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Medical Informatics and Statistics in an Undergraduate Nursing Curriculum: Survey of Students' Perception

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Abstract

Aim: A survey was conducted in undergraduate medical students enrolled in 3 or 4-year degree programs in Nursing, Midwifery, Radiology and Medical Imaging (technician), Physiotherapy and Kinetotherapy (technician) and Clinical laboratory (technician) in order to identify their perception of the medical informatics and statistics curriculum.

Material and Method: A qualitative study was carried out in 1st year undergraduate students at the "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca, Romania during the 2008-2009 academic year. A questionnaire containing 10 categories of items for assessing lectures and 19 for assessing practical activities was developed as an online tool with a database connection using Google Docs.

Results: Students' attendance to lectures proved not to be statistically related with their final mark. The mean final mark obtained by students (6.02±1.57) proved to be statistically lower compared to the expected mean (6.58±1.23; $t = -2.76$, $DF = 54$, $p = 0.0078$). The *teacher*, the *problems solved during lectures*, the *lecture summaries* as well as the *course web page* proved to statistically influence the learning process. The results revealed that all students were satisfied with the materials used within lectures and practical activities as well as with the objectiveness of the final evaluation. Most students classified the difficulty of the practical activities as *reasonable* ($p < 0.05$) and their pace as *just about right* ($p < 0.05$). The overall quality of the practical activities was classified as *easy* by 13% of respondents, *pretty easy* by 30%, *reasonable* by 29%, and *difficult* by 25%.

Conclusions: Overall, undergraduate students were satisfied with the materials used within lectures and practical activities as well as with the teacher's attitude and support in the learning process.

Keywords: Medical Informatics and Statistics; Education; Student's perception.

Introduction

The increasing use of computers and information technologies in the healthcare field has created new requirements in the training of healthcare staff [1,2]. Medical informatics and statistics are useful in daily practice (nursing management and processing [3,4]) as well as in research (acquisition of knowledge and competencies [5-7] , continuing nursing education [8,9] (including eHealth strategies [10]),master's degrees in nursing [11], doctoral degrees in nursing [12], etc.). The training of nursing professionals in the field of health informatics and the integration of nursing informatics into daily practice is a priority for both professional associations [13-15] and universities [16,17]. Since *nursing involves the application of art and science through theoretical concepts and scientific research*

[18], the training in medical informatics and statistics of undergraduate students has become an important issue [19,20].

The requirements for competent nursing practice, established by national [19] and/or international agencies (European Union [21,22]), currently include computer competencies [23]. Access to patient information and evidence-based content in patient care is needed within all nursing professions. Access to patient information requires computer and medical informatics skills while understanding evidence-based content requires knowledge of medical statistics.

The present study aimed to explore issues connected with student effort, teacher attitude, materials used within lectures and practical activities as well as with the objectiveness of the final evaluation of undergraduate students at the end of the medical informatics and statistics course.

Material and Method

A qualitative survey was conducted in undergraduate medical students enrolled in 3 or 4-year degree programs in Nursing, Midwifery, Radiology and Medical Imaging (Technician), Physiotherapy and Kinetotherapy (technician) and Clinical laboratory (technicians) at the "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania during the 2008-2009 academic year. The university had 3146 students in the 2008-2009 academic year out of which 88 enrolled in the above-mentioned degree programs.

The three or four-year degree programs (depending on specialty) include fifteen courses in basic subjects in the first year of study, which is followed by two or three years of mainly clinical teaching.

Radiology and Medical Imaging (Technician), Physiotherapy and Kinetotherapy (technician) and Clinical laboratory (technician) are 3-year degree programs at our university while Nursing and Midwifery are 4-year degree programs.

In the 2008-2009 academic year medical informatics and statistics was compulsory in the 1st year of study for all students (2.5 lecture hours and 2 hours of practical activities a week for one semester). The course aimed to provide students with basic knowledge of information technologies applied in healthcare and basic methods in medical statistics.

