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EFFECTIVE TRAINING OF PhD STUDENTS WITH EVIDENCE-BASED PHARMACY – THE USE OF ONLINE MULTI-MODULE COURSE

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Abstract: Due to its advantages, e-learning appears to be an adequate method to form competencies of PhD students in Evidence-Based Pharmacy (EBP), such as the critical appraisal of scientific articles, solving problems, and decision making based on scientific evidence. The objective of the study was to assess the Evidence-Based Practice Profile of PhD students at the Faculty of Pharmacy at the Medical University of Warsaw. The efficiency of education of PhD students was assessed with the use of an online multi-module course devised for learning EBP skills. The study participants were 36 PhD students (72% women), including graduates with the title of Master of Sciences of Pharmacy (N = 30) or Medical Laboratory (N = 6). The data to determine the EBP profile of the PhD students from the Evidence-Based Practice Profile Questionnaire (EBP^2Q) were collected using the CAPI method. Activity reports and the score for problems and analytical tasks obtained by students were generated from the Moodle™ e-learning platform. The evaluation concerned the relationship between specific domains comprising the EBP profile and the students' activity during the online course, as well as the results of the final tests (correlation coefficient (r_p)). The total result and the score from specific domains, as obtained from EBP^2Q, were average with the domination of lower results. The average time spent on the online course was about 7h, while the most time was spent on studying "Secondary data analyses: meta-analysis and systematic review" by the PhD students (average 1.5 h). The most difficult tests were the meta-analysis interpretation tests and the tests for guidelines for clinical practice. A significant correlation was observed between the number of hits and the score for tasks ($r_p = 0.661$, $p < 0.001$). Also, a strong positive correlation was observed between the EBP profiling result and the score of PhD students obtained from specific modules of the online course (the total score for the entire online course $r_p = 0.734$, $p < 0.001$). The insufficient level of knowledge, behaviors and attitudes in EBP reveals the need to introduce education in critical thinking and decision making based on the scientific evidence and the program of studies of III degree studies. As the expected educational results depended on the involvement of PhD students in the online course, activating educational forms should be introduced to the course, such as workshops or project tasks. It is necessary to continue the study to determine whether e-learning improved skills or professional practice and whether e-learning is effective at increasing knowledge in the long-term.

Keywords: pharmacy education, e-learning, blended-learning, PhD students, evidence-based pharmacy practice

An increasing number of universities offer courses and thematic modules related to Good Research Practice, including the methodology and ethics of research in a given field of expertise, in their PhD programs (1-3). A substantial important part of the study program is comprised of classes which allow the skills necessary to properly evaluate the available research evidence to be formed. The critical appraisal of scientific articles is among the key competencies required for academic work, as well as for the professional practice of a pharmacist, performed according to the concept of Evidence-Based Pharmacy (EBP) (4, 5). EBP may successfully support the process of problem solving and decision making through the application of the selection and evaluation of various information sources from primary or secondary scientific research (5, 6). According to the report of The U.S. Institute of Medicine, the skills related to Evidence-Based Practice are one of the five basic competencies which should be developed and maintained in the course of professional work for all healthcare professionals (7). From the systematic review of the literature published by Awaisu & Alsalimy (5), it

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may be concluded that pharmacists recognize the importance of scientific research in promoting practice based on evidence and also express significant interest in and readiness to become involved in research projects. It may be therefore concluded that education in EBP is the development of competencies necessary for research activities and on is an efficient tool to cope with problems encountered in the pharmacist profession. In making use of scientific knowledge, the pharmacist explains thoroughly researched, evidence-based accounts of facts and data, and provides interpretations based on the analysis of importance, meaning, and significance.
It is expected that PhD students who have completed their studies will have developed the ability to problem solve and critically analyze various sources of scientific information (8-11). As traditional teaching requires the focus of students' attention on the central person, such as the teacher or lecturer, such a model fails to encourage the development of key EBP competencies (12). Moreover, the traditional teaching method with the dominating role of textbook knowledge sources and scripts does not teach the skill of using online resources, such as e.g. bibliographic and abstract databases (13). The traditional learning methods do not facilitate the competencies of PhD students in EBP, where the special emphasis should be placed on critical thinking, solving problems, and decision making based on the latest scientific evidence available (13). Applying a variety of e-learning techniques and active learning forms may improve the quality of learning for PhD students in the methodology of scientific research and EBP. However, the efficiency of such learning, where a wide scope of independence is given to the student, requires continuous monitoring of progress and verification of the achieved learning outcome at the end of the course, e.g. through the use of online assessment methods (11, 22).

