Original Article

Distance learning technologies in online and mixed learning in pre-professional education of medical lyceum students

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ABSTRACT

COVID-19 has excited the established system of teaching in educational institutions, as learning with the help of distance electronic technologies became the main method of teaching curricula during the forced self-isolation. This problem was very acutely identified for medical high school students when they switched to e-learning with the help of ZOOM and Skype Internet technologies. After six weeks of learning in an online environment and six weeks of hybrid learning, a questionnaire-based feedback study was carried out to examine the perception of this type of learning among high school students and teachers of the medical high school. The data were analyzed using standard statistical software. The group of respondents were 120 students and 15 teachers of the medical profile lyceum. Based on the respondents' answers, the main advantages and disadvantages of online learning were identified. In terms of learning efficiency, i.e., acquisition and assimilation of new knowledge, no significant statistical difference was observed between online learning and face-to-face ($p = 0.46$). In terms of improving practical skills ($p < 0.001$) and social competencies ($p < 0.001$), online learning was less effective than face-to-face learning. During online classes, students reported decreased self-activity incomparison with face-to-face classes ($p < 0.001$). E-learning was considered to be convenient by 80% of respondents. E-learning is a strong tool for pre-professional training of medical high school students. However, a well-thought-out strategy is required for the successful introduction of online learning into the curriculum, a certain restructuring of the educational process, and an active approach to innovation.

Keywords: Pre-professional education, Information and communication technologies, Distance learning, Continuous medical education, Pedagogical innovations

Introduction

The COVID-19 coronavirus pandemic has stirred up the established coherent and independent system of teaching in educational institutions in many countries, including Ukraine [1, 2]. Because of the threat of infection spreading in Ukraine, the Cabinet of Ministers issued a decision [3, 4] according to which quarantine measures were introduced throughout the country from March 12, 2020, for a long time, limiting visits of students and teachers to educational institutions, so eye classes had to be suspended to make sure that itssafe. Especially, these difficulties affected the pre-professional training of students in medical lyceums. To ensure that the effects of forced isolation were not detrimental to the effectiveness of the educational process and were minimized, medical education institutions had to find other updated theoretical and methodological approaches to the training of future medics. Based on the already implemented modern technologies, certain distance learning methods (online via the Internet) were chosen to become the main method of teaching curricula during forced isolation. The basic principles of the organization and implementation of distance learning in Ukraine were defined by the Order of the Ministry of Education and Science of Ukraine and approved by the "Provisions on distance learning" from 2013 [5, 6]. Ensuring the continuity of learning and functioning of the medical lyceum as an institution of pre-professional training of students in the COVID-19 pandemic is the basis for the effectiveness of the system of

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continuous medical education, which provides students receive complete general secondary education, basic professional skills, personal and professional growth. Therefore, learning through distance learning technologies is a convenient case to solve the problem of breaking the important continuity of medical education by using information and communication technologies (e-learning, E-Learning, Web-based learning, on-line-learning) to enhancethe education'squality [7]. Distance learning in pre-professional education was widely used in the pedagogical process still not as the only method, but in combination with the traditional teacher-led approach [8].The effectiveness of distance learning educational technology depends on severalfactors, among which should be highlighted: accessibility, the use of appropriate methods, adaptionto adequate assessment criteria, andthe Internet platform course content.It has certain disadvantagesand advantages, and both the first and the second are fixed on both sides of the educational process: both applicants for education and teachers. In addition to the advantages of distance learning during the spread of COVID-19 coronavirus as a measure of epidemiological means, it is worth noting other, not determined by time constraints. Thus, increased convenience, accessibility of educational resources regardless of place and time, as well as environmental factors such as reducing carbon footprint, such as carbon dioxide emissions due to reduced traffic, energy consumption, and air pollution, etc., are a priority [9]. Distance learning with modern Internet technology also has disadvantages or limitations, which may include problems of a technical nature (Internet access, poor quality connections) or insufficient digital skills. Interestingly, some characteristics are ambivalent, e.g., time flexibility, which is assessed as an advantage, can also be defined as a limitation, especially for students who have self-disciplinedifficulty [10, 11].