The following subjects were taught during lectures: ▪ History of computers; ▪ Data, Information and Knowledge (definition and management); ▪ Information Theory; ▪ Quantity of information; ▪ Coding information; ▪ Data and information used in healthcare; ▪ Operating systems; ▪ Files and folders: concepts and management; ▪ Using computers in healthcare; ▪ Processing text documents; ▪ Management of healthcare data using Microsoft Excel; ▪ Management of medical data using Microsoft Access; ▪ Medical data processing with Microsoft Excel; ▪ Presentation of medical data using Microsoft PowerPoint; ▪ Informatics systems used in healthcare; ▪ The Internet in health care and in continuing health education; ▪ Mathematical symbols and operations; ▪ Mathematical operations with Microsoft Excel; ▪ Stages of scientific knowledge; ▪ Basic knowledge of statistics (data, constant, variable, scale of measurement, statistical population, sample, sampling); ▪ Descriptive statistics (measures of centrality, dispersion, localization and symmetry); ▪ Probabilities (introduction, odds and ratio, conditional probabilities); ▪ Random variables; ▪ Frequency distributions; ▪ Summary statistics (one or two variables, numerical and ordinal variables; good graphical and table practices); ▪ Estimation of statistical parameters (confidence intervals for mean and frequency); ▪ Hypothesis testing: concepts and practice; ▪ Statistical inference on qualitative data (chi-square test); ▪ Testing means (Z test, t test); ▪ ANOVA; ▪ Non parametric tests (Mann-Whitney, Wilcoxon); ▪ Correlations and regressions; ▪ Analysis of survival data; ▪ Statistical software. The practical activities aimed to develop the following skills: ▪ Management of folders and files; ▪ Operations on documents (open, create, save, delete, cut, move, print); ▪ Steps in creating a document; ▪ Document formatting (page, text, paragraph, characters, etc.); ▪ Page header and footer, page number; ▪ Working with predefined styles and formatting; ▪ Creation of document contents; ▪ Working with equations in Microsoft Word; ▪ Creation and manipulation of Word templates; ▪ Formatting Excel documents (space of work, rows, columns, cells); ▪ Creation of Excel databases; ▪ Excel forms; ▪ Defining functions in Excel (average of blood pressure, hospitalization costs, body mass index, etc.); ▪ Working with predefined functions (basic statistics parameters); ▪ Summary statistics of quantitative and qualitative variables using Excel; ▪ Graphical representations using Microsoft Excel; ▪ Inferential statistics using Microsoft Excel (confidence intervals for means, chi-square test, correlations and regressions).

The students sat two examinations at the end of the semester: a practical examination (to assess computer skills) and a theoretical examination (multiple-choice questions with five possible answers, one up to four correct answers). The theoretical examination accounted for 70% of the final mark while the practical examination represented 30% of the final mark. Students passed the examination if they were awarded a mark higher than 5 for both the practical and the theoretical examination.

A survey was carried out in order to meet the aim of the present research. Our questionnaire had three parts: a section containing students' personal information, one that evaluated students' perceptions of lectures and a third one that evaluated their perception of practical activities. Two types of questions were used: open-ended (participants provided answers using their own words) and closed-ended (participants chose the most suitable answer from a list of options). The questionnaire was developed as an online tool using a Google Docs form.

The assessment of the lectures aimed to evaluate the following: student effort (participation, preparation, and learning) and teacher attitude.

- Student effort:
  - *Open-ended questions*: C1. Hours a week devoted to the subject; C2. Hours a week for learning; C3. Expected final mark.
  - *Closed-ended questions*.
    - *Lecture participation and preparation* (N/A = not relevant – Never – Rarely – Sometimes – Often - Always): C4. A. Attended; B. Prepared for lectures; C. Actively participated; D. Reviewed previously taught material; E. Asked for help.
    - *Learning:*
      - *Outcome*s (Not relevant– None – A little – Some – A lot – An exponential amount): C.5. (learning outcomes) A. Gained factual knowledge; B. Developed fundamental principles; C. Learnt to apply taught material; D. Developed oral communication skills; E. Developed writing skills; F. Developed visual or mathematical representation skills; G. Learned to search for resources needed to answer questions or solve problems; H. Leaned to analyze or critically assess ideas, arguments or points of view; I. Understood how different parts of the course fit together.
      - *Usefulness of different resources or activities* (Not al all useful – Slightly useful – Somewhat useful – Very useful – Extremely useful): C.6. A. Teacher; B. Problems solved during lectures, lecture summaries; C. Ongoing evaluation; D. Lectures; E. Class discussions; F. Class demonstrations; G. Practical activities; H. Audio-video materials; I. Course web page.
- Teacher attitude: (Not relevant for the course – Poor – Fair – Good – Very good - Excellent): C.7. A. Showed interest in students' learning; B. Clearly explained the course requirements; C. Clearly explained the aim and objectives of the course; D. Provided feedback to improve student performance; E. Scheduled course work; F. Demonstrated the importance and relevance of the course; G. Used examples to illustrate concepts; H. Explained lecture material; I. Designed tests that covered the most important concepts of the course; J. Introduced stimulating ideas; K. Showed respect for all students.
- (Easy – Pretty Easy – Reasonable – Difficult – Very Difficult): C.9. The difficulty level of the lectures.
- (Very slow – Somewhat slow – Just about right – Somewhat fast – Very fast): C.10. The pace of the lectures.
- (Poor – Fair – Good – Very good – Excellent): C.8. Overall evaluation of lectures.

