Choosing a Lecture Format in Higher Pharmaceutical Education

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Abstract The forced massive transition of universities to distance learning due to the pandemic has raised questions about the effectiveness of online education in general and video lectures in particular. Research shows that video lectures are either comparable or less effective than face-to-face lectures. In this work, based on the data collected as part of the experiment, we compare two lecture formats (video lecture and face-to-face lecture) based on the educational results of students, and also evaluate the combined lecture format. The experiment involved 151 second-year students in the direction of training 'Pharmacy' of Sechenov University. The field experiment was carried out in the spring semester of the 2020–2021 academic year in three stages. At the first stage, some of the students listened to a face-to-face lecture, and some — to a video lecture. At the second stage, both groups were swapped. At the final stage, both groups listened to a combined lecture. Our research has shown that a video lecture and a face-to-face lecture are the same in their effectiveness: on average, students received the same educational results as a result of mastering the lecture material. At the same time, the combined lecture led to an increase in the educational results of students — after the combined lecture format, students received a higher score for the post-test, and also showed a greater increase in the level of knowledge. The results of the study will be especially relevant for the administration of universities responsible for the implementation of online learning, and teachers who conduct lectures.

Keywords face-to-face lectures, video lectures, combined lectures, pharmaceutical education, educational technologies.

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The shift to distance learning implemented by the majority of foreign and Russian universities in March 2020 due to COVID-19 risks [Gordon et al., 2020; Klyagin et al., 2020] led to a new round in the discussion of 'eternal' problems, such as inequality in education, and gave a new momentum to studies into student and teacher well-being in the online environment, as well as the effectiveness of distance learning [Klyagin et al., 2020; Bekova, Terentev, Maloshonok, 2021; Bekova et al., 2021; Gruzdev et al., 2022; Larionova et al., 2021a; Sukhanova, Froumin, 2021; Larionova et al., 2021b].

In a distance learning setting, teachers used different learning modes: synchronous and asynchronous, leveraging internal and external resources, such as online courses on the National Open Education Platform [Klyagin et al., 2020; Bekova et al., 2021]. New practices have raised numerous questions: How will the introduction of asynchronous learning and the use of video lectures instead of 'live' lectures affect the quality of education? Wouldn't this lead to a decline in students' educational outcomes? How do the students themselves feel about this teaching format? Would it be appropriate to integrate video lectures into the learning process in

the post-COVID period? Finding answers to these questions constitutes an urgent need for medical universities due to the specific nature of their field of study, as well as the more negative attitude of medical students towards distance learning than that of students in other fields of study [Bekova et al., 2021].

On the one hand, video lectures satisfy students' demand for autonomy, as students decide for themselves where and how they wish to receive the lecture material. Portioned presentation makes it easier to assimilate the information, without the need to concentrate on absorbing it for lengthy periods, as in face-to-face lectures [Humphries, Clark, 2021; Hughes, Pan, Kendrach, 2017]. On the other hand, video lectures provide no interaction between the lecturer and students, and its absence is recognised as one of the key problems of distance learning in general [Jaggars, 2014; O'Neill, Sai, 2014]. Furthermore, teachers note that the material presented in video lectures is perceived more superficially [Albon, Larson, Marchand, 2020]. In contrast, 'live' lectures can encourage students to engage with the material, thereby deepening their knowledge.

The results of comparative research into the effectiveness of these presentation modes are inconsistent. In a number of papers, students who had studied the subject through video lectures performed less well than those who had listened to face-to-face lectures: for example, in the final assessment test, those who had listened to a 'live' lecture completed, on average, 74.9% of the assignments, while students who had studied the subject by video completed 68.6% of the assignments [Ramlogan, Raman, Sweet, 2014]. However, other studies showed that video lectures and face-to-face lectures were equally effective [Brockfeld, Müller, Laffolie, 2018; Solomon, 2004; Farahani et al., 2020]. As regards the choice of students themselves, the majority prefer 'live' face-to-face lectures to video lectures, with one study showing a 21% difference in preferences in favour of face-to-face lectures [Brockfeld, Müller, Laffolie, 2018].

The effectiveness of different learning modes can be influenced by the traditions and practices of a particular culture. Therefore, the research carried out in foreign universities needs to be validated in a sample of students from Russian medical universities.

