

## E-LEARNING IN MEDICAL EDUCATION – IMPLEMENTATION

**Magdalena Roszak<sup>1</sup>, Barbara Kołodziejczak<sup>1</sup>, Wojciech Kowalewski<sup>2</sup>,  
Anna Ren-Kurc<sup>3</sup>, Piotr Leszczyński<sup>4</sup>, Andrzej Bręborowicz<sup>5</sup>**

<sup>1</sup> Department of Computer Science and Statistics  
Poznan University of Medical Sciences

79 Dąbrowskiego St, 60-529 Poznań, mmr@ump.edu.pl

<sup>2</sup> Adam Mickiewicz University

Faculty of Geographical and Geological Science,

27 Dzięgielowa St, 61-680 Poznań

<sup>3</sup> Adam Mickiewicz University,

Faculty of Mathematics and Computer Science

87 Umultowska St, 61-614 Poznań

<sup>4</sup> Faculty of Natural Science, Siedlce University of Natural Sciences and  
Humanities, 14 Bolesława Prusa St, 08-110 Siedlce, Poland,  
Collegium Masoviense, College of Health Sciences, Żyrardów, Poland

<sup>5</sup> Department of Pathophysiology

Poznan University of Medical Sciences, 8 Rokietnicka St, 60-806 Poznań,  
Higher Vocational State School, 4 Nowy Świat St, 62-800 Kalisz

**Abstract:** *The aim of this paper is to analyse the implementation of e-learning in medical education, exemplified by classes in basic medical sciences, and to present the results of their evaluation provided by medicine students (n=478) during the academic year 2014/2015 (group 1) and 2015/2016 (group 2). During the two years of teaching the subject of pathophysiology, they used an open-source e-learning portal as well as e-courses, being identical in terms of contents, communication and organisation. The only differences concerned the format and structure of audiovisual materials introduced after the classes were assessed by group 1. The evaluation given by the students of the two groups was analysed in terms of suitability of the educational materials, work using the e-learning portal and the general way of conducting the classes. The results indicate that the proposed implementation of blended learning (b-learning) in teaching future physicians appeared to be a success and is worth continuing, which is also expected by students themselves. In the authors' opinion, the presented results and the process of e-learning will encourage other educational units to undertake*

*similar innovative projects for education methods used at medical science or health science courses.*

**Keywords:** e-learning, blended learning, medical education, implementation, pathophysiology, educational materials, multimedia, academic education, distance education

## **MOTIVATION FOR IMPLEMENTING E-LEARNING**

E-learning is a new method of working with the students, which becomes an important element of contemporary academic education. E-learning (distance education) may be a significant source of the university's competitive advantage and may influence the quality and effectiveness of educating the contemporary students (Gregorczyk, S., 2010).

In daily life, interpersonal face-to-face communication is fading and giving way to short graphical or text messages, as well as multimedia forms and podcasts (Hargis, J., 2008). Young people are particularly proficient in the use of digital technologies, including e-learning, which is applied both in formal and informal education (Cox, M.J., 2013).

Technological development inevitably leads to the implementation of new technologies in education, at the level of schools, universities and continuing education (Kowalewski, W., Kołodziejczak, B., Roszak, M., and Ren-Kurc, A., 2013; Kołodziejczak, B., Roszak, M., Kowalewski, W., Ren-Kurc, A., 2014; Półjanowicz, W., Roszak, M., Kołodziejczak, B. and Kowalewski, W., 2014). Especially, interactive e-learning courses are very well received by students, who may use them to perform better in terms of knowledge acquisition than using conventional methods (Wang, T.H., 2007; Roszak, M., Kołodziejczak, B., Ren-Kurc, A. and Kowalewski, W., 2013; Leszczyński, P., Gotlib, J., Kopański, Z., Wejnarski, A., Świeżewski, S., Gałązkowski, R., 2015).

