Original Article

Using Information Technology in Teaching of the Course "Analytical Chemistry" in Bogomolets National Medical University

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Abstract

In the past decade, electronic learning has increased in popularity. Technology-enhanced learning is the progressive area for researching (studying, investigation). The information age provides uneclipsed feasibilities for the educational process, such as communication, exchange of information, having up-to-date knowledge. Further growth in demand for e-learning is expected. The combination of digital technologies and resources provides opportunities to improve the quality of learning and teaching. The paper focuses on the experience of organizing e-learning of course "Analytical Chemistry" in Bogomolets National Medical University for 488 students (93 students of full-time education and 395 students of part-time education) of the second year of study of the pharmaceutical faculty using tools of the Moodle and other information technology (Zoom, pre-recorded video lectures, and laboratory works, social networks). The purpose of this article is to analyze and evaluate the information technology learning process that is required during the COVID-19 pandemic. An important achievement of this article is the creation of a well-structured Analytical Chemistry online course at the platform LIKAR_NMU. The evaluation of students' performance shows that online learning, which was proposed, can be estimated as effective in obtaining necessary skills and knowledge in Analytical Chemistry. The survey data illustrates that pre-recorded video lectures and live lectures are equally effective (according to the following criteria: the ability to concentrate, the intelligibility of content, degree of interest aroused, and lecture overall). And social networks (messengers Viber, Telegram, and WhatsApp) are effective tools for solving the accompanying problems related to the subject of Analytical Chemistry.

Keywords: Analytical chemistry, Distance learning, Education, Electronic learning, Information technology

Introduction

Today, technology is not only developing rapidly, but it also altering the way of life of society in many areas (education, communication, working life) [1]. The wide use of information technologies and social media networks in education is observed because contemporary teenagers adapt to technology and gain continuous access to different communication channels such as mobile phones and social media [2].

Education is one of the fields that is most influenced by technological progress. That is why the role of e-learning has grown in importance over the past decade. In this regard, e-learning is gaining increasing importance [3-6].

The concept of online education is not new. According to general knowledge of online Encyclopedia Britannica "distance learning (also called distance education, e-learning, and online learning) in the form of education in which the main elements include physical separation of teachers and students during instruction and the use of various technologies to facilitate student-teacher and student-student communication".

A central question about online learning is its effectiveness compared to traditional (face-to-face) instruction. E-learning has advantages and disadvantages over compared to traditional learning. The main advantages of e-learning as a convenient and effective option are education or training yourself anytime or whenever you have free time and from anywhere. But during e-learning, the face-to-face learning experience is missing [7, 8].

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Nowadays e-learning is used in different areas of life. See some examples of how e-learning is used in different industries: medicine [9], administrative sciences [10], high education [11-13], industrial engineering education [14]. Systematic reviews [3, 15-18] are very useful for a broad understanding of distance learning development.

Chemistry is so important to the other fields of science such as biology, physics, medicine, engineering, pharmacy, and material science. Only a few studies focused entirely on online learning in undergraduate chemistry courses: inorganic chemistry course [19], general chemistry course [20], introductory chemistry course [21]. We seek to fill this gap.

The paper focuses on the analysis of the effectiveness of the educational process in Bogomolets National Medical University in pandemic times based on Learning Management Systems (LMS) such as Moodle, combining with other information technology (Zoom, pre-recorded video lectures, and laboratory works, social networks). The effectiveness of online courses by evaluation of student performance and student attitude are both important factors. That is why the paper has looked at both student learning (performance on testing and overall grades) and student attitudes towards proposed online course chemistry.

Materials and Methods

Online form and blended form of education were adopted in Bogomolets National Medical University due to the COVID-19 pandemic in the 2020/2021 academic year. Bogomolets National Medical University has implemented the platform LIKAR_NMU based on Learning Management Systems Moodle for distance education for the period of quarantine [22]. LMS such as Moodle is a great repository of materials and has great potential. LMS is used in the higher education system to improve the teaching and learning experience [23, 24].

