

# Computer-Assisted Instruction in Evidence-Based Medicine: A Pilot Study

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**Abstract** — The paper presents a computer-based curriculum designed for evidence-based medicine (EBM) training of Romanian undergraduate students. A series of materials and cases were developed and integrated into a virtual training environment in order to provide the students the opportunity to learn about and to assess their evidence-based medicine knowledge and skills. The interactive web-based approach was efficient and effective in undergraduate students' EBM education, suggesting that could be the appropriate method for teaching evidence-based medicine.

**Keywords** — Computer-Assisted Instruction, Undergraduate Medical Education, Evidence-Based Medicine (EBM) Education, Self-Evaluation.

## I. INTRODUCTION

The concept of evidence-based medicine (EBM), introduced by Guyatt & all in 1991 [1] and defines as "conscientious, explicit, and judicious use of the best evidence in making decisions about the care of individual patients" [2], imposes the translation of knowledge resulted from research in daily individual decisions.

There are two related components on practicing EBM: knowledge translation and evidence-based medicine education. Knowledge translation refers the steps from evidence generation (brilliant ideas scientific validated) to clinical application [3]. These steps can be summarized as follows [3]:

- Synthesis of the research results (systematic reviews with or without meta-analysis)
- Developing clinical policy (action statements that grade the evidence according with its strengths and weaknesses, with local expertise and resources, taking into consideration the costs of its application into practice)
- Implementation and application of health care policy
- Inclusion of the new clinical knowledge into individual clinical decision taking into consideration personal expertise and patient's circumstances, wishes, values and expectations.

Evidence-based medicine education refers the education of undergraduate students, residents and practitioners in spirit of including the best available, valid and reliable evidence into daily individual decisions [4].

Looking at the steps of EBM practice, which include the ability to formulate appropriate questions, search for

valid and relevant evidence and critically appraising of them, integration of the best available evidence into individual medical decision and evaluation of changes in practice [1], the EBM education is undoubtedly a necessity. Note that, the EBM practice has also been seen as an instrument useful in improving quality of health care [5] and in controlling the health services costs [6]. So, it can be said that the EBM education represents the first step in implementation of the concept into practice [7], [8]. Comparing with no intervention, short EBM educational strategies proved to be able to transfer knowledge and sometimes to improve critical appraised skills for medical students [9], [10], residents [11], [12] and physicians [13], [14].

According with explosive development of information and communication technologies in the last decade [15], the medical practice has been changed. Electronic processes and communication technologies support today medical practice [16], [17]. The information and communication technologies had an influenced on EBM training [18], [19].

In response to the national needs on providing opportunities for students to learn about and to practice EBM, a computer-based curriculum has been developed and its effectiveness was evaluated.

## II. MATERIALS AND METHOD

The present study examined how the implementation of an interactive, computer-based curriculum in undergraduate medical students influenced the EBM knowledge and skills.

### A. Computer-Based Evidence-Based Medicine Curriculum

The computer-based EBM curriculum was designed with three core goals: (1) to promote the access to EBM knowledge and resources for the Romanian medical students, (2) to increase students' awareness and use of relevant medical evidence, (3) to teach the calculation and interpretation of fundamental EBM metrics from different type of research (therapy intervention, diagnostic or screening tests, disease prognosis). The computer-based EBM design was guided by educational psychology principles [20].

The computer-based EBM curriculum incorporates thirteen modules and five categories of resources, as follows:

- Software for assisting creation and browsing of critical appraised topics [21], [23]

- Software for assisting creation and browsing of guidelines models and clinical practice guidelines [24]
- Software for calculation of 95% confidence interval for proportions [25], [26], [27]
- Twenty diagnostic and treatment guidelines published by the Romanian College of Physicians [28]
- Seventeen materials on proved based medicine published by Stetoscop Journal [29])
- EBM dictionary.

For each module, an interactive system for self-evaluation is available, incorporating five multiple-choice questions with one to up to four correct answer(s). The incorporated modules are in Romanian language, while the resources and both in Romanian and English languages.

An interactive assessment environment was incorporated into the application in order to ensure an objective evaluation of the students' knowledge at the end of the self-directed training.

The computer-based curriculum for EBM education was developed for self-directed learning. A period of three months was imposed for this research, on which the interaction between students and teacher was done by e-mail.

