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Assessment of the Effectiveness of Medical Education on the Moodle e-Learning Platform

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Abstract. This paper presents an analysis of learning effectiveness for the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" taught in the years 2009–2011 at the Medical University of Bialystok, Poland. We compared the effectiveness of traditional and distance learning methods; an e-learning platform was implemented experimentally for the purpose of this study. We assessed the usefulness of online learning in terms of organization, knowledge gained and students' satisfaction with the course. The study was conducted among 75 second year master degree students in the nursing field in the academic years 2009/2010 and 2010/2011. The students were divided into two groups. For the study group of 39 persons (52%), lectures and seminars took place on an e-learning platform, while 36 persons (48%) in the control group attended traditional classes. 80% of students in the e-learning group and 89% of students in the traditional group assessed the organization of both forms of courses positively. The fact that the majority of students in both the e-learning (89%) and traditional classes (86%) gave positive feedback indicates that for both forms there was a high level of content and technical preparedness. The mean scores of the final exam for both courses were 82% in the e-learning group and 79% in the traditional group in the years 2009– 2011. The above results show that both forms of learning are equally effective.

Introduction

A growing number of people are interested in distance learning. Widespread access to computers and the Internet means that more and more people can participate in the e-learning process. The search for new methods of learning and teaching has caused distance learning to be increasingly used at the university level. E-learning is independent of place

and time, and the teachers determine the rules of conduct and access to classes. E-learning does not intend to replace traditional forms of education, but it is a good way to supplement and widen knowledge transfer (Allan, 2007; Arbaugh et al., 2010; Bramley, 2001; Smith et al., 2008).

The availability of a number of distance learning programs enables the development of modern e-learning courses, which are placed on an accessible platform in accordance with SCORM, AICC, and IMS (Piskurich, 2003; Waćkowski et al., 2007). With these tools, interactive tests, quizzes and tasks to test students' knowledge can be created.

This study of learning effectiveness in the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" aimed at evaluation of the effectiveness of nursing education supplemented by distance learning techniques. The Bioethics Committee of the Medical University of Bialystok approved the study (consent No. R-I-002/338/2009).

Aim

The courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" were taught experimentally in a complementary e-learning system during the 2009–2011 academic years. The lectures and seminars were conducted on-line, but practical classes were taught traditionally. Students who participated in the e-learning method had free access to the distance-learning platform (Moodle) and to the courses. Students had continuous and unlimited access to the teaching materials on the platform, but the teacher responsible for the course determined the order of the topics and the period of their availability. The final exam was, however, in "traditional" form, as laid out in the Regulations of the Medical University of Bialystok.

Material and Methods

The study was conducted with a group of 75 second year master degree nursing students enrolled in the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" during the years 2009–2011. The students were divided into two groups. In the control group (36 people), lectures and seminars were taught traditionally. In the study group (39 people), lectures and seminars took place on the e-learning platform MOODLE, ver. 1.9 (Rice, 2010) (Figure 1), where all didactic ma-
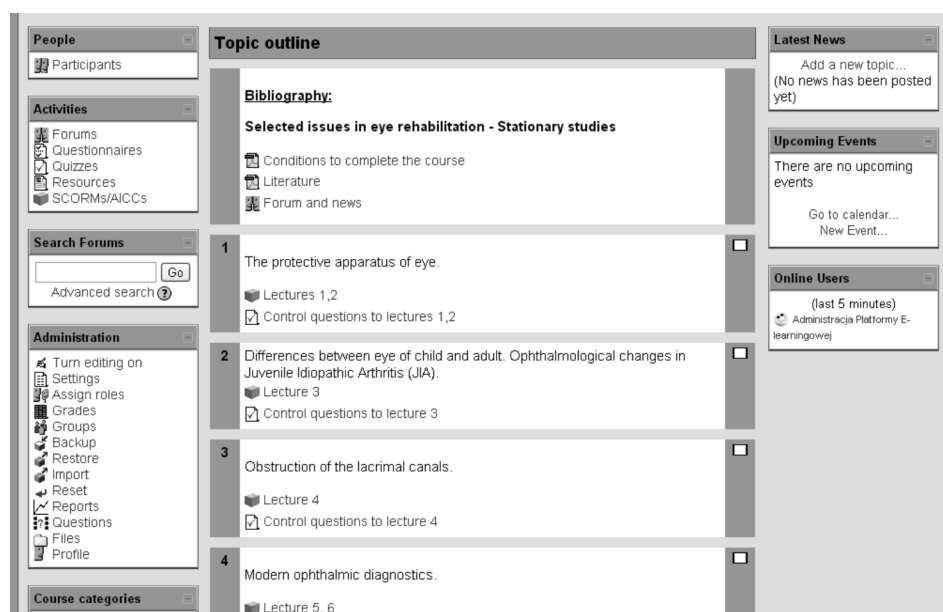
Figure 1. Screenshot of e-learning course "Selected issues in visual rehabilitation"