Literature review

The system of continuing medical education at all levels, from secondary pre-professional and to higher medical education, has many developed pedagogical approaches to teaching, historically, priority has been in face-to-face classes (lessons, lectures, seminars, etc.) with classroom pedagogy [12]. This particular approach to educational practice can become more widespread, gaining some successes, [13] but also leading to a reluctance to adopt new and innovative practices and technologies [14]. In recent decades, there has been a shift in the practice of continuing medical education from traditional forms of learning to more innovative modern pedagogical forms and tools that increasingly use pure (less frequent) or blended (more frequent) online, distance, or e-learning [7, 15]. This phenomenon or phenomenon is formulated as "Distance or online learning" (digital, electronic), which can be defined using electronic/digital technology and media to provide, support, and enhance both learning and teaching, and which involves communication between students and teachers using online content. Such online distance learning can give secondary education applicants in pre-professional medical training easier and more effective access to more diverse content, more information, more free access to teachers on less time and reliability, those evidence-based, research, can strengthen the position by encouraging teachers to implement pedagogical innovation [16, 17]. However, the transition from traditional to online learning, moreover, which takes place within a rather coercive situation (forced isolation during the COVID-19 coronavirus pandemic), cannot be free of problems. Increasing demands for educational efficiency and certain limitations on time (which is in constant short supply under the conditions of forced "change of horses at the crossroads"), constantly put forward, both for students and teachers of 21st-century medical schools, forced to look for new and innovative ways to provide more independent and personalized learning. Within such a narrow framework of distance education pathways, implemented through modern dynamic Internet platforms and digital technologies, an adequate outlet [18]. In a modern and dynamic environment, the need for constant rapid updating of knowledge, skills, abilities of both teachers and students, who all need to be aware of and remain "digital literate" [19] becomes acute and of great relevance. To implement and operate distance education, the foundation of which is digital literacy as an ability, one must:use digital technology, networks, or communicationsto find, evaluate, use, and create information,understand and utilizeinformation in different formats and from a wide range of sources presented in the digital Internet environment,read and interpret media and reproduce images and data through digital manipulation [20]. The emergence of modern mobile devices and software, the rapid growth of social networking technologies, etc. provide students with the opportunity to create their personalized learning processes [21]. Many factors can influence the success (or lack thereof) of distance learning [22, 23]. For example, additional pressure is given to teachers who already suffer from time, emotional and mental overload [24]. Implementing and integrating distance learning into the teaching practice of a medical education institution or program will help address the major problems caused by the spread of COVID-19 coronavirus. To provide a basis of evidence regarding certain advantages or disadvantages of distance or blended online learning in pre-professional medical education, as well as solutions to address its problems, it is critical to consider all perspectives to date (student, teacher, educational institution body, etc.) [25-27].

The purpose of the studyis to analyze the perception of effectiveness (success) and to identify the main advantages and disadvantages of online distance learning based on the Internet platform ZOOM and communication technology Skype.

Materials and Methods

In the situation that developed after the announcement of the epidemic emergency in Ukraine, due to the high risk of infection by a coronavirus, the only possible and adequate response of secondary and higher education institutions - that is, universities and colleges to the external challenge was a temporary transition to alternative forms, such as distance learning and self-study

based on training programs, which were developed by teachers of the institution. And in these conditions, all possible resources of educational institutions, external content providers, providers, Internet services were used for the realization of the educational process using a network the Internet. Face-to-face training in educational institutions, including medical ones, was suspended, all of them were obliged to conduct online distance learning or mixed form training (use of distance alternating with face-to-face). However, there was no evidence that these distance methods could outperform, or at least not lose out in success, traditional teaching methods such as face-to-face classroom instruction, lectures, etc. Conducting this study was to be one step in comparing existing traditional teaching methods with new forms of distance innovative pedagogical forms in terms of learning effect, student, and teacher satisfaction, and positive (or negative) evaluation by them.After 6 weeks of exclusively online learning without face-to-face and 6 weeks of mixed-form learning, anonymous questionnaire forms (see Annex 1) were provided to students - future medical students and their pre-professional teachers working in a medical high school, which could be obtained via social networks, e-mail, or lace file repositories of choice.The question forms, available in Annex 1, were available online for 2 months, from February 20 to April 20 (the deadline was chosen so that data collection would be completed by the end of the spring semester). It did not have any exclusion criteria. Each faculty member and student were allowed to complete the questionnaire once. All respondents were informed of the purpose of the study fully and knowingly agreed to voluntarily participate in this study, 120 students and 15 medical schoolteachers were surveyed. The study was approved and discussed at a scientific and practical conference with international participation "Bioethics and Biosafety: Multidisciplinary Aspects" (May 2020) [28]. Using descriptive statistics, the data were analyzed. A non-parametric Wilcoxon sign-rank test, also Mann-Whitney tests and χ-square were used to compare respondents' scores for online learningand face-to-face. P <0.05 was considered statistically significant.