The platform LIKAR_NMU and a set of guidelines for teachers and students on how to use this tool one can find on the official website of Bogomolets National Medical University (http://nmuofficial.com/distant-education/).

Pharmaceutical students of the second year (both full-time and part-time forms of education) take a mandatory course in Analytical Chemistry at the Bogomolets National Medical University during the third and fourth semesters of education. The total number of students is 488 (93 students of full-time education and 395 students of part-time education). The course comprises 15 lectures (30 hours) and 30 practical lessons (total 120 hours) for full-time education; 4 lectures (7 hours) and 18 practical lessons (total 36 hours) for part-time education; a total of 8.0 credits. The course consists of three content modules, such as: "Qualitative Analysis" (10 topics), "Quantitative Analysis" (14 topics), and "Instrumental methods of analysis" (6 topics).

Analytical chemistry is a component of the Unified State Qualification Exam for the students enrolled in the Master's academic program and majoring in the "22 Healthcare" branch of knowledge (https://www.testcentr.org.ua/en/usqe). That is why increased attention has been paid to Analytical Chemistry [25, 26].

The using distance learning platform LIKAR_NMU allows creating a well-structured teacher-student interaction [27]. **Figure 1** demonstrates the organizing of courses in Analytical Chemistry at the Bogomolets National Medical University at the platform LIKAR_NMU.

Let's describe course blocks in more detail.

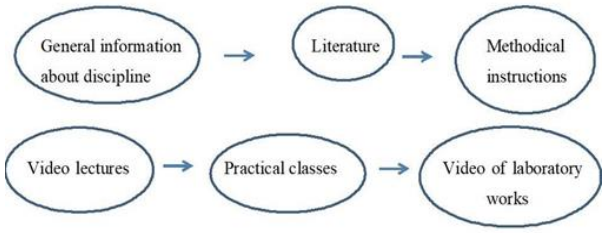

Figure 1. The main blocks of the structure of discipline "Analytical Chemistry" at the distance learning platform LIKAR_NMU

Module "General information about discipline" includes pdf-files of education curriculum, calendar-thematic plan of practical lessons, and calendar-thematic plan of lectures. This information is important for students and helps them hit their goals and targets in line with the course curriculum in "Analytical Chemistry".

Module "Literature" includes pdf-files of the basic textbooks and a list of additional material with full initial information.

Module "Methodical instructions" includes pdf-files of methodical instructions to each practical class (total 30 methodical instructions). The goal of the methodical instructions to practical classes is to help students during the independent study of theoretical principles of discipline "Analytical Chemistry". The actuality of the topic, general aims, actual aims and abilities, key questions on the corresponding topics, lesson vocabulary, and list of references with clearly indicated pages for study are given for each lesson as well as problems for the home task followed by solution guidelines.

Module "Video lectures" includes 9 pre-recorded video lectures for full-time form education (and 6 lectures were live Zoom lectures) and 19 pre-recorded video lectures for part-time education. Lecturers use PowerPoint with the voiceover feature for creating online lectures. PowerPoint with voiceover is a tool that allows us to provide voice explanations of examples, tables, facts, graphs, etc. The final result was being saved as a video in the mp4 file format. Part-

time education is a method for learning for students who need to work or care for their families. Part-time form of education takes place in a concise form. Therefore, it was decided to create short video lectures for each practical lesson (and another video lecture on laboratory safety rules) for distance learning to improve the quality of education.

Module "Practical classes" includes tasks for current control for each practical class and a student notebook for experimental chemistry. Current control includes multiple-choice questions, calculated and situational problems.

Module "Video of laboratory works" includes video of realization of all experiments according to education curriculum (total 26 videos of laboratory works).

Results and Discussion

Qualitative research was realized by interviewing students about the benefits and drawbacks of online learning, which was proposed. 71.1% of students had estimated the course like effective in obtaining necessary skills and knowledge with good organizational structure.