The present paper uses the design of an experiment conducted by German researchers in 2014, prior to the large-scale transition to distance learning [Brockfeld, Müller, Laffolie, 2018]. A total of 205 students of medicine at the University of Göttingen who were preparing for their examinations were divided into two groups. The first group watched a face-to-face lecture, and the second group watched a video lecture, after which they switched places and then were tested. No significant differences in learning outcomes between the groups were found. In addition to replicating the

experiment conducted by the German researchers, this paper aims to evaluate the effectiveness of the combined lecture compared to a video lecture and a face-to-face lecture and its potential as an alternative to these modes of delivery.

The combined lecture blends online and offline components and allows the students to get the best out of both lecture formats. In this study, it included watching a video lecture, as well as elements of lecture/discussion and lecture/consultation [Retivyh, 2021].

Thus, the experiment aims to answer two research questions:

- which is more effective: a face-to-face lecture or a video lecture;
- is a combined lecture a more effective format than a face-to-face or video lecture?

The shift to distance learning in the majority of foreign and Russian universities due to risks associated with COVID-19 pandemic [Gordon et al., 2020; Klyagin et al., 2020] led to a new round of discussions in education and gave momentum enhancing research on students and teachers well-being in the online environment, as well as the effectiveness of distance learning [Klyagin et al., 2020; Bekova, Terentev, Maloshonok, 2021; Bekova et al., 2021; Gruzdev et al., 2022; Larionova et al., 2021a; Sukhanova, Froumin, 2021; Larionova et al., 2021b].

In a distance learning setting, teachers employ synchronous and asynchronous learning modes with the involvement of internal and external resources, such as online courses on the National Open Education Platform [Klyagin et al., 2020; Bekova et al., 2021] . However, new practices have raised numerous questions: How will the introduction of asynchronous learning and video lectures instead of 'live' lectures affect the quality of education? Wouldn't this lead to a decline in students' educational outcomes? How do the students perceive a new teaching format? Would it be appropriate to integrate video lectures into the learning process in the post-COVID period? Finding answers to these questions constitutes an urgent need for medical universities due to the specific nature of their field of study, as well as less enthusiastic attitude towards distance learning among medical students in comparison with other majors [Bekova et al., 2021].

On the one hand, video lectures satisfy students' demand for autonomy, as students decide where and how they wish to receive the lecture material. Moreover, 'chunking' lectures into shorter recordings makes it easier to assimilate information, without needing to absorb it for lengthy periods, as in face-to-face lectures [Humphries, Clark, 2021; Hughes, Pan, Kendrach, 2017]. At the same time, video lectures provide no interaction between the lecturer and stu-

dents which is recognized as a drawback of distance learning in general [Jaggars, 2014; O'Neill, Sai, 2014]. Furthermore, teachers note that the material presented in video lectures is processed more superficially [Albon, Larson, Marchand, 2020]. In contrast, 'live' lectures can encourage students to engage with the material, thus deepening their knowledge.

The results of comparative research into the effectiveness of these presentation modes are inconsistent. In some papers, students who studied the subject through video lectures performed less well than those who attended face-to-face or 'live' lectures. For example, in the summative assessment test, students correctly answered 74.9% of the test following a 'live' lecture versus 68.6% following a video pre-recorded lecture format. [Ramlogan, Raman, Sweet, 2014]. However, other studies showed that video and face-to-face lectures were equally effective [Brockfeld, Müller, Laffolie, 2018; Solomon, 2004; Farahani et al., 2020]. Regarding the students' preferences, the majority opt for 'live' rather than video lectures, with one study showing a 21% difference gap in preferences favouring face-to-face lectures [Brockfeld, Müller, Laffolie, 2018].

The effectiveness of different learning modes can be influenced by the traditions and practices in a particular cultural context. Therefore, the research carried out in foreign universities needs to be validated with a sample of students from Russian medical universities.

The present paper uses the design of an experiment conducted by German researchers in 2014, prior to the large-scale transition to distance learning [Brockfeld, Müller, Laffolie, 2018]. A total of 205 students of medicine at the University of Göttingen were divided into two groups while preparing for examinations. The first group watched a face-to-face lecture, and the second group watched a video lecture, after which they switched places and then were tested. No significant differences in learning outcomes between the groups were found. Apart from replicating the experiment conducted by German researchers, this paper aims to evaluate the effectiveness of the combined lecture in comparison with video and face-to-face formats and its potential as an alternative mode of lecture delivery.

The combined lecture encompasses online and offline components, allowing students to get the best out of both lecture formats. This study included watching a video lecture along with the elements of discussion and consultation during the lecture [Retivyh, 2021].