The practical activities were evaluated in terms of: materials used (structure, difficulty, pace, and quality), teacher attitude and objectiveness of examinations.

- Materials (Totally agree – Agree – None – Disagree – Totally disagree): L.1. Clearly defined objectives; L.2. Content helped meet objectives; L.3. Provided clear hints; L.4. Allotted sufficient time for each activity.
- Teacher attitude (Totally agree – Agree – None – Disagree – Totally disagree): L.5. Used different teaching methods; L.6. Taught effectively; L.7. Helped students whenever required; L.8. Presented the materials in an interesting way; L.9. Contributed to student personal development and training; L.10. Encouraged active involvement; L.11. Showed positive attitude; L.15. Used specialized language; L.16. Connected content with other subjects.
- Objectiveness of examinations (Totally agree – Agree – None – Disagree – Totally disagree): L.12. Examinations included content taught during lectures and practical activities; L.13. Evaluation criteria were clearly defined; L.14. Teacher assessed students' performance objectively.
- (Easy – Pretty Easy – Reasonable – Difficult – Very Difficult): L.17. Level of difficulty; L.19. Overall evaluation of practical activities.
- (Very slow – Somewhat slow – Just about right – Somewhat fast – Very fast): L.18. Pace of practical activities.

The students were asked to fill in the survey form at the end of the semester after all the examinations but before the final marks were announced. The results were analysed according to the type of variables in the questionnaire using NCSS 2007. The expected and obtained marks in the first examination session were analyzed in order to see how objectively the students evaluated their knowledge and skills (student t-test for dependent sample at a significance level of 5% was applied). The link between different variables used in the study was assessed using the Spearman rank correlation coefficient. Chi-square statistics was used to identify relationships in contingency tables (5% significance level). The test for comparing two proportions was used at a significance level of 5% whenever appropriate.

Results

Fifty-six students (female/male ratio of 7:1) out of eighty-eight (~64%) agreed to participate in the study and filled in the survey form.

Assessment of Lectures

The number of hours a week devoted to the subject ranged from 0 to 10, with a mean of 5.26 (95%CI [4.71-5.82]). On average students spent 3.71 hours (95%CI [2.08-5.34]) a week for learning. No gender differences were identified in connection with the hours spent for learning, reading and practicing ($t = 0.128$, $p = 0.898$ for hours spent on preparing for class; $t = 0.170$, $p = 0.866$ for hours dedicated to learning).

The expected mark and the mark obtained in first examination session are presented in Table 1.

Table 1. Expected vs. obtained final mark

Mark	Expected (exp)	Obtained (obt)	p (%exp - %obt)
4	0	18	0.0000
5	15	0	0.0001
6	8	16	0.0680
7	21	11	0.0383
8	7	9	0.5874
9	4	2	0.4123
Missing data	1	0	0.3154
Total	***56***	***56***	

Seven students out of 56 predicted their final mark correctly. This result provided an accuracy of 0.13 (perfect concordance between the expected and the observed mark divided by the total number of students participating in the survey). Seventy students under-estimated their knowledge and did not pass the exam in the first examination session. Seventy students over-estimated their knowledge and obtained a final mark lower than expected while fourteen students under-estimated their knowledge and obtained a final mark higher than expected.

A mean of 6.02±1.57 was obtained for the final mark while a mean of 6.58±1.23 was expected by respondents ($t = -2.76$, $DF = 54$, $p = 0.0078$).

