

Pre-Clinical Remote Undergraduate Medical Education During the COVID-19 Pandemic: A Survey Study

Bitá Shahrviní, BS

University of California San Diego

Sally L. Baxter, MD, MSc

University of California San Diego <https://orcid.org/0000-0002-5271-7690>

Charles S. Coffey, MD

University of California San Diego

Bridget V. MacDonald, BA

University of California San Diego

Lina Lander, ScD (✉ linalander@health.ucsd.edu)

University of California San Diego

Research Article

Keywords: COVID-19, medical education, pre-clinical, distance learning, remote learning, medical students

Posted Date: June 10th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-33870/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at BMC Medical Education on January 6th, 2021. See the published version at <https://doi.org/10.1186/s12909-020-02445-2>.

Abstract

Background: The COVID-19 pandemic has necessitated a sudden transition to remote learning in medical schools. We aimed to assess student perceptions of remote learning during the pre-clinical curricular training phase.

Methods: A survey was distributed to first- and second-year medical students enrolled at the University of California San Diego School of Medicine in March 2020. Frequencies of responses to structured multiple-choice questions were compared regarding impacts of remote learning on quality of instruction and ability to participate, value of various remote learning resources, living environment, and preparedness for subsequent stages of training. Responses to open-ended questions about strengths and weaknesses of the remote curriculum and overall reflections were coded for thematic content.

Results: Of 268 students enrolled, 104 responded (53.7% of first-year students and 23.9% of second-year students). Overall, students felt the quality of instruction and their ability to participate had been negatively affected. Most (64.1%) preferred the flexibility of learning material at their own pace. Only 25.5% of respondents still felt connected to the medical school or classmates. Most second-year students (56.7%) felt their preparation for the USMLE Step 1 exam was negatively affected and 43.3% felt unprepared to begin clerkships. In narrative responses, most appreciated the increased flexibility of remote learning but recognized that digital fatigue, decreased ability to participate, and lack of clinical skills and hands-on lab learning were notable deficits.

Conclusions: Videocasted lectures uploaded in advance, electronic health record and telehealth training for students, and training for teaching faculty to increase technological fluency may be considered to optimize remote learning curricula.

Background

The COVID-19 pandemic has disrupted countless aspects of economy, society, and human health. Medical schools have been challenged by the abrupt transition to entirely remote learning, enacted to protect patients and students. With the unprecedented cancellation of in-person classes, small groups, and clinical experiences, this study aims to assess the relative successes and areas for improvement in a preclinical remote learning curriculum.

On March 16, 2020, the University of California San Diego School of Medicine (UCSD) announced that all pre-clinical classes and activities would be conducted completely online and remotely. Prior to this announcement, the standard pre-clinical curriculum consisted of lecture-based organ system blocks, problem-based learning small groups, laboratory-based classes such as anatomy, histology, and ultrasound, and various pre-clinical electives. Clinical exposures included a course in doctoring/humanism (Practice of Medicine) and longitudinal ambulatory care apprenticeships where students participated in weekly clinics with faculty mentors. Table 1 describes these curricular components in more detail as well as the changes implemented to transition to remote learning.

Table 1: Summary of UCSD School of Medicine pre-clinical curriculum before and after the transition to remote learning.

Remote Learning Changes in the UCSD SOM Curriculum		
	Before the transition	After the transition
Organ System Blocks	2-4 hours of consecutive lectures with videocasts made available following the in-person lectures. Final Exams taken on personal computers on campus.	2-4 hours of consecutive videocasted lectures, with all videocasts for the block uploaded in advance. Final Exams taken on personal computers at students' homes.
Lab Classes (Anatomy, Histology, Ultrasound)	In-person labs with lab manuals posted online in advance.	All labs cancelled. Manuals posted online in advance. Optional, live videoconference office hours offered.
Practice of Medicine	4-hour small group sessions every other week. In-person practice of physical exam/doctoring skills and student encounters with patient actors.	4-hour videocasted small group sessions every other week. No physical exam learning. Videoconference student encounters with patient actors.
Problem Based Learning	2-hour in-person small group sessions twice a week to review patient cases and present relevant topics.	2-hour videoconference small group sessions twice a week to review patient cases and present relevant topics.
Outpatient Care Apprenticeships	Students paired with a primary care preceptor in San Diego to practice conducting patient histories, physical exams, and writing notes.	Cancelled.
Pre-clinical Electives	Range from clinical preceptorships to community service to lecture based electives.	Some cancelled, others moved to videoconference platforms.

Remote learning has gained popularity in higher education over the last decade, yet its integration into the medical curriculum has been relatively slow. While students have had the option to view lectures online and purchase optional remote learning resources (e.g. question banks, video subscription services, and flashcards), most preclinical knowledge was still disseminated in-person. The sudden and complete transition to remote learning necessitated by COVID-19 meant that medical educators were tasked with rapidly developing remote learning curricula to meet complex learning objectives.

