

# Electronic Distance Learning of Pre-clinical Studies During the COVID-19 Pandemic: A Preliminary Study of Medical Student Responses and Potential Future Impact

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**ABSTRACT** **Background:** Social distancing, implemented to decrease the spread of coronavirus disease-2019 (COVID-19), forced major changes in medical practices, including an abrupt transition from face-to-face to remote patient care. Pre-clinical medical studies were concomitantly switched to electronic distance learning.

**Objectives:** To explore potential implications of COVID-19 on future pre-clinical medical studies.

**Methods:** We examined responses of pre-clinical medical students to the remote electronic learning in terms of quality of and satisfaction with teaching and technical support, attendance to classes, and the desire to continue electronic learning in the post-epidemic era. A survey of responses from first-year students at the Adelson School of Medicine was conducted. To optimize the reliability of the survey, a single research assistant conducted telephone interviews with each student, using a structured questionnaire concerning aspects of participation and satisfaction with teaching and with technical components of the remote electronic learning.

**Results:** With 100% response rate, the students reported high satisfaction with the electronic learning regarding its quality, online interactions, instructions given, technical assistance, and availability of recording for future studies. Most of the students (68.6%) noted a preference to continue > 90% of the learning online in the post-outbreak era. A high level of overall satisfaction and a low rate of technical problems during electronic learning were significantly correlated with the desire to continue online learning ( $P < 0.01$ ).

**Conclusions:** The high satisfaction and the positive experience with the electronic distance learning imposed by the COVID-19 epidemic implied a successful transition and might induce future changes in pre-clinical medical studies.

*IMAJ* 2020; 22: 489–493

**KEY WORDS:** coronavirus disease-2019 (COVID-19), medical education, medical students, electronic learning

The coronavirus disease-2019 (COVID-19) is caused by an infection with the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which crossed the species barrier, leading to significant morbidity and mortality worldwide [1-3], including in Israel [4,5]. Since a vaccine against the infection is not yet available, personal hygiene measures, quarantine, and social distancing have been implemented in an attempt to decrease the spread of the epidemic [3,6]. These preventive measures forced major changes in our practice of medicine in hospitals and in the community [7,8]. Transition from the traditional face-to-face medical care to remote medicine has occurred abruptly, using video conferencing, audio conferencing, tele-health services, and other digital methods such as smart mobile phone-based applications (e.g., WhatsApp Messenger, WhatsApp, Inc.) and advanced technological infrastructures for remote examination and diagnosis (e.g., Tyto Care home kits, TytoCare Ltd.) [9,10].

In addition to its effects on patient care, the COVID-19 outbreak has had a major impact on pre-clinical and clinical medical education [11]. Quarantine and social distancing precluded students from gathering in lecture halls or even in small-group rooms. Pre-clinical medical studies are mostly based on frontal lectures, complemented by exercises, laboratory experience, and anatomic dissections. These had to be disrupted promptly with a quick transition of the entire pre-clinical curriculum to a mode of distance learning, which is defined as a, “form of learning 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” [12]. It is important to explore whether the actual revolution in pre-clinical studies that has been imposed on medical educators and students may influence the future of pre-clinical medical education.

The aims of the present study were to examine the responses of the medical students to the remote electronic learning methods and tools in terms of satisfaction with perceived quality of teaching, technical assistance, and training, as well as their relationship to attendance and active participation. In addition, we explored the potential implications of COVID-19 on the structure of pre-clinical medical studies in the future. To this end,

we examined the extent that the students expressed a desire to continue with electronic learning in the post-epidemic era.

## METHODS

### STUDY SETTING

The academic year at the Adelson School of Medicine at Ariel University started on 27 October 2019. During the first semester, formal lectures constituted approximately 70% of the curriculum and were complemented by small-group exercises, small-group interactive teaching and exercising of communication skills in our simulation center, and anatomic dissections. The opening day of the second semester was scheduled for 12 March 2020. However, due to the measures of quarantine and social distancing imposed by the COVID-19 outbreak, the opening was postponed. Intensive instructions/training of the lecturers and students on electronic distance learning were conducted, and the semester opened on 15 March 2020 with online distance learning.

### ELECTRONIC TEACHING DURING THE COVID-19 EPIDEMIC

Teaching was switched to an online electronic format using mainly the Zoom Video Communications platform [13]. The platform enables the adoption of prepared presentations, mainly using Microsoft PowerPoint software (Microsoft Corp, Richmond, CA, USA). The learning options included online interactive lecturer-student and student-student communications via computer audio and video, written chats, polls, electronic division rooms, and recordings of all video, audio, and chat correspondence. Unlimited future viewing of sessions was possible. All formal curriculum—including lectures of the courses in anatomy, embryology, neuroanatomy, pathology, physiology, medical education, ethics and law, clinical epidemiology, clinical microbiology, and clinical immunology—were delivered by electronic distance learning throughout the semester. On 15 May, eight weeks after the semester opening, teaching in groups of 15 students in the university was allowed by the Ministry of Health and the Committee for Higher Education, with adherence to face masks and personal hygiene measures. From that day, complementary teaching of concentrated small-group anatomic dissections was performed.