A weak but significant correlation was noticed between the obtained and the expected final mark (Spearman rank correlation coefficient of 0.427, $p = 0.001$).

The results of student preparation for lectures expressed as absolute frequency are presented in Table 2. Two out of three students who never actively participated during lectures passed the examination in the first session.

Table 2. Results of student effort: lecture participation and preparation

	Attended	Prepared for lectures	Actively participated	Reviewed previously taught material	Asked for help
Never	0	0	3	2	1
Rarely	1	5	9	4	4
Sometimes	8	23	22	18	15
Often	19	18	14	23	17
Always	24	4	6	6	17
Not relevant	0	2	0	1	1
Missing	4	4	2	2	1
Total	***56***	***56***	***56***	***56***	***56***

No statistically significant correlation was identified between the final mark and student effort in lecture participation and preparation (Spearman rank correlation lower than 0.2, $p > 0.05$).
Nine learning outcomes were analyzed in terms of the association between learning and outcomes from the students' perspective (Table 3). The chi-square test was applied and the results are presented in Table 4.

Table 3. Contingency of students' perception of the link between learning and outcomes

Outcome	None	A little	Some	A lot	Exponential amount	Total
Gained factual knowledge	0	2	14	26	14	56
Developed fundamental principles	0	3	19	28	3	53
Learnt to apply taught material	0	5	11	31	9	56
Developed oral communication skills	5	14	16	18	2	55
Developed writing skills	2	6	26	13	6	53
Developed visual or mathematical representation skills	1	9	13	21	11	55
Learned to search for resources needed to answer questions or solve problems	1	6	12	30	7	56
Leaned to analyze or critically assess ideas, arguments or points of view	2	7	19	24	3	55
Understood how different parts of the course fit together	2	6	19	19	9	55
Total	***13***	***58***	***149***	***210***	***64***	***494***

In order to analyze the association among different types of help and learning processes from the students' perspective, the Chi-square test was applied on the data presented in Table 5. The observed frequencies (as categorical variable) of resource/activity type that helped students in the learning process were used in this analysis. The results are presented in Table 6.

The students' perception of teacher attitude during lectures, expressed as relative frequency, is presented in Table 7.

Table 4. Chi-square statistics (χ^2) on contingency between learning and outcome

Outcome	None	A little	Some	A lot	Exponential amount	Total (χ^2)	p(χ^2)
Gained factual knowledge	1.47	3.18	0.49	0.20	6.27	11.62	$2.04 \cdot 10^{-2}$
Developed fundamental principles	1.39	1.67	0.57	1.33	2.18	7.14	$1.29 \cdot 10^{-1}$
Learnt to apply taught material	1.47	0.38	2.05	2.17	0.42	6.50	$1.65 \cdot 10^{-1}$
Developed oral communication skills	8.72	8.81	0.02	1.24	3.69	22.48	$1.61 \cdot 10^{-4}$
Developed writing skills	0.26	0.01	6.27	4.03	0.11	10.68	$3.03 \cdot 10^{-2}$
Developed visual or mathematical representation skills	0.14	1.00	0.78	0.24	2.11	4.26	$3.71 \cdot 10^{-1}$
Learned to search for resources needed to answer questions or solve problems	0.15	0.05	1.42	1.61	0.01	3.24	$5.19 \cdot 10^{-1}$
Leaned to analyze or critically assess ideas, arguments or points of view	0.21	0.05	0.35	0.02	2.39	3.01	$5.56 \cdot 10^{-1}$
Understood how different parts of the course fit together	0.21	0.03	0.35	0.82	0.49	1.91	$7.53 \cdot 10^{-1}$
Total	***14.04***	***15.18***	***12.31***	***11.67***	***17.66***	***70.85***	***$9.22 \cdot 10^{-5}$***

Table 5. Students' perception of the link between resources/activities and their usefulness

Resource/Activity	Usefulness					∑
	Not at all	Slightly	Somewhat	Very	Extremely	
Teacher	0	2	3	35	10	50
Problems solved during lectures, lecture summaries	1	4	10	30	8	53
Ongoing evaluation	1	3	19	20	2	45
Lectures	0	1	6	31	18	56
Class discussions	0	0	12	26	18	56
Class demonstrations	0	0	8	29	18	55
Practical activities	0	0	2	15	39	56
Audio-video materials	0	2	7	30	13	52
Course web page	0	0	5	18	33	56
Total	***2***	***12***	***72***	***234***	***159***	***479***