We surveyed pre-clinical first- and second-year UCSD medical students to better understand the relative successes and failures of the remote learning experience and inform best practices for curriculum design, even after the COVID-19 pandemic resolves.

Methods

Study population

This study was conducted at the UCSD School of Medicine, an accredited allopathic medical school in La Jolla, CA. Eligible participants included all medical students enrolled in their first or second year as of March 30, 2020. The UCSD Institutional Review Board (IRB) approved this protocol as a quality improvement study.

Survey design and implementation

The full survey instrument is included in Appendix 1. The survey instrument was based on other annual student surveys and in consultation with faculty, staff, and students to establish face validity. Students rated the value of various remote learning resources, aspects of curricular structure, communication from leadership, feelings of connectedness, out-of-pocket expenses, and suitability of their living environment. Second-year students were asked about preparedness for subsequent stages of training. Finally, open-ended questions asked students about telehealth experiences, strengths and weaknesses of the remote curriculum, components that should be incorporated into the standard curriculum, and overall reflections.

The survey was hosted on an online software platform (Qualtrics, Provo, UT) and distributed via e-mail to all eligible participants. Survey completion required approximately 10 minutes to complete and was anonymous, optional, and not linked to any student evaluations.

Statistical analyses

Descriptive statistics were generated using the mean and standard deviations or counts/frequencies where appropriate. Statistical analyses were conducted in Microsoft Excel Version 2004 (Microsoft Corporation, Redmond, WA, USA). Open-ended responses were coded by two independent coders (CC and BS) for thematic content. Patterns were identified and comments were iteratively reviewed and mapped to various thematic domains. Discrepancies in emerging themes were reviewed by all co-authors until a consensus was reached. Representative comments demonstrating the major themes, chosen and agreed upon by all co-authors, were extracted for illustration.

Results

Of 268 students (134 in each class) invited to participate in the survey, a total of 104 responded (38.8%). Respondents consisted of 72 first year students (53.7%) and 32 second year students (23.9%).

Effects of remote learning on curricular components

For all curricular components besides lectures, most students felt the quality of instruction had been somewhat or very negatively affected by the remote learning transition (Table 2). Curricular components where the highest proportions of students felt that remote learning had very negatively affected the

quality of instruction were anatomy (49/74, 66.2%), ultrasound (39/47, 83.0%), and the ambulatory care preceptorship (51/53, 96.2%). Students felt that remote learning had somewhat or very positively affected other curricular components, such as lecture-based learning (23/93, 24.73%) and problem-based learning (14/101, 13.9%). However, for the remaining curricular components, <10% of students felt that the remote learning transition had any positive effects.

Pre-clinical students' perceptions of how remote learning affected their ability to participate in the curriculum followed similar patterns. Besides lectures and problem-based learning, where students generally felt neutral about their ability to participate remotely, the majority (>60%) of students felt remote learning had somewhat or very negatively affected their ability to participate in all other curricular components (Table 2).

Table 2. Perceptions of the effects of remote learning on quality of instruction and on ability to participate among pre-clinical medical students at the University of California San Diego, March-April 2020. The number of respondents is indicated for each specific curricular component.

	Very negatively affected		Somewhat negatively affected		Neutral	Somewhat positively affected		Very positively affected	
Effect of Remote Learning on Quality of Instruction									
Lecture-based learning (n=93)	8	(8.6%)	23	(24.7%)	39 (41.9%)	12	(12.9%)	11	(11.8%)
Problem-based learning (n=101)	11	(10.9%)	41	(40.6%)	35 (34.7%)	10	(9.9%)	4	(4.0%)
Practice of Medicine (n=77)	38	(49.4%)	32	(41.6%)	7 (9.1%)	0	(0.0%)	0	(0.0%)
Anatomy (n=74)	49	(66.2%)	20	(27.0%)	4 (5.4%)	1	(1.4%)	0	(0.0%)
Histology (n=74)	26	(35.1%)	27	(36.5%)	15 (20.3%)	4	5.41%	2	(2.7%)
Ultrasound (n=47)	39	(83.0%)	7	(14.9%)	1 (2.1%)	0	(0.0%)	0	(0.0%)
Ambulatory Care Preceptorship (n=53)	51	(96.2%)	0	(0.0%)	2 (3.8%)	0	(0.0%)	0	(0.0%)
Pre-clinical Electives (n=69)	30	(43.5%)	17	(24.6%)	19 (27.5%)	3	4.35%	0	(0.0%)
Effect of Remote Learning on Ability to Participate									
Lecture-based learning (n=95)	14	(14.7%)	17	(17.9%)	42 (44.2%)	11	(11.6%)	11	(11.6%)
Problem-based learning (n=101)	8	(7.9%)	32	(31.7%)	46 (45.5%)	12	(11.9%)	3	(3.0%)
Practice of Medicine (n=78)	17	(21.8%)	30	(38.5%)	26 (33.3%)	3	(3.9%)	2	(2.6%)
Anatomy (n=73)	38	(52.1%)	20	(27.4%)	13 (17.8%)	1	(1.4%)	1	(1.4%)
Histology (n=73)	33	(45.2%)	24	(32.9%)	14 (19.2%)	1	(1.4%)	1	(1.4%)
Ultrasound (n=46)	37	(80.4%)	6	(13.0%)	2 (4.4%)	0	(0.0%)	1	(2.2%)
Ambulatory Care Preceptorship (n=53)	45	(84.9%)	4	(7.6%)	3 (5.7%)	0	(0.0%)	1	(1.9%)
Pre-clinical Electives (n=68)	25	(36.8%)	17	(25.0%)	22 (32.4%)	2	(2.9%)	2	(2.9%)