terials, prepared for distance learning were available. Every student from the study group had 24-hour access to didactic materials, including multimedia, knowledge assessment tests and evaluation forms. Students' activity (e.g. lecture reading, watching multimedia materials or completing an evaluation form) was registered and a log of individual achievements was created. The order of didactic topics and the period of their availability was supervised by academic teachers responsible for particular subjects.

A final assessment of both courses (e-learning and traditional) was conducted traditionally in the form of a multiple-choice test at the same time for both groups. The final exam scores for both groups were compared in order to analyze the level of knowledge gained. At the end of the cycle of classes but before completion of the final exam, students in both groups filled an evaluation questionnaire pertaining to their opinions of the course, the level of their satisfaction with the course, and the organization of classes.

Results and Discussion

This study on learning effectiveness for the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" in-

**Table 1. Final exam scores (in %) for the study and the control groups
in the course "Selected issues in visual rehabilitation"
in the academic years 2009–2011**

Academic year	Group	Parameter								
		n	mean score $\bar{x}$	SD	Min.	Q_1	Me	Q_3	Max.	p
2009/2010	Study	22	81.8%	9.1%	65%	75%	80%	90%	100%	**0.004**
	Control	17	71.8%	10.4%	55%	65%	70%	80%	90%	
2010/2011	Study	17	86.5%	8.2%	75%	80%	90%	90%	100%	0.34
	Control	19	83.9%	5.4%	75%	80%	85%	90%	90%	

**Table 2. Final exam scores (in %) for the study and the control groups
in the course "Ophthalmology and ophthalmic nursing"
in the academic years 2009–2011**

Academic year	Group	Parameter								
		n	mean score $\bar{x}$	SD	Min.	Q_1	Me	Q_3	Max.	p
2009/2010	Study	22	78.0%	13.2%	47%	71%	79%	89%	95%	0.62
	Control	17	74.9%	14.9%	47%	63%	79%	89%	95%	
2010/2011	Study	17	79.4%	3.3%	72%	78%	78%	83%	83%	**0.04**
	Control	19	81.6%	2.7%	78%	78%	83%	83%	83%	

cluded relatively equal groups of students participating through the use of e-learning and according to the traditional method. 39 persons were (52%) in the e-learning group and 36 students (48%) belonged to the traditional learning methods group. Table 1 presents the mean final exam scores for the course "Selected issues in visual rehabilitation" of the students in the e-learning and traditional groups in the academic years 2009–2011. Table 2 presents the mean final exam scores for the course "Ophthalmology and ophthalmic nursing" in both groups during the same period.

It can be concluded that the mean scores obtained on the final exams during 2009–2011 had an upward trend for both courses in both groups of students.

In the academic year 2009/2010, the mean final exam score for the course "Selected issues in visual rehabilitation" was 81.8% ($\pm$9.1%) in the

e-learning group and 71.8% ($\pm 10.4\%$) in the traditional group. The differences between these mean scores were statistically significant ($p < 0.05$). In 2010/2011 mean scores were 86.5% ($\pm 8.2\%$) and 83.9% ($\pm 5.4\%$) respectively, which was not statistically significant ($p > 0.05$).

In the academic year 2009/2010, the mean final exam score for the course "Ophthalmology and ophthalmic nursing" was 78% ($\pm 13.2\%$) in the e-learning group and 74.9% ($\pm 14.9\%$) in the traditional group. The difference was not statistically significant ($p > 0.05$). In 2010/2011, the mean final exam score for this course was 79.4% ($\pm 3.3\%$) and 81.6% ($\pm 2.7\%$), respectively. Differences between these mean scores were statistically significant ($p < 0.05$).

