Title

Lessons From Learners: Adapting Medical Student Education During and Post COVID-19

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Lessons From Learners: Adapting Medical Student Education During and Post COVID-19

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Abstract

In response to the COVID-19 pandemic, many medical schools suspended clinical clerkships and implemented newly adapted curricula to facilitate continued educational progress. While the implementation of these new curricula has been described, an understanding of the impact on student learning outcomes is lacking. In 2020, the authors followed Kern's 6-step approach to curricular development to create and evaluate a novel COVID-19 curriculum for medical students at the University of California San Francisco School of Medicine and evaluate its learning outcomes. The primary goal of the curriculum was to provide third- and fourth-year medical students an opportunity for workplace learning in the absence of clinical clerkships, specifically for students to

develop clerkship-level milestones in the competency domains of practice-based learning and improvement, professionalism, and systems-based practice. The curriculum was designed to match students with faculty-mentored projects occurring primarily in virtual formats. A total of 126 students enrolled in the curriculum and completed a survey about their learning outcomes (100% response rate). Of 35 possible clerkship-level milestones, there were 12 milestones for which over half of students reported development in competency domains including practice-based learning and improvement, professionalism, and interpersonal and communication skills. Thematic analysis of students' qualitative survey responses demonstrated 2 central motivations for

participating in the curriculum: identity as physicians-in-training and patient engagement. Six central learning areas were developed during the curriculum: interprofessional teamwork, community resources, technology in medicine, skill-building, quality improvement, and specialty-specific learning. This analysis demonstrates that students can develop competencies and achieve rich workplace learning through project-based experiential learning, even in virtual clinical workplaces. Furthermore, knowledge of community resources, technology in medicine, and quality improvement was developed through the curriculum more readily than in traditional clerkships. These could be considered as integral learning objectives in future curricular design.

The COVID-19 pandemic drastically and abruptly changed the global medical education landscape. Most medical schools were forced to alter planned curricula and suspend clinical clerkships, necessitating innovation to continue training students.[1,2] As medical educators move from the initial phase of immediate curricular adaptations due to COVID-19 into the next phase of medical education design, there is an urgent need to examine outcomes data to articulate learning gaps and guide future innovations.

In the face of limited to no availability of clinical clerkships at the outset of the

COVID-19 pandemic, undergraduate medical education leaders redesigned workplace learning experiences for clerkship students.[3] Workplace learning is experiential learning in the clinical setting through which learners apply the clinical knowledge, skills, and behaviors of their professional roles and receive feedback in real time.[4] Clerkships are vital for medical student workplace learning,[5–7] enabling participation in clinical activities through workplace affordances that allow exploration of tasks and activities, relationships and interpersonal dynamics, and rules and norms. Workplace learning encourages learner engagement and shapes knowledge, skills, attitudes, and beliefs.[8,9]

To offer clinical learning opportunities without extending time to graduation, educators created novel workplace learning experiences for clerkship students. These new student roles mitigated exposure risk and involved students interfacing with patients via telemedicine, coordinating public health responses, and developing

patient, provider, and community resources.[10,11] While the implementation of some of these COVID-19-adapted medical curricula has been previously described, an understanding of student learning outcomes is, to our knowledge, lacking.[12–15]

We therefore set out to apply Kern's 6-step approach to curriculum development to the design and evaluation of a novel COVID-19 curriculum for clerkship medical students.[16–19] Those 6 steps are:

- Problem identification and general needs assessment;
- Targeted needs assessment;
- Goals and objectives;
- Educational strategies;
- Implementation; and
- Evaluation and feedback.

We analyzed student projects, motivations, competencies, and learning themes. Here, we report medical student learning outcomes and lessons learned

to inform education innovations aimed at engaging and empowering students in workplace learning during and after the COVID-19 pandemic.

Application of Kern's Framework to the COVID-19 Response Curriculum

Step 1: Problem identification and general needs assessment

In March 2020, the Association of American Medical Colleges recommended pausing clinical clerkships because of changed circumstances due to COVID-19.[20] That week, clinical clerkships were suspended at the University of California San Francisco School of Medicine (USCF), leaving third- and fourth-year medical students lacking a mechanism for workplace learning experiences.

Step 2: Targeted needs assessment

The associate dean for curriculum charged a group of faculty involved in project-based curriculum development for preclinical students with creating an educational opportunity for clerkship-level students. Four clerkship medical students participated in virtual focus groups with this curricular team and identified 2 priority needs: learners' need for safe and experiential workplace learning and the health system's need for additional support responding to new and changing problems due to conditions created by COVID-19.

Step 3: Goals and objectives

The primary goal of the UCSF COVID-19 response curriculum was to provide an opportunity for workplace learning in the absence of traditional clinical clerkships. Specifically, our aim was for students to fill identified health systems gaps, and in doing so, develop clerkship-level milestones in the competency domains of practice-based learning and improvement, professionalism, and systems-based practice. Development in the competency domains of patient care, medical knowledge, interpersonal and communication skills, and interprofessional collaboration were not primary goals because student participation in direct in-person patient care was discouraged and students would likely be working primarily via virtual platforms. An additional goal was to enable students to continue career and specialty exploration.

