

# COMPUTER AIDED SYSTEM FOR STUDENT'S KNOWLEDGE ASSESSMENT

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## ABSTRACT

**Purpose:** According with the principles of impartial evaluation of the students' knowledge, with the national trends in ensuring the efficient and effective end-of-course evaluation, the authors developed an original computer-assisted examination system.

**Materials and Methods:** The information discussed at courses and laboratory class, for the Physical Chemistry Course and for the Microbiology and Toxicology Course were transposing into multiple-choice questions and was included into a database by the use of MySQL database server. Using the futures offered by PHP programming language, the interface of computer-assisted system was connected with the multiple-choice database and was implemented.

**Results:** The computer-assisted end-of-course evaluation system was created and is available via the address: [http://vl.academicdirect.org/general\\_chemistry/physical\\_chemistry/](http://vl.academicdirect.org/general_chemistry/physical_chemistry/) (for Physical Chemistry evaluation), and

[http://vl.academicdirect.org/general\\_chemistry/microbiology\\_toxicology/](http://vl.academicdirect.org/general_chemistry/microbiology_toxicology/) (for Microbiology and Toxicology evaluation). The end-of-course evaluation contains a number of thirty multiple-choice questions with at least one correct answer and is available just in test center the access to the evaluation being restricted by the IP addresses.

**Conclusion:** The online computer-assisted evaluation system proved to be a real solution in end-of course assessment, providing a more accurate and more efficient evaluation in terms of objectivity as well as in term of time.

**Keywords:** online evaluation system (electronic evaluation); higher education; evaluation criteria.

## 1. INTRODUCTION

Nowadays, the computer-assisted systems are widely used in students training [1,2] as well as in end-of-course examinations [3,4].

The methodology apply to end-of-course assessment of students that follow the Physical Chemistry Course (third year of study) and Microbiology and Toxicology Course (forth year of study) at the Faculty of Materials Science and Engineering from Technical University of Cluj-Napoca, Romania, is a classical one. This includes a written examination (essay exam), practical examination and tutor assessments of the students' laboratory activity, evaluating the acquired knowledge presented and discussed at courses, laboratory and seminars. Most of the time, the classical evaluation is not able to evaluate objective the students' knowledge [5].

According with the principles of impartial evaluation of the students' knowledge, with the national trends in ensuring the quality of university education including in efficient and effective end-of-course evaluation, the authors developed an original computer-assisted examination system.

## 2. MATERIALS AND METHODS

### Multiple choice exam methodology

The material discussed at courses and laboratory class, for the two topics were transpose into multiple-choice questions. The multiple choice questions were construct following the specifications:

- Question (the steam): It is constructing as a statement or a situation;
- Possible answer (the options): Possible choices to address the situation or question;
- Number of possible answers: Five;
- Correct answers (key): At least one option it is the correct one and no more than four options. It

is guaranteed that the correct answer is among possible responses.

### End-of-course examination methodology

The developed methodology of the end-of-course examination follows the methodology:

Specification	Remarks
Place of exam	Test center, C414 Room
Type of examination	Tutor assisted, and computer-assisted
Type of evaluation	Multiple choice questions
Number of questions	Thirty
Type of answer	Checking a radio-button
Number of question in database	Three hundred
Multiple choice generation	Randomly from the database
Giving up after the test begin	Not allowed. There is applied penalties for giving up
Correct answer	It is consider when were exact marked the key or keys
The mark of exam	Computer-scored
Number of examinations	As many times as the students consider that is necessary
Period of examination	One month

### Marks and Standards for Computer-Assisted Examination

The final examination mark is compute by taking into consideration the testing score obtained by the student and the means of student testing scores. The mean of student testing score is compute by taking into consideration all the scores obtained by an individual student after elimination (when there are at least two evaluations) of the lowest mark and performing the average of the remaining marks. The lowest mean of testing score from database has associated the mark equal with 4 and the higher one equal with 10 (10 being the best mark). At the testing score can be adding up to 2 points for the activities of develop the database with multiple choice questions. From the testing score can be subtraction 0.5 points for each giving up the test examination after beginning and up to 1 point for unaccomplished the activities take to creation multiple choice questions.

### Implementation of online evaluation system

For implementation of the computer-assisted multiple-choice system were used the feature offered by MySQL [6] and PHP (Hypertext Preprocessor) [7] because they allow to create powerful and fast database Web site applications and proved to be useful in creating evaluations systems [8,9].

The application consists in:

- The MySQL database called 'chemistry' which store the steam, the options and the key. The

database contains four tables as follows: 'microb\_tox\_tests' and 'microb\_tox\_users' tables (for Microbiology and Toxicology course), and 'phys\_chem\_tests' and 'phys\_chem\_users' tables (for Physical Chemistry Course);

- A series of testing interface \*.php programs ('definitions.php', 'index.php', 'msg.txt.php', 'testare.php', 'functions.php', 'q\_list\_all.php', etc.);
- Ten specific \*.php programs for inserting and modifying the stems, options and key or keys.