Due to the vast range of issues to be covered by the EBP course, a significant difficulty is caused by the small number of hours assigned in the PhD program (14, 15). Also, the inability of some students to participate in the course due to their academic, didactic and professional workload, in combination with the application method used during lectures, makes it unlikely that PhD students will achieve the expected education results, especially concerning complex skills (10). Considering the objective obstacles in the practical execution of all EBP educational content in the classroom, one of the available options is to use the blended-learning method (16). The use of a combined approach allows for a decrease in the total number of didactic hours in a lecture room. It should be remembered, however, that the application of blended-learning is combined with the need to continuously monitor the quality of such classes (17).

Assessment of the efficiency of the e-learning methods is not simple and requires a comprehensive approach. In general, there are four aspects of training programs including e-learning: (I) reaction, (II) learning, (III) behavior, and (IV) results (18). Reaction is a measure of program satisfaction, learning is a measure of attitude, knowledge, or skill change as a result of the program, behavior is represented by the transfer of learning to the workplace, and finally, results are a measure of how the learning has changed organizational practice (16). In the application of e-learning in teaching pharmacy students and professionally active pharmacists, a number of papers were published (19-28). However, there is a lack of research on the effectiveness of the education of PhD students from pharmacy departments. From the systematic review published by Salter et al. (16), it may be concluded that e-learning in pharmacy education effectively increases knowledge and is a highly acceptable instructional format for pharmacists and pharmacy students. However, there is limited evidence to confirm that e-learning effectively improves skills or professional practice. The degree to which e-learning is effective at increasing knowledge in the long-term is also not clear (16). The above findings result in the necessity to conduct research to assess the efficiency of e-learning used in the education of pharmacy students, PhD students and pharmacists. Therefore, a potential impact of the e-learning methods on the knowledge and skills of students in EBP should be subject to verification.

The aim of the study was to assess the Evidence-Based Practice Profile of PhD students at the Faculty of Pharmacy at the Medical University of Warsaw (MUW). In addition, the efficiency of the education of PhD students was specified with the use of the online multi-module course designed to teach clinical methods and form basic competencies in Evidence-Based Pharmacy.

MATERIALS AND METHODS

Context

The program of III degree studies at the Faculty of Pharmacy at MUW contains mandatory practical classes in the field of scientific research methodology, with 10 teaching hours. The course was conducted for the first time in the Academic Year 2015/16 and its participants were PhD students

from the three first years of studies. Classes were also provided as an asynchronous multimodal online course. The course was available via the Moodle™ learning platform (Modular Object-Oriented Dynamic Learning Environment) (29), which is used to support distance education (LCMS, Learning Content Management System).

The online course "Clinical Research and Basics of Evidence-Based Pharmacy" was certified by its Author from The Association of Academic E-learning. The online course includes methods for evaluating and improving drug therapy outcomes including the critical appraisal of drug literature, clinical service literature, and quality assessment and improvement techniques, with special focus on patient and medication safety. This seven-module course was accompanied by a bibliography list and a glossary with the following range of topics: (I) What is EBM (Evidence-based medicine)? (II) Types and methodology of clinical research; (III) Evaluation of credibility of clinical research; (IV) Evaluation of articles concerning treatment, prognosis or harmfulness; (V) Evaluation of information about the diagnostic method; (VI) Secondary analysis of data: meta-analysis and systematic review; and (VII) Guidelines for clinical practice.