Due to the numerous benefits of e-learning, students more and more often acquire knowledge from the internet sources rather than traditional handbooks (Gutmann, J., Kühbeck, F., Berberat, P.O., Fischer, M.R., Engelhardt, S., Sarikas, A., 2015; Kołodziejczak, B., Roszak, M., Kowalewski, W., Ren-Kurc, A., Bręborowicz, A., 2015; Morze, N., Spivak, S., Smyrnova-Trybulska, E., 2015). Therefore, it seems appropriate to implement the e-courses and streaming media which include reliable educational contents that replace conventional lectures. (Bridge, P., Jackson, M., Robinson, L., 2009; Roszak, M., Kołodziejczak, M., Kowalewski, W., Ren-Kurc, A., 2016).

## **E-LEARNING IN MEDICAL TRAINING**

E-learning (distance education) is also commonly used in teaching medicine students, and the literature proves that its effectiveness compared to the traditional forms is similar, if not even better (Półjanowicz, W., Mrugacz, G., Szumiński, M., Latosiewicz, R., Bakunowicz-Łazarczyk, A., Bryl, A., Mrugacz, M., 2013; Półjanowicz, W., Roszak, M., Kołodziejczak, B., Bręborowicz, A., 2014; Greif, R., Lockey, A.S., Conaghan, P., Lippert, A., De Vries, W., Monsieurs, K.G., 2015). As results from the literature, most e-learning courses are intended for physicians (58%), nurses, pharmacists and dentists (Frehywot, S., Vovides, Y., Talib, Z., Mikhail, N., Ross, H., Wohltjen, H., Bedada, S., Korhumel, K., Koumare, A., Scott, J., 2013).

E-learning is not only a method applied in academic teaching but also in company courses and trainings, in which the medical students may (will) participate during their careers. The lack of ICT competence, useful in e-education upon graduation is a serious problem, as it is difficult for the graduates to obtain such qualifications (experience) outside the university (Ren-Kurc, A., Kowalewski, W., Roszak, M., Kołodziejczak, B., 2012; Kołodziejczak, B., Roszak, M., Kowalewski, W., Ren-Kurc, A., Bręborowicz, A., 2015).

Due to its specific nature, distance teaching in academic medical training is mainly carried out using blended learning (b-learning), e-learning courses being rather occasional. In practical subjects, most popular method is b-learning, which combines education in virtual environment with practical activities performed in real world under supervision of the teacher (Thomson, N.M., Campbell, D.E., O'Leary, F.M., 2011). This is the characteristic of most subjects taught when educating future physicians.

In the opinion of the authors, the organisation of the teaching process with the use of electronic contents in medicine training is not only a response to the demand of contemporary students, but most of all a proof of the high awareness of medicine teachers regarding the possibility of using technological solutions in education, which is not so obvious (Ren-Kurc, A., Kowalewski, W., Roszak, M., Kołodziejczak, B., 2012). At the same time, it may be an example of interdisciplinary cooperation of researchers and experts in e-learning technologies, with teachers.

The authors present the implementation of innovative teaching methods in pathophysiology classes, conducted for the 2<sup>nd</sup> year of medicine course at Poznan University of Medical Sciences. The presented e-learning experience in teaching the basic medicine may be a valuable model for other educational institutions which introduce remote methods at medical science or health science courses.

## **IMPLEMENTATION OF E-LEARNING IN MEDICAL TRAINING**

Correct implementation of e-learning depends on several factors, which may be grouped into two categories: technology and human resources. The most important components include appropriate organisation of work (Rozsak, M., Kołodziejczak, M., Kowalewski, W., Ren-Kurc, A., 2016), resource management tools (Rozsak, M., Kołodziejczak, B., Półjanowicz, W., Bręborowicz, A., Ren-Kurc, A., Kowalewski, W., 2015), working (editing, publishing) on teaching materials, including the LCMS portal (Learning Content Management System), as well as ICT competence of the providers and recipients of knowledge, who take part in the education process (Ren-Kurc, A., Kowalewski, W., Rozsak, M., Kołodziejczak, B., 2012; Kołodziejczak, B., Rozsak, M., Kowalewski, W., Ren-Kurc, A., Bręborowicz, A., 2015). In order to implement and conduct distance education in an efficient way, we need an interdisciplinary team: experts in a given field and persons with high ICT competence and experience in distance education. Naturally, each distance course must contain reliable contents.