The application for EBM training is available from the following URL: [http://vl.academicdirect.org/medical\\_informatics/EBM\\_Rom/EBMRom.chm](http://vl.academicdirect.org/medical_informatics/EBM_Rom/EBMRom.chm)

A detailed description of the computer-based EBM curriculum and of evaluation design and methodology has previously been published [30].

### B. Evaluation Methodology

One series of fourth-year undergraduate medical students at the Faculty of Medicine, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania participated to the study, on the academic year 2005-2006. Applying of a random method, a series of students out of five was chose to participate to the research. The aim of the study and the possibility to enrol to the intervention group was presented. The students were considered to be eligible for the intervention group if they accomplished the following criteria: (1) attended to the traditional course for EBM education and to the research presentation, (2) complete the baseline characteristics form, and (3) complete the consent participation form. The consent form imposed the access to an individual computer with CD-ROM, with or without Internet connection. The students that complete the consent form were assigned to the intervention group and the other students from the series to the control group.

Both groups participated to a traditional EBM two-hour course. Note that all participants previously received training in research methodology, epidemiology, and statistics. All participants fill a questionnaire regarding demographic data (gender, age), information about computer and Internet access, and graded on a scale from 1 to 5 (1 = extremely unimportant, 2 = unimportant, 3 = unconcerned, 4 = important, 5 = extremely important)

their perception regarding continuing medical education, quality of health care, and patient satisfaction. There was also included a question regarding the previous contact with EBM concepts.

The traditional two-hour course covered the steps of practicing evidence-based medicine. At the end of the EBM traditional course the evidence-based medicine knowledge and skills, searching techniques and critical appraisal of evidence of all participants were measured using an eighteen true/false paper-based questionnaire that incorporated five problem-based questions.

The students from intervention group received additional training via an interactive computer-based curriculum available on CD-ROM and on Internet. A brief presentation on using the educational application has been provided. Note that, the computer-based curriculum enclosed deepens EBM knowledge, clinical problem with or without solutions, links to evidence-based medicine resources in native and in English languages and to medical publications. The EBM knowledge and skills, searching techniques and critical appraisal of evidence on the intervention group were measured through on a computer- and tutor-assisted online multiple-choice questionnaire at the end of the three-month self-directed training. The questionnaire had forty-five questions with five possible options and one and up to four correct answer(s), from which fifteen were clinical problem-based questions.

### C. Statistical Analysis of Data

The participant's characteristics were summarized and the comparisons of the two groups (intervention and control) were performed according with the type of variable. Differences in proportions were tested using chi-square statistics and difference test for proportions, Statistica software. Differences between scores and number of correct answers were evaluated using Mann-Whitney U test. All statistical tests were applied at a significance level of 5%. The 95% confidence intervals for proportions were calculated with a method based on the binomial distribution hypothesis [27].

## III. RESULTS

### A. Summary of Groups Characteristics

All students from intervention and control groups completed the form with demographic data. Data related to the demographic composition of the groups were summarized and are presented in Table 1 and 2. The demographic compositions of intervention and control groups were compared. There were not identified statistically significant differences between the groups for gender (67.50% female in intervention group and 64.29% female in control group,  $p = 0.743$ ), age (mean 21.78 in intervention group and 21.91 in control group,  $p = 0.235$ ), access to a computer ( $p = 0.713$ ), and access to the Internet ( $p = 0.676$ ). Regarding the moment of time when students heard first time about EBM, a statistically significant differences was obtained ( $p = 0.003$ ) between

groups, a greater percent of students from intervention group being familiar with the EBM previous to the study compared with the control group. To a deepen analysis, a significant statistically differences between proportion of students from intervention group and from control group that classify the access to the Internet as “*relative difficult*” has been identified ( $p = 0.0432$ ).

TABLE 1: STUDENTS’ CHARACTERISTICS – INTERVENTION GROUP (n = 40).