Upon completion of the course students will be able to:

- Find and evaluate published medical literature for use in clinical decision-making and to understand scientific reasoning and research processes in this context;
- Describe how clinical findings are summarised in evidence reports and apply them appropriately in clinical decision-making;
- Identify opportunities for changes in practice that are feasible and effective for improving patient outcomes.

In order to accomplish these aims, each thematic module was designed on the basis of specially selected didactic materials. They include, among others, excerpts of scientific literature with the lecturer's commentary, and links to reliable websites, films, radio broadcasts, and PowerPoint® presentations with explanations prepared by an academic teacher. Each module is organized in the form of an online lesson and ends with several tasks prepared in the format of problems and analytical questions, including multiple-choice questions (MCQs). Individual topics form an educational path of forced transitions in such a way that students are prevented from going through the course in any order. The student can only move on to the next module after completing all mandatory tasks required for the given topic. During the course, PhD students were able to consult the teacher online, both in the synchronic mode (Skype™, chat) and in the asynchronous mode (e-mail, forum).

Data collection

The study was conducted from February to June 2016, i.e. the summer semester of the Academic Year 2015/16. Its participants were all PhD students studying at the Faculty of Pharmacy at MUW from the first three years of studies (N = 36; 72% women). With regard to education of the participants, the group was varied. The majority were pharmacy students (83.3%) and medical laboratory students (16.7%). Other PhD students had a Master's degree in Biology, Chemistry or Biotech-

Table 1. Structure of the EBP2Q with the separate domains and contained statements (all items based on a five-point Likert scale).

Domain		Item numbers	Description
I.	Relevance	1-14 (14 items)	Attitude towards expanding own competence in Evidence-Based Practice, expressed on a scale from 1 to 5 (1 - not at all true; 5 - very true)
II.	Sympathy	15-21 (7 items)	Attitude towards selected aspects of the Evidence-Based Practice in work, assessed by respondents on a scale from 1 to 5 (1 - strongly disagree; 5 - strongly agree)
III.	Terminology	22-38 (17 items)	The level of knowledge about the terminology related to scientific research; given terms and issues were rated on a scale from 1 to 5 (1 - never heard the term; 5 - understand and could explain to others)
IV.	Practice	39-47 (9 items)	Frequency of use of individual elements of Evidence-Based Practice in daily clinical work, assessed on a scale from 1 to 5 (1 - never; 5 - daily)
V.	Confidence	48-58 (11 items)	Confidence in skills related to Evidence-Based Practice rated on a scale from 1 to 5 (1 - not at all confident; 5 - very confident)
VI.	Demographics	-----	Selected sociodemographic variables

nology and were not included in this study. Participation in the study was voluntary, but due to the type of collected data and the applied analysis method, it was not anonymous. The study participants agreed to their personal data being processed for this study. Raw data were obtained from the three following sources:

- Data on the profile of Evidence-Based Practice were obtained using the CAPI interviewing technique (computer-assisted personal interview). This stage of the study was conducted in February 2016 and immediately preceded the start of the e-learning classes;
- Activity reports generated by the Moodle™ E-learning platform. The reports contained personalized data of each course participant and referred to the participant's activity in the online course: the number of hits and the time spent on the platform. The data were collected from March to June 2016;
- Results obtained by the students for test questions which were evaluated at the completion of each of the seven thematic modules of the online course. The results were collected from March to June 2016.