Thus, it is recommended to establish cooperation with an e-education entity, lab/centre of distance learning or computer science lab, which employs persons with high competence in distance education, both in terms of technology and methodology. Such institutions usually perform the following functions:

- 1) development of e-learning tools and their implementation in teaching;
- 2) research of new education technologies in the scope of the subjects being taught (analysis of current technical capabilities) and implementation of innovative methods in education.

As part of the mentioned activities, such an entity collaborates with other experts in the field, actively participates in professional projects and seminars, including the ones being interdisciplinary and carried out at various universities. It should arrange regular trainings for teachers, which will make the classes using the learning portal more efficient, and which will allow the knowledge providers to supplement their ICT competence and improve their techniques.

## **B-LEARNING IN PATHOPHYSIOLOGY COURSE**

The department of pathophysiology has conducted classes using the e-learning portal OLAT (Online Learning And Training) for Polish-speaking medicine students since 2013. In one year of medicine, there are approximately 260 students. Simultaneously with the medicine classes conducted by the department, there are other classes attended in other courses, including Programs in English. The department has its own e-education lab.

Since 2014, medicine classes have been conducted with the use of the b-learning method. The subject includes practical training, carried out during 3 to 4 weeks,

and lectures delivered for 10 weeks. Work on the e-learning portal is treated as supplementation of the classes conducted on a stationary basis. Below we present a description of the most important components of the e-courses, defined in three areas of use as: 1. materials (multimedia, interactivity, textual-graphical), 2. communication, 3. organisation. The elements include:

- educational films with the teacher's voice commentary, which are to prepare the students for all the 10 topics raised during classes (*1. audiovisual materials - multimedia*),
- possibility of communicating with the tutor of a given topic by asking direct questions, and the possibility of clarifying any doubts while studying (*2. communication*),
- individual monitoring of knowledge. A database of self-tests have been prepared for all the classes, including a self-test which introduces the students to pathophysiology, available a week before the classes begin. Self-tests play a substantial role in formative e-assessment by supporting the teaching and learning processes, as well as provide feedback to the student and teacher during the course (*1. interactive materials - interactivity*),
- lecture-related materials and the contents of clinical cases (analysed in classes) in the form of a static graphical presentation with the teacher's text commentary. A part of such materials is available for print in relevant folders, as pdf files. The lecture-related materials function as notes which the students use during the stationary lectures. The materials are uploaded several days before the lecture, after the teacher updates their contents (*1. textual-graphical materials*),
- the entire assessment process is electronic, conducted via the e-learning portal in the University's computer rooms (Kołodziejczak, B., Roszak, M., Ren-Kurc, A., Bręborowicz, A., Kowalewski, W., 2015). The students get the credit based on the aggregate of points obtained from three tests: physiology introductory test, the test taken after completing all the classes, and the test covering the lectures. If the student is not awarded the credit, they may still retake the test twice. Next, they take the exam in one of three proposed terms – two resits are possible (*3. organization*),
- evaluation of knowledge with a large number of students is a great organisational challenge, taking into account different dates of the tests, their number or diversity. The system requires electronic enrolment for the tests, which includes selection of the date, time and room – everything is carried out via the e-learning portal. The student may still change the date 24 hours prior to the test, provided there are still any places available. (*3. organization*),

- communication is maintained through discussion forums (for topics) and a general forum for the entire group. The general forum is used to provide current organisational information, and the Department staff responsible for teaching matters answer questions regarding the classes, e.g. about the possibility of changing the group, attending a stationary class on another day, etc. (2. *communication*, 3. *organization*),
- information materials related to the classes, such as: current schedule, class regulations, rules for receiving the credit, topics, recommended literature, etc. There is also a mechanism for the notification of any changes in the course, with the possibility of sending information to the student's e-mail address using the system of grouping the users on the e-learning portal (2. *communication*, 3. *organization*),
- at the end of the classes, the students are asked to fill an anonymous questionnaire concerning the subject, with particular focus on the assessment of work on the e-learning portal, the available electronic materials and their suitability during the learning process (2. *communication*, 3. *organization*).