	% [95% CI]
Gender	
Female	67.50 [50.06–82.44]
Age (years old)	
21	32.50 [17.56–49.94]
22	57.50 [40.06–72.44]
23	10 [2.56–22.44]
Previously heard about EBM	
Yes	55 [37.56–69.94]
Access to a computer	
Easy	42.50 [27.56–59.94]
Relative easy	32.50 [17.56–49.94]
Difficult	20.00 [10.06–34.94]
No access	2.50 [0.06–12.44]
I don’t know	2.50 [0.06–12.44]
Access to the Internet	
Easy	27.50 [15.06–44.94]
Relative easy	45.00 [30.06–62.44]
Difficult	22.50 [10.06–37.44]
No access	5.00 [0.06–17.44]
I don’t know	0.00 [n.a.]
Continuing medical education	
Unconcerned	0.00 [n.a.]
Important	60.00 [42.56–74.94]
Extremely important	37.50 [22.56–54.94]
Missing data	2.50 [0.06–12.44]
Quality of health care	
Unconcerned	5.00 [0.06–17.44]
Important	35.00 [20.06–52.44]
Extremely important	55.00 [37.56–69.94]
Missing data	5.00 [0.06–17.44]
Patient satisfaction	
Unconcerned	5.00 [0.06–17.44]
Important	50.00 [32.56–67.44]
Extremely important	40.00 [25.06–57.44]
Missing data	5.00 [0.06–17.44]

95% CI = 95% confidence interval; n.a. = not applicable

Regarding the importance accorded by students to continuing medical education, quality of health care and patient satisfaction, with two exceptions, there were not identified significant statistic differences between groups ( $p > 0.05$ ). The exceptions were identified for quality of health care on two scales “*important*” ( $p = 0.0019$ ) and “*extremely important*” ( $p = 0.0001$ ). A greater percent of students from control group classified the quality of health care as “*important*”, while a greater percent of students from intervention group classified it as “*extremely important*”.

### B. Evaluation of Web-Based Curriculum

The research sought to analyze EBM knowledge acquiring in intervention and control groups. The statistics of the correct answers gave by the students included into the study are presented in Table 3.

TABLE 2: STUDENTS’ CHARACTERISTICS – CONTROL GROUP (n = 56).

	% [95% CI]
Gender	
Female	64.29 [50.03–76.75]
Age (years old)	
21	19.64 [10.75–32.11]
22	69.64 [55.39–82.11]
23	10.71 [3.60–21.40]
Previously heard about EBM	
Yes	25 [14.32–37.47]
Access to a computer	
Easy	44.64 [30.39–58.90]
Relative easy	19.64 [10.75–32.11]
Difficult	30.36 [17.89–44.61]
No access	1.79 [0.03–8.90]
I don’t know	3.57 [0.03–12.47]
Access to the Internet	
Easy	33.93 [21.46–48.18]
Relative easy	25.00 [14.32–37.47]
Difficult	35.71 [23.25–49.97]
No access	1.79 [0.03–8.90]
I don’t know	3.57 [0.03–12.47]
Continuing medical education	
Unconcerned	5.36 [1.82–14.25]
Important	50.55 [35.75–64.25]
Extremely important	44.64 [30.39–58.89]
Missing data	0.00 [n.a.]
Quality of health care	
Unconcerned	16.07 [7.17–28.54]
Important	67.86 [53.60–80.32]
Extremely important	16.07 [7.17–28.54]
Missing data	0.00 [n.a.]
Patient satisfaction	
Unconcerned	3.57 [0.03–12.47]
Important	53.57 [39.32–67.82]
Extremely important	42.86 [30.39–57.11]
Missing data	0.00 [n.a.]

95% CI = 95% confidence interval; n.a. = not applicable

TABLE 3: EBM KNOWLEDGE ASSESSMENT: RESULTS.

	Group	
	Intervention (n = 40)	Control (n = 56) & Intervention (n = 40)
No. questions (type)	45 (MCQs with five options)	18 (True/False statement)
Average	37.90	11.11
[95%CI]	[37.21–75.11]	[10.64–11.58]
StDev	2.15	2.32
Me	38	11
Min	32	7
Max	42	16

MCQs = multiple-choice questions; StDev = standard deviation; Me = median; Min = minimum; Max = maximum; 95% CI = 95% confidence intervals.

The graphical representation of the percent of students that gave a specified number of correct answers on eighteen true/false questions test versus total number of questions ratio for all students was illustrated in Figure 1.

