

# Medical, Dental, and Nursing Students' Experience with Virtual Practical Sessions: A Cross-Sectional Study in a Developing Country

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**Background:** The COVID-19 pandemic has disrupted the scope of healthcare education and shifted the teaching methods from on-campus to virtual. The impact of such a shift has rarely been investigated, and limited evidence exists about students' experience in terms of effort made and time spent, especially for laboratory sessions. Assessing students' experiences will provide paramount evidence to fine-tune laboratory virtual learning sessions.

**Objective:** To assess students' experience of virtual (online) laboratory sessions versus on-campus laboratory sessions, including preference, time spent, the effort made, ability to remember instructions, and preference for future teaching.

**Methods:** A cross-sectional study was utilized. A Google Forms questionnaire was prepared and sent to medicine, dentistry, and nursing school students registered at Jordan University of Science and Technology (JUST) during the 2019/2020 academic year. Self-reported preference, time spent, efforts made, ability to remember instructions and preference for future teaching were assessed for virtual versus on-campus anatomy, pathology, microbiology, histology, and physiology laboratory sessions.

**Results:** A total of 455 students participated in this questionnaire. More students in histology (55.2%), pathology (57.4%), and microbiology (55.3%) laboratories, but not anatomy (39.6%) physiology (443.95), reported preferring virtual sessions over on-campus sessions. More students from histology (35.6%) and microbiology (37.0%) reported spending less effort than on-campus sessions. More than half of the participants agreed that virtual laboratory sessions consumed less time than on-campus sessions. Participants reported that they cannot remember the instruction given during virtual teaching compared to on-campus teaching. Differences in students' experiences were detected by gender, major, and year of study.

**Conclusion:** The COVID-19 pandemic has the potential to change the future of healthcare education, and preparation for future crises is paramount. Effort made, time spent, ability to remember, and preference for virtual education should be considered in terms of gender, major of study, and year. These differences should also be reflected in the planning of virtual sessions for effective implementation.

**Keywords:** medical students, COVID-19, laboratory sessions, virtual environment, on-campus sessions, Jordan

## Introduction

Significant disease outbreaks related to severe acute respiratory syndrome coronaviruses (SARS) have been reported in the Middle East and East Asia over the last two decades. Coronavirus disease 2019 (COVID-19) later witnessed a global spread, resulting in a worldwide pandemic,<sup>1</sup> with evidence of life-threatening manifestations.<sup>2</sup>

To flatten the COVID-19 epidemiologic curve and achieve disease containment, countries, including Jordan, adopted non-pharmaceutical public health intervention measures, including nationwide curfews and restricting non-essential activities.<sup>3,4</sup> As a response, universities have turned to pure online education and have partially or completely closed their campuses to limit the spread of the SARS-CoV-2 virus. This rapid transition has severely disrupted the teaching process.<sup>5</sup> Educational institutions have encountered numerous obstacles during this drastic transition in teaching medical students.<sup>6</sup> In addition, major concerns, such as possible technical problems, limited internet access, the inability of laboratories to instruct clinical skills, and concerns about academic performance, have limited the credibility of remote electronic exams during the transition from on-campus laboratory sessions to remote online (virtual) laboratory sessions.<sup>7-9</sup>

Several factors were found to influence students' preference for virtual learning. A recent study at the University of Nevada explored several factors. First, learning pace, technology skills, work status, and previous online courses significantly influenced students' preferences and experiences.<sup>10</sup> Instructor training, student training, and structured schedules were also found to influence the success of virtual learning.<sup>11</sup> Among medical students in the United Kingdom, employing online teaching platforms to allow students to digest knowledge on their own time and then constructively discuss it with their peers effectively achieved learning outcomes.<sup>12</sup> Another recent case-control study among physiotherapy students in Italy reported a preferable outcome of online teaching compared to face-to-face delivery of the same course.<sup>13</sup> While these studies investigated students' preferences and experience with virtual learning in developed countries, little evidence has been generated from developing countries. This is a critical gap in evidence as healthcare educational institutions in developing and developed countries vary significantly in terms of available resources, infrastructure, and healthcare priorities. Limited resources and infrastructure (including internet access and utilization and virtual environment), more focus on basic skills, and reliance on classical instructional methods have been reported from developing countries.<sup>14</sup> To bridge this research gap and to explore students' experience with virtual laboratory sessions, the present study aimed to assess medical, dental, and nursing students' preferences and experiences related to virtual education compared to on-campus education.