The students are given 7-day/24-hour Internet access to the resources, throughout the course, until the exam session, which allows them to use materials adapted to their individual needs and enables studying at any place and time.

During the two years of teaching the subject, they have used an open-source e-learning portal as well as courses, being identical in terms of contents, communication and organisation. The only differences concerned the format and structure of the audiovisual materials introduced after the classes were assessed by group 1 students. Below we present the analysis and interpretation of the results.

## STATISTICAL ANALYSIS

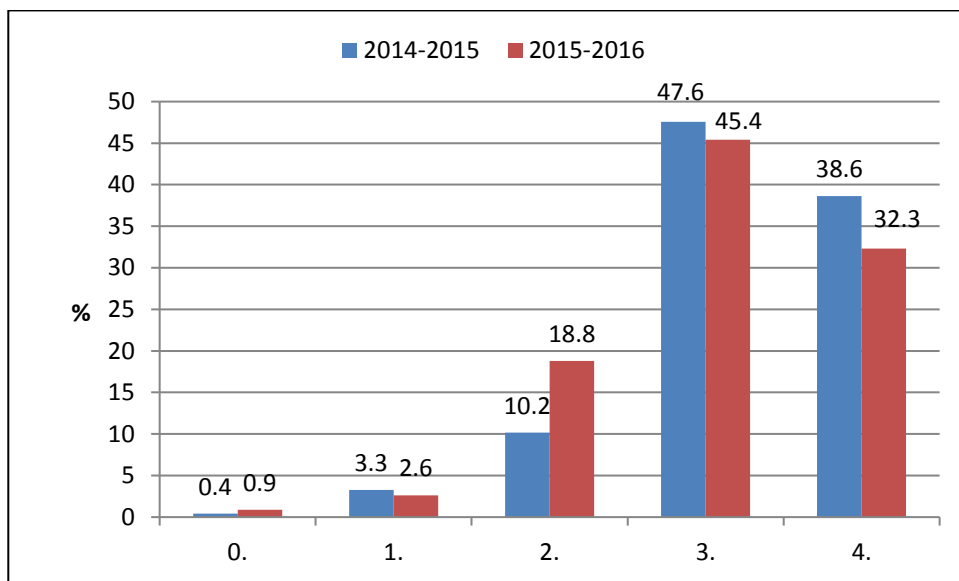
Analyzed data are presented as medians (Me), interquartile ranges (lower quartile - Q1, upper quartile - Q3) or percentage, as appropriate. For comparison of two groups Mann-Whitney U test was used. The relationship between variables was analyzed with the Spearman's rank correlation coefficient. All results were considered significant at  $p < 0.05$ . Statistical analyses were performed with STATISTICA 10.0 PL (StatSoft. Inc).

## RESULTS AND DISCUSSION

The analysis covered 478 questionnaires filled during two years of teaching. In the academic year 2014/2015, the questionnaire was filled by 246 students (group 1), which corresponds to 99% of attendees, and in the academic year 2015/2016 it was 232 students, corresponding to 91% of the total quantity (group 2).

## Comparisons

The students assessed the suitability of the electronic educational materials available on the e-learning portal, which they used for the classes and during the preparation to the tests and the final exam. The grades (0-4) represent the following categories: *very useful* – *they improved my learning efficiency* (4), *useful* (3), *hard to say* (2), *not useful* (1), *absolutely not useful* (0). The analysis has revealed that the opinions in this matter were different ( $p=0.035$ ,  $p<0.05$ ), though the p-value is on the line of statistical significance ( $\alpha=0.05$ ). The median of the results of both groups is 3, which means that the electronic materials have been evaluated as *useful*, *interquartile ranges*:  $Q1=3$ ,  $Q3=4$ . Detailed results are presented in Figure 1.