### Testing score methodology

The methodology of computing the final mark takes into consideration the following components:

- The average time necessary for choosing the correct key/keys ( $t_{mn\_rc\_global}$ ): All tests stored in database are consider in calculation;
- The average time necessary for choosing the correct answer by the current student ( $t_{m\_rc}$ ): Just the current evaluation is consider in calculation;
- The time coefficient ( $C_t$ ): Formula -  $m\_rc/t_{mn\_rc\_global}$ ;
- The average number of correct answers ( $nr\_rc\_global$ ): All test stored in database are consider in calculation;
- The average number of individual correct answer ( $nr\_rc$ ): Just the correct answers of individual are consider in computing;
- The correct answers coefficient ( $C_{ca}$ ): Formula -  $nr\_rc/nr\_rc\_global$ ;
- The geometric mean of time and correct answers coefficients ( $G_{mean}$ ): Formula -  $\sqrt{C_t * C_{ca}}$ ;
- The testing score ( $T_{score}$ ): Formula -  $10 * \sqrt{C_t * C_{ca}}$ .

### Assessment of end-of-course examination

All the student which followed the Physical Chemistry Course (third year of study) and Microbiology and Toxicology Course (forth year of study) at the Faculty of Materials Science and Engineering from Technical University of Cluj-Napoca, Romania were tested at the end of the semester by using the above described computer-assisted methodology integrated online. The students had the possibility to familiarize with the new methodology by testing theirs knowledge in the test center for one month before the end-of-course final evaluation. The end-of-course final evaluation

takes place from a period of one month in which every student has the possibility to perform the test as many times as they considered.

The results obtained by the students which performed the evaluation at Physical Chemistry were compared with the results obtained by the students which performed the evaluation at Microbiology Toxicology by applying the t-test for independent groups, two tails.

### 3. RESULTS

#### The computer-assisted end-of-course evaluation system

The implemented computer-assisted evaluation system is available via the address:

- for physical chemistry evaluation:  
[http://vl.academicdirect.org/general\\_chemistry/physical\\_chemistry/](http://vl.academicdirect.org/general_chemistry/physical_chemistry/)
- for microbiology and toxicology evaluation:  
[http://vl.academicdirect.org/general\\_chemistry/microbiology\\_toxicology/](http://vl.academicdirect.org/general_chemistry/microbiology_toxicology/)

Note that the application can be access just for the test center (by checking the IP addresses) and is protected by the tutor password.

The generation of the multiple-choice test is randomly from the whole database. The questions were created by the students coordinate by the tutor and were included into databases three hundred sixty-three multiple-choice questions for Microbiology and Toxicology topic and four hundred and twenty-four for Physical Chemistry topic. The distributions of the type of multiple-choice questions for the two topics take into discussions, express as absolute frequency ( $A_f$ ), relative frequency ( $R_f$ ) and confidence intervals (CI) are in table 1.

**Table 1. The distributions of the questions in `chemistry` database**

	Physical Chemistry			Microbiology and Toxicology		
	$A_f$	$R_f$	CI	$A_f$	$R_f$	CI
1 key	209	49.29	[44.34, 54.24]	237	65.29	[60.05, 70.25]
2 keys	114	26.89	[22.88, 31.37]	59	16.25	[12.67, 20.66]
3 keys	70	16.51	[13.21, 20.51]	38	10.47	[7.71, 14.05]
4 keys	31	7.31	[5.19, 10.38]	29	7.99	[5.51, 11.29]
Total	424	100		363	100	

#### The assessment results

The results of the end-of-course evaluation by the use of the developed computer-assisted system applied to Physical Chemistry and Microbiology and Toxicology, express as testing score ( $T_s$ ), the

average time necessary for choosing the correct key/keys express in seconds ( $T_{ca(s)}$ ), the values of bonus points ( $B_p$ ), the sum between  $T_s$  and  $B_p$ , and the mark (M) are in table 2.