Results and Discussion

Questionnaire material

The questionnaire to identify the advantages and disadvantages of distance learning was developed by the authors for this study and consisted of 4 parts. In the first - when interviewing applicants for education were asked to enter their demographic data (age, gender, grade 10 or 11), to describe their IT skills and experience in online learning and indicate whether they have previously had experience in any online courses of an educational nature, the latter could give a characteristic of self-discipline and experience of independent learning. In the second part of the questionnaire, respondents had to assess a pre-formulated set of options regarding the advantages and disadvantages of distance learning. In the list of these positive and negative qualities, it was possible to choose what suited them specifically. To form such a list among the respondents (students and teaching staff), a preliminary free-form questionnaire was conducted: what advantages and disadvantages do they see in distance learning in general. Then, in the 3rdpart, the respondents had to compare, from their subjective positions, face-to-face, and online learning. The emphasis was on the ability to master the learning objectives (knowledge, professional skills of the chosen profession, and social competencies). Using a Likert summative rating scale [13], [29], which formulated the following limit values: from 1 = unconditionally ineffective to 5 = unconditionally effective, with an arbitrary range of values chosen by respondents. Such psychometric scales, developed in 1932 by Rensis Likert, are often used in surveys and personal studies, where it is necessary to determine and standardize subjects' ratings of their degree of agreement or disagreement with a particular judgment separately, from "strongly agree" to "strongly disagree". The sum of the ratings of each judgment reveals the respondent's attitude from the research question. Simplicity and evidence are based on the fact that attitudes toward the subject matter under study are based on uncomplicated, non-contradictory judgments, and cover the full spectrum from one critical point through neutral to the opposite of critical. That is, the criteria for success and effectiveness of online distance learning classes are set from a purely negative attitude to a purely positive one. Students and teachers were also invited to rate their activity during class (1 = extremely inactive, 5 = extremely active). Student and teacher data were analyzed separately. The fourth part of the student and teacher surveys separately covered results on the acceptance level of effectiveness of online classes on a Likert scale from 1 to 5 (1 = extremely unpleasant, 5 = very pleasant). Because there was a marked difference in the responses on the efficacy ratings between the medical school students ($10^{th}$and 11^{th}grade) and between the students and educators, there were comparatively common and separate responses between these two groups of applicants and educational conductors.

Statistical analysis

Using descriptive (descriptive) statistics,empirical data, that is, thedisadvantages, advantages, and the level of acceptance of e-learning, which wereidentified during the study were analyzed.A non-parametric Wilcoxon sign-rank test was used to compare opinions about ocular and online learning. The χ 2 and Mann-Whitney tests were used to compare responses of less and more advanced students. P <0.05 was considered statistically significant. Respondent group: 120 students and 15 teachers at a medical high school (n = 135). According to the respondents' answers, the main advantages and disadvantages of online learning were identified. In terms of learning efficiency, i.e., acquisition and assimilation of new knowledge, no significant statistical difference was observed between online learning and face-to-face (p = 0.46). Online learning wasless effective than face-to-face learning in terms of increasing practical skills (p < 0.001) and social competencies (p < 0.001). In comparison with ocular classes,students noted decreased self-reported activity