## Methods

### Study Settings

Healthcare education at Jordan University of Science and Technology (JUST) encompasses a significant portion of laboratory services provided to medical, nursing, and dental students. These are provided between years one and four as part of stand-alone sessions or systems and modules. The medical school at JUST houses all these laboratories and is responsible for students' learning within practical sessions. The first semester of the academic year of 2019/2021 included on-campus practical sessions. This has shifted to online teaching/sessions as of the second semester, given the COVID-19 pandemic.

### Study Design and Tools

A cross-sectional study design was utilized. A preliminary questionnaire was created and reviewed by three faculty members at the School of Medicine at JUST. The questionnaire was further edited after initial review by a sample of medical, dentistry, and nursing students (N=10).

The questionnaire was distributed online via the Google Forms link and shared with students through the e-learning platform. After three and six days, a follow-up reminder was sent. The questionnaire was distributed after the second semester of the 2019/2020 academic year. The survey included 16 questions that collected students' demographics (academic major and gender), and the major part aimed to assess the students' experience of virtual (online) laboratory sessions versus on-campus laboratory sessions, including preference, time and effort spent, ability to remember instruction and preference for future teaching.

### Participants

Eligible students were those enrolled in JUST's medical, dental, and nursing specialties. An email was sent to students registered in virtual laboratory classes during the second semester of the academic year 2019/2020.

## IRB Approval

Approval for the study was obtained from the institutional review board (IRB) of JUST (IRB number 13/134/2020). On the first page of the online questionnaire, participants were informed about the study's aim, objective, and right to withdraw at any point. Also, they were assured that all information would be confidential and used for research purposes only. Participation was voluntary.

## Statistical methods

Data was extracted into an Excel sheet and then into SPSS version 26. Data were reported in numbers and percentages as appropriate. The chi-square test was used for statistical comparisons. The alpha level was set at 0.05 for statistical significance.

## Results

### Characteristics of Study Participants

A total of 455 students from the faculty of medicine, dentistry, and nursing at Jordan University of Science and Technology agreed to participate in the survey. About half (50.1%,  $n=228$ ) of the participants were females, 48.6% ( $n=221$ ) were from the first-year level, while the other second, third-, and fourth-year levels were 30.8% ( $n=140$ ), 19.3% ( $n=88$ ), and 1.3%, respectively. Five laboratories were taken during the Spring semester of the 2019/2020 academic year, including anatomy, histology, pathology, microbiology, and physiology. The majority of students were from the faculty of medicine (83.7%,  $n=381$ ), while the faculty of dentistry and nursing were 16.3% ( $n=74$ ). Physiology was the major laboratory taken, with 455 students, while participants enrolled in anatomy, histology, pathology, and microbiology were 448, 436, 362, and 362 students.

### Participants' Experience with Virtual Sessions

Participants' experience in virtual sessions is presented in [Table 1](#). Virtual laboratory sessions for histology (55.2%,  $n=237$ ), pathology (57.4%,  $n=198$ ), and microbiology (55.3%,  $n=194$ ) were preferred over on-campus sessions (P-value  $<0.05$  for all comparisons). In contrast, anatomy (60.4%,  $n=265$ ) and physiology (56.2%,  $n=172$ ) on-campus sessions were preferred over virtual sessions (P-value  $<0.05$  for both comparisons). In all laboratories investigated, students reported that virtual laboratory session consumes less time than on-campus sessions, with 56.7% ( $n=244$ ) for anatomy, 58.9% ( $n=246$ ) for histology, 54.1% ( $n=192$ ) for pathology, 56.2% ( $n=200$ ) for microbiology, and 56.5% ( $n=174$ ) for physiology ([Table 1](#)).