Table 6. Chi Square statistics (χ^2) on the contingency between resources/activities and their usefulness

Resource/Activity	Not at all	Slightly	Somewhat	Very	Extremely	Sum(χ^2)	p(χ^2)
Teacher	0.21	0.45	2.71	4.58	2.62	10.57	$3.19 \cdot 10^{-2}$
Problems solved during lectures, lecture summaries	2.74	5.38	0.52	0.65	5.23	14.52	$5.81 \cdot 10^{-3}$
Ongoing evaluation	3.51	3.11	22.13	0.18	11.21	40.14	$4.05 \cdot 10^{-8}$
Lectures	0.23	0.12	0.69	0.49	0.02	1.55	$8.18 \cdot 10^{-1}$
Class discussions	0.23	1.40	1.52	0.07	0.02	3.25	$5.17 \cdot 10^{-1}$
Class demonstrations	0.23	1.38	0.01	0.17	0.00	1.79	$7.75 \cdot 10^{-1}$
Practical activities	0.23	1.40	4.89	5.58	22.41	34.52	$5.82 \cdot 10^{-7}$
Audio-video materials	0.22	0.37	0.09	0.83	1.05	2.56	$6.34 \cdot 10^{-1}$
Course web page	0.23	1.40	1.39	3.20	11.17	17.40	$1.62 \cdot 10^{-3}$
Total	***7.84***	***15.01***	***33.96***	***15.74***	***53.74***	***126.29***	***$3.80 \cdot 10^{-13}$***

p(χ^2)($\Sigma\chi^2$,df): the probability of Chi Square distribution to observe a departure from the agreement higher than the observed one (Sum(χ^2)); df = 4 for every resource/activity (Sum(χ^2)) and df = 4*8 for all activities/resources (ΣΣ)

The classification in descending order of lecture difficulty level was as follows: pretty easy (52%) – reasonable (34%) – difficult (9%) – easy (9%).

The classification in descending order of the pace of lectures was: somewhat slow (55%) – just about right (38%) – somewhat fast (5%) – very slow (2%).

Seventy-one percent of students classified the lectures as *good* or *very good*, 25% as *fair* and 4 % as *poor*.

Table 7. Assessment of teacher attitude: results

Teacher attitude	Poor (%)	Fair (%)	Good (%)	Very good (%)	Excellent (%)	Not relevant (%)
Showed interest in students' learning	4	11	31	35	20	0
Clearly explained the course requirements	0	4	15	55	27	0
Clearly explained the aim and objectives of the course	0	0	20	51	29	0
Provided feedback to improve student performance	4	4	33	42	18	0
Scheduled course work	2	4	29	35	27	2
Demonstrated the importance and relevance of the course	2	4	27	44	24	0
Used examples to illustrate concepts	0	5	15	40	40	0
Explained lecture material	0	0	11	45	44	0
Designed tests that covered the most important concepts of the course	0	4	20	42	33	2
Introduced stimulating ideas	2	2	38	33	20	5
Showed respect for all students	2	0	9	24	62	4

Assessment of Practical Activities

Table 8 presents the results of the practical activities evaluated in terms of the materials used.

Table 8. Assessment of practical activities materials: results

Material	Percent				
	Totally agree	Agree	None	Disagree	Totally disagree
Clearly defined objectives	70	30	0	0	0
Content helped meet objectives	63	38	0	0	0
Provided clear hints *	64	34	0	0	0
Allotted sufficient time for each activity	32	48	14	4	2

* missing answers

Table 9 shows the results of the assessment of teacher attitude during practical activities.

Table 9. Assessment of teacher attitude: results

Teacher attitude	Percent				
	Totally agree	Agree	None	Disagree	Totally disagree
Used different teaching methods *	40	58	2	0	0
Taught effectively	89	11	0	0	0
Helped students whenever required	89	11	0	0	0
Presented the materials in an interesting way	54	43	4	0	0
Contributed to student personal development and training *	45	46	7	0	0
Encouraged active involvement	66	32	2	0	0
Showed positive attitude	80	20	0	0	0
Used specialized language *	79	21	0	0	0
Connected content with other subjects	56	35	7	0	0

* missing answers

Students' perception of the objectiveness of the examinations (theoretical and practical) were as follows:

- All students *agreed/totally agreed* that the assessment included content taught during lectures and practical activities and that the teacher assessed students' performance objectively.
- 95% of students *agreed/totally agreed* that the evaluation criteria were clearly defined. Two students neither agreed nor disagreed with "*Evaluation criteria were clearly defined*" while one student *disagreed* with the statement.