during online classes (p < 0.001). Teachers noted decreased student activity and (p <0.001).E-learning was rated as convenient by 80% of respondents. Of the 135 respondents, 39 (29%) were male and 96 (71%) were female. The age of the interviewees ranged from 16 to 49 years where the mean M = 22.65 - standard deviation (standard deviation) SD = 2.15, calculated for the entire sample for each of n = 135 54 (40%) respondents had a previous distance learning experience, while 81 (60%) had not. 76 (56%) respondents described their IT skills as good, 57 (41%) as moderate, and 2 (3%) as poor.The characteristics of the study sample of respondents (n = 135) are shown in **Table 1**. Younger students (10th-grade medical high school) more often chose technicalproblems with the Internetand learning equipment – computer.

Table 1. Features of the sample of respondents understudy

Variables	n (%)
Gender	1)
male	39 (29%)
female	96 (71%)
Age (years)	2)
16-18	120 (89%)
18-30	13 (8%)
31-49	2 (3%)
Previous experience in distance learning (photo)	3)
Yes	54 (40%)
No	81 (60%)
IT skills	4)
High	76 (56%)
Moderate	57(41%)
Low	2(3%)

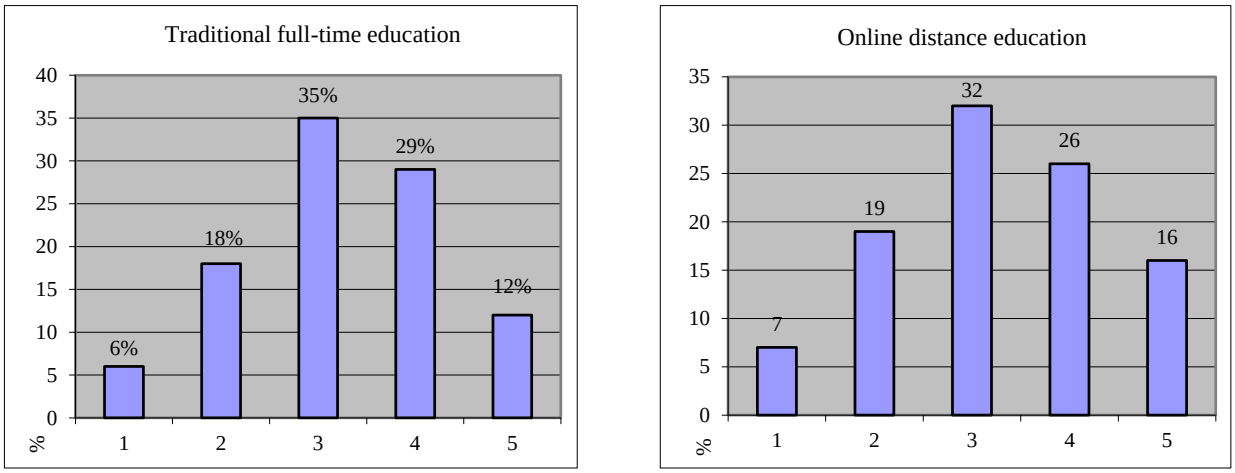
camera, headphones, quality of communication, etc. (P = 0.003), lack of self-discipline (P < 0.001), and social isolation (P = 0.008) as the most annoying disadvantages of distance learning via the Internet, while grade 11 students and teachers more often chose lack of quick teaching interaction, communication with the teacher, inability to get a quick answer to a question that arose during class (P <0,001).Most respondents chose as the main disadvantages the lack of quick direct and direct interaction with the teacher, that is, you mustwait for more to ask a question (70%) and technical problems with IT equipment (54%) **(Table 2)**.