Remote learning resources and curricular structure

Utilization of remote learning resources by pre-clinical students was variable (Figure 1). Resources regarded as valuable by half or more of respondents included a laptop, tablet, online question bank subscription, recorded didactic lectures, videoconferencing software (Zoom Pro), digital anatomy

education app (Complete Anatomy), and online office hours and review sessions (Figure 1). Resources of relatively lesser value included Online MedEd, online textbooks, JOVE Science Education, and Aquifer.

Almost two-thirds (66/103, 64.1%) of students preferred having the flexibility of learning material at their own pace rather than having required modules and set due dates. When asked about the ideal frequency of due dates, most (55/103, 53.4%) preferred weekly due dates. Fewer students preferred due dates to occur daily (4/103, 3.9%), every few days (15/103, 14.6%), biweekly (16/103, 15.5%), or monthly (13/103, 12.6%).

Costs, living arrangements, and connectedness

For most (72/103, 69.9%) students, transitioning to remote learning incurred less than \$100 of additional out-of-pocket expenses for educational resources. However, almost a quarter (24/103, 23.3%) spent \$101-\$500, and there were 7 students (6.8%) who spent over \$500 during the remote learning transition.

With the transition to remote learning, approximately one-fifth of the students (20/98, 20.4%) moved outside the greater metropolitan area surrounding the institution. The remaining students stayed locally, whether in their current housing arrangements (72/98, 73.5%) or moving to different housing nearby (6/98, 6.1%). About one-fifth of students (21/98, 21.4%) felt their living arrangements were not conducive to remote learning (Table 3). This was primarily attributed to lack of quiet study space, a barrier identified by a quarter of students (24/98, 24.5%). Very few students (5/98, 5.1%) indicated lack of sufficient internet or technology.

Overall, students felt less connected during remote learning. Over half of respondents felt disconnected to the medical school or to their classmates (Table 3). Only about a quarter of students still felt connected to the medical school or to their classmates.

Table 3. Living arrangements and feelings of connectedness among pre-clinical (first- and second-year medical students) at the University of California San Diego, March-April 2020.

Statements (N=98 students)	Scale of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Overall, my current living arrangements are conducive to remote learning.	6 (6.1%)	15 (15.3%)	17 (17.4%)	40 (40.8%)	20 (20.4%)
I have access to sufficient internet to meet the demands of remote learning.	1 (1.0%)	8 (8.2%)	7 (7.1%)	40 (40.8%)	42 (42.9%)
I have access to sufficient technology (i.e. a computer with a webcam, iPad, etc) to meet the demands of remote learning.	0 (0%)	5 (5.1%)	2 (2.0%)	43 (43.9%)	48 (50.0%)
Given my living arrangements, I have sufficient access to quiet study space to meet the demands of remote learning.	7 (7.1%)	17 (17.4%)	16 (16.3%)	38 (38.8%)	20 (20.4%)
Given the transition to remote learning, I still feel connected to UCSD School of Medicine .	14 (14.2%)	38 (38.8%)	21 (21.4%)	20 (20.4%)	5 (5.1%)
Given the transitions to remote learning, I still feel connected to my classmates .	20 (20.4%)	31 (31.6%)	20 (20.4%)	26 (26.5%)	1 (1.0%)

Preparation for subsequent stages of training

Second-year students also felt that preparation for subsequent stages of training were negatively affected. Over half (17/30, 56.7%) felt that their preparation for the United States Medical Licensing Examination (USMLE) Step 1 examination was somewhat or very negatively affected. About a quarter (7/30, 23.3%) felt that preparation was somewhat or very positively affected, and the remainder felt their preparation for Step 1 had not changed. Similarly, in terms of feeling of prepared to begin clinical clerkships, 13 (43.3%) felt somewhat or very unprepared, 9 (30.0%) felt somewhat or very prepared, and the remainder were neutral.