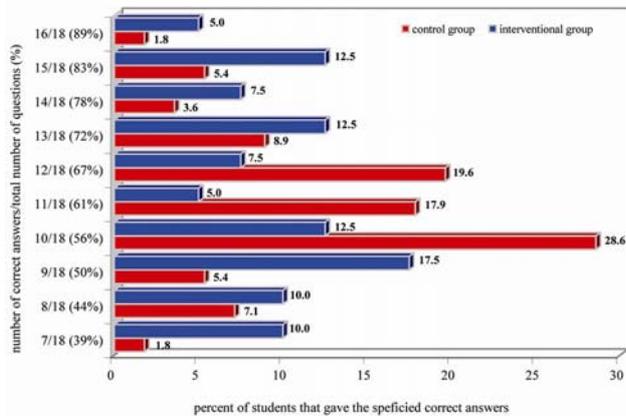


Fig. 1. Students' performances (both groups): eighteen questions test.

For 7/18 to 16/18 ratios, a test was applied in order to identify if there were significant differences between percent of students that gave the correct answers in intervention and control groups. With one exception, there were not identified significant statistic differences ( $p > 0.05$ ).

A significant statistic higher percent ( $p = 0.0426$ ) of students from intervention group (nine students out of forty) gave nine correct answers out of eighteen comparing with control group (three students out of fifty-six). In order to identify significant differences at the end of the EBM traditional intervention, the Mann-Whitney U test was applied to compare the average of the correct answers gave by the students from intervention and control group. The results revealed that, at the end of EBM course, there were not significant differences on EBM knowledge between intervention and control groups ( $p = 0.7948$ ,  $n_{\text{intervention}} = 40$ ,  $n_{\text{control}} = 56$ ).

The graphical representation of the percent of students from intervention group that gave a specified number of correct answers reported to the total number of questions (forty-five) is illustrated in Figure 2.

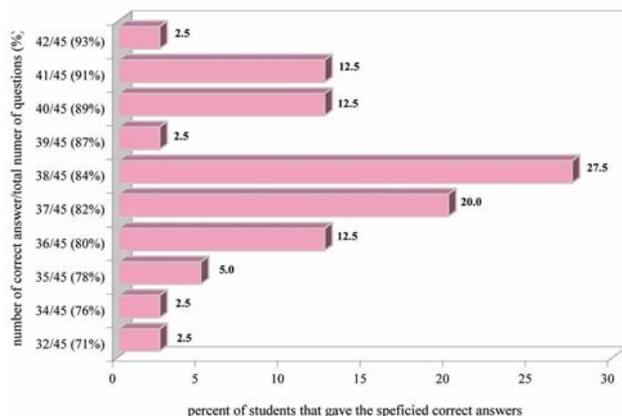


Fig. 2. Students' performances (both groups): eighteen questions test.

The comparison of the EBM knowledge in intervention and control groups was performed by analyzing the averages of the proportion of correct answers. The results shown that the average of the proportion of the correct answers in the intervention group (0.844,  $n = 40$ ) was statistical significant greater ( $p = 0.0174$ ) compared with the average of the proportion of the correct answers in control group (0.617,  $n = 56$ ). In order to identify from where this difference appears, four cases were analyzed by splitting the intervention and control groups in four classes according with the percent of correct answers. The criteria used for creation of classes were as follows:

- Percent of correct answers more than or equal with fifty (class 1):  $\geq 23$  correct answers for intervention group and  $\geq 9$  correct answers for control group
- Percent of correct answers more than or equal with sixty (class 2):  $\geq 27$  correct answers for intervention group,  $\geq 11$  correct answers for control group
- Percent of correct answers more than or equal with seventy (class 3):  $\geq 32$  correct answers for intervention group,  $\geq 13$  correct answers for control group
- Percent of correct answers more than or equal with eighty (class 4):  $\geq 36$  correct answers for intervention group,  $\geq 14$  correct answers for control group.

The results of obtained on intervention and control groups according with the above-described classes are presented in Table 4.

TABLE 4: RESULTS OF COMPARISON BETWEEN INTERVENTIONAL AND CONTROL GROUPS.