Table 2. Pros and cons of e-learning

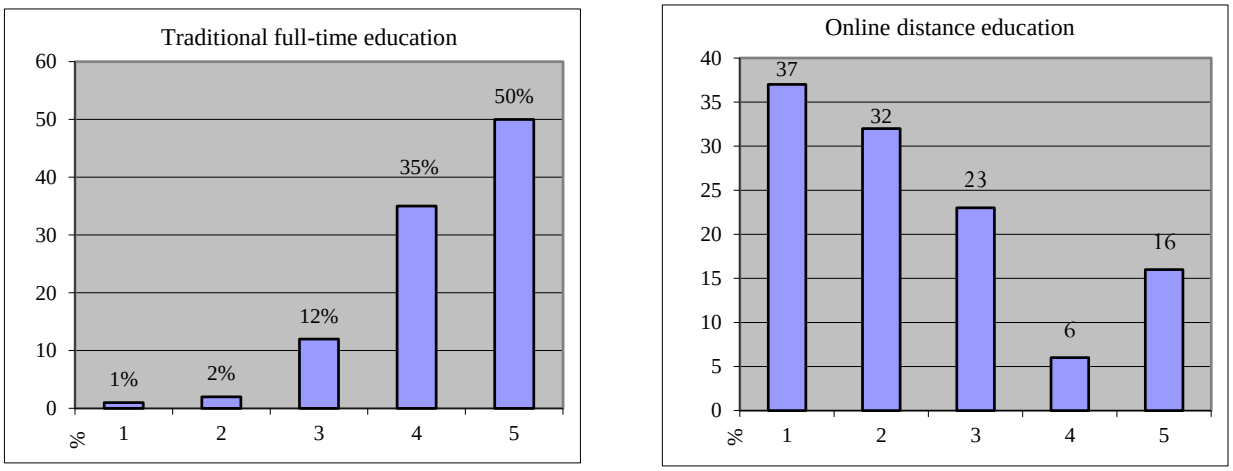
Variables	Students. Grade 10 n = 62 (46%)	Students. Grade11 n = 58 (43%)	Teaching staffn = 15 (11%)	*n*	Total n = 135 (100%)
Benefits of Online Distance Learning via the Internet					
Free access to online materials	42 (68%)	40 (69%)	10 (69%)	0,77	(69%)
The learning process is at a comfortable pace	40 (64%)	37 (64%)	10 (65%)	0,95	(64%)
The ability to stay in the comfort of your home during classes	42 (67%)	42 (72%)	11 (70%)	0,12	(69%)
interactivity of classes	2 (3%)	4 (6%)	1 (5%)	0,05	(4%)
Ability to record video and audio on digital media and view them later	14 (23%)	11 (18%)	3 (20%)	0,07	(21%)
Low stress level - comfortable environment - psychological and physical	32 (51%)	33 (57%)	5 (55%)	0,08	(54%)
Cons of online learning					
Reduced interaction between the parties to the learning process	29 (47%)	25 (43%)	7 (44%)	0,33	(45%)
Technical problems	37(59%)	28 (49%)	8 (54%)	0,003	(54%)
Lack of direct interaction (as in face-to-face learning)	33(54%)	52 (90%)	11 (71%)	<0,001	(70%)
Poor conditions for online learning at home	11(18%)	8 (13%)	2(16%)	0,07	(15%)
Lack of self-discipline	30 (49%)	19 (32%)	6 (40%)	<0,001	(41%)
Social isolation	27(44%)	20 (35%)	6 (40%)	0,008	(40%)

Comparison of face-to-face and online learning

No statistical difference was observed between online learning and face-to-face learning in the lyceum classroom (M = 3.23) via the Internet (M = 3.27) in terms of opinions regarding the ability of the distance learning method to improvethe level of theoretical knowledge, practical skills, and abilities of medical lyceum students (P = 0.46).Distance learning via the Internet was considered less effective than face-to-face learning in terms of increasing the level of achievement of meaningful knowledge in certain curricula (M = 2.03, M = 4.3, respectively), (P < 0.001) and social competencies (M = 2.03, M = 4.2, respectively), (P < 0.001) **(Figure 1)**. Respondents used a Likert scale, where 1 = learning is unconditionally ineffective, 5 = learning is unconditionally effective.



a)