Narrative results

Four dominant themes emerged from 254 unique narrative responses to open-ended survey questions:

1. Structure – flexibility and efficiency

Many students praised the increased flexibility afforded by remote learning. Almost two-thirds (38/59, 64.4%) cited increased flexibility as the best part of the remote learning curriculum (Table 4), noting the benefits of self-pacing and indicating that a traditional 50-minute lecture format is not ideal. Students reflected that self-pacing the lecture schedule permitted them to pause and work out difficult concepts, or to speed up recordings to enhance efficiency. Many appreciated the opportunity to get ahead of the lecture schedule via pre-recorded lectures (Table 5, a, b). Several students noted they were able to coordinate studies with their circadian rhythms to optimize periods of productivity, efficiency, and learning (Table 5, c, d). Students also valued the flexibility to engage in activities such as research, Step 1 studying, self-care, and volunteering with COVID-19 relief efforts (Table 5, e). Several students praised

remote learning for the time and financial gains from eliminating commutes, either from home to school or from one building on campus to another (Table 5, f).

By contrast, some students struggled with decreased structure, citing that without a regular schedule, it was easy to fall behind (Table 5, g). When asked specifically about gaps in the remote learning curriculum, 7/61 respondents (11.5%) noted lack of a structured schedule and disorganization (Table 4). Others conveyed that productivity and motivation were hindered by home environments that were not conducive to studying (Table 5, h).

II. Remote learning format – digital fatigue and participation

Prolonged engagement in remote learning formats proved problematic for many students. Numerous respondents (11/61, 18.0%) specifically reported digital fatigue as a significant drawback of the remote curriculum. Interestingly, some students noted the greatest digital fatigue with synchronous, small group sessions which were designed to be interactive, but instead led to disengagement, exhaustion, and inability to focus (Table 5, i, j). Some respondents felt remote formats hampered participation due to technical issues and inability to study in groups or effectively use office hours (Table 5, k, l). In contrast, some students felt the remote format enhanced small group interactions, and 9/54 respondents (16.7%) desired that virtual PBL be continued beyond the pandemic period (Table 4).

III. Content gaps – lab classes and clinical skills learning

Unsurprisingly, when asked specifically about the biggest gaps in the remote learning curriculum, 31/61 respondents (50.8%) cited clinical skills learning (Table 4). Many students noted deficiencies with history-taking and physical exam training. The overall dearth of clinical skills training left students feeling unprepared for clinical assessments and encounters (Table 5, m, n). Students also felt a loss of motivation when opportunities to participate in the clinical realm disappeared (Table 5, o). Most students also felt that digital substitutes were inadequate for lab classes like anatomy, histology, and ultrasound (Table 5, p).

While many students missed out on opportunities within the curriculum to learn clinical skill, a handful of students who were able to participate in telehealth found the experience quite valuable. Fourteen students reported participating in some form of telehealth since transitioning to remote learning, the majority of whom (78.6%) obtained the experience via a student-run Free Clinic elective in which students help provide healthcare to uninsured members of the San Diego community. While students had mixed feelings regarding the effectiveness and efficiency of telehealth patient visits, students highly valued opportunities to participate in patient care and stated that telehealth patient visits were a source of motivation (Table 5, q-s).

IV. Mental health – anxiety and isolation

Pre-clinical students typically spend the majority of each day learning together in-person in the standard curriculum, thus developing close-knit relationships with each other. The transition to remote learning and

the accompanying isolation took a noticeable toll on students' mental health (Table 5, t-v). A notable proportion of students (11/66 respondents, 16.7%) mentioned isolation, feelings of disconnectedness, or declining mental health in their responses. Anxiety and uncertainty made it difficult for many to focus on academics. Disruption of normal routines and additional stresses from stay-at-home orders made remote learning particularly trying for some students (Table 5, w). An incessant barrage of mixed and sometimes contradictory information was also difficult to navigate, and several students noted that effective communication from medical school administration was necessary to assuage feelings of uncertainty and maintain a positive educational environment (Table 5, x).

Table 4. Free responses among pre-clinical (first- and second-year medical students) at the University of California San Diego, March-April 2020. Best and worst components of the remote learning curriculum and aspects that should be continued in future, hybrid curricula.

<i>What are the best components of the remote curriculum?</i> (N=59)	N (%)	<i>Which components of the remote curriculum should be continued in the standard curriculum in the future?</i> (N=54)	N (%)	<i>What gaps remain in the remote curriculum?</i> (N=61)	N (%)
Increased flexibility	38 (64%)	Videocasted lectures, uploaded in advance for the block	27 (50%)	Clinical skills learning (POM, ACA)	31 (51%)
Videocasted lectures, uploaded in advance for the block	18 (31%)	Virtual PBL	9 (17%)	Lab classes (Anatomy, Histology, Ultrasound)	15 (25%)
Increased efficiency	10 (17%)	Increased office hours/review sessions	7 (13%)	Zoom/Digital Fatigue	11 (18%)
Increased office hours/review sessions	4 (7%)	Extra resources/practice questions	6 (11%)	Difficult to participate/ask questions	8 (13%)
Virtual PBL	4 (7%)			Disorganization/ Lacking structured schedule	7 (11%)
				Poor communication/ Transparency	5 (8%)

Table 5. Student quotations illustrating thematic content of free response questions.