Evidence-Based Practice Profile Questionnaire

The original English language version of the Evidence-Based Practice Profile Questionnaire (EBP^2Q) was devised at the University of South Australia by the team supervised by Maureen McEvoy (30). The Polish language version of the questionnaire was validated by Panczyk et al. (31, 32). The EBP^2 questionnaire consists of 58 items (all 5-point Likert scales) allowing for assessment in five domains (Table 1). EBP^2 is characterized with high validity and reliability of measurement (30-32). Moreover, as emphasized by its authors, apart from good psychometric parameters, an additional advantage of the EBP^2 is its ability to be used for the self-reporting of EBP competencies by students, lecturers and professionals (30). The published study results with the EBP^2Q suggest that it is a good quality tool which may be applied to assess knowledge, behaviors and attitudes in EBP (33).

Ethical considerations

The authors sought advice from the Bioethics Committee of MUW to conduct the presented study. As the "commission does not issue opinions on the survey, retrospective and other non-invasive scientific studies", approval was not required. The authors of this work obtained the consent of the Local Administrator of the Sensitive Data Protection Office to process the personal data of students learning at MUW.

Statistical analysis

The data from the EBP profile assessment EBP and the results of the test questions were juxtaposed against the following parameters of descriptive statistics: mean (M), standard deviation (SD), coefficient of deviation (CV), and skewness of distribution. The raw point results for the entire EBP^2, as well as for five specific domains, and the results for the test questions were normalized to sten scores (0-10) which allowed mutual comparison of results for variables with the different total number of points. On the basis of the EBP profile, the following two student subgroups were distinguished:

- Student group with general low result in EBP profile (M-SD),
- Student group with general high results in EBP profile (M+SD).

In the comparative analysis of particular results of students from different years of study, the nonparametric Kruskal-Wallis H test (K-W test) was used. To compare results for the test questions between the groups with low and high results in the EBP profile, the nonparametric Mann-Whitney-Wilcoxon test (MWW test) was used with the effect size estimation for the aid in rank-biserial correlation coefficient (r_{rb}). The application of nonparamet-

Table 2. Evidence-Based Practice Profile of PhD students of pharmacy (sten scores: 0-10).

Domain		Mean	SD	CV [%]	Skewness
I.	Relevance	5.6	1.83	32.7	-0.91
II.	Sympathy	5.6	1.79	31.8	-1.33
III.	Terminology	5.5	2.03	37.1	-0.43
IV.	Practice	5.6	2.11	37.7	0.50
V.	Confidence	5.4	1.98	36.4	-0.11
TOTAL		5.5	1.83	33.1	-0.97

Table 3. Results of PhD students of pharmacy obtained from specific course modules (sten scores: 0-10).

Module		Mean	SD	CV [%]	Skewness
1.	What is EBM (Evidence-Based Medicine)?	5.8	1.97	33.7	-1.20
2.	Types and methodology of clinical research	5.4	2.01	36.9	-0.81
3.	Evaluation of credibility of clinical research	5.3	1.99	38.0	-0.56
4.	Evaluation of articles concerning treatment, prognosis or harmfulness	5.4	1.55	28.4	0.10
5.	Evaluation of information about the diagnostic method	5.6	1.99	35.7	-1.18
6.	Secondary data analyses: meta-analysis and systematic review	5.2	1.89	35.1	-0.33
7.	Guidelines for clinical practice	5.7	1.90	33.3	-1.23
TOTAL		5.4	1.85	34.2	-0.20

ric statistics was justified by the low number of individuals in the studied group and the non-fulfillment of conditions required for the normal distribution in parametric tests.

To evaluate the relationship between the individual domains which make up the EBP profile, the students' activity during the online course and the results for the question tasks, the Pearson correlation coefficient (r_p) was applied.

All statistical calculations were performed using the statistical package IBM® SPSS® Statistics, version 23. For all analyses, a p-level of < 0.05 was considered statistically significant.

RESULTS

Evidence-Based Practice Profile

The profiling results of PhD students in EBP demonstrate the average of the intensity of variables related to knowledge, behaviors and attitudes (Table 2). Both the total result of students from the EBP^{2}Q and the results from specific domains were average. The result distribution was clearly left-asymmetric. This demonstrates the dominance of lower results in the study group. Additionally, in the comparative analysis of the results of profiling, PhD students from successive years of study showed no statistically significant differences in this respect (K-W test, H = 0.869, p = 0.647).