### STUDENT SURVEYS

A survey of the responses of the first-year students to the remote electronic learning was conducted toward the end of the second semester. To increase the reliability of the survey, a single research assistant conducted telephone interviews with each of the 70 students, using a structured questionnaire. The response rate was 100%. The research assistant recorded student responses anonymously using Microsoft Excel (Version 97–2003) software (Microsoft Corp, Richmond, CA, USA). The study was

approved by the ethics committee at Ariel University.

To prevent any possible identification of the students, personal questions (gender, family status, number of children) were not asked. The study questionnaire contained 12 questions, related to the following five categories:

- **Satisfaction with electronic learning:** This category included six questions concerning overall satisfaction; including satisfaction with the quality of teaching, the technical instruction and assistance given prior to and during the semester, interactions with the lecturers, and the availability of recorded lectures. The responses to each question were rated on a 5-point Likert-type scale ranging from 1 (very low) to 5 (very high).
- **Technical difficulties:** One question rated the frequency of technical difficulties on a 5-point Likert-type scale ranging from 1 (never) to 5 (in all lectures).
- **Attendance and active participation in online lectures:** Three questions rated the percent of online lectures in which the student participated synchronically, interacted actively with the lecturers by asking/answering questions, and viewed the recorded presentations on his/her free time. For each question, five possible responses were offered: 0–29%, 30–49%, 50–69%, 70–90%, and > 90%.
- **Expected attendance in planned frontal lectures:** One question rated the percent of frontal lectures the student might have attended had the pandemic not occurred during the second semester. Five possible responses were offered: 0–29%, 30–49%, 50–69%, 70–90%, and > 90%.
- **Desire for distance learning in the future:** One question rated the student's desire to continue distance electronic learning in the post-epidemic era, when no social distancing is required. Five possible responses were offered: > 90%, 50–90%, 10–49%, < 10%, and 0.

### STATISTICAL ANALYSIS

Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 24 (SPSS, IBM Corp, Armonk, NY, USA). To identify the various facets of satisfaction and technical factors associated with the extent of the student desire to continue electronic learning in the future, we assessed the bivariate associations (Spearman's Rho) between the responses to 'desire to continue' and responses to the six questions on student satisfaction, as well as the questions on technical problems/malfunctions. Notably, the responses to the question on the desire to continue online learning were not normally distributed; 68.6% of the students preferring that most future lectures would be delivered online [Figure 1]. Therefore, we divided the sample into two groups representing: 1 = a high desire for future online learning (all those choosing that > 90% of classes be continued with electronic learning, n=48); and 2 = a moderate or low desire (all students checking any of the other responses, n=22). A series of Mann-Whitney U tests were performed to compare responses to the other questions between the two groups.

**RESULTS**

**STUDENT SATISFACTION WITH THE ELECTRONIC DISTANCE LEARNING**

The students reported a high level of satisfaction with the electronic learning [Table 1]. The vast majority (88.6%) rated their overall satisfaction as high or very high, and none graded it as low or very low. The quality of teaching was graded as high/very high by 85.7%, with no grading as very low. The instructions/training and the technical assistance given were also graded high/very high by 87.2% and 91.5% of the students, respectively. Despite the mode of distance learning, the quality of online interactions with the lecturers was perceived as high/very high by 65.7%. The availability of recording was generally graded as high or very high (51.4%), and as low and very low by only 17.1% and 0%, respectively [Table 1]. As the survey did not include personal questions, we could not study the influence of gender or family status on satisfaction or on other parameters.

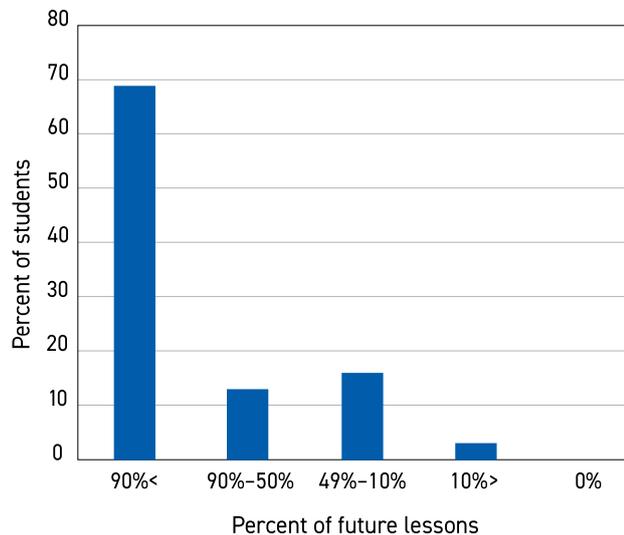
**TECHNICAL DIFFICULTIES**

Technical difficulties were uncommon: 61.5% of the students encountered difficulties in less than half of the lectures, and only 8.6% had frequent difficulties [details are shown in Table 2].