I. Structure: Flexibility and Efficiency
a. "I do not learn well in the physical lecture session bc I cannot pause and address confusion right away."
b. " I appreciate having all the block's lectures at the beginning so I can watch them at my own pace and get ahead if I choose."
c. "I am an early riser so I do like being able to wake up early and start on lectures by six AM."
d. "The ability to learn more or less depending on the energy level of the day is absolutely massive. And has been the STRONGEST addition to my education, regardless of the circumstance."
e. "More freedom to productively use my time (research/STEP studying)."
f. "I also commute to school so remote learning is saving me a lot of money and time, which I am very happy about."
g. "The biggest killer in remote learning is time self management... I sleep in more than I should and do less work than I should. I would like help keeping myself accountable by having more assignments with more set due dates. If the assignments are there, I will do them."
h. "At grad housing, my neighbors above have children who are persistently loud and while at home my large family are all working and always on calls. Many students feel that it's difficult to focus, be engaged, and be placed in an environment conducive to learning. As such, a student like myself who used to never struggle with having motivation to get to work is having more difficulties now than ever to simply be a student."
II. Remote Learning Format: Digital Fatigue and Participation
i. "Zoom classes feel much longer online than in person."
j. "POM [Practice of Medicine] for 4 hours straight is impossible. Many of the activities are difficult to do over Zoom. Honestly, the past few weeks after logging off the 4 hour POM zoom call, I have been so discouraged that I couldn't focus for the rest of the evening. Four hours on a Zoom call is physically and emotionally draining."
k. "Interaction with faculty and students is simply not the same. It's a bit hard to describe, but as someone who is very much an "in person" and "tangible" learner, going to lecture and seeing the faculty, speaking with peers, and interacting with everyone in person is more conducive to my learning style."
l. "It's very hard to do any sort of group studying. It's very hard to find a quiet place to study. It's very hard to learn doctoring skills... There is no way to practice your skills/ask questions."
III. Content: Lab Classes and Clinical Skills Learning
m. "As someone who learns best through hands on methods, I'm struggling with anatomy and POM and really missing the opportunity to practice patient interviewing/physical exams during ACA. I do not feel prepared for an OSCE at the end of the year."
n. "As of now I do not feel prepared for step style questions, or comfortable trying to apply my knowledge in relevant clinical settings."
o. "It has also been hard not having clinical experiences, since that was my favorite part of medical school."
p. "Anatomy is extremely difficult to learn remotely - and I know a lot of students who have just resigned to not learning pelvic anatomy given the circumstances."
q. "(Telehealth participation) has been very valuable and a great learning experience and is helping me stay grounded and connected to my role as a med student."
r. "Telehealth... Was a great learning experience, practiced taking a hx, presenting to attending, writing a note."
s. "(Telehealth participation) has been hugely helpful for my motivation and keeping up with my interviewing skills."
IV. Mental Health: Anxiety and Isolation
t. " Being more or less alone for the past ~2 months has showed me the importance of connection and social interaction in my own mental well-being and the role that our in-person classes served in meeting that need for me. I miss in-person class for that reason the most. And I would be worried that if the SOM switched to more remote learning permanently after COVID-19, a lot of student's mental health would decline due to isolation and lack of relationships with classmates. "
u. " It's an incredibly isolating experience... mental health is more so a challenge than ever with all of this, and it is impacting all facets of our student life: academic performance, extracurricular commitments, socializing, etc. "
v. " Some of us are being hit more by the complete psychological lack of interaction, that can't really be remedied by looking at boxes on a computer with friends and mentors faces in them."
w. " In addition to family issues and regular coursework, it's more difficult to go about daily activities, such as

grocery shopping or exercising; some of us do not have access to a quiet study space with reliable internet; some of us are managing free clinic responsibilities, where more administrative duties are falling on students. Some of us have had a known exposure to COVID-19 ourselves or have responsibilities to our communities outside of school. "

x. "I also wish I knew what was going on—I get so many emails from the school and UC San Diego Health that I don't know what to open for actual information about my own curriculum, etc."

Discussion

The COVID-19 pandemic forced medical schools around the world to transition their entire pre-clinical curricula to remote learning platforms overnight (1). Unsurprisingly, this posed immense challenges for administrators, course directors, and students alike (2–5). Recent articles have discussed the impact of COVID-19 on medical education, but these have largely consisted of editorial or opinion pieces without data demonstrating students' perspectives. Few studies have captured the experience of pre-clinical medical students, and those that have focused on a single curricular component such as anatomy, offering only a narrow glimpse into students' experience (4,5).

Because circumstances did not permit sufficient time to re-design the entire pre-clinical curriculum tailored specifically to remote learning, our institution migrated the majority of the structure and content of the existing curriculum to videoconference formats, with the exception of several components which were cancelled outright. Our survey results suggest that pre-clinical students had mixed feelings about this approach, finding some aspects of this remote learning curriculum beneficial and others detrimental both to their studies and mental health. Our key findings were that (1) pre-clinical students felt the loss of clinical experiences acutely, 2) the learning experiences in laboratory-based classes were particularly negatively impacted, and (3) students enjoyed the increased flexibility afforded by remote learning, particularly as it pertained to videocasted lectures.