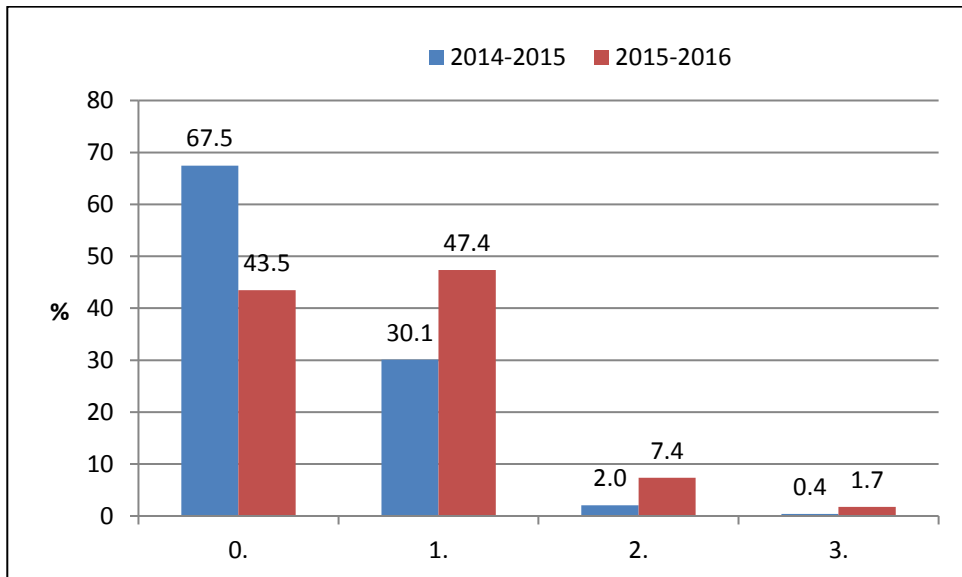


**Figure 1. Suitability of the electronic educational materials (group 1: n=246, group 2: n=229)**

*Source: own elaboration*

Therefore, the electronic learning materials prepared by the teachers have been assessed very high by both groups. Grade 4 (*very useful*) or 3 (*useful*) was awarded by 86.2% of students from group 1 and 77.7% of students from group 2. The results are also supported by other surveys (Bridge, P., Jackson, M., Robinson, L. 2009; Półjanowicz, W., Roszak, M., Kołodziejczak, B., Bręborowicz, A., 2014; Leszczyński, P., Gotlib, J., Kopański, Z., Wejnarski, A., Świeżewski, S., Gałązkowski, R., 2015) which prove that the students appreciate the interactive educational materials, which substitute the conventional form of classes. Of course if we assume they contain reliable information.

It must be added that the students from both groups did not have any classes conducted using distance methods – group 1 was the first year to study pathophysiology with the use of the e-learning portal in the form described above. Students who attended the classes in the year 2013/2014 used the learning portal which only contained the self-test database and selected elements of communication and organisation. Students of the year 2015/2016 (group 2), at the beginning of the course, were informed by their friends from the year 2014/2015 (group 1) that the Department of Pathophysiology conducted the education process with the use of b-learning, which could explain the significant differences between the groups regarding the assessment of materials. Unlike group 1, group 2 already expected such form of classes and the availability of audiovisual materials on the portal, which may explain the higher grades as compared to group 2. However, to confirm this conclusion, it is recommended to carry out the survey in the following years and to monitor the relations.



**Figure 2. Technical aspect of the learning portal (group 1: n=246, group 2: n=230)**

*Source: own elaboration*

The technical aspect of the learning portal has also been assessed. The participants have been asked if they experienced any technical issues during their work, e.g. problems with logging in, filling of the tests/self-tests, playing the audiovisual materials, etc. The grades (0-3) represent the following categories: *none* (0), *occasionally* (1), *frequently* (2), *very frequently* (3). The analysis has revealed that the grades given for this part are different ( $p < 0.001$ ,  $p < 0.05$ ). The median grade in group 1 is 0, which means that the students did not have any technical problems during their work on the portal, whereas in group 2 the grade is 1, which means



that the students had some occasional technical problems. Interquartile ranges in both groups are the same: Q1=0; Q3=1. Detailed results are presented in Figure 2.

