC is the *Akaike* criterion used for the comparison of two or more econometric models. The econometric model for which the smallest value corresponding to this indicator was obtained is chosen (for the linear model *AIC is* 5.56).

Between the score obtained by the students and the necessary time there is an average intensity and direct correlation (*R* – the correlation ratio is *0.64*).

The assessed model is: $\hat{Y}$= *4,71 + 0,60x*

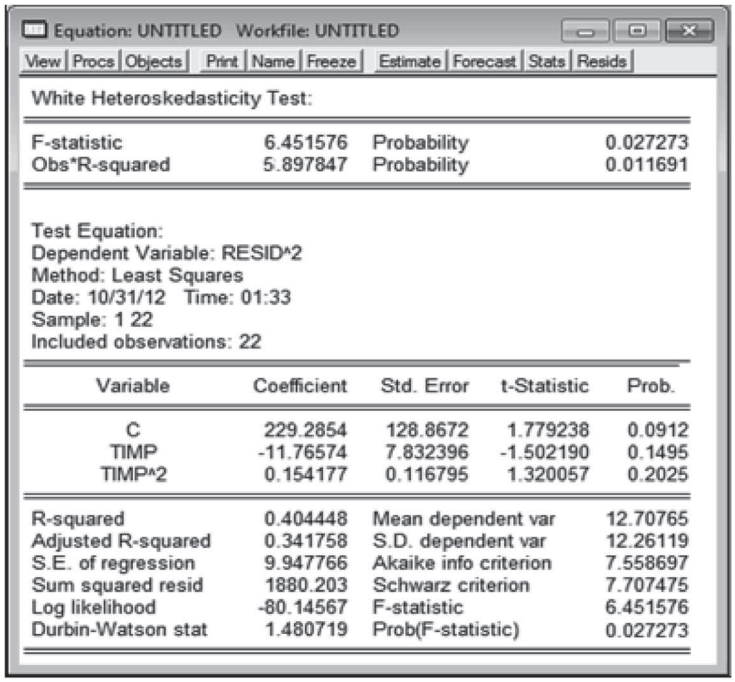
The values of the residual variable will result from the following relation: $\varepsilon = Y - \hat{Y}$

The verification of the significance of the model involves:

1. the verification of the random variable self-correlation assumption;
2. the verification of the random variable homoscedasticity assumption;
3. the verification of the significance of the estimators;
4. the verification of the significance of the correlation ratio.

1. The verification of the random variable self-correlation assumption: d_L= *1,24* and d_U = *1.43* (taken from the *Durbin-Watson distribution* table). The calculated Durbin-Watson is: d_c = *2.06*. If $d_c > d_U$, this means that the random variable self-correlation assumption is rejected, i.e. the values of the random variables are independent of each other, which implies the fact that data records in samples were independent. In this situation, the model is statistically correct.

2. The verification of the random variable homoscedasticity assumption. The verification of the random variable homoscedasticity assumption will be performed by means of the *White test* (see figure 13).



Equation: UNTITLED Workfile: UNTITLED

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White Heteroskedasticity Test:

F-statistic	6.451576	Probability	0.027273
Obs*R-squared	5.897847	Probability	0.011691

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 10/31/12 Time: 01:33
Sample: 1 22
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	229.2854	128.8672	1.779238	0.0912
TIMP	-11.76574	7.832396	-1.502190	0.1495
TIMP^2	0.154177	0.116795	1.320057	0.2025

R-squared	0.404448	Mean dependent var	12.70765
Adjusted R-squared	0.341758	S.D. dependent var	12.26119
S.E. of regression	9.947766	Akaike info criterion	7.558697
Sum squared resid	1880.203	Schwarz criterion	7.707475
Log likelihood	-80.14567	F-statistic	6.451576
Durbin-Watson stat	1.480719	Prob(F-statistic)	0.027273