Clinical skills learning: shortfalls and opportunities for growth

Given that clinical experiences constituted a small portion of the pre-clinical curriculum, it was surprising to learn the profound effect of losing these experiences on pre-clinical students' motivation and morale. Students explained that direct patient care experiences fueled their motivation to keep up with the academic rigors of medical school. This observation highlights the value of increasing clinical exposure during the first two years of medical school, as many institutions have done (6–8). Both our quantitative and qualitative results demonstrate that pre-clinical students identified lack of clinical skills learning as the biggest deficit in the remote learning curriculum.

Although the loss of clinical skills training is problematic, our study revealed that bolstering medical student participation in telehealth may be a potential solution to address this challenge. Students voiced positive experiences participating in telehealth encounters through pre-clinical electives and volunteer efforts, allowing them to practice essential skills like taking histories, presenting to attending physicians, and writing notes. Studies found that interaction with telehealth during medical school contributes to improved core competencies, medical knowledge, overall learning and higher quality patient care (9). The

increased reliance on telemedicine should motivate allocation of structured time in the pre-clinical curriculum for telehealth training, which may include electronic health record (EHR) training as well, to equip students with the practical skills they will need to succeed in an evolving clinical landscape.

Negative impacts on lab class experiences

More than 90% of students surveyed felt that lab experiences like anatomy, histology, and ultrasound were negatively affected by the remote learning transition. Pre-clinical students at UCSD participate in cadaveric anatomy dissections throughout the first year of training. As a result, our cohort of first-year respondents offered unique insight into student perspectives regarding digitally simulated anatomy compared to traditional cadaveric dissection and prosection. Most students were not satisfied with learning anatomy remotely, and several commented that online platforms were not adequate replacements for in-person learning with anatomic specimens. However, our results may have been affected by the fact that the remote learning anatomy curriculum at our institution was passive; lab manuals were posted online, and instructors hosted optional, live office hours to answer questions. Remote anatomy instruction with more active student engagement and directed activities may be more successful.

With several medical schools moving away from cadaveric dissections and towards online platforms such as Complete Anatomy, 3D printed organs, and virtual reality to teach anatomy (10–14), our survey results contribute to the discussion about whether or not these methods enhance pre-clinical anatomy learning from the student perspective. Moreover, as others have noted, unique ethical issues come into play when trying to integrate human donor dissections with videoconferencing tools used for remote learning (4). Moving forward, medical educators may consider a hybrid approach to optimize the pre-clinical anatomy curriculum by combining traditional laboratory dissection with remote learning resources to augment learning wherever possible.

Increased flexibility offered a positive experience

Medical school is extremely fast paced, with vast amounts of material taught every day. Constant exposure to new material may leave students feeling overwhelmed and having little time to absorb lecture material makes it easy for some students to fall behind. The ability to engage in self-paced learning due to schedule flexibility and early availability of pre-recorded lectures was highly valued by students in this survey. Nearly two-thirds of students praised increased flexibility as the single best aspect of the remote learning curriculum. Additionally, with optimized efficiency afforded by increasing the speed of videocasted lectures and the ability to work ahead, students found more time to engage in extracurricular activities like research, Step 1 preparation, and self-care.

While there was generally positive sentiment regarding the opportunity for increased efficiency, students noted that the abruptness of the transition brought some challenges. Technical difficulties with videoconferencing posed an initial challenge for many faculty members, which detracted from some students' learning. Efforts to improve digital "fluency" by training faculty in the fundamentals of remote

teaching technologies should help to ensure a more consistent and successful experience. Digital fatigue was also frequently cited as a barrier to student engagement and efficient learning. Future initiatives to design more effective remote learning curricula might mitigate digital fatigue by replacing small group sessions lasting 3 or 4 hours with multiple, shorter modules.

Despite the aforementioned challenges, over 50% of respondents would like to continue having videocasted lectures uploaded in advance for the entirety of each block. There is growing debate about whether in-person lectures for pre-clinical medical education are necessary and whether medical schools should pursue centralized online content as the primary basis for didactic teaching (15–20). Opting for the latter could create opportunities for multi-institutional teaching consortia and shared learning platforms, potentially freeing the resources of medical educators at home institutions to focus on more individualized instruction and clinical experiences.

Limitations

This study may have limited generalizability given its focus on a single medical school. About half of pre-clinical students responded to the survey; there may have been response bias leading to overrepresentation of those with the strongest feelings, either positive or negative. To preserve the anonymity of the students, we did not ask about demographic factors and therefore could not analyze students' perceptions of remote learning by age, gender, or race/ethnicity.