Online multi-module course

The average student activity measured with the number of hits was 170.0 ± 41.29 (min. 96, max. 285) and was similar irrespective of the year of study (K-W test, H = 1.301, p = 0.522). The average time spent online by students during the entire course was 428.0 minutes (ca. 7 h). PhD students spent most time on the thematic module "Secondary Data Analyses: Meta-analysis and Systematic Review" (average 1.5 h). The results of test questions on specific thematic modules were average (mean in the sten score from 5.4 to 5.8). No final tests had significantly different results regarding their difficulty (Table 3). Additionally, the total number of points gained by students did not depend on the year of study (K-W test, H = 5.338, p = 0.069). It was observed, however, that there is a statistically significant correlation between the number of hits and the results obtained by the student in the final tests (Table 4).

Among the mandatory problem and analytical tasks, the most difficult proved to be the tasks concerning meta-analysis results interpretation and principles of designing and the use of guidelines for clinical practice. The majority of problems were caused by tasks based on determining the homogeneity and comparison of precision of individual primary research. Also, the specification of research with the greatest overall impact on the final result of meta-analysis, and the proper data reading from the forest plot were frequent problems for students. Regarding methodology of the creation of guidelines for clinical practice, tasks considered difficult were those with credibility criteria and an assessment of the strength of recommendations.

The effectiveness of online training

A strong positive correlation was observed between the initial result of EBP profiling and the students' results from specific modules of the online course (Table 5). An exception was the result for the "Types and Methodology of Clinical Research" test for which no significant correlation with the profiling result was observed (p = 0.060). The strongest

relationship was observed in the case of the total score of students calculated for the entire online course ($r_p = 0.734$, $p < 0.001$). Moreover, when comparing the score for the course between the student groups with low and high profiling results, it was demonstrated that the first group had significantly lower results than the second (MWW test, U = 84.0, Z = -2.196, p = 0.028, $r_{rb} = 0.44$).

DISCUSSION

A crucial finding of the study is the demonstration that knowledge and skills in EBP of the PhD students are not considerable. This conclusion supports the thesis of the purposefulness of the inclusion of obligatory classes on teaching competencies to PhD students in the program of III degree studies at the Faculties of Pharmacy, teaching the critical appraisal of scientific articles, problem solving, and decision making based on scientific evidence. Secondly, another major conclusion from the presented study is shown by evidence confirming that the use of the online multi-module course to educate PhD students is an effective educational tool. E-learning solutions offered by the Moodle™ platform allowed training to be devised and implemented which provided students with favorable conditions with which to form EBP competencies. The above findings also correspond with the observations of other authors who use distance education systems such as Moodle™ (34, 35). The popularity of the platform may be estimated on the basis of the available statistics which show that it is used on nearly 54 thousand registered websites in at least 228 countries (36). With the use of Moodle™ tools, ca. 7.5 million online courses were devised which cover 68 million pupils/students. Among such a large number of available courses, there are courses applicable to education in medical sciences: pharmacology (37, 38), surgery (39), radiology (40), dermatology (41), emergency medicine (42) and research methodology (43-45). Moreover, the published papers on e-learning education of pharmacy students and pharmacists also confirm that in this field (16).

Table 4. Number of hits of course items (activity) and the results obtained by PhD students of pharmacy from specific thematic modules.