**STUDENT PARTICIPATION IN ELECTRONIC DISTANCE LEARNING**

The online electronic lectures were well-attended in real-time: the mean attendance rate was 68.0% of the lectures, with 67.1% attending > 70% of the lectures and approximately one-quarter

**Figure 1.** The percent of lectures that the students would prefer to have as electronic distance learning after the COVID-19 period, when no social distancing is required (data are presented as the percent of students)



attending < 50% of the lectures [Table 2]. The attendance rate at the electronic lectures was similar to the 74% attendance that the students stated as their expected attendance in the initially planned formal lectures. However, active participation by asking/answering questions was much lower: only 17.1% were active in > 70% of the lectures, while the majority (64.3%) were active in < 30% of the online lectures. The mean active participation was 26.0%.

**Table 1.** Student satisfaction with the electronic learning

Facet of satisfaction	Very high n (%)	High n (%)	Moderate n (%)	Low n (%)	Very low n (%)
Overall satisfaction	23 (32.9%)	39 (55.7%)	8 (11.4%)	0	0
Quality of teaching	17 (24.3%)	43 (61.4%)	9 (12.9%)	1 (1.4%)	0
Instructions/training given	51 (72.9%)	10 (14.3%)	7 (10.0%)	2 (2.9%)	0
Technical assistance	44 (62.9%)	20 (28.6%)	5 (7.1%)	1 (1.4%)	0
Interaction with lecturers	21 (30.0%)	25 (35.7%)	18 (26.0%)	4 (5.7%)	2 (2.9%)
Availability of recording	15 (21.4%)	21 (30.0%)	22 (31.5%)	12 (17.1%)	0

**Table 2.** Student participation in electronic learning

Type of participation	> 90% of lectures n (%)	70-90% of lectures n (%)	50-69% of lectures n (%)	30-49% of lectures n (%)	< 30% of lectures n (%)
Online real-time participation	28 (40.0%)	19 (27.1%)	5 (7.1%)	7 (10.0%)	11 (15.7%)
Active participation*	4 (5.7%)	8 (11.4%)	6 (8.6%)	7 (10.0%)	45 (64.3%)
Faced technical difficulties	0	6 (5.6%)	21 (30.0%)	29 (41.4%)	14 (20.1%)
Viewed recording	8 (11.4%)	7 (10.0%)	17 (24.3%)	12 (17.1%)	26 (37.1%)

\*Asking/answering questions

Among those who attended the lectures synchronically, the mean rate of viewing the recordings for further learning was 41.0%; only 45.7% of the students viewed > 50% of the recorded lectures [Table 2].

#### STUDENT DESIRE FOR FUTURE ELECTRONIC LEARNING

The majority of the students preferred to continue most of the learning online even after cessation of the need for social distancing [Figure 1]. More than two-thirds (68.6%) expressed a desire to have > 90% of the future lectures presented electronically. Only 2.9% responded that they would like to have < 10% of the lectures as electronic and none preferred to have the previous schedule of only formal in-class lectures.

#### FACTORS ASSOCIATED WITH THE DESIRE FOR FUTURE ELECTRONIC LEARNING

Two factors included in the questionnaire were found to be strongly associated with the choice to continue online learning in the future: a high score of overall satisfaction with the electronic learning ( $r_s = 0.54$ ,  $P < 0.01$ ) and low rate of technical difficulties/malfunctions during the lectures (negative association;  $r_s = -0.37$ ,  $P < 0.01$ ). Similarly, the results of Mann-Whitney U tests showed that students who preferred to continue mostly online had significantly higher levels of overall satisfaction (mean  $4.44 \pm 0.54$ ) than the other students (mean  $3.73 \pm 0.55$ ,  $Z = 4.25$ ,  $P < 0.001$ ). Furthermore, students who preferred to continue mostly online also experienced technical problems less often (mean  $2.04 \pm 0.80$ ) than the other students (mean  $2.77 \pm 0.87$ ,  $Z = -3.05$ ,  $P < 0.002$ ). Thus, the higher the level of overall satisfaction and the lower the number of technical problems, the stronger was the expressed wish to continue online learning in the post-outbreak era.