**Table 2. The results of knowledge assessment**

Physical Chemistry						Microbiology and Toxicology					
No.	$T_s$	$T_{ca(s)}$	$B_p$	$T_s+B_p$	M	No.	$T_s$	$T_{ca(s)}$	$B_p$	$T_s+B_p$	M
ph_01	5.04	171.5	0	5.04	5	mt_01	7.62	19.1	2.1	9.72	10
ph_02	8.09	69.9	0	8.09	8	mt_02	5.24	52.6	0	5.24	5
ph_03	5.36	152.7	0	5.36	5	mt_03	6.79	25.0	0	6.79	7
ph_04	10.00	50.1	0	10	10	mt_04	4.00	273.5	0	4	4
ph_05	5.62	31.0	0	5.62	6	mt_05	5.46	43.8	1.5	6.96	7
ph_06	8.20	72.2	1.3	9.5	10	mt_06	6.03	35.8	0	6.03	6
ph_07	6.14	119.4	0	6.14	6	mt_07	5.94	30.9	1.5	7.44	7
ph_08	5.36	153.9	1.7	7.06	7	mt_08	9.74	8.6	0	9.74	10
ph_09	7.81	40.0	1.7	9.51	10	mt_09	9.40	10.0	1.9	11.3	10
ph_10	7.13	87.5	0	7.13	7	mt_10	7.06	17.9	1.6	8.66	9
ph_11	6.61	112.4	3	9.61	10	mt_11	6.14	30.4	1.7	7.84	8
ph_12	5.07	194.3	2.9	7.97	8	mt_12	7.88	13.5	0	7.88	8
ph_13	5.36	44.0	0	5.36	5	mt_13	10.00	7.6	1.2	11.2	10
ph_14	4.52	279.8	1.5	6.02	6	mt_14	5.80	41.2	0	5.8	6
ph_15	5.83	111.1	0	5.83	6	mt_15	7.15	19.8	0	7.15	7
ph_16	5.77	28.8	0	5.77	6	mt_16	7.62	19.1	0	7.62	8
ph_17	7.01	100.8	1.8	8.81	9	mt_17	5.71	45.2	0	5.71	6
ph_18	5.58	85.3	0	5.58	6	mt_18	5.82	42.9	0	5.82	6
ph_19	4.86	41.0	0	4.86	4	mt_19	5.61	40.8	0	5.61	6
ph_20	6.14	92.7	0	6.14	6	mt_20	7.79	13.4	0	7.79	8
ph_21	6.49	86.4	2.4	8.89	9	mt_21	4.11	233.0	0	4.11	4
ph_22	4.00	365.8	1.3	5.3	5	mt_22	5.67	32.3	0	5.67	6
ph_23	6.20	128.0	0	6.2	6	mt_23	5.89	33.0	1	6.89	7
ph_24	6.03	112.4	0	6.03	6	mt_24	8.37	29.7	1.4	9.77	10
ph_25	6.81	111.7	0	6.81	7	mt_25	6.10	9.6	1.1	7.2	7
ph_26	7.45	83.2	1.5	8.95	9	mt_26	8.89	24.6	2	10.89	10
ph_27	7.65	70.2	0	7.65	8	mt_27	6.57	60.9	0	6.57	7
ph_28	5.71	138.3	1.7	7.41	7	mt_28	5.53	36.4	0	5.53	6
ph_29	6.58	92.9	0	6.58	7	mt_29	6.67	15.3	0	6.67	7
ph_30	6.04	19.7	0	6.04	6	mt_30	6.85	24.0	1.6	8.45	8
ph_31	7.71	87.0	0	7.71	8	mt_31	6.14	38.1	0	6.14	6
ph_32	5.13	183.3	0	5.13	5	mt_32	6.81	26.7	0	6.81	7
ph_33	6.43	100.2	0	6.43	6	mt_33	5.60	25.1	0	5.6	6
ph_34	5.77	30.4	0	5.77	6						
ph_35	5.07	127.9	0	5.07	5						
ph_36	4.29	310.4	1.9	6.19	6						
ph_37	6.09	108.6	0	6.09	6						
ph_38	5.51	98.8	0	5.51	6						
ph_39	5.16	102.2	0	5.16	5						
ph_40	5.57	114.3	0	5.57	6						
ph_41	5.61	52.2	0	5.61	6						
ph_42	5.10	189.6	2.9	8	8						

The results of testing the hypothesis that there are no differences between the variable categories from table 2 from students which performed at Physical Chemistry course and at Microbiology and Toxicology course are in table 3.

**Table 3. Results of testing the hypothesis**

	Mean <sub>ph</sub>	Mean <sub>mt</sub>	t-value	p	N <sub>ph</sub>	N <sub>mt</sub>
$T_s$	6.0929	6.66667	-1.8843	0.063501	42	33
$T_{ca(s)}$	113.14	41.8121	4.62981	0.000016	42	33
$B_p$	0.6095	0.56364	0.21936	0.826981	42	33
$T_s+B_p$	6.7024	7.23030	-1.3615	0.177556	42	33
M	6.7381	7.24242	-1.3225	0.190126	42	33

The distributions of the final marks for physical chemistry are in figure 1 and for microbiology and toxicology in figure 2.