In the study group (e-learning), the median final exam score for the course "Selected issues in visual rehabilitation" was 80% in 2009/2010 and 90% in 2010/2011. Differences between these scores were not statistically significant ($p > 0.05$). In the control group (traditional form of learning) the median final exam scores for this course during these years were: 70% and 85%, respectively. These differences in scores were statistically significant ($p < 0.001$). The results obtained are presented in Figure 2.
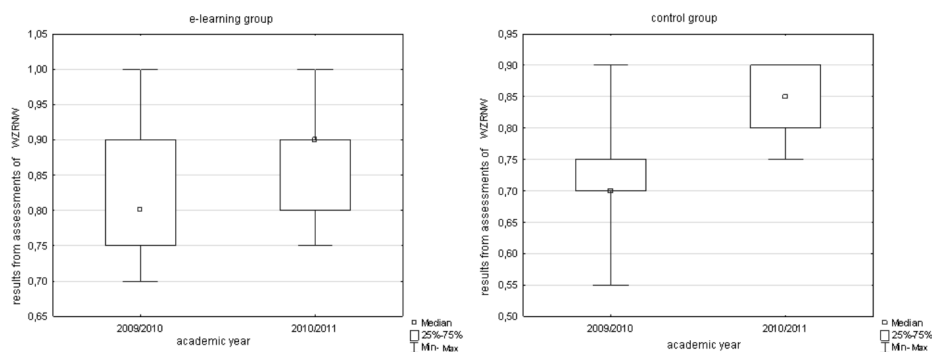

Figure 2. Final exam scores for the course "Selected issues in visual rehabilitation" in the academic years 2009–2011 in the study and control groups

A slightly better median final exam score in the study group may be explained by full-time access to didactic materials on the e-learning platform, which facilitated repeated readings and multiple analyses of didactic materials. In contrast, students from the control group based their studying on their own notes and information from the recommended literature list.

The change in the final exam scores for the course "Ophthalmology and ophthalmic nursing" during 2009–2011 (two academic years) is illustrated
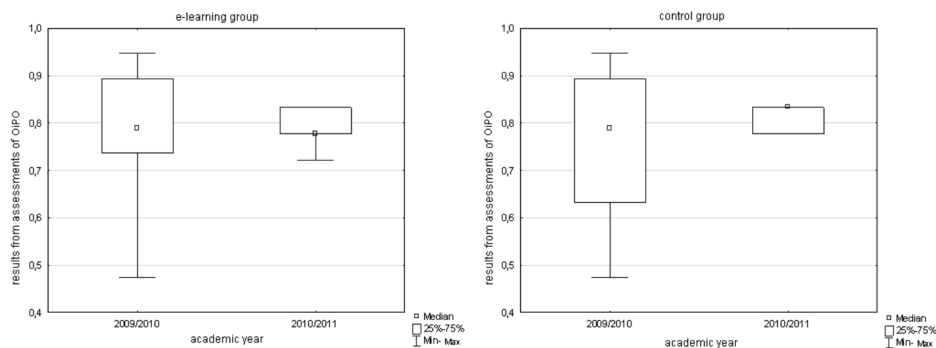
Figure 3. Final exam scores in the course "Ophthalmology and ophthalmic nursing" in the academic years 2009–2011 in the study and control groups

Table 3. Assessment of course organization in the academic years 2009–2011

Academic year	Course	Group	n	definitely no (1)	rather no (2)	I don't know (I don't have any opinion) (3)	rather yes (4)	definitely yes (5)	p
2009/2010	Selected issues in visual rehabilitation	Study	22 100%	0 0%	4 18.2%	2 9.1%	12 54.5%	4 18.2%	0.531
		Control	17 100%	0 0%	3 17.6%	0 0%	12 70.6%	2 11.8%	
	Ophthalmology and ophthalmic nursing	Study	22 100%	0 0%	3 13.6%	2 9.1%	14 63.6%	3 13.6%	0.628
		Control	17 100%	0 0%	3 17.6%	0 0%	12 70.6%	2 11.8%	
2010/2011	Selected issues in visual rehabilitation	Study	17 100%	0 0%	0 0%	0 0%	9 52.9%	8 47.1%	0.138
		Control	19 100%	0 0%	0 0%	2 10.5%	13 68.4%	4 21.1%	
	Ophthalmology and ophthalmic nursing	Study	17 100%	1 5.9%	2 11.8%	2 11.8%	9 52.9%	3 17.6%	0.139
		Control	19 100%	0 0%	0 0%	0 0%	12 63.2%	7 36.8%	

in Figure 3. The similar results prove that distance learning is comparable to the traditional approach.

Evaluation of the two-year study period shows that the organization of classes was rated positively by 31 (80%) of the students in the e-learning groups and 32 (89%) of the students in the traditional groups. Only about 13% of students had a negative opinion on the organization of both forms of courses (Table 3). Differences on the Likert scale between the analyzed groups were not statistically significant ($p > 0.05$).

In the questionnaire the students were asked about course preparation as well as availability and relevance of the didactic content. 36 students from the e-learning group (91%) and 32 students from control group (88%) graded those issues positively (Table 4). In the academic year 2009/2010, differences between the responses in both groups were statistically significant ($p < 0.05$).