Class	1: $\geq 50$	2: $\geq 60$	3: $\geq 70$	4: $\geq 80$
$f_{a-int}$	40	40	40	36
$f_{r-int}$	1	1	1	0.9
95% $CI_{f_r-int}$	[0.90-1.00]	[0.90-1.00]	[0.90-1.00]	[0.78-0.97]
$f_{a-con}$	51	32	11	6
$f_{r-con}$	0.9	0.6	0.2	0.1
95% $CI_{f_r-con}$	[0.80-0.96]	[0.43-0.70]	[0.11-0.32]	[0.04-0.21]
p	0.0421	< 0.001	< 0.001	< 0.001

$f_a$  = absolute frequency;  $f_r$  = relative frequency;  
 95%  $CI_{f_r}$  = 95% confidence interval for relative frequency;  
 int = intervention group ( $n = 40$ ); con = control group ( $n = 56$ )

#### IV. DISCUSSION

The study shown that the interactive computer-based approach for EBM training was efficient and effective; the intervention group obtained statistical significant better results comparing with the control group.

Even if a number of EBM educational resources were already available on the Internet, the proposed EBM computer-based curriculum is unique. The uniqueness of the system is in the way that follows a deliberate sequence of educational activities in order to promote reflection and active interaction of the students with the online available resources, by require them to apply EBM concepts in order to solve real medical problems. Note also, that is the unique resource for EBM education in Romanian language.

Analyzing the results it can be observed that the two

groups included into the analysis were homogenous in terms of participant's gender and age. There were found significant differences between two groups regarding the first contact with EBM concept; a greater proportion of students from intervention group heard previously about the concept. This could be the explanation of the enrolment in the intervention group, these students being interested to learn more about EBM.

Regarding the access to a computer and to the Internet classifications, it can be observed that there were not identified statistical significant differences between the intervention and the control groups. One observation must be made here. The student's that classified the access to computer and to the Internet as easy or relative easy, on the interview declared that they had access at parents' home not on campus.

All participant to the study classified the importance of continuing medical education and patient satisfaction almost identical; could not be identified any significant differences. Analyzing the importance of health care quality revealed that, for students from intervention group was "extremely important", while for students from control group was just "important".

The studied groups (intervention and control) have been homogenous from the point of EBM knowledge at the end of the traditional course. Because the average of the correct answers gave by students from intervention group was not significant different from the average of the correct answers gave by students from control group, the results obtained at the end of self-directed training are real and valid.

Regarding the assessment and analysis of the student's knowledge on EBM concepts, even if the ranges of correct answers in both groups were almost equal (10 for case group and 9 for control group), significant differences between the studied groups had been identified ( $p = 0.0174$ ). It can be observed from Table 4 that the 95% confidence intervals for proportion of students that gave a specified number of correct answers for three out of four criteria ( $\geq 60\%$ ,  $\geq 70\%$ , and  $\geq 80\%$ ) did not overlap on each other in intervention and control groups. These observations shown that the students from intervention group obtained greater EBM performances comparing with the students from the control group. The most relevant information from Table 4 is the results obtained for criterion  $\geq 80$ , because in terms of passing of an exam the student must to prove that he/she acquired 80 percent of the information.

Even if the outcome variables are not identical into studied groups, the differences could be bigger than those observed. The differences derived from different evaluation methods used in knowledge assessment on two-studied groups. The method chose to evaluate the control group knowledge were constructing as true/false statement. In terms of probability, the chance to guess the correct answer for a question of this type is equal with 0.5. For a questionnaire with eighteen questions, the probability becomes equal with 0.0278. For a multiple-choice questionnaire, the probability of guessing the

correct answer can be calculated taking into consideration the number of possible combinations for each number of correct options. On average, the probability to guess the correct answer of a multiple-choice question with five options and one or up to four correct answers is of 0.15. For a sample of forty-five questions, the probability becomes 0.0033, which is ten times less comparing with probability of guessing a correct answer on a test with eighteen true/false statements.

As conclusion, it can be said that a traditional method for EBM training did not offer enough EBM knowledge (note that was a two-hour course). The web-based intervention proved to be a better solution in EBM training. The self-directed educational approach offered to the students the possibility of choosing the time, place and modality of learning. In addition, offered the possibility of using specialized online resources, an interactive self-evaluation environment, and an interactive web-based multiple-choice questionnaire for knowledge assessment. The web-based intervention in EBM training proved its usefulness and effectiveness for fourth-year medical students enrolled in the research, but the content and educational design are relevant to a broad spectrum in medical education. Offering the possibility of interactive education and evaluation without interruption of practical activities, the proposed computer-based curriculum for EBM education could be a realistic solution for continuing medical education.