#### DISCUSSION

The present study presents new indirect outcomes of the COVID-19 pandemic, namely, its profound influence on the delivery of pre-clinical medical studies and the perceptions of medical students to the switch to online learning. A main finding is the high level of student satisfaction with the quality of electronic learning and with the ability to communicate with the lecturers in this type of educational delivery. The overall satisfaction was very high as well. This finding is probably related in part to the convenient accessibility to the electronic lectures from diverse geographical locations, including residences, which has been shown to be important to today's health professional students [11,14,15]. The students in the current survey stated that their attendance online in the electronic lectures was similar to the attendance they had expected in frontal lectures. However, the availability of the recorded lectures for future viewing, especially during examination times, with flexibility of time and location, was shown to be very relevant to the students [14,15].

We also found a very high level of student satisfaction with the instruction, training, and technical assistance given. Due to the latter, technical difficulties during the electronic learning were uncommon. This achievement is impressive, since the situation was very challenging, as the new COVID-19 outbreak imposed an immediate need for change with only a few days available for preparations. The explanation probably lies with the advanced electronic platforms for remote communications that have been already available, as well as the preparedness of medical students to such a change. Previous studies, predating the COVID-19 pandemic, have shown positive attitudes of most students in the medical field toward electronic learning: 79% desired to include electronic courses in the curriculum and 76% had already used web-based digital learning resources that have been developed by other institutions [14,16,17].

Although abruptly imposed by the COVID-19 outbreak, our survey shows that the vast majority of the students indicated a preference for a high proportion of the future pre-clerkship teaching to be implemented by electronic distance learning. Furthermore, none of the students elected to stop electronic learning after the current outbreak ends. The response is in concert with previous observations, unrelated to the current outbreak, on the positive attitude of students regarding electronic learning [11,14]. This attitude may be particularly relevant to "Generation Z" (born between 1965 and 1980) or "Millennials (born between 1980 and 2000) who tend to be technology-oriented and very practical [14,18,19]. The preference for electronic learning in the future was, however, correlated in the present study with the high satisfaction level and low-rate of technical difficulties associated with the distance learning during the COVID-19 outbreak.

It seems that the change imposed by the coronavirus outbreak actually accelerated an ongoing process lasting for more than a decade [11,17]. Most medical schools have been engaged in reforming medical education by reducing frontal lectures and increasing self-directed and asynchronous electronic learning ("anytime/anywhere"), while implementing technologies and simulations to partially replace anatomy dissections and laboratory experience [11,14,20]. Encouraging findings have shown that electronic learning can facilitate student performance [11,20], physician knowledge [21,22], and diagnostic confidence [23]. It seems that the implementation of technology in medical education, if done wisely, can in some respects improve learning outcomes of students, with concomitant reduction of costs [11,18]. In many ways, this is a cornerstone in shaping medical schools of the future [11,24,25].

#### THE FUTURE

What does the future hold? Based on our findings, the prompt major change in pre-clinical medical studies imposed by the COVID-19 epidemic might have a lasting effect on future medical education and actually facilitate ongoing trends [11].

We, medical educators, need to carefully analyze the consequences of the current changes in medical education and elucidate their benefits and disadvantages to adopt electronic teaching, with the appropriate amount and type. For this end, preparations and staff education are needed, as we may be confronted with additional unprecedented events in which quarantines and social distancing may be required. The effects of the COVID-19 pandemic are obviously beyond the scope of medical education, with the vast influences on diverse aspects of patient care [7-10], as have occurred in previous outbreaks and disasters [11].

### LIMITATIONS

Our study has several imitations. First, we performed a survey of student perceptions, not an objective evaluation of the quality of the imposed electronic learning. Our intention was to conduct a short-time preliminary assessment that is crucial for near-future planning. Quality outcome evaluation and the impact on knowledge could not be determined in this short period and are beyond the scope of the present study. These issues should be investigated in further complementary investigations. The study group was relatively small but seemed adequate for a preliminary report. The strengths include the method for collecting the data (interviews by a single research assistant rather than by completing a self-reporting questionnaire), which ensured 100% compliance and minimized missing values, and a real-time evaluation that reduced memory biases.

### CONCLUSIONS

The fast and successful switch to remote online learning enabled the medical school to overcome the severe and long-lasting disruption caused by the need for social distancing. The present study documents high student satisfaction with the quality of electronic distance learning during the COVID-19 epidemic, including the instructions/training given, technical assistance, and low rates of technical malfunctions, which is translated to a very high desire to continue, to some extent, electronic learning after the outbreak ends. The changes in pre-clinical medical studies imposed by the outbreak might affect future medical education.

### ACKNOWLEDGEMENTS

We thank the medical students at Adelson School of Medicine for their participation in the survey and for their thoughtful response to the interviews and Idit Kleinerman for conducting the interviews

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