Conclusions

Remote learning had some negative impacts on pre-clinical learning, chiefly related to the loss of clinical experiences in the core curriculum, reduced impact of laboratory courses, and heightened feelings of anxiety and isolation. However, students also perceived positive aspects of remote learning including increased flexibility, opportunities to explore different learning resources, and time to focus on wellness. Given the likelihood that periodic disruptions to medical education due to new or resurgent pandemics will continue, it is imperative that medical schools develop sustainable remote learning curricula. This includes implementing structured EHR and telehealth training time within the core curricula for students and developing fluency in remote teaching formats and technologies amongst medical educators. The COVID-19 pandemic has created opportunities to expand the role of remote learning in medical education, and this study provides valuable insight for educators participating in re-designing preclinical curricula to effectively meet the needs of students.

List Of Abbreviations

UCSD: University of California San Diego

IRB: Institutional Review Board

Declarations

Ethics approval and consent to participate: The UCSD IRB approved this study as a quality improvement protocol (Project #200535QI). The study adhered to the Declaration of Helsinki. Signed informed consent was not obtained in order to preserve participant anonymity.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: CC is an educational consultant for CooperSurgical.

Funding: The study was supported by the National Institutes of Health, grant number T15LM011271. The funding body had no role in the design of the study or collection, data analysis or interpretation, or writing of the manuscript.

Authors' contributions: All authors participated in study design. LL distributed the survey to acquire data from medical students. SB, BS, and CC conducted primary data analysis. All authors contributed to data interpretation. BS and SB drafted the manuscript. All authors critically reviewed the manuscript for important intellectual content and approved the final manuscript.

Acknowledgements: Not applicable.

Competing interests: The authors declare the following competing interests:

Dr. Coffey is an educational consultant for CooperSurgical. Dr. Baxter is supported by the National Institutes of Health/National Library of Medicine, grant number T15LM011271. Dr. Lander, Ms. Shahrivini, and Ms. MacDonald declare no competing interests.

References

1. Rose S. Medical Student Education in the Time of COVID-19. JAMA. 2020 Mar 31;
2. Ferrel MN, Ryan JJ. The Impact of COVID-19 on Medical Education. Cureus [Internet]. 2020 Mar 31 [cited 2020 May 11]; Available from: <https://www.cureus.com/articles/29902-the-impact-of-covid-19-on-medical-education>
3. Liang ZC, Ooi SBS, Wang W. Pandemics and Their Impact on Medical Training: Lessons From Singapore. Acad Med. 2020 Apr;1.
4. Pather N, Blyth P, Chapman JA, Dayal MR, Flack NAMS, Fogg QA, et al. Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic. Anat Sci Educ. 2020 Apr 18;
5. Moszkowicz D, Duboc H, Dubertret C, Roux D, Bretagnol F. Daily medical education for confined students during COVID -19 pandemic: A simple videoconference solution. Clin Anat. 2020 Apr 22;ca.23601.

6. O'Connor Grochowski C, Halperin EC, Buckley EG. A curricular model for the training of physician scientists: the evolution of the Duke University School of Medicine curriculum. *Acad Med J Assoc Am Med Coll.* 2007 Apr;82(4):375–82.
7. Dienstag JL. Evolution of the New Pathway curriculum at Harvard Medical School: the new integrated curriculum. *Perspect Biol Med.* 2011;54(1):36–54.
8. Curriculum [Internet]. University of Michigan Medical School. 2016 [cited 2020 May 16]. Available from: <https://medicine.umich.edu/medschool/education/md-program/curriculum>
9. Waseh S, Dicker AP. Telemedicine Training in Undergraduate Medical Education: Mixed-Methods Review. *JMIR Med Educ.* 2019 Apr 8;5(1):e12515.
10. Jaffar AA. YouTube: An emerging tool in anatomy education. *Anat Sci Educ.* 2012 Jun;5(3):158–64.
11. McMenamin PG, McLachlan J, Wilson A, McBride JM, Pickering J, Evans DJR, et al. Do we really need cadavers anymore to learn anatomy in undergraduate medicine? *Med Teach.* 2018;40(10):1020–9.
12. Weyhe D, Uslar V, Weyhe F, Kaluschke M, Zachmann G. Immersive Anatomy Atlas-Empirical Study Investigating the Usability of a Virtual Reality Environment as a Learning Tool for Anatomy. *Front Surg.* 2018;5:73.
13. Bartikian M, Ferreira A, Gonçalves-Ferreira A, Neto LL. 3D printing anatomical models of head bones. *Surg Radiol Anat SRA.* 2019 Oct;41(10):1205–9.
14. Motsinger SK. Complete Anatomy. *J Med Libr Assoc JMLA.* 2020 Jan;108(1):155–7.
15. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of E-learning in medical education. *Acad Med J Assoc Am Med Coll.* 2006 Mar;81(3):207–12.
16. Schreiber BE, Fukuta J, Gordon F. Live lecture versus video podcast in undergraduate medical education: A randomised controlled trial. *BMC Med Educ.* 2010 Oct 8;10:68.
17. Vaccani J-P, Javidnia H, Humphrey-Murto S. The effectiveness of webcast compared to live lectures as a teaching tool in medical school. *Med Teach.* 2016;38(1):59–63.
18. Schwartzstein RM, Roberts DH. Saying Goodbye to Lectures in Medical School - Paradigm Shift or Passing Fad? *N Engl J Med.* 2017 Aug 17;377(7):605–7.
19. Chen SF, Deitz J, Batten JN, DeCoste-Lopez J, Adam M, Alspaugh JA, et al. A Multi-Institution Collaboration to Define Core Content and Design Flexible Curricular Components for a Foundational Medical School Course: Implications for National Curriculum Reform. *Acad Med.* 2019 Jun;94(6):819–25.
20. Emanuel EJ. The Inevitable Reimagining of Medical Education. *JAMA.* 2020 Mar 24;323(12):1127–8.