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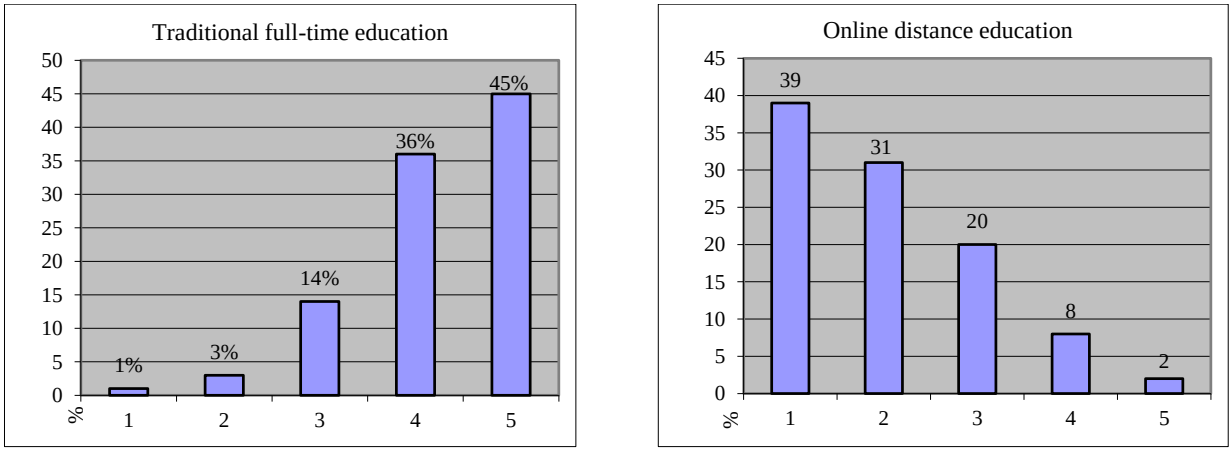

c)

Figure 1. Medical high school students' perceptions of their ability to expand theoretical knowledge (a), practical skills (b), and social skills (c) during face-to-face and distance learning

Respondents rated that they were less active during online distance learning via the Internet (M = 2.72) compared to traditional face-to-face classroom instruction (M = 3.82) (P<0.001) **(Figure 2)**.

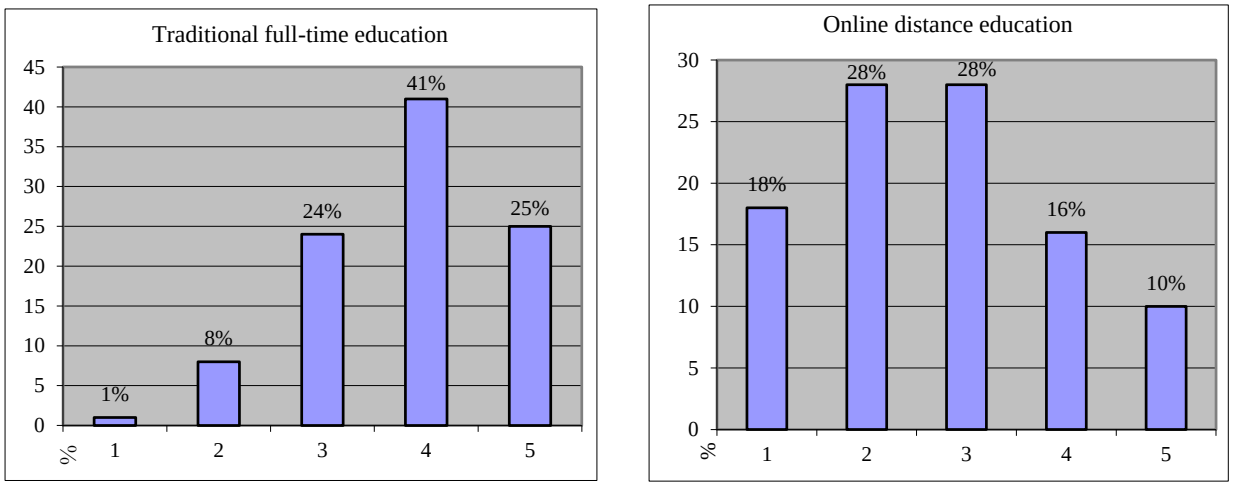

Figure 2. The activity of medical high school students in full-time and e-learning, where 1 = the student is extremely inactive, 5 = a regularly active student

Adoption of e-learning

(73%) of respondents rated e-learning as acceptable. Amongthese, (15%) found this form extremely acceptable, (29%) found it very acceptable, and (28%) found online distance learning acceptable under certain circumstances, that is, givingan average rating.Overall, (27%) participants were not satisfied with online learning. Of these, (10%) respondents found this form of learning extremely unacceptable and uncomfortable (and therefore ineffective), and (17%) found it very unacceptable **(Figure 3)**. There was no statistically significant difference between the responses of younger students (9th-grade students) and more advanced students and teachers (P = 0.63).