A statistically higher percent of students rated the difficulty level of the practical activities as *reasonable* compared to the percent of students that classified it as *difficult* or *very difficult* (p = 0.0004,

α = 5%, see Figure 1(a)). A statistically significant difference was also observed when the percent of students that classified the difficulty of practical activities as *easy* or *pretty easy* was compared to the percent of students that classified it as *difficult* or *very difficult* ($p < 0.0001$, α = 5%). The percent of students that classified the difficulty of practical activities as *easy* / *pretty easy* was not statistically different from the percent of students that classified it as *difficult* or *very difficult* ($p = 0.6043$, α = 5%).

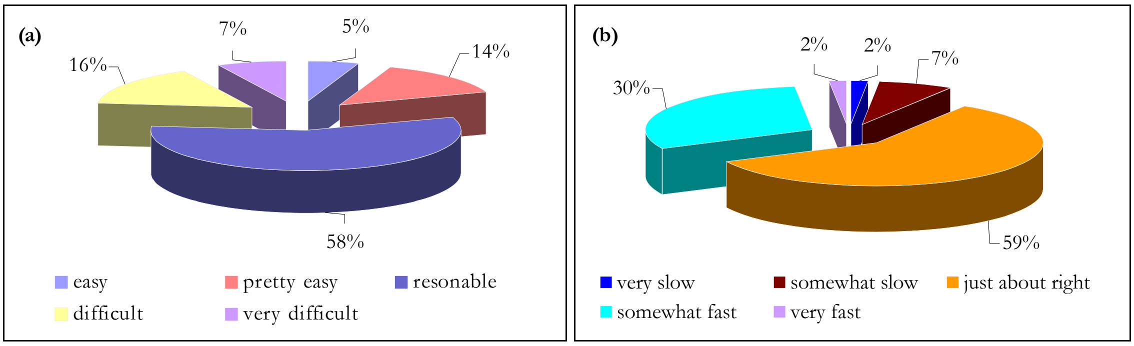

Figure 1. (a) Distribution of level of difficulty of practical activities; (b) Distribution of pace of practical activities

A statistically higher percent of students classified the pace of practical activities as *just about right* compared to the students that rated it as *somewhat fast* / *very fast* ($p = 0.0049$, α = 5%) or compared to the students who thought the pace was *very slow* / *somewhat slow* ($p < 0.0001$, α = 5%, Figure 1(b)). The percent of students that classified the pace of labs as *somewhat fast* / *very fast* was statistically higher compared to the percent that rated it as *somewhat slow* / *very slow* ($p = 0.0032$, α = 5%).

The overall quality of the practical activities was classified as *easy* by 13% of respondents, *pretty easy* by 30%, *reasonable* by 29%, and as *difficult* by 25%.

The following statistically significant correlations (Spearman's ρ rank correlation coefficient) were identified between the final mark and:

- Hours a week devoted to the subject: $\rho = 0.312$ ($p = 0.026$)
- Learnt to apply taught material: $\rho = 0.275$ ($p = 0.040$)
- Developed writing skills: $\rho = 0.303$ ($p = 0.023$)
- Usefulness of course web page: $\rho = 0.283$ ($p = 0.035$)

Discussion

The study aimed to explore issues connected with student effort, teacher attitude, the materials used within lectures and practical activities as well as with the objectiveness of the final evaluation of undergraduate students at the end of the medical informatics and statistics course. The aims of the study were met successfully.