Students reported spending less effort on virtual teaching than on-campus teaching in histology (35.6%,  $n=155$ ) and microbiology (37%,  $n=134$ ) laboratories. Similar measures for virtual and on-campus teaching methods were reported for pathology (38.7%,  $n=140$ ). However, students reported spending more effort on virtual teaching compared to on-campus teaching in anatomy (44.2%,  $n=198$ ) and physiology (25.7%,  $n=117$ ) laboratories ([Table 1](#)).

The ability to remember instructions during virtual laboratory sessions was inferior to on-campus laboratory sessions in all laboratories as 40.2% ( $n=159$ ) in the anatomy laboratory, 46.4% ( $n=181$ ) in the histology laboratory, 48.9% ( $n=153$ ) in the pathology laboratory, 47.8% ( $n=150$ ) in the microbiology, and 44.7% ( $n=122$ ) in the physiology reported remembering instructions better during virtual laboratory sessions ([Table 1](#)).

The majority of students in histology, pathology, and microbiology laboratories reported preferring future virtual sessions, with 222 students (59.8%), 195 students (52.56%), and 184 students (49.6%), respectively. However, students in anatomy and physiology laboratories reported not preferring virtual future sessions, with 225 students (60.65%) and 149 students (40.16%), respectively ([Table 1](#)).

### Differences by Gender, Major, and Year

As shown in [Table 2](#), significant differences in effort made and ability to remember instructions were detected by gender in various laboratories taken. In comparison to on-campus sessions, 41.1%, 41.8%, 44.6%, and 38.4% of males put in "less effort" in virtual histology, pathology, microbiology, and physiology laboratory sessions, respectively, while 42.2%,

**Table 1** Distribution of Study Participants by Laboratory and Virtual Preference, Time Spent, Effort Made, Ability to Remember Instructions, and Preference for Considering Virtual Laboratory in the Future

	Laboratory									
	Anatomy		Histology		Pathology		Microbiology		Physiology	
	n	%	n	%	n	%	n	%	n	%
Preference for virtual laboratory over on-campus laboratory										
No	265	60.40%	192	44.80%	147	42.60%	157	44.70%	172	56.20%
Yes	174	39.60%	237	55.20%	198	57.40%	194	55.30%	134	43.80%
Time spent on virtual laboratory compared to on-campus laboratory										
Less	244	56.70%	246	58.90%	192	54.10%	200	56.20%	174	56.50%
More	92	21.40%	70	16.70%	66	18.60%	62	17.40%	58	18.80%
Similar	94	21.90%	102	24.40%	97	27.30%	94	26.40%	76	24.70%
Effort made on virtual laboratory compared to on-campus laboratory										
Less	131	29.20%	155	35.60%	123	34.00%	134	37.00%	102	22.40%
More	198	44.20%	129	29.60%	99	27.30%	105	29.00%	117	25.70%
Similar	119	26.60%	152	34.90%	140	38.70%	123	34.00%	95	20.90%
Students' ability to remember instruction better in virtual laboratory										
No	237	59.80%	209	53.60%	160	51.10%	164	52.20%	151	55.30%
Yes	159	40.20%	181	46.40%	153	48.90%	150	47.80%	122	44.70%
Preference for considering future virtual laboratory										
No	272	60.60%	174	40.00%	170	47.00%	181	50.00%	227	50.00%
Yes	163	36.40%	261	60.00%	192	53.00%	181	50.00%	228	50.00%

48.0%, 39.7%, and 38.5% of females put in “similar effort” in virtual histology, pathology, microbiology, and physiology laboratory sessions, respectively (p-value <0.05 for all comparisons). Also, 45.2% and 52.6% of males were able to remember instructions better in anatomy and histology virtual sessions, respectively, whereas 35.5% and 40.5% of females were able to remember instructions better in anatomy, and histology virtual sessions, respectively (p-value <0.05).