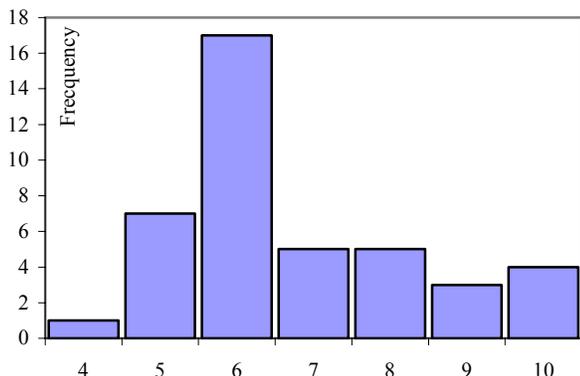


Figure 1. Physical Chemistry Final Marks Distribution

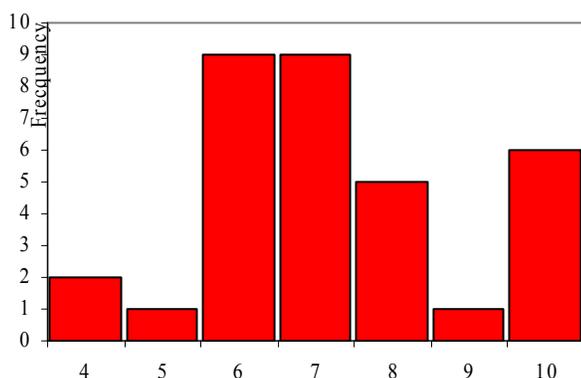


Figure 2. Microbiology and Toxicology Final Marks Distribution

#### 4. DISCUSSIONS

The purpose of end-of-course evaluation is to give the students a mark which to be representative for his/her knowledge. In order to evaluate correct the student's knowledge and stroll the students to whole curriculum, the multiple-choice test is better comparing with an essay examination. The multiple-choice test allow to assess each student's knowledge of the whole materials discussed and presented at courses and practical activities as well as in which degree their knowledge can be applied to specific situations.

The presented computer-assisted evaluation system was design for students from the Faculty of Materials Science and Engineering from Technical University of Cluj-Napoca, Romania, which followed the curriculum of Physical Chemistry Course (third year of study) and Microbiology and Toxicology Course (forth year of study). Minimal

knowledge of using a computer is required as prerequisites.

The computer-assisted evaluation system analysis can be conducted through its advantages and disadvantages:

- + Provide an interactive environment for student's knowledge end-of-course evaluation;
- + Random generation of the questions for each test avoid the collaboration between student;
- + Give to the tutor the possibility of investigation of the whole knowledge presented, debated and discussed at courses, practical activities and seminars;
- + Allows grading the student's knowledge more objective comparing with essays examination. The students could not complain that the tutor was subjective in its evaluation;
- + Easy to update and modify: any changes, which must be made in the multiple choice questions can be done easily and in real time;
- + Easy to use: a mouse is enough;
- + Multi-user: it can be evaluating simultaneously more than one student;
- + Less time necessary to assess each student (comparing with traditional essay examination);
- Required formulation the multiple-choice questions;
- Required accessibility to computers and Internet.

The grading system used to end-of-course evaluation is a complex one and allows including in the final mark the knowledge of the students and its abilities in recognition as fast as possible the key/keys of the questions as well as to remunerate the students actively implied in the course activities.

Looking at the results obtained by the two samples of students it can be observed that, as well as in an essay assessment, there are a number of students which did not was able to pass the exam. The minimum final mark at which is consider that the student pass the exam is equal with 5. It can be observed from the table 2 that the students which are in four-year of study are more conscientious comparing with the students in three-year of study. The students which performed the Physical Chemistry examination have the mean of the final mark less than the students which performed the Microbiology and Toxicology examination (6.74 comparing with 7.24 - see figure 1 and 2). The results of the student test shows us that there are no statistical significant differences (see table 3) between the two classes of students (first which performed Physical Chemistry evaluation and

second which performed the Microbiology and Toxicology evaluation) with one exception. There was a significant difference between the average times necessary for choosing the correct key/keys express in seconds ( $T_{ca(s)}$ ). The mean time was less at the level of students which followed the Microbiology and Toxicology course. This observation can be explained by the interest accorded by the students to a specific course. Another plausible explanation is that the students from four-year of study have better abilities in computer using comparing with the students from three-year of study. Most probable explanation is a combination of above-describe reasons. The presented computer-assisted online evaluation system can be implemented securely to any course, providing an environment of evaluation which is able to ensure the quality of end-of-course assessment if it is appropriately implemented.

## 5. CONCLUSION

The online computer-assisted evaluation system can be implemented securely and efficiently for any curriculum at university level, providing an assessment environment more objective comparing with the traditional examination.

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