The research had some limitations. First limitation refers the allocation of the students into one group or another. Not all medical students included into the study had access at an individual computer. Because there could not be found a realistic solution for the access to a computer in university laboratories (the students' schedule did not overlap on computers lab availability), the student's allocation in the intervention or control group was not done by randomization. The second limitation refers the research outcomes. There were not included as outcome of the study neither critical appraisal skills (as skills not as knowledge about skills) nor the attitude regarding EBM because there could not be allocated more time for the traditional approach and for web-based training for EBM due to lack of time in students' schedule. The series of students' chose randomly was enrolling on a six-week module with three topics and an average of three hours of courses and/or seminars and four hours of practical and/or clinical activities per day. According with students' possibility in terms of hours for EBM education, the aim of the research was limited to EBM knowledge and problem-based assessment. Future interventions on evidence-based medicine skills and attitude will allow mapping realistically the reality regarding the topic.

The research has compared only two methods for teaching EBM and was focused on undergraduate medical students. More researches comparing EBM educational strategies, considering other medical professionals as nurses, residents, and practitioners could identify the best solution for EBM training according with learners' category.

Critically appraisal skills on searching the best available evidence able to answer to a specific medical question and on assessment of the validity, reliability and usefulness of the evidence in treatment of an individual patient, professional behaviour in spirit of inclusion into daily medical decision of the best available evidence, as well as long-term effects on patient outcomes require further investigations.

## V. CONCLUDING REMARKS

The interactive web-based approach was efficient and effective in undergraduate students' EBM education, suggesting that could be the appropriate method for teaching evidence-based medicine. However, more researches comparing the proposed web-based curriculum with other educational models, applied on residents and practitioners are imperative. In addition, evaluation of the professional behaviour in spirit of inclusion of the best available evidence into daily medical decision, and long-term effects on patient outcomes require further investigations.