There was also no statistical difference between female and male respondents(P = 0.46).

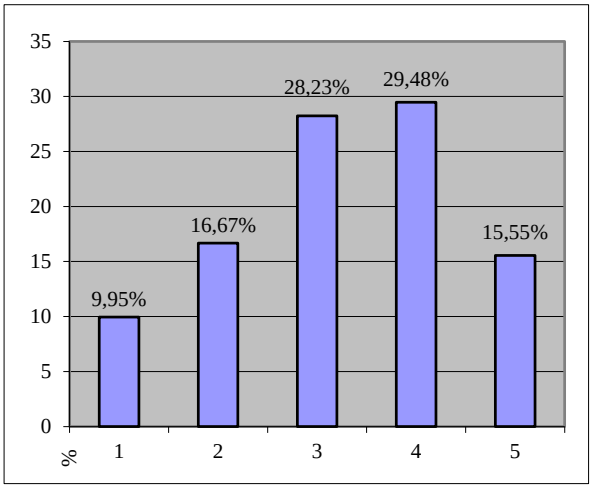

Figure 3. Level of convenience and acceptance of distance learning via the Internet, where 1 = such training is extremely uncomfortable and unacceptable, 5 = it is extremely comfortable and very acceptable

This study evaluated the perceptions of online distance learning via the Internet by Ukrainian medical school students and teachers in forced self-isolation as part of the COVID-19 coronavirus measures.The strongest advantages of online distance learning via the Internet among the respondents of the survey were the ease of access to training materials and the ability to choose a convenient place and time for the learning process.Remote access is an important factor, which is of particular importance when providing quarantine measures against the background of the spread of coronavirus COVID-19, but such access on the one hand can facilitate the learning process because of reduced transportation costs, reduced time, and carbon footprint, but in other conditions, where there are certain technical difficulties or lack of Internet connection, remote access is a limiting factor.Online distance learning allows for quick delivery of instructional materials to students, quick standardization, and updating when necessary. A flexible approach is also a plus of distance forms of pre-professional training in online education because learning content can be provided to students using two different approaches that complement each other: self-study using the provided materials, instructions, and methodological guidelines, and online learning under the direct supervision of a teacher - tutor or tutor. Independent distance learning allows the student to manage their learning activities under their control, activating volitional functions and aimed at the formation of a strong personality of the student, conscious professional self-determination, ensuring further professional development in higher medical education institutions. The results of modern research have shown that independent distance learning as a component of a unified flexible and adaptive to the challenges of the modern pedagogical system can surpass the effectiveness of traditional face-to-face learning in school classrooms and university classrooms [29]. Online distance learning has disadvantages. The main problem for the respondents to the survey, especially for the final year students and teaching staff, was the lack of rapid and direct pedagogical interaction between the two sides of the pedagogical process. This resultis in accordancewith other recently published studies that assess students' perceptions of online classes during the pandemic [18-20]. Similar problems have been noted in many countries. Continuing education (especially in medical institutions), which should provide the basis for further acquisition of medical education, where the practical clinical component is crucial, should also preserve the continuity of the