The distribution of gender resembled that of students enrolled at the "Iuliu Hațieganu" University of Medicine and Pharmacy, Cluj-Napoca in the degree programs included in the research. The analysis of the expected mark and the mark obtained in the first examination session revealed that students were not able to assess their knowledge correctly. The expected mean proved to be statistically higher compared to the obtained mean ($p = 0.0078$) due to an increased number of students who over-assessed their knowledge (~ 62%, including here also the students who failed in the first examination session). All students were self-confident in their knowledge and skills and none of them expected to fail the medical informatics and biostatistics examination. A statistically higher percent of students were awarded mark 5 compared to the expected percent ($p = 0.0001$) since a statistically lower percent obtained mark 7 compared to the expected percent ($p = 0.0383$). Almost 13% of students proved to be able to assess their medical informatics and statistics knowledge and skills correctly at the end of the semester. Moreover, the percent of students that over-estimated their knowledge was equal to the percent of students that under-estimated their knowledge. This may reveal a shortcoming of the Romanian educational system or it may be applicable only to the students included in this study. Further research on the educational pathway may explain this phenomenon.

The analysis of student effort (Table 2) revealed the following:

- The attendance to lectures was rated as *always* by 43% of respondents and *often* by 34% of respondents. This result was expected since the university rules stipulate that students must attend at least 70% of the lectures and 100% of the practical activities.
- 41% of students prepared for lectures *sometimes* and 32% *often*.
- Most students actively participated in lectures *sometimes* (39%) or *often* (25%).
- *Sometimes* (32%) or *often* (41%) students reviewed previously taught material.
- Only 30% of students always asked for help.

Although according to the above-mentioned results a higher percent of students was expected to pass the final examination, this failed to happen. Such a result could be explained by the fact that students did not ask for help whenever needed, they did not review previously taught material and failed to actively participate in lectures. The medical informatics and statistics course requires a specialized glossary that is not used by the other subjects in the 1st year curriculum at the "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca. Thus, attendance to lectures only is not sufficient to pass the examination.

At least one-half of participants in the study were unable to ask for help when needed. A strategy for encouraging students to ask questions and find answers must be implemented in order to help the learning process. Contrary to expectations, no statistically significant link between student effort and the final mark obtained was identified.

The analysis of learning outcomes revealed the following:

- Most students (~ 71%) gained *a lot* or *an exponential amount* of *factual knowledge*.
- Almost 55% of respondents developed *a lot* and *an exponential amount* of *fundamental principles*.
- 71% of respondents learnt to apply taught material.
- Less than half of the students acquired *a lot of* or *an exponential amount* of *oral communication and writing skills*.
- 58% of students developed *a lot* or *an exponential amount* their *visual or mathematical representation skills*.
- 66% of respondents stated that they *learnt to search and use resources to find answers or to solve problems a lot / an exponential amount*.
- 49% of respondents stated that they *learnt to search for resources needed to answer questions or solve problems a lot / an exponential amount*.
- 51% of students specified that they *understood how different parts of the course fit together a lot / an exponential amount*.

In terms of learning and outcome, it can be concluded that students gained *factual knowledge* and developed *oral communication and writing skills* (see Table 4).

The analysis of students' perception of the link between resources or activities and their usefulness in the learning process revealed the following:

- 90% of respondents rated as *very / extremely useful* the involvement of the teacher (statistically significant, Table 6).
- 72% of respondents rated as *very / extremely useful* the problems solved during lectures as well as the lecture summaries (statistically significant, Table 6).
- 49% of respondents rated ongoing evaluation as *very / extremely useful* (statistically significant, Table 6).
- 88% of respondents classified lectures as *very / extremely useful*.
- 79% of respondents classified class discussions as *very / extremely useful*.
- 85% of respondents classified class demonstrations as *very / extremely useful*.
- 96% of respondents classified the practical activities as *very / extremely useful* (statistically significant, Table 6).
- 83% of respondents classified the audio-video materials as *very / extremely useful*.

- 91% of respondents classified the course web page as *very / extremely useful* (statistically significant, Table 6).

Most students rated teacher attitude as *very good / excellent* (see Table 8). The weakest points were obtained by *introduced stimulating ideas* and *showed interest in students' learning*. It may prove difficult to stimulate 1st year students to actively become involved in medical informatics and statistics since they have neither theoretical nor practical knowledge. Medical informatics is perceived with more difficulty since only a few university hospitals and clinics in Cluj-Napoca use informatics tools for patient information and data management [24-26].

Even if most students perceived the lectures as *pretty easy,* not all students passed the first examination; however they managed to pass the second one. Since only 9% of students classified the course as *difficult*, only 5 students were expected to fail the examination instead of 18. This result showed again that the students were not able to correctly assess their abilities, skills and knowledge needed for passing the medical informatics and statistics examination.