Thus, the experiment aims to answer the following research questions:

- Which lecture format is more effective: face-to-face or video?
- Is a combined lecture more effective than a face-to-face or video lecture format?

1. Materials and Methods

1.1. Research Design

In order to collect data, an experiment was conducted during the spring semester of the academic year 2020/2021, involving second-year students of the 'Pharmacy' course at A.P. Nelyubin Institute of Pharmacy at Sechenov University. The learning material comprised three major topics: 'Agents affecting cholinergic innervation' (cholinomimetics); 'Agents inhibiting cholinergic innervation' (cholinoblockers) and 'Agents inhibiting adrenergic innervation' (adrenergic blockers). The module topics were of equal learning load. For the experiment, the lecture material of this module was presented to students in three different formats: face-to-face, online (video lectures), and combined. The video lectures were recorded by professors from the Department of Pharmacology at A.P. Nelyubin Institute of Pharmacy and posted on the unified educational portal of Sechenov University[1], based on the Moodle online learning and course management system. The combined format included a video lecture and a 'live' form, such as discussion and consultation of the material of the video lecture.

Out of 229 students, 180 signed a statement of informed consent to participate in the experiment. The final sample consisted of 151 students who participated in all stages of the study. Randomisation was carried out at the study streams: students in the first stream were placed in Experimental Group 1 (86 students), and students in the second stream were in Experimental Group 2 (65 students). The streams differed only in the order of face-to-face, video, and combined lecture delivery.

In the first stage of the study, the first lecture on the first topic of the course took place in a face-to-face format for students in Experimental Group 1 and in a video format for students in Experimental Group 2. In the second stage, the groups rotated, with students in Experimental Group 1 watching a video lecture on the second topic of the course, and students in Experimental Group 2 attending face-to-face. Finally, in the third stage, a combined lecture on the third theme of the course was delivered to both groups of students (Table 1).

Table 1. **Research Design**

	Stage 1 (cholinomimetics)	Stage 2 (cholinoblockers)	Stage 3 (adrenergic blockers)
Face-to-face	Group 1 (teacher A)	Group 2 (teacher B)	—
Video	Group 2 (teacher A)	Group 1 (teacher B)	—

[1] https://dl.sechenov.ru/

	Stage 1 (cholinomimetics)	Stage 2 (cholinoblockers)	Stage 3 (adrenergic blockers)
Combined	—	—	Group 1 (teacher C on video and teacher C face-to-face)
	—	—	Group 2 (teacher C on video and teacher C face-to-face)
Assessment of learning levels	Pre-test, post-test, self-assessment of learning	Pre-test, post-test, self-assessment of learning	Pre-test, post-test, self-assessment of learning

To check their level of knowledge, students completed online pre-test and post-test powered by the website www.socrative.com [Dakka, 2015; Awedh et al., 2014; Cerqueiro, Harrison, 2019], which offers the option of creating tests for students and checking their acquired knowledge under the direct supervision of a teacher. Each pre-test and post-test consisted of ten multiple-choice questions related to the topic (with one or more correct answers). They covered various domains of knowledge and competence from classification of medicines and mechanisms of action to indications for drug use and side effects. All test assignments were examined by the Department of Monitoring of Education Quality at Sechenov University. Simultaneously with the pre-test and post-test, the students rated their own level of knowledge on a 6-point Likert scale using an online questionnaire with five questions. In addition, at the end of the second stage of the study, students in both experimental groups rated their level of satisfaction with the face-to-face and video lectures according to several criteria: learning climate, suitable environment for concentration, usefulness and practicality in preparing for written and oral examination, clear structure, capacity to promote interest.

1.2. Data Analysis

To answer the question about the effectiveness of a face-to-face lecture versus a video lecture in learning the module, the analysis of variance (ANOVA, no covariates) and the analysis of covariance (ANCOVA, with covariates) were used. The analyses were carried out separately for the first and second stages of the experiment. The dependent variable was the post-test score, the independent variable was the format of the lecture (video or face-to-face); the covariates were the self-assessed level of knowledge on the course topic after the lecture and the academic performance in the spring semester of the 2019/2020 academic year. The post-test score for each topic in the lecture was calculated as the proportion of assignments

correctly solved. The level of self-assessment was taken as the average of five indicators of self-assessment of competence in several sections of the topic. The academic performance indicator was the grade point average for the spring semester of the 2019/2020 academic year.