Figures

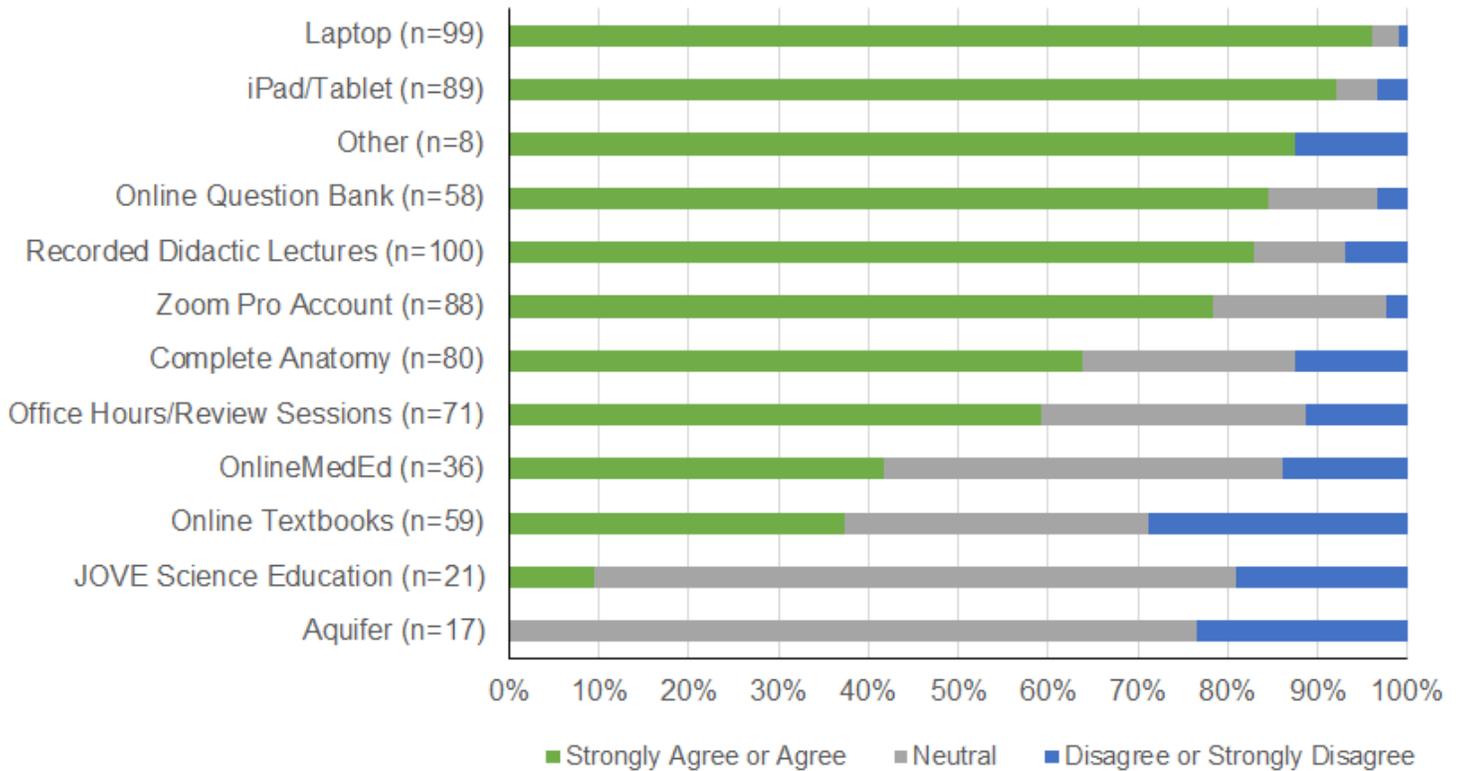


Figure 1

Perceptions regarding the value of various remote learning resources among pre-clinical (first- and second-year medical students) at the University of California San Diego, March-April 2020. Students were asked to rate their level of agreement with whether the specific remote learning resources were valuable for their medical education.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Appendix.pdf](#)