Students were divided into two groups; the first was those in medicine college, and the second was those in dentistry and nursing college. A statistical significance (p-value <0.05) was seen in preference for virtual laboratory, time spent, and ability to remember in different laboratories. Medicine college students preferred virtual sessions in pathology and microbiology laboratories (59.6% and 57.7%, respectively) compared to dentistry, and nursing college students (38.5% and 38.1%, respectively). Meanwhile, 59.8%, 60.3%, 56.2%, and 59.2% of medicine college students spend less time with anatomy, histology, pathology, and physiology virtual laboratory sessions, respectively, in contrast to 40.0%, 48.2%, 39.5%, and 40.8% of dentistry, and nursing college students spend less time with anatomy, histology, pathology, and physiology virtual laboratory sessions, respectively.

As illustrated in Table 2, significant differences by the increase of the year of study were detected for preference of virtual laboratory over on-campus laboratory in histology, pathology, microbiology, and physiology, as well as for effort made in anatomy, pathology, microbiology, and physiology. Students were able to remember the instructions better for the virtual laboratory in all laboratories taken (anatomy, histology, pathology, microbiology, and physiology).

**Table 2** Distribution of Study Participants by Preference, Time Spent, Efforts Made, and Ability to Remember and by Gender, Study Major, and Year

		Gender					Major					Year of Study								
		Female		Male		P-value	Dentistry, Nursing		Medicine		P-value	1		2		3		4		P-value
		No.	%	No.	%		No.	%	No.	%		No.	%	No.	%	No.	%	No.	%	
Preference for anatomy virtual laboratory over on-campus laboratory	No Yes	141 80	63.8% 36.2%	125 94	57.1% 42.9%	0.149	36 31	53.7% 46.3%	230 143	61.7% 38.3%	0.222	142 74	65.7% 34.3%	78 56	58.2% 41.8%	40 43	48.2% 51.8%	6 1	85.7% 14.3%	0.019
Preference for histology virtual laboratory over on-campus laboratory	No Yes	94 121	43.7% 56.3%	98 117	45.6% 54.4%	0.926	30 26	53.6% 46.4%	162 212	43.3% 56.7%	0.150	108 103	51.2% 48.8%	55 77	41.7% 58.3%	26 54	32.5% 67.5%	3 4	42.9% 57.1%	0.031
Preference for pathology virtual laboratory over on-campus laboratory	No Yes	78 94	45.3% 54.7%	70 104	40.2% 59.8%	0.336	24 15	61.5% 38.5%	124 183	40.4% 59.6%	0.012	81 45	64.3% 35.7%	47 83	36.2% 63.8%	17 66	20.5% 79.5%	3 4	42.9% 57.1%	<0.001
Preference for microbiology virtual laboratory over on-campus laboratory	No Yes	81 94	46.3% 53.7%	76 101	42.9% 57.1%	0.528	26 16	61.9% 38.1%	131 179	42.3% 57.7%	0.016	84 45	65.1% 34.9%	54 80	40.3% 59.7%	17 65	20.7% 79.3%	2 5	28.6% 71.4%	<0.001
Preference for physiology virtual laboratory over on-campus laboratory	No Yes	91 65	58.3% 41.7%	82 69	54.3% 45.7%	0.477	27 18	60.0% 40.0%	146 116	55.7% 44.3%	0.593	74 39	65.5% 34.5%	63 53	54.3% 45.7%	29 42	40.8% 59.2%	7 0	100.0% 0.0%	<0.001
Time spent on anatomy virtual laboratory compared to on-campus laboratory	Less Similar More	120 47 49	55.6% 21.8% 22.7%	124 47 44	57.7% 21.9% 20.5%	0.847	28 17 25	40.0% 24.3% 35.7%	216 77 68	59.8% 21.3% 18.8%	0.002	109 48 55	51.4% 22.6% 25.9%	84 23 24	64.1% 17.6% 18.3%	46 23 13	56.1% 28.0% 15.9%	5 0 1	83.3% 0.0% 16.7%	0.094