The pace of the lectures was adjusted in the following academic year in order to meet the students' needs as revealed by their answers.

The assessment of the practical activities indicated that all students *totally agreed/agreed* that the objectives were clearly defined, the content helped meet the objectives and the hints given to solve the problems were clear (Table 8). As far as *allotted sufficient time for each practical activity* was concerned, 6 students *disagreed/totally disagreed.* This result could be explained by the absence of previous experience in using computers.

The analysis of students' perception of teacher attitude during practical activities revealed the following:

- Teacher used different teaching methods (98% of respondents *totally agreed/*agreed).
- Teacher *taught effectively* (100% of respondents *totally agreed/agreed*).
- Teacher *helped students whenever required* (100% of respondents *totally agreed/agreed*).
- With two exceptions, students considered that the practical activity materials were presented in an interesting way.
- Teacher *contributed to student personal development and training* in 93% of cases.
- Teacher *encouraged active involvement* in the practical activities in 98% of cases.
- Teacher *showed positive attitude* in 100% of cases.
- Without any exception, teacher *used specialized language*.
- Students *totally agreed/agreed* that teacher *connected content with other subjects* in 91% of cases.

As far as the difficulty of the practical activities was concerned, three distinct groups were identified: the smallest group (14%) for which the practical activities were *easy/pretty easy*; the intermediate group (23%), not statistically different from the first one, for which the practical activities were *difficult/very difficult* and the largest group (58%) for which the practical activities were *reasonable* in terms of difficulty. Most students classified the pace of the practical activities as *just about right*; the percent of these students was significantly higher compared to the percent of students who considered that the pace was *somewhat fast/very fast* or *very slow/somewhat slow*. In addition, a statistically higher percent of students regarded the pace as *somewhat fast/very* fast compared to the percent of students who rated it as *very slow/somewhat slow*.

In view of the above-analyzed results, a good strategy would be to test students' computer skills at the beginning of the course and then to divide them into groups according to the results obtained. However, all students must be able to solve the same problems during the practical activities and be assessed using the same criteria. Therefore, it will be necessary to work harder and cover basic concepts with the students who lack computer skills.

The final mark proved to be statistically positive and weak related to *hours a week devoted to the subject*, *learnt to apply taught material* (the correlation was higher as students' rating was better), and *developed writing skills*. In addition, the mark was higher in students who rated the *usefulness of course web page* higher.

Without any exceptions, all students *agreed* that the examinations reflected *content taught during lectures and practical activities* and that the teacher *assessed students' performance* in medical informatics and statistics *objectively*. Moreover, most students (95%) *agreed/totally agreed* that the *evaluation criteria were clearly defined*.

Students' assessment of lectures and practical activities allows the teacher to improve the materials used according to the students' needs. The faculty members have a crucial role in deciding the content that is taught to their students. The Ohio State University College of Nursing had a positive feedback in developing informatics skills across the baccalaureate nursing curriculum [17,27]. Since clinics have also witnessed the development of technology, all healthcare professionals must be able to use information technologies effectively in day-to-day practice as well as for personal development [28,29].

Unfortunately, the faculty members of our university decided to reduce the number of hours allotted to medical informatics and statistics to 1 lecture hour and 1 practical activities hour a week, for one semester, starting with the 2009-2010 academic year. Thus, undergraduate students can only acquire basic knowledge and skills, which are not enough for coping with information technologies at their future work place.

In this situation, personal and continuing education become the only alternative for improving one's knowledge and skills.

Students' assessment of lectures and practical activities must be carried out whenever possible as it enables teachers to adapt course materials in order to meet students' needs.

Conclusions

The present research revealed that most undergraduate students included in the study were unable to estimate correctly their medical informatics and statistics knowledge and skills.

Overall, the undergraduate students were satisfied with the materials used during lectures and practical activities as well as with the teacher's attitude and support within the learning process.

The teacher, the problems solved during lectures, the lecture summaries as well as the course web page proved to statistically influence the learning process.

As far as the students' computer skills are concerned, an effective strategy would be to test their skills at the beginning of the course and then to divide students into groups according to the results obtained. This could improve undergraduate students' computer knowledge and skills and better prepare them for future clinical practice.

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