Our observations as well as the opinion of 63.1% of students indicate some disadvantages of online learning. The most important disadvantage is a lack of real (by hand) laboratory experiments and skills in using laboratory equipment safely and correctly are also absent because chemistry is an experimental science and cannot be separated from laboratory works.

The aim of the present study was also to compare the effectiveness of pre-recorded video lectures and live Zoom lectures. The survey question was asked the respondents how effective the two forms of lectures were to learn the concepts for discipline "Analytical Chemistry". 45.2% of the full-time education students preferred pre-recorded video lectures, 47.3% of the full-time education students live Zoom lectures and 7.5% stated "neutral". Another trend was observed among part-time students. So, 80.1% of these students preferred pre-recorded video lectures, and only 8.7% of these students preferred live Zoom lectures; the rest of the students did not express any opinion. These results can be explained by the special learning conditions for different types of students' education. The part-time students are accustomed to a high degree of independence since their activity in any course depends on their ability to work at a certain time. Therefore, pre-recorded video lectures are a convenient and useful tool for obtaining and improving students' knowledge. Indeed, students can use video lectures anytime and anywhere. In addition, both live and video lectures were assessed separately on a 5-point scale (5 = "very good", 1 = "very poor") according to the following criteria: the ability to concentrate, the intelligibility of content, degree of interest aroused and lecture overall. Then, the responses were averaged to get the mean. **Table 1** illustrates that pre-recorded video lectures and live Zoom lectures are equally effective. It should be noted that video recordings of lectures offer some benefits to the students. They can view the lecture at any time and place, and repeat it as often as wanted, which is particularly useful for a deep understanding and the preparation of exams.

Table 1. Mean values (%) of criteria of pre-recorded video lectures and live Zoom lectures

Criterion	Live Zoom lecture	Pre-recorded video lecture
Ability to concentrate	3.0	3.4
Intelligibility of content	3.3	3.1
Degree of interest aroused	3.3	3.4
Lecture overall	3.1	3.2

Each practical lesson (according to the schedule) is occurred like videoconference using Zoom, which allows communicating in real-time. Zoom was chosen via such its important advantages, such as:

- recording function, which is useful for students with poor access to the internet;
- convenient screen sharing which gives the teacher flexibility to use tools such as PowerPoint, whiteboard function, etc., which is useful and essential for the teaching of chemical sciences (for showing video, writing chemical reactions, and problems solutions/discussion).

Social networks are also used in the educational process as an additional element of the course "Analytical Chemistry". Between a lot of resources that can be used for communication with the students outside the class, we can outline the messengers Viber, Telegram, and WhatsApp. It was proposed to students choose any messenger for educational purposes. The percentage and number of social network users by differentiating the software are given in **Table 2**. Among our students, the Telegram software is the most popular and widespread. A total of 41 different messenger groups (according to the student's wishes) were created for students of the second year of study of the pharmaceutical faculty.

Table 2. Percentage and number of social network users by differentiating the software

Type of social network	The number of social network users
Viber	151 (30.9%)
Telegram	199 (40.8%)
WhatsApp	138 (28.3%)

The social media application is used in the educational process for the following purposes:

- encouraging information sharing among students,
- increasing the motivation of the students about the course,

- information sharing the audio records, problems, solution of the problems and documents related to a subject,
- instant answers to obscure topics,
- reminding the deadline for assignments.

The survey question was asked the students about the effectiveness of the social networks in solving their problems. The results were ranked as follows: strong effectiveness (29%), moderate effectiveness (38%), low effectiveness (33%).

All surveys were optional. The above-stated results about the effectiveness of information technology in the teaching of the course "Analytical Chemistry" in Bogomolets National Medical University correlate with student's activity in the course on the distance learning platform LIKAR_NMU: 56% of students gained the results ranging from 80% to 100%; 30% of students performed the tests at 70−80% efficiency; 14% of students performed the tests at less than 70% **(Figure 2)**. It should be noted, that the students of full-time education have higher scores in comparison with students of part-time education. It can be explained by objective reasons like less time spent in learning and less instructor control.