To evaluate the effectiveness of a combined lecture versus face-to-face and video lectures, a repeated measures analysis of variance was used. The post-test scores and self-assessed knowledge level were measured for each student during the transition process from face-to-face to video and combined lectures. The independent variable was nominal, related to the experimental condition: the order in which students were exposed to various lecture formats. The dependent variables were the post-test score, the difference between the post-test and pre-test scores, the self-assessed knowledge level after the lecture, and the difference between the self-assessment levels after and before the lecture.

2. Results

2.1. Comparison of Face-to-Face and Video Lectures Based on Post-Test Results

The model without covariates (Table 2) and the model with covariates (Table 3) showed no statistically significant relationship between lecture format and post-test score.

Table 2. **Results of ANOVA (Without Covariates) for the First and Second Stages of the Study**

	The 1st stage of the study					The 2nd stage of the study				
	Sum of Squares	*df*	*F*	*p*	η^2	Sum of Squares	*df*	*F*	*p*	η^2
Lecture mode	64.52	1.00	0.22	0.64	< 0.01	264.08	1.00	0.85	0.36	< 0.01

Note. Homogeneity correction using the Brown–Forsythe test was performed.

Table 3. **Results of ANCOVA (With Covariates) for the First and Second Stages of the Study**

	Th1st stage of the study					The 2nd stage of the study				
	Sum of Squares	*df*	*F*	*p*	η^2	Sum of Squares	*df*	*F*	*p*	η^2
Lecture mode	3.13	1.00	0.01	0.92	< 0.01	117.30	1.00	0.41	0.52	< 0.01
Self-assessed knowledge level	2486.66	1.00	9.05	< 0.01	0.06	4332.66	1.00	15.24	< 0.01	0.09
Academic performance	690.26	1.00	2.51	0.12	0.02	68.81	1.00	0.24	0.62	< 0.01

Both in the first stage of the experiment, when the first experimental group attended the face-to-face lecture and the second group watched the video ($F = 0.22$, $p = 0.64$ for the model without

covariates; $F = 0.01$, $p = 0.92$ for the model with covariates), and in the second stage when the groups swapped places ($F = 0.85$, $p = 0.36$ for the model without covariates; $F = 0.41$, $p = 0.52$ for the model with covariates), the average post-test scores of both groups were almost identical. In the first stage of the experiment, students who had attended a face-to-face lecture correctly answered 71.6% of the post-test assignments, and those who had watched a video lecture correctly answered 70.3% (Figure 1). In the second stage, the corresponding values were 70.5 and 67.8% (Figure 2).

Figure 1. **Mean Post-Test Score and Standard Deviation for the First Stage of the Study**

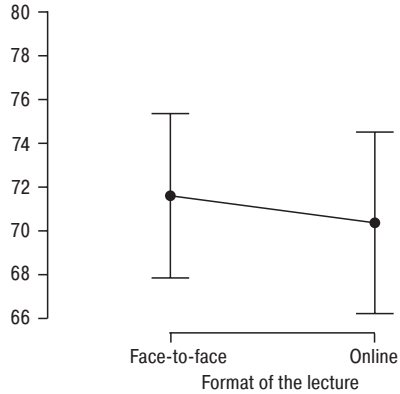
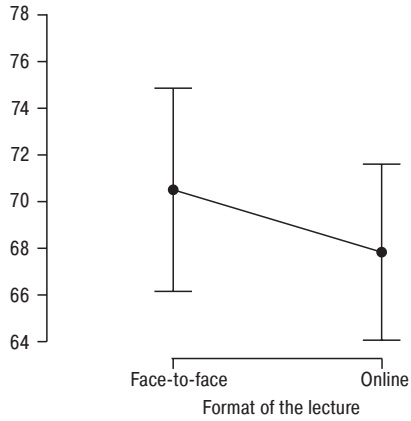


Figure 2. **Mean Post-Test Score and Standard Deviation for the Second Stage of the Study**



Post-test scores were significantly associated with self-assessment levels ($F = 9.05$, $p < 0.01$ for the first stage of the study; $F = 15.24$, $p < 0.01$ for the second stage). The higher the student's self-assessment level after attending a 'live' lecture or watching a video lecture, the higher their score for the post-test. This relationship is observed for both stages of the experiment.