Module		Pearson's r	t-statistic	p-value
1.	What is EBM (Evidence-based medicine)?	0.854	26.195	< 0.001
2.	Types and methodology of clinical research	0.419	7.367	< 0.001
3.	Evaluation of credibility of clinical research	0.656	13.868	< 0.001
4.	Evaluation of articles concerning treatment, prognosis or harmfulness	0.663	14.130	< 0.001
5.	Evaluation of information about the diagnostic method	0.633	13.055	< 0.001
6.	Secondary data analyses: meta-analysis and systematic review	0.713	16.228	< 0.001
7.	Guidelines for clinical practice	0.704	15.835	< 0.001
TOTAL		0.661	4.492	< 0.001

Table 5. Evidence-Based Practice Profile *vs.* education results from specific modules of the e-learning course.

Module		Pearson's r	t-statistic	p-value
1.	What is EBM (Evidence-based medicine)?	0.372	2.119	0.043
2.	Types and methodology of clinical research	0.360	1.967	0.060
3.	Evaluation of credibility of clinical research	0.636	4.363	< 0.001
4.	Evaluation of articles concerning treatment, prognosis or harmfulness	0.614	4.115	< 0.001
5.	Evaluation of information about the diagnostic method	0.474	2.846	0.008
6.	Secondary data analyses: meta-analysis and systematic review	0.604	4.005	< 0.001
7.	Guidelines for clinical practice	0.393	2.180	0.039
TOTAL		0.734	5.711	< 0.001

E-learning in pharmacy education is recognized not only by academic and postgraduate education centres but also has advantages appreciated by students/pharmacists (21-24, 27). Such advantages include the possibility to individualise the pace and adjust the learning style to the student's own preferences. It is believed moreover that the use of computers, in comparison with the use of only traditional learning methods, facilitates the better consolidation of knowledge and also contributes to the growth of the degree of understanding of the discussed phenomena and processes (19, 20, 22-24, 26-28, 46). Online courses give also the possibility to learn certain important skills, especially those which are related to independent problem solving (22, 47-50). Such crucial skills are necessary for PhD students for proper planning and academic study.

The Evidence-Based Practice profile of PhD students obtained in this study indicates that they demonstrated an average baseline of knowledge, behaviors and attitudes. However, these were slightly better results in comparison with those obtained from studies conducted on young physiotherapists (51), physiotherapy students (33), nurses and midwives in specialist courses (31), and students of licentiate studies in occupational therapy, medical radiation and in human movement (33). The above results suggest that irrespective of the degree of study and the practiced profession, the level of knowledge, behaviors and attitudes concerning Evidence-Based Practice is insufficient and requires adequate educational solutions to be implemented. Both McEvoy et al. (30, 33) and Panczyk et al. (31) demonstrated that the use of online learning in student education may lead to the significant development of specific domains of the Evidence-Based Practice profile.

The activity analysis, i.e. the number of hits of the PhD students during the online course, proved that there were no significant differences in this area between specific years of study. Still, the number of hits of the students with the lowest activity was nearly three times smaller than the results for students with the highest activity. Additionally, it was observed that the number of hits was significantly positively correlated with the results of students from the following thematic modules of the online course. The impact of the students' activity, measured by the number of views of specific components of the course, on learning efficiency, has been analysed in several studies (52-56). Ramos & Yudko (53), with the use of the stepwise multiple regression analysis, found that the number of hits is a predictive factor with an important influence on the results of the final exam, which summarises education with the e-learning method in the Psychopharmacology course. They demonstrated a positive correlation between the number of hits and the total number of points obtained by a student from the final test ($r_p = 0.479$, $p < 0.001$). Also, Wang & Newlin (56) confirmed that the number of hits is strongly correlated with the final grade from the course for which the computer-based learning was provided. Lovatt et al. (52) observed a similar relationship with chemistry students educated via the Moodle™ platform. Also in this study, students who systematically used online courses had very good results in the final exam on Organic Chemistry. On the other hand, Seluakumaran et al. (55) did not confirm such a relationship in their studies on medicine students who used Moodle™ in Medical Physiology. There were no dependencies between the activity during the online course and the result of the final exam.