Figure 13. Verification of the hypothesis of homoscedaticitate through the calculation of the test using the White EViews programs

It is noticed that for the significance threshold $\alpha = 0.05$ we have $Fc = 6.45 \geq F_{0,05;1;20} = 4.35$ and $LM = 5.90 \geq X^2_{0,05;1} = 3.84$ and the model parameter estimators are significant ($t_{0,05;20} = 2.09$) indicating the presence of the heteroscedasticity of errors, but, for the significance threshold $\alpha = 0.01$, $F_c = 6.45 < F_{0,01;1;20} = 8.10$ and $LM = 5.90 < X^2_{0,05;1} = 6.63$, and the model parameter estimators are insignificant ($t_{0,01;20} = 2.95$), so the homoscedasticity assumption is verified.

3. The verification of the significance of the estimators. In relation to estimator b, the regression coefficient is significantly different from zero because t-Statistic $= 3,68 \geq t_{0,05;20} = 2.09$ and $p = 0.0015 < \alpha = 0.05$ while estimator a is not significantly different from zero because t-Statistic $= 0,87 < t_{0,05;20} = 2.,09$ and $p = 0.395 > \alpha = 0.05$.
4. The correlation ratio is significantly different from zero because: F-statistic $= 13.57 \geq F_{0,05;1;20} = 2.09$ and $p = 0 < \alpha = 0.05$.

In conclusion, model $\hat{Y} = 4.71 + 0.60x$ may be assessed as representative for the ca description of the dependence between the score obtained by the students and the necessary time.

6. Conclusions

The implemented electronic platform has a opened and adaptive structure that contains the following interaction components:

- the administration component,
- the educational component,
- the communication component.

The administration component is very important and contains:

- user administration,
- educational component administration (secretariat),
- discussion forum administration.

The educational component allows the educational material to be created online and offline. The management of the educational component is very important and contains:

- The course management: course making, adding, changing and deleting chapters, course visualising,
- The test and project management: adding, changing and deleting certain questions in the test or evaluation cards, updating the project topics. Every test will contain a set of questions established by the teacher; the questions are chosen at random from the set of questions of each chapter,
- The virtual laboratory management: with specialized software for each course.

The communication component includes a discussion forum, students' update, e-mail and chat communication with the tutors. The designed platform e-learning is an integrated teaching, learning and content management system based on modern educational principles. The platform e-learning provides support to teach and learn, test and evaluation, content administration, education monitoring and curricular conception. Therefore it offers the student the possibility to access the curricula (didactic material) anytime and anywhere, thus developing mobility and facility for the theoretical activity. Through this platform, the students may have online examinations, receive the feedback for his/ her results, or monitor his/ her performance in his/ her personal page.

The statistical methods applied to process the experimental data confirmed the hypothesis about the positive impact (influence) of multimedia course implementation in the teaching-learning process for the experimental groups and the efficiency of the methods applied to the experimental groups, in contrast to the traditional methods applied to the control groups.

Considering the heterogeneous elements of the statistical population, the conclusion is statistic only for the elements involved in the experiment. For other elements, the conclusion is applicable only through analogy.

We presented the data processing by some statistical tests, applied in evaluating the results of the pedagogical experiment. According to the criteria I used and the hypothesis I checked, I may conclude that:

- the general analysis of the statistical and mathematical evaluations indicate satisfactory progress for all the students involved in the research experiment;
- the methods applied contribute to increasing the efficiency of the teaching-learning process and provide a learning possibility according to each student's individual particularities;
- the multimedia course implementation contributes to information learning, by applying knowledge in the creation process;
- the computer assisted learning generates an increase in the quality of learning;
- the multimedia courses applied in the teaching-learning process of all subjects increases students' interest toward the respective subjects.

This study tried to propose a new perspective of the teaching-learning process, according to the presented exigencies. The use of information technologies provides new possibilities to stimulate interest and new ways to involve the student in the knowledge process.

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