(Continued)

**Table 2** (Continued).

		Gender						Major						Year of Study									
		Female		Male		P-value	Dentistry, Nursing		Medicine		P-value	1		2		3		4		P-value			
		No.	%	No.	%		No.	%	No.	%		No.	%	No.	%	No.	%	No.	%				
Time spent on histology virtual laboratory compared to on-campus laboratory	Less	120	57.4%	126	60.0%	0.854	27	48.2%	219	60.3%	0.041	112	56.0%	83	63.8%	46	55.4%	5	83.3%	0.290			
	Similar	53	25.4%	49	23.3%		13	23.2%	89	24.5%		48	24.0%	28	21.5%	26	31.3%	0	0.0%				
	More	36	17.2%	35	16.7%		16	28.6%	55	15.2%		40	20.0%	19	14.6%	11	13.3%	1	16.7%				
Time spent on pathology virtual laboratory compared to on-campus laboratory	Less	94	52.8%	99	55.6%	0.706	17	39.5%	176	56.2%	0.092	68	51.1%	73	54.9%	47	56.0%	5	83.3%	0.263			
	Similar	52	29.2%	45	25.3%		14	32.6%	83	26.5%		32	24.1%	39	29.3%	25	29.8%	1	16.7%				
	More	32	18.0%	34	19.1%		12	27.9%	54	17.3%		33	24.8%	21	15.8%	12	14.3%	0	0.0%				
Time spent on microbiology virtual laboratory compared to on-campus laboratory	Less	100	56.2%	100	55.9%	0.309	18	41.9%	182	58.0%	0.122	71	54.2%	80	58.8%	45	53.6%	4	66.7%	0.526			
	Similar	42	23.6%	52	29.1%		14	32.6%	80	25.5%		34	26.0%	33	24.3%	27	32.1%	0	0.0%				
	More	36	20.2%	27	15.1%		11	25.6%	52	16.6%		26	19.8%	23	16.9%	12	14.3%	2	33.3%				
Time spent on physiology virtual laboratory compared to on-campus laboratory	Less	84	54.9%	90	57.7%	0.848	20	40.8%	154	59.2%	0.017	59	51.3%	74	62.2%	37	52.9%	4	80.0%	0.163			
	Similar	38	24.8%	38	24.4%		13	26.5%	63	24.2%		27	23.5%	26	21.8%	23	32.9%	0	0.0%				
	More	31	20.3%	28	17.9%		16	32.7%	43	16.5%		29	25.2%	19	16.0%	10	14.3%	1	20.0%				
Effort made on anatomy virtual laboratory compared to on-campus laboratory	Less	59	26.2%	72	32.1%	0.378	16	22.5%	115	30.4%	0.084	52	23.9%	46	33.3%	32	37.2%	1	14.3%	0.007			
	Similar	63	28.0%	56	25.0%		15	21.1%	104	27.5%		56	25.7%	30	21.7%	29	33.7%	4	57.1%				
	More	103	45.8%	96	42.9%		40	56.3%	159	42.1%		110	50.5%	62	44.9%	25	29.1%	2	28.6%				
Effort made on histology virtual laboratory compared to on-campus laboratory	Less	65	29.8%	90	41.1%	0.004	18	30.5%	137	36.2%	0.693	69	33.0%	50	36.5%	35	41.7%	1	14.3%	0.197			
	Similar	92	42.2%	60	27.4%		22	37.3%	130	34.4%		73	34.9%	43	31.4%	31	36.9%	5	71.4%				
	More	61	28.0%	69	31.5%		19	32.2%	111	29.4%		67	32.1%	44	32.1%	18	21.4%	1	14.3%				