It should be noted, however, that the educational success of a student, which may be measured by a score from a summary test, consists of many various factors which were omitted in the presented studies. They include factors such as: motivation, the student's scientific interests, the level of technophobia (computer anxiety) or proficiency when using computer tools for information and communication.

An important decisive factor how the student's success may be influenced by the student's online course activity is the newness of issues being studied. The analysis of the results of specific modules of PhD students leads to the conclusion that the most difficult tasks were those related to "Secondary data analyses: meta-analysis and systematic review". Yet the easiest task was about the general principles of EBP – "What is EBM (Evidence-Based Medicine)?" Ramos & Yudko (53) noted that when the topic of the e-learning course is new to the student, and refers to contents which were not previously studied, even at a basic level in previous education cycles, the efficiency of such online courses depends very strongly on the activity of the participants. Such a relationship may explain differences in the predictive ability of activity in the student's educational success prediction for different courses. The assessment of dependencies between the initial EBP profile of PhD student and the results obtained from an online course confirms the assumptions of Ramos & Yudko (53), which are referred to above. The efficiency of the course was higher if the PhD student had a better EBP profile, and if the student's activity during the online course was also higher.

However, Ramos & Yudko (53) emphasized that it is not the number of hits or the time spent on the course which determines the educational success, but rather the quality and efficiency of use by students specific components of the e-learning course, as also stated by other authors (57, 58).

The use of computer technology and online tests significantly changed the approach to the evaluation of educational results at medical universities (59, 60). Presently, the available systems designed for distance learning, such as Moodle™, meet the requirements for methods used for a competency evaluation in online situations (developing a framework to write multiple-choice and short development educational and summary questions, including the random generation of questions from a bank of questions) (35, 61-63). Panczyk et al. (45, 64) demonstrated that with the use of tools available in the Moodle™ platform it is possible to efficiently assess students' educational progress, both in knowledge and in certain skills, e.g. data synthesis, information analysis and reasoning. The use of problem and analytical questions in the EBP online course allowed the didactic process to be monitored. Moreover, students were also able to self-evaluate, identifying their own weaknesses. On the basis of the obtained results, the issues which were the most problematic for students were identified by the course tutor, i.e. Secondary data analyses: meta-analysis and systematic review. Both the amount of time spent by students on this course module and the correctness of the tasks prove that these issues are the most difficult. Therefore, it is necessary to include a higher number of issues on the methodology for the creation and assessment of secondary scientific research in the classroom in the following years.

An additional solution which may improve the efficiency of the online course on meta-analysis and systematic review will be the introduction of a workshop module to the course. It will increase the participants' involvement and allow for the mutual assessment of tasks by students. An expansion of the range of tasks is planned to include the need for independent scientific literature searches with the use of abstract and bibliographic databases, such as PubMed MEDLINE® or Web of Science™.

Limitations

The primary limitation of this study is the lack of long-term efficiency assessment of the online course used. Moreover, the impact of the knowledge and skills acquired by PhD students on their academic and professional practice was not estimated. The above issues require the study to be continued, which will allow for EBP profile assessment and monitoring of the professional histories of graduates, so that the long-term consequences of the presently applied educational methods may be determined.

CONCLUSIONS

The observed insufficient knowledge, behaviors and attitudes of EBP prove that education in the critical appraisal of scientific articles, solving problems, and decision making based on the latest scientific evidence available should be introduced to III degree studies. It was also proven that the use of blended learning, where the traditional classroom is combined with online multi-module course, may be an efficient learning method in this area. As success in the expected outcome in EBP learning depended on the participant's involvement with the online course, activating educational forms should be introduced, e.g. workshops or project tasks to be completed by virtual groups (learning-by-doing). It may be assumed that the knowledge gained during the online course and the skills in practical aspects of EBP will prove useful in the academic and professional work of PhD students of the Faculty of Pharmacy. However, on the basis of the present observations, it cannot be concluded whether e-learning improved skills or professional practice and whether e-learning is effective at increasing knowledge in the long-term.

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