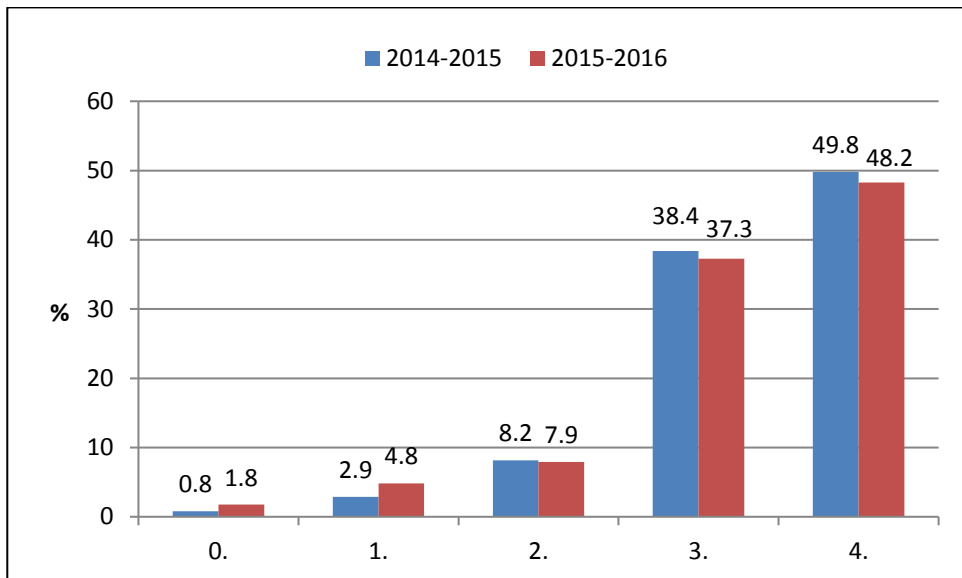
In the year 2014/2015, a speech synthesizer was used (male and female voice), though it was not accepted by the students (Roszak, M., Kołodziejczak, B., Ren-Kurc, A., Kowalewski, W., 2015), and therefore in 2015/2016 it was replaced by the original voices of the teachers. In the first year, the audiovisual materials were provided in the swf format, where the students (depending on the needs) could activate or deactivate the teacher's voice commentary in a particular fragment of the educational information. It was also possible to stop the sound at any moment (pause) or to listen to the whole commentary to a single slide without the possibility to reverse it to a chosen fragment. The latter issue was indicated by the group 1 students as inconvenience during learning (Roszak, M., Kołodziejczak, B., Ren-Kurc, A., Kowalewski, W., 2015). In the second year, the materials were played in the mp4 format, with the possibility of multiple, smooth sound playing, pausing, reversing or complete deactivation, depending on the preference. Changes in the format of the multimedia files appeared to be problematic for the students. The computer hardware on which the multimedia materials were to be played had to be equipped with later versions of software. Sometimes it was difficult to inform the students remotely on the required process of downloading and installing the software. The problem concerned the students with lower ICT skills (Ren-Kurc, A., Kowalewski, W., Roszak, M., Kołodziejczak, B., 2012; Kołodziejczak, B., Roszak, M., Kowalewski, W., Ren-Kurc, A., Bręborowicz, A., 2015). This explains the significant differences between group 1 and group 2 in the assessment of the technical part.

The students were also asked if they would like such an e-course on the learning portal (educational materials, self-tests, etc.) to be available also for other subjects. The grades (0-4) represent the following categories: *definitely yes* (4), *yes* (3), *no opinion* (2), *no* (1), *definitely no* (0). The analysis has revealed that the grades given for this part are similar ( $p=0.542$ ,  $p>0.05$ ). The median grade in both groups is 3, which means that the students would like to use such an e-course also in other subjects; interquartile ranges: Q1=3; Q3=4. Detailed results are presented in Figure 3.

Therefore, the students from both groups assess the e-learning course (b-learning method) very high and demand it also for other subjects. The answer *Definitely yes* (4) or *yes* (3) was given by 88.2% of students from group 1 and 85.5% of students from group 2. This result is also supported by other surveys that confirm the students appreciate e-learning (b-learning), which supports and supplements the conventional medical training.