Effort made on pathology virtual laboratory compared to on-campus laboratory	Less Similar More	46 86 47	25.7% 48.0% 26.3%	77 54 53	41.8% 29.3% 28.8%	<0.001	11 19 15	24.4% 42.2% 33.3%	112 121 85	35.2% 38.1% 26.7%	0.341	33 47 52	25.0% 35.6% 39.4%	51 53 34	37.0% 38.4% 24.6%	38 35 13	44.2% 40.7% 15.1%	1 5 1	14.3% 71.4% 14.3%	0.001
Effort made on microbiology virtual laboratory compared to on-campus laboratory	Less Similar More	52 71 56	29.1% 39.7% 31.3%	82 52 50	44.6% 28.3% 27.2%	0.007	13 17 15	28.9% 37.8% 33.3%	121 106 91	38.1% 33.3% 28.6%	0.490	41 39 53	30.8% 29.3% 39.8%	51 49 38	37.0% 35.5% 27.5%	41 30 14	48.2% 35.3% 16.5%	1 5 1	14.3% 71.4% 14.3%	0.003
Effort made on physiology virtual laboratory compared to on-campus laboratory	Less Similar More	41 60 55	26.3% 38.5% 35.3%	61 35 63	38.4% 22.0% 39.6%	0.004	11 13 28	21.2% 25.0% 53.8%	91 82 90	34.6% 31.2% 34.2%	0.024	27 29 58	23.7% 25.4% 50.9%	46 38 39	37.4% 30.9% 31.7%	29 23 20	40.3% 31.9% 27.8%	0 5 1	0.0% 83.3% 16.7%	<0.001
Students' ability to remember instruction better in anatomy virtual laboratory	No Yes	129 71	64.5% 35.5%	108 89	54.8% 45.2%	0.049	40 27	59.7% 40.3%	197 133	59.7% 40.3%	0.999	135 64	67.8% 32.2%	70 56	55.6% 44.4%	31 38	44.9% 55.1%	1 2	33.3% 66.7%	0.004
Students' ability to remember instruction better in histology virtual laboratory	No Yes	116 79	59.5% 40.5%	93 103	47.4% 52.6%	0.017	31 21	59.6% 40.4%	178 161	52.5% 47.5%	0.339	121 77	61.1% 38.9%	64 57	52.9% 47.1%	23 45	33.8% 66.2%	1 3	25.0% 75.0%	<0.001
Students' ability to remember instruction better in pathology virtual laboratory	No Yes	83 72	53.5% 46.5%	77 82	48.4% 51.6%	0.364	24 18	57.1% 42.9%	136 136	50.0% 50.0%	0.389	77 36	68.1% 31.9%	63 61	50.8% 49.2%	19 54	26.0% 74.0%	1 3	25.0% 75.0%	<0.001
Students' ability to remember instruction better in microbiology virtual laboratory	No Yes	84 68	55.3% 44.7%	80 83	49.1% 50.9%	0.272	22 18	55.0% 45.0%	142 133	51.6% 48.4%	0.691	82 37	68.9% 31.1%	64 58	52.5% 47.5%	17 53	24.3% 75.7%	1 3	25.0% 75.0%	<0.001
Students' ability to remember instruction better in physiology virtual laboratory	No Yes	77 57	57.5% 42.5%	74 66	52.9% 47.1%	0.444	27 22	55.1% 44.9%	124 101	55.1% 44.9%	0.999	70 28	71.4% 28.6%	59 54	52.2% 47.8%	21 37	36.2% 63.8%	1 4	20.0% 80.0%	<0.001

## Discussion

The COVID-19 pandemic and associated non-pharmaceutical interventions changed education delivery methodologies. With the presence of modern technology, the opportunity for the swift switch to virtual teaching techniques was provided, and virtual courses were offered in the majority of health-related specialties. Still, little is known about students' experiences from within developing countries. This study explored students' experience related to virtual learning methods within laboratory settings compared to the usual on-campus teaching modality, inferring key recommendations to build inclusive virtual curricula. The results indicate that while there is a preference for using virtual sessions, differences in experiences must be addressed by gender, year, and major of study. This area needs further investigation to fine-tune students' experiences with virtual sessions better.