## REFERENCES

- [1] G. H. Guyatt: *Evidence-based medicine*, ACP J Club 114(1991)A-16.
- [2] D. L. Sackett, W. M. Rosenberg, J. A. Gray, R. B. Haynes, W. S. Richardson: *Evidence-based medicine: what it is and what it isn't*, Br Med J 312(1996)71-72.
- [3] A. Kitson, G. Harvey, B. McCormack: *Enabling the implementation of evidence based practice: a conceptual framework*, Qual Health Care 7(1998)149-158.
- [4] Association of American Medical Colleges. Report of the Ad Hoc Committee of Deans, "Educating doctors to provide high quality medical care. A vision for medical education in the United States", Washington, DC; 2004.
- [5] B.W. McCrindle: *Optimizing outcomes through clinical research and evidence-based clinical decision-making*, Prog Pediatr Cardiol 20(2005)53-64.
- [6] C. G. Wise, V. Bahl, R. Mitchell, B. T. West, T. Carli: *Population-based medical and disease management: an evaluation of cost and quality*, Dis Manag 9(2006)45-55.
- [7] B. S. Alper, D. C. Vinson: *Experiential curriculum improves medical students' ability to answer clinical questions using the Internet*, Fam Med 37(2005)565-569.
- [8] M. A. O'Neill, R. C. Brownson: *Teaching evidence-based public health to public health practitioners*, Ann Epidemiol 15(2005)540-544.
- [9] M. Rhodes, R. Ashcroft, R. A. Atun, G. K. Freeman, K. Jamrozik: *Teaching evidence-based medicine to undergraduate medical students: A course integrating ethics, audit, management and clinical epidemiology*, Medical Teacher 28(2006)313-317.
- [10] K. Schilling, J. Wiecha, D. Polineni, S. Khalil: *An interactive web-based curriculum on evidence-based medicine: Design and effectiveness*, Fam Med 38(2006)126-132.
- [11] L. J. Nicholson, L. Y. Shieh: *Teaching evidence-based medicine on a busy hospitalist service: Residents rate a pilot curriculum*, Academic Medicine 80(2005)607-609.
- [12] K. S. Yew, A. Reid: *Teaching evidence-based medicine skills: An exploratory study of residency graduates' practice habits*, Family Medicine 40(2008)24-31.
- [13] L. J. Nicholson, C. M. Warde, J. R. Boker: *Faculty training in evidence-based medicine: Improving evidence acquisition and critical appraisal*, Journal of Continuing Education in the Health Professions 27(2007)28-33.
- [14] B. J. Kilian, L. S. Binder, J. Marsden: *The Emergency Physician and Knowledge Transfer: Continuing Medical Education, Continuing Professional Development, and Self-improvement*, Academic Emergency Medicine 14(2007)1003-1007.
- [15] M. Nentwich: *Cyberscience: Modelling ICT-induced changes of the scholarly communication system*, Information Communication & Society 8(2005)542-560.
- [16] G. Gartlehner: *Evidence-based medicine breaking the borders--a working model for the European Union to facilitate evidence-based health care*, Wien Med. Wochenschr. 154(2004)127-132.
- [17] H. Q. Nguyen, D. Cuenco, S. Wolpin, J. Benditt, V. Carrieri-Kohlman: *Methodological considerations in evaluating eHealth interventions*, Can J Nurs Res 39(2007)116-134.
- [18] T. Greenhalgh, P. Toon, J. Russel, G. Wong, L. Plumb, F. Macfarlane: *Transferability of principles of evidence-based medicine to improve educational quality: Systematic review and case study of an online course in primary health care*, Br Med J 326(2003)142-145.
- [19] M.-P. Gagnon, F. Légaré, M. Labrecque, P. Frémont, M. Cauchon, M. Desmartis: *Perceived barriers to completing an e-learning program on evidence-based medicine*, Informatics in Primary Care 15(2007)83-91.
- [20] S. Bolboacă, L. Jäntschi, "Computer-Assisted Training and Evaluation System in Evidence-Based Medicine", in *Proceeding of the 11th International Symposium for Health Information Management Research*, Halifax, Nova Scotia, CA, pp. 220-226, July 2006.
- [21] G. Salomon, T. Almog: *Educational psychology and technology: A matter of reciprocal relations*, Teachers College Record 100(1998)222-241.
- [22] S. Bolboacă, L. Jäntschi, T. Drugan, A. Achimaş Cadariu: *Creating Therapy Studies Critical Appraised Topics. CATRom Original Software for Romanian Physicians*, Applied Medical Informatics 15(2004)26-33.
- [23] S. Bolboacă, L. Jäntschi, A. Achimaş Cadariu: *Creating Diagnostic Critical Appraised Topics. CATRom Original Software for Romanian Physicians*, Applied Medical Informatics 14(2004)27-34.
- [24] S. Bolboacă, L. Jäntschi, A. Achimaş Cadariu: *Creating Etiology/Prognostic Critical Appraised Topics. CATRom Original Software for Romanian Physicians*, Applied Medical Informatics 13(2003)11-16.
- [25] L. Jäntschi, S. Bolboacă, "Organizing Guidelines Models and Clinical Practice Guidelines", in *Proceeding of the 11th International Symposium for Health Information Management Research*, Halifax, CA, pp. 328-338, 2006.
- [26] T. Drugan, S. Bolboacă, L. Jäntschi, A. Achimaş Cadariu: *Binomial Distribution Sample Confidence Intervals Estimation I. Sampling and Medical Key Parameters Calculation*, Leonardo Electronic Journal of Practices and Technologies 3(2003):47-74.
- [27] S. Bolboacă, L. Jäntschi, "Binomial Distribution Sample Confidence Interval Estimation for Positive and Negative Likelihood Ratio Medical Key Parameters", in *Proceeding of the American Informatics Medical Association Annual Symposium on Biomedical and Health Informatics from Foundations to Applications to Policy*, Washington DC, USA, pp. 66-70, 2005.
- [28] Binomial distribution; online software. Available: [http://vl.academicdirect.org/applied\\_statistics/binomial\\_distribution/](http://vl.academicdirect.org/applied_statistics/binomial_distribution/)
- [29] Romanian College of Physicians. Available: <http://www.cmr.ro>
- [30] Stetoscop.ro. Available: <http://www.stetoscop.ro>