In the questionnaires, the students were asked to summarise the entire subject, including the stationary classes, e-learning course, the use of learning portal for the classes and for the communication student-teacher, teacher-student and student-

student. The question *how do you evaluate the teaching process at the Department of Pathophysiology in the scale from 0 (very bad) to 10 (very good)*, was answered similarly ( $p=0.335$ ,  $p>0.05$ ) by the students from both groups (2014/2015, 2015/2016). In both groups, the median was 8, and the interquartile ranges were:  $Q1=7$ ,  $Q3=8$ . When analysing the results, we can say that the students have appreciated the several years of work, performed by the interdisciplinary team of teachers and e-learning specialists, to prepare and carry out the classes using distance techniques. Implementation of e-learning in the process of teaching the basic medical subjects may be considered reasonable, and the assessment provided by the students encourages for further development of this method of teaching at the medical university.



**Figure 3. Implementation of an e-course in other subjects (group 1: n=245, group 2: n=228)**

*Source: own elaboration*

In the questionnaire, the students were also asked to evaluate further steps to be taken by the team that will conduct the classes in the following years, which concerned in particular the classes including interactivity and the extension of the interactive educational materials. Due to the limitations of this article, the issue will be raised in the following publications.

### Correlations

Another matter covered by the analysis was the relation between the answers to the aforesaid questions concerning the e-learning course, separately for group 1 and group 2. Detailed results are presented in Table 1.

**Table 1.****The analysis of the relation between the answers to the aforesaid questions concerning the pathophysiology course**

No.	Variables	Correlation coefficient		p-value	
		2014-2015 n=245	2015-2016 n=227		
1	Suitability of educational materials and the implementation of e-learning course in other subjects	0.43	0.52	<0.001	
2	Suitability of educational materials and general assessment of the classes	0.44	0.52		
3	General assessment of the classes and the implementation of e-learning course in other subjects	0.31	0.44		
4	Technical aspect of e-learning and general assessment of the classes	-0.17	Not significant	0.007	0.228

*Source: Own elaboration*

As it appears, both groups have shown certain positive relations ( $p < 0.05$ ) described in points 1, 2 and 3, Table 1. The higher grade given by the students to the educational materials, the more clear was the opinion that the e-learning course should be implemented in other subjects. As we can see, the assessment of suitability of the educational materials has a positive effect on the general assessment of the entire subject conducted using b-learning. The general assessment of the subject relates to the opinions on the implementation of e-learning courses in other subjects. The lack of technical problems during learning with the use of distance methods also ensures a high evaluation of the classes. To summarise: reliable contents, being well prepared and designed on the e-learning portal, and their effectiveness in the teaching process are the main components of successful classes, according to the students. The results mentioned above also confirm that the implementation of e-learning should be carried out by an interdisciplinary team, i.e. a team of experts cooperating with persons with high ICT skills and experience in e-learning.

## CONCLUSION

In view of the authors' research, the efficiency and acceptance of e-learning in medical education are proved by the results of statistical analyses of the collected

data. Despite the large workload and the need to adapt to the standards of publishing of the educational materials (multimedia and interactivity), acceptable by the students, it is the right direction of the development of e-learning materials in medical sciences. All the types of multiple-choice tests available in LCMS appear to be an important supplement to the multimedia information. Additionally, electronic testing considerably helps the teachers to master the process of knowledge evaluation in an acceptable time, when dealing with large groups of students.

New medicine students, who treat online resources as an obvious source of information, enforce teachers of subjects to use the innovative education methods and online education. The staff teaching the subject of pathophysiology and the team responsible for publishing electronic materials are now ready for further changes, which is proved by their common educational effects.

The described e-learning experience in teaching a subject included in the basic medical sciences may be a valuable guideline for other educational institutions as regards the direction and stages of e-learning implementation in medical education. This article presents a positive example of the use of innovative education methods, which should promote such implementations even among persons being sceptical to e-learning.

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