Table 4. Students' opinions on the preparation, availability and relevance of the didactic content of the courses in the years 2009–2011

Academic year	Course	Group	n	definitely no (1)	rather no (2)	I don't know (I don't have any opinion) (3)	rather yes (4)	definitely yes (5)	p
2009/2010	Selected issues in visual rehabilitation	Study	22 100%	0 0%	0 0%	0 0%	14 63.6%	8 36.4%	**0.015**
		Control	17 100%	0 0%	1 5.9%	2 11.8%	14 82.4%	0 0%	
	Ophthalmology and ophthalmic nursing	Study	22 100%	0 0%	0 0%	0 0%	14 63.6%	8 36.4%	**0.015**
		Control	17 100%	0 0%	1 5.9%	2 11.8%	14 82.4%	0 0%	
2010/2011	Selected issues in visual rehabilitation	Study	17 100%	0 0%	0 0%	1 5.9%	10 58.8%	6 35.3%	0.78
		Control	19 100%	0 0%	0 0%	2 10.5%	12 63.2%	5 26.3%	
	Ophthalmology and ophthalmic nursing	Study	17 100%	0 0%	2 11.8%	3 17.6%	6 35.3%	6 35.3%	0.06
		Control	19 100%	0 0%	0 0%	0 0%	13 68.4%	6 31.6%	

The Parameter spanning header covers columns n through definitely yes (5).

The students were asked whether the implemented curriculum enriched their knowledge and skills. 34 students in the e-learning group (86%) and 30 in the control group (83%) responded affirmatively (rather yes, definitely yes) (Table 5). Differences between the analyzed groups, however, were not statistically significant ($p > 0.05$).

Table 5. Opinions on the prepared courses in the years 2009–2011 (acquired knowledge and skills)

Academic year	Course	Group	Parameter						
			n	definitely no (1)	rather no (2)	I don't know (I don't have any opinion) (3)	rather yes (4)	definitely yes (5)	p
2009/2010	Selected issues in visual rehabilitation	Study	22 100%	0 0%	1 4.5%	2 9.1%	13 59.2%	6 27.3%	0.122
		Control	17 100%	0 0%	2 11.8%	2 11.8%	13 76.5%	0 0%	
	Ophthalmology and ophthalmic nursing	Study	22 100%	0 0%	1 4.5%	2 9.1%	14 63.3%	5 22.7%	0.186
		Control	17 100%	0 0%	2 11.8%	2 11.8%	13 76.5%	0 0%	
2010/2011	Selected issues in visual rehabilitation	Study	17 100%	0 0%	0 0%	0 0%	7 41.2%	10 58.8%	0.212
		Control	19 100%	0 0%	2 10.5%	2 10.5%	8 42.1%	7 36.8%	
	Ophthalmology and ophthalmic nursing	Study	17 100%	0 0%	2 11.8%	3 17.6%	8 47.1%	4 23.5%	0.081
		Control	19 100%	0 0%	0 0%	0 0%	11 57.9%	8 42.1%	

The obtained results lead to the conclusion that e-learning can be a good way to supplement traditional methods. In some forms, such as lectures or seminars, it can successfully replace traditional classes. Setting e-learning courses available to students in other medical fields is advisable and justified because of the intensity of the different types of activities demanded of these students, i.e. lectures, seminars, practical or lab classes, clinic hours or internships.

The students' opinions indicate a high level of preparation of teaching materials and course organization. The popularity of distance learning may result from interactive access to the information contained in the online course (lesson, quiz, task, forum) or just multiple access to the course material resources. A student can repeatedly refer to the previously analyzed issue, learn it better, acquire knowledge on the topic, and independently test their knowledge on the subject (Douglas et al., 2004; Półjanowicz et al., 2009; Półjanowicz et al., 2010).