2.2. Comparison of Combined Lecture With Face-to-Face and Video Lectures on the Results of the Post-Test and Self-Assessment of Knowledge

The results of the repeated measures ANOVA showed that the most effective format for presenting material to students was the combined lecture. In both experimental groups, 1 ($F = 7.41$, $p < 0.01$) and 2 ($F = 13.85$, $p < 0.01$), students who attended the combined lecture scored higher on the post-test than they did after the face-to-face or video lecture (Tables 4, 5).

Table 4. **Mean Post-Test Score and Its Standard Deviation for Face-to-Face, Video, and Combined Lectures**

	Mean	*SD*	*N*
Post-test score in Group 1			
Face-to-face	71.63	17.41	86
Video	67.79	17.58	86
Combined	77.67	15.77	86
Post-test score in Group 2			
Face-to-face	70.46	17.63	65
Video	70.31	16.67	65
Combined	83.23	14.48	65

Table 5. **Repeated Measures ANOVA Results for Post-Test Scores**

Experimental Group 1						Experimental Group 2					
Sum of Squares	*df*	Mean Square	*F*	*p*	η^2	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2
4270.54	1.95	2188.15	7.41	< 0.01	0.08	7151.81	1.96	3641.21	13.85	< 0.01	0.18

Note. The Greenhouse — Geisser sphericity correction was performed.

Statistically significant differences, related to the lecture format, were detected in the knowledge gain indicator, that is the difference in post-test and pre-test scores. Here, the proportions of the formats in the first and second experimental groups differ in terms of the knowledge gain indicator. Students in Group 1 had the greatest knowledge gains after the combined and face-to-face lectures, and the smallest gains after the video lecture ($F = 5.90$, $p < 0.01$) (Tables 6 and 7). A post hoc analysis (Holm correction) revealed statistically significant differences in knowledge gain after video lecture versus face-to-face and combined lectures: the differences were –8.02, $t = -2.74$, $p = 0.01$ between video lecture and face-to-face lecture and –9.30, $t = -3.17$, $p < 0.01$ between video lecture and combined lecture.

Students in Experimental Group 2 showed the greatest knowledge gains after the combined lecture, an average gain after the video lecture, and the smallest gain after the face-to-face lecture

(F = 19.26, p < 0.01) (Tables 5 and 6). A post hoc analysis (Holm correction) showed that the strongest difference in knowledge gain was between the combined lecture and the face-to-face lecture (this difference was –14.50, t = –6.12, p < 0.01). For the video lecture, the difference in knowledge gain with the combined lecture was smaller amounting to –5.11, with t = –2.15, p = 0.03.

Table 6. **Mean Value of the Difference in the Post- and Pre-Test Results, and Its Standard Deviation for Face-to-Face, Video, and Combined Lectures**

	Mean	*SD*	*N*
Difference in post-test and pre-test results in Group 1			
Face-to-face	30.71	18.20	86
Video	22.67	17.59	86
Combined	31.98	20.68	86
Difference in post-test and pre-test results in Group 2			
Face-to-face	17.54	19.12	65
Video	28.77	23.29	65
Combined	38.92	22.79	65

Table 7. **Results of the Repeated Measures ANOVA for the Difference in Post-Test and Pre-Test Scores**

Experimental Group 1						Experimental Group 2					
Sum of Squares	*df*	Mean Square	*F*	*p*	η^2	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2
16347.46	1.99	8216.39	19.26	< 0.01	0.11	4372.87	1.98	2206.75	5.90	< 0.01	0.07

Note. The Greenhouse — Geisser sphericity correction was performed.

The self-assessed knowledge level after the combined lecture was higher than after the face-to-face and video lectures, but only for students in Experimental Group 1 (F = 6.18, p < 0.01) (Tables 8 and 9).

Table 8. **Mean Self-Assessed Knowledge Level and Its Standard Deviation for Face-to-Face, Video, and Combined Lectures**

	Mean	*SD*	*N*
Self-assessed knowledge level in Group 1			
Face-to-face	3.37	0.64	86
Video	3.17	0.86	86
Combined	3.65	1.19	86
Self-assessed knowledge level in Group 2			
Face-to-face	3.27	0.61	65
Video	3.13	0.65	65
Combined	3.26	0.65	65

Table 9. **Results of the Repeated Measures ANOVA for the Self-Assessed Level of Knowledge**

Experimental Group 1						Experimental Group 2					
Sum of Squares	*df*	Mean Square	*F*	*p*	η^2	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2
10.07	1.89	5.32	6.18	< 0.01	0.07	0.78	1.94	0.40	0.89	0.41	0.01

Note. The Greenhouse — Geisser sphericity correction was performed.