About half of the study participants preferred virtual delivery methods over on-campus ones. Similarly, about half preferred to have virtual sessions in the future. Based on these findings, comparable satisfaction with the virtual learning experience can be suggested. This finding agrees with previous reports from China documenting high satisfaction rates of virtual education.<sup>15</sup> Studies from our region showed lower satisfaction rates, with only 30% of students satisfied with the online learning experience.<sup>16</sup> Multiple factors could be accounted for in determining the overall satisfaction with virtual learning. Among the positives, commuting time, learning at one's own pace, learning from the convenience of the household, and availability of all relevant material were reported.<sup>16</sup> In the meantime, low-quality internet connectivity, tutors' internet literacy, the platform, its design, and the ability to enhance interaction could be among the main restraints to online learning.<sup>17</sup> In a scoping review, several factors were determined as facilitators and barriers to intervention effectiveness, including pedagogical background, course design, students' profiles, and methodology of delivery.<sup>18</sup> The platform's role was emphasized earlier, and students' satisfaction was related to page appearance, navigation potentials, online applications, and interactive environment.<sup>19</sup> Given the newer generations' awareness of digital platforms, investigating digital health competencies and attitudes could help shape the future of virtual learning, moving the reliance from computer-dependent learning to the use of multiple modalities, including tablets and smartphones.<sup>20</sup> Finally, the findings highlight the need to holistically address virtual learning, making the most of advanced technology, and proper planning since the recent experience was mandatory and forced by the pandemic.

Among the five subjects of concern, three, pathology, microbiology, and histology, were preferred when given virtually. This could be due to the nature of the provided material, but the determinant of this association is not well understood and warrants further investigations. Another previously studied variant that impacts the preference of virtual and on-campus teaching methods is the interactions, whether it is student-instructor or student-student. Traditional face-to-face teaching has always been preferred to increase engagement and provoke interactions.<sup>21</sup> Nonetheless, other factors may impact this satisfaction, including the psychological impacts of COVID-19 and the technology used to improve interactions.<sup>22</sup>

It is worth mentioning that the understanding of the teaching material was less with virtual sessions in all five laboratories. Despite that, the virtual sessions yielded a comparable knowledge of some topics, which could indicate that some topics can be shifted into virtual or hybrid teaching in the future, granting holistic and careful, attentive planning. Moreover, enhancing virtual teaching platforms could help in pandemic preparedness, which will equip our educational system with the need to improve remote teaching in similar circumstances.

This study has limitations. At first, the sample is not generalizable to all healthcare students, even in Jordan, as the data was collected from students at one university. As well, the online survey does not provide a representative sample. Accordingly, more research should be utilized using cross-country samples and a more random sampling approach. The number of medical students and participants from the first years of study was predominant. As such, this is a threat to internal and external validity. More qualitative studies should focus on understanding gender differences regarding efforts made and time spent.

## Conclusion

The COVID-19 pandemic can potentially change the future of medical education, and preparing for future crises is paramount. Virtual teaching has many benefits and can be promoted and implemented if adequately planned and executed in line with student feedback during the COVID-19 experience. Gender difference, as well as study major and year of



study, seems to play a role in efforts made, time spent, and ability to remember when considering. More research is recommended to fine-tune and improve students' experience with virtual teaching.

## Data Sharing Statement

Further data is available from the corresponding author on reasonable request.

## Ethics Approval

The study was approved by the Institutional Review Board (IRB) of Jordan University of Science and Technology with IRB approval reference number 13/134/2020.

## Consent to Participate

On the first page of the online questionnaire, participants were informed about the study's aim, objective, and right to withdraw at any point. Also, they were assured that all information would be confidential and used for research purposes only.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare no conflicts of interest in this work.

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