As a result of online learning, the university teacher has a new role as a kind of mentor. Using the prepared teaching materials (Figure 4) and tests (Figure 5), the teacher can conveniently check the students' knowledge. Both the teacher and student are able to see test results immediately (Rice, 2010).
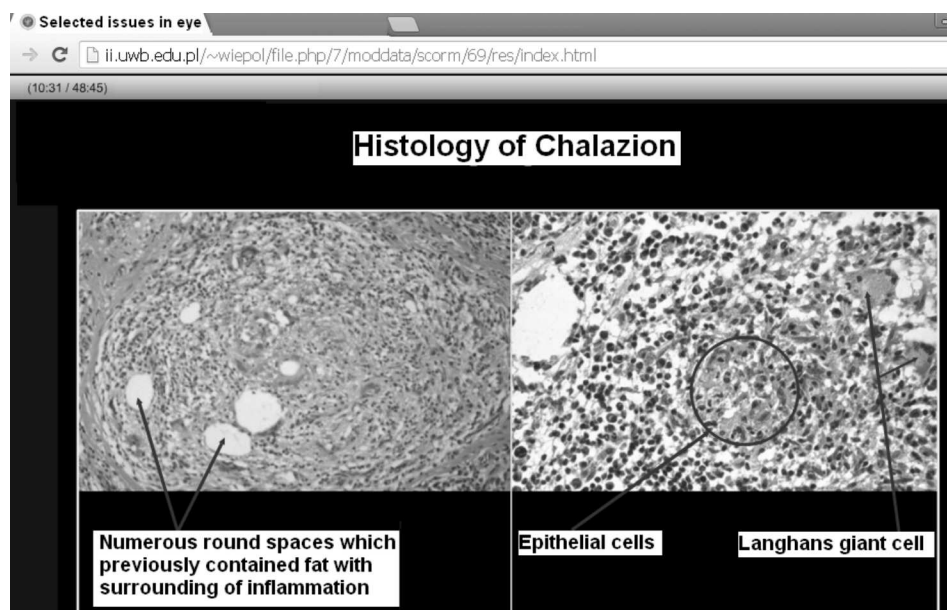

Figure 4. Screenshot of multimedia teaching materials on visual rehabilitation

Pilot studies conducted among students majoring in *computer sciences* at the School of Humanities and Journalism and *medicine* at the Medical University in Poznan in the academic year 2011/2012 to assess the relevance of e-learning materials and electronic examination of students (Roszak et al., 2013a; Roszak et al., 2013b) confirmed a high evaluation of e-learning methods and tools in the teaching process.

Figure 5. Screenshot of quiz assessing student knowledge in the course "Ophthalmology and ophthalmic nursing"

Studies performed at Maria Curie-Skłodowska University of Lublin on Logopedy with Audiology Faculty (in cooperation with the Institute of Physiology and Pathology of Hearing, Warsaw) confirmed that the majority of students evaluated e-learning systems positively (as very good – 64% and good – 31% of students), regarding quality and accessibility of didactic materials. Approximately 68% of students reported that e-learning is an effective method of education while nearly 86% reported that electronic knowledge assessment tests are a great advantage of distance learning. However, the major advantages of e-learning are: all day access to didactic materials (90%), saving time (98%), and individualization of the teaching process (71%). Moreover, according to academic teachers from the Institute of Physiology and Pathology of Hearing in Warsaw, e-learning allows time spent on educational activities to be reduced without a decrease in learning quality (Bombol-Lagha et al., 2012).

Our study included a group of 75 nursing students enrolled in the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" in the years 2009–2011 using e-learning and traditional learning methods. The positive results produced by a comparison of these groups confirmed the assumption that the use of e-learning would not worsen the state of professional knowledge, student satisfaction, or learning effectiveness compared with students attending traditional classes.

In connection with the development of Internet access and mobile devices, distance education is and will continue to become more and more popular and natural. Students enrolling in virtual courses are not bound to the place or time of their implementation. They can acquire knowledge at their own time and save time on commuting to the university. Virtual systems of consultation with the instructor (forums, FAQ, chat) do not leave the student alone in the jungle of available information. Students have more flexibility in content implementation; however, this is directly connected with more self-discipline, conscientiousness and responsibility on the part of the learners (Douglas et al., 2004; Selvi, 2010; Shroff et al., 2007; Wu et al., 2010). The next step to increase the attractiveness of distance learning is to personalize e-learning courses according to individual learning style. This may increase student satisfaction and knowledge gained.

Conclusions

The results obtained during this study allow us to conclude that e-learning is not inferior to traditional teaching methods for the courses "Selected issues in visual rehabilitation" and "Ophthalmology and ophthalmic nursing" for nursing majors.

The study and statistical analysis allow us to conclude that course organization was rated positively by 80% of the students in the e-learning groups and 89% in the traditional groups. 91% of the students in the e-learning groups and 88% in the traditional groups rated course preparation as well as availability and relevance of the didactic content positively. In addition, 86% of students in the e-learning groups and 83% in the traditional groups rated their acquisition of knowledge and skills positively.

The multimedia, e-learning teaching materials, available to students throughout the semester, enabled more flexible learning opportunities and preparation for the final exam, while simultaneously allowing students to widen and assimilate knowledge of ophthalmology and visual rehabilitation.

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