There were no significant differences in the increase in self-assessed knowledge level after the face-to-face, video, and combined lectures in Experimental Group 2, whereas the sphericity test was violated for Group 1, so we cannot rely on the results of the analysis for this group (Tables 10 and 11).

Table 10. **Mean Value of the Increase in Self-Assessed Knowledge Level, and Its Standard Deviation for Face-to-Face, Video, and Combined Lectures**

	Mean	*SD*	*N*
Difference in post-test and pre-test results for knowledge self-assessment in Group 1			
Face-to-face	0.84	0.71	86
Video	0.89	1.01	86
Combined	1.47	1.56	86
Difference in post-test and pre-test results for knowledge self-assessment in Group 2			
Face-to-face	0.98	0.96	65
Video	0.91	0.81	65
Combined	1.20	1.08	65

Table 11. **Results of the Repeated Measures ANOVA for the Difference in Post-Test and Pre-Test Results of Knowledge Self-Assessment**

Experimental Group 2					
Sum of Squares	*df*	Mean Square	*F*	*p*	η^2
3.044	1.980	1.537	1.499	0.227	0.023

Note. The Greenhouse — Geisser sphericity correction was performed.

3. Discussion and Conclusions

In recent years, especially since the outbreak of the COVID-19 pandemic, higher education institutions around the world have been actively introducing digital technologies of distance learning, massive open online courses, and video lectures as well as developing e-learning educational portals. Their proliferation has given rise to discussions about the extent and scope in which digital education can replace face-to-face education, how effective it can be, and how

the two formats of learning could complement each other. A number of comparative studies have suggested that there is no difference in the effectiveness of different lecture formats, while others have found an advantage of face-to-face lectures over video lectures [Ramlogan, Raman, Sweet, 2014; Brockfeld, Müller, Laffolie, 2018; Solomon et al., 2004; Farahani et al., 2020; Golikova et al., 2020]. The present study compared the effectiveness of face-to-face, video, and combined lecture formats in teaching Pharmacology course for students at A.P. Nelyubin Institute of Pharmacy at Sechenov University. Previously, this type of research on higher pharmaceutical education has not been conducted in Russia.

The study showed that video lectures are just as effective as face-to-face lectures. Students who watched a video lecture and those who attended a face-to-face lecture received approximately the same post-test scores. The study result is consistent with previous research concluding that the lecture format has a neutral effect on student knowledge levels [Ramlogan, Raman, Sweet, 2014; Brockfeld, Müller, Laffolie, 2018; Solomon et al., 2004] and that there is no significant difference in distance and online learning formats [Bowen et al., 2014; Collins, Pascarella, 2003].

At the same time, the combined lecture proved to be more effective than both face-to-face and video lectures. Upon completion of the combined lecture, students scored significantly higher on the final test. In addition, they showed a greater increase in knowledge compared to the stages of the experiment in which they listened to a video lecture and attended a face-to-face lecture.

These findings suggest that there are good reasons to combine offline and online formats in the delivery of lectures. Online presentation of the study material enables students to review it on their own. Face-to-face discussions and consultations on the class topic allow students to interact directly with the course tutor, thus offsetting one of the main limitations of the distance learning format [Jaggars, 2014; O'Neill, Sai, 2014]. In this way, the combined lecture holds the best of each format and provides opportunities for enhancing the educational outcomes of the students. Maintaining face-to-face interaction with the teacher is particularly important for medical university students specialising in Pharmacy, General Medicine, Dentistry, and Paediatrics. Such interaction is essential for developing practice-oriented competencies [Taylor, Miflin, 2008], which are critical for the formation of thoughtful specialists and their integration into the community of practitioners and pharmacists. It also implies that lecturers can devote the extra time freed up from regular lecturing to practical and research work with students.

Thus, face-to-face lectures and video lectures are almost equally effective in teaching Pharmacology course. As such, face-to-face lectures can be replaced by video lectures without the risk of compromising the knowledge level of the students. However, the com-

plete replacement of face-to-face training by online learning may not seem appropriate. The most effective in terms of learning outcomes was a combined lecture, consisting of a video lecture with the elements of 'live' discussion and consultation.

Research on a broad sample of learning modules will be needed to develop criteria for selecting the best forms of teaching in each specific discipline of pharmaceutical education.

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