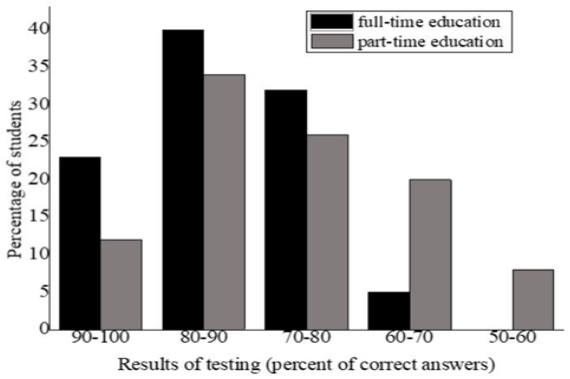

Figure 2. The results of testing of students on the distance learning platform LIKAR_NMU

The results of submodules "Qualitative analysis", "Quantitative analysis" and "Instrumental methods of analysis" controls of the students of the full-time education are represents in ECTS grade and shown in **Table 3**. Most students earned an A, B, and C.

Table 3. Number of students who received grades of A, B, C, D, or E in an online course

Submodule	A (%)	B (%)	C (%)	D and E (%)
"Qualitative analysis"	28 (30.1%)	35 (37.6%)	25 (26.9%)	5 (5.4%)
"Quantitative analysis"	31 (33.3%)	34 (36.6%)	20 (21.5%)	8 (8.6%)
"Instrumental methods of analysis"	22 (23.6%)	30 (32.3%)	31 (33.3%)	10 (10.8%)

We have observed the decreasing of students' performance from submodule "Qualitative analysis" till "Instrumental methods of analysis". We have asked students to explain this fact from their standpoint. Some comments summarize well the students' experience of this course:

"I have arranged parts of the online course "Analytical Chemistry" according to the increasing of their complication by the following way: "Qualitative analysis", "Quantitative analysis", "Instrumental methods of analysis".

"I earned mark B for both submodules "Qualitative analysis" and "Quantitative analysis", mark D – for "Instrumental methods of analysis". The part "Instrumental methods of analysis" is difficult to learn since it requires both practical skills and understanding of many physical and chemical concepts (electrochemistry, optics)".

Conclusion

The findings allow drawing some conclusions. The distance learning platform LIKAR_NMU based on LMS Moodle together with video conferencing, pre-recorded video lectures, and social software, are recommended as an effective online learning tool. Platform LIKAR_NMU is applicable to provide students with effective training to master a future profession and necessary skills. Among numerous benefits of this platform, we can distinguish such as user-friendly interface, content management (uploading documents and videos, sharing materials), responsive design, assessment and testing (flexible testing and assessment features), reporting and tracking (record learners' progress during the learning process).

The survey data suggest the effectiveness of pre-recorded lectures to obtaining necessary skills and knowledge for discipline "Analytical Chemistry" and effective application of social networks like Telegram, Viber, WhatsApp for communication between the teacher and students outside the class. Video lectures could increase the quality of the teaching through the possibilities of distance learning. Here, the characteristics of ability to concentrate and degree of interest aroused are assessed better for pre-recorded video lectures than in the live Zoom lectures. Social networks could be an effective tool in easing the achievement of the educational goals (information sharing among students, increasing the motivation of the students about the course). Telegram had the highest usage followed by Viber and WhatsApp.

Our data indicate that most students of full-time education earned an A, B, C for submodules "Qualitative analysis", "Quantitative analysis" and "Instrumental methods of analysis" controls in an online course format. This high level of the students' performance as the result of course "Analytical Chemistry" confirms that online education is an effective tool as well as face-to-face classes.

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