link between the educational applicant and the educator. The process of adequate educational acquisition in medical profile institutions cannot be completely replaced by distance learning [30, 31]. To some extent, the solution to this problem could be the use of innovative technical solutions, the introduction of advanced pedagogical approaches and technologies, the mastering of technical solutions of simulation and virtual learning spaces, etc. [22]. It is interesting, but more than 60% of respondents in this questionnaire have never previously encountered any form of online distance learning (neither in the context of formal pre-university education nor in its less formalized forms, such as learning with tutors, extracurricular training, systematic acquisition of knowledge by mastering a hobby/hobby, etc.) in self-isolation due to the COVID-19 pandemic. And this may be the reason why technical problems were the second major disadvantage of online distance learning in the study presented. Distance learning requires a reliable Internet connection and the availability of the necessary equipment and certain software. The students of the medical lyceum and its teachers had to be familiar with the necessary equipment for the educational purpose, and also for these reasons they needed to receive technical support and sound advice from the department ofIT of the educational institution, whose competence includes providing support for the educational process by the educational institution, at least before and during the implementation of online learning. Self-learning with the provided training materials and tutorials requires students to maintain self-discipline. And this can be an arduous task without the teacher directly offering supervision, which happens during face-to-face classes almost by default. Poor student-teacher interactions and a lack of clarity about goals and objectives to professional learning can hinder the pedagogical process. Some researchers have argued that the maturity (development of will and self-control) of high school students can increase their self-disciplinedegree, which is consistent with the results of the present study [23].

In the cited study, the analysis of the evaluated data may indicate that distance learning with the help of online platforms and Internet resources allows students to expand their informationto the same extent as traditional face-to-face learning. However, according to students, online distance learning is less effective in improving their practical and social skills. The distance form of learning for mastering practical skills (which during classical full-time education, for example, are realized and consolidated during laboratory, practical and similar work) is most effective in combination with traditional eye lessons - that is, the practical value is confirmed by the mixed form, in which that knowledge that can be given to students for independent learning, conducted remotely, and those that require the participation of teachers - in person.Instead of the use of textual materials, convenient and justified in full-time learning, for mastering practical skills are probably better-suited video instructions and innovative practices for the acquisition of practical skills through a computer game (Gamification).According to the results of the study, it turned out to be interesting that respondents rated their learning activity as less pronounced during distance learning via the Internet, versus the same during traditional face-to-face classroom instruction. One of the reasons may be a tactical error - the lack of a well-thought-out step-by-step and flexible interactive approach when designing courses for online distance learning for future physicians. Only a small number (4%) of respondents chose such a characteristic as "interactivity of classes" as an advantage of online distance learning during the forced self-isolation during the spread of COVID-19 coronavirus infection. There are various ways to increase the online learning's interactivity. One of the new and promising methods is Gamification, in which elements of game design are used not in the game, but the learning context for effective learning pedagogical purposes. Such an innovative pedagogical approach as Gamification has proven effective in many areas, especially in pre-professional secondary education, especially in medical institutions.Another approach might be social and cooperative learning, a method that allows students to interact socially with each other as well as with teachers. Both sides of the pedagogical process can work together to share ideas and expand their knowledge in forums open to discussions, such as professionally oriented forums, social media communities, and the like. Each pedagogical solution generates new challenges and new opportunities that push pre-professional education forward. All these promising methods have the goal of achieving better outcomes for pre-professional education in medical schools.

Limitation

Another approach might be social and cooperative learning, a method that allows students to interact socially with theteachers as well as withone another. Both sides of the pedagogical process can work together to exchangeideas and widentheir infromationin forums open to discussions, such as professionally oriented forums, social media communities, and the like. Each pedagogical solution generates new challenges and new opportunities that push pre-professional education forward. All these promising methods have the goal of achieving better outcomes for pre-professional education in medical schools.

Conclusion

This study showed that distance learning using modern online technologies and with the help of the latest technical solutions (Internet platforms ZOOM and Skype) is a valuable method of teaching secondary medical education institutions (lyceums) students in Ukraine. According to the respondents of this survey, distance learning via the Internet is an effective means of improving knowledge, acquiring practical skills and is in great demand, which will increase in the future. However, it is necessaryto focus on both increasing knowledgeandalso gaining social and practical skills. Distance learning should be based on the delivery of educational content (theoretical component)andalso on the fact that students should be able to work independently with learning materials, have the formed

ability to control learning, that is, the developed volitional sphere, as well as receive feedback and adequate pedagogical communication with the teacher. A well-thought-out pedagogical strategy is required for asuccessful introduction of online distance learning technologies into the curriculum, a more active approach to implementing educational innovations, solving problems of a technical nature.

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