Specific course objectives were to:

- Describe the challenges associated with altered health system resources and restrictions on traditional physician–patient interactions in a pandemic;

- Articulate the changing roles of the health care team and the medical system to continue to provide excellent patient care in the pandemic environment;

- Within the context of the health care team, seek and select evidence-based strategies for an identified gap around clinical quality, safety, patient experience, or value;

- Contribute to care delivery efforts to improve the quality, safety, patient experience, or value for a panel or population of patients during a pandemic;

- Respond to mesosystem (e.g., community or public health) needs regarding access to care, health and health care disparities, and intersystem links between care providers (e.g., hospital to clinic, prison to community); and

- List one's own roles and responsibilities and those of professionals on the health care team and seek feedback throughout the experience.

Step 4: Educational strategies

The COVID-19 response curriculum was designed to match clerkship medical students with projects led by faculty at 3 UCSF-affiliated health systems: the UCSF Health system, the city and county San Francisco General Hospital (ZSFG)/ Department of Public Health, and the San Francisco Veterans Affairs (SFVA) Health Care System.

Faculty-mentored COVID-19 clinical projects for students were identified by health system site teams, composed of faculty and students affiliated with each site. These teams identified faculty partners from a variety of specialties to solicit and brainstorm experiences that would target the pandemic response. Faculty were encouraged to design experiences that could accommodate individual student availability, such that students could determine their own weekly participation schedules. Site teams anticipated that this structural flexibility could empower students to take

ownership of their learning in the rapidly evolving context of the pandemic.

Faculty with potential projects met with site teams to discuss logistics and feasibility before submitting a project proposal. Site teams provided guidance to project leaders and assessed the educational value of the opportunities. Projects that did not meet logistical requirements (e.g., required exposure to COVID-positive patients, conflicted with mandatory student didactics) or were assessed as not providing sufficient educational value (e.g., lacked workplace learning component, data-entry only roles) were not assigned students.

Step 5: Implementation

All third- and fourth-year students were offered the opportunity to sign up for the curriculum and none were required to enroll. Students were queried by electronic survey about their health system onboarding access, scheduling availability, language fluency, and general interests. Students were then matched to projects by the curricular design team, with special consideration given to matching students to projects relating to their interests (e.g., pediatrics, population health). The number of students matched to each project was based on project need. Elective units, not required for graduation but reflected on students' final transcripts, were offered for participation. Students received a pass/no pass grade for this curriculum.

We encountered several challenges while establishing the curriculum. First, the immediate high demand from clinical sites interested in student participation challenged our administrative capacity. This high demand was likely due to the increased burden on the health system from COVID-19 combined with our clinical faculty's enthusiasm to continue teaching students. We addressed this difficulty by triaging projects by urgency, quickly matching students to active projects and efficiently supporting faculty with timely and short planning meetings. Second, we were challenged to ensure equity for students when assigning projects, as some students were interested in participating in multiple projects and had experience and skills applicable to several projects. We offered all students 1 project before allowing students to participate in multiple projects. Due to the high degree of faculty engagement,

we were able to offer sufficient and equal opportunity for students to participate in projects aligned with their interests.

Step 6: Evaluating the effectiveness of the curriculum

We queried students by electronic Qualtrics survey following completion of the curriculum (version XM; Qualtrics, Provo, Utah; 2020) (the full survey may be found at https://ucsf.co1.qualtrics.com/jfe/form/SV_cZvkmbVNOov984B). The survey explored students' narrative motivations, goals, and learning outcomes and also included a checklist for learners to self-identify UCSF clerkship-level competency milestones developed during the curriculum in competency domains of patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, systems-based practice, and interprofessional collaboration.[21] Students were required to complete this survey to receive academic credit for curriculum participation.

Survey responses were de-identified before coding. We tabulated quantitative data, including student appraisal of clerkship-level competency milestones developed during participation in the curriculum, in Excel (version 16.41; Microsoft; 2020).

Qualitative data included student responses about motivations for participating in the curriculum and learning points taken away from the curriculum. We conducted thematic analysis using the 6-step method described by Kiger and colleagues, adopted from Braun and Clarke's model.[22,23] An inductive approach was taken, deriving themes from the data without a deductive preexisting framework. First, 3 authors involved with development of the curriculum, namely, 2 third-year medical students (L.M.C. and M.R.H.C.) and 1 faculty member (S.E.F.), familiarized themselves with the data by individually reading through all student survey responses. Then, responses were divided and distributed to each of the 3 authors, who began generating initial codes within their subset, allowing for multiple codes per response and reviewing responses as new initial codes emerged. The team then compared, contrasted, and combined initial codes identified within their subset of responses. Using these updated codes, the team synthesized and mapped out themes that emerged. After developing this set of themes and subthemes, authors (L.M.C., M.R.H.C., and S.E.F.) reviewed it to ensure these accurately reflected responses. Team members were then assigned a different subset of responses to review to ensure correct assignment and accurate reflection of themes and subthemes, such that all responses were reviewed by at least 2 team members. Before data analysis, the student authors received training in thematic analysis from faculty authors with extensive experience in this method.

Student Learning Outcomes

Student participation and project characteristics

A total of 126 medical students enrolled in the curriculum and submitted their postcurriculum survey (100% response rate). Student demographics are presented in Table 1. A total of 38 projects across the 3 health systems (academic, county, and veterans) were created, of which 32 (84%) were completed remotely. Distribution of projects across departments was as follows:

- Internal medicine: 20 (53%)
- Obstetrics–gynecology: 4 (11%)
- Public health: 3 (8%)
- Emergency medicine: 3 (8%)
- Pediatrics: 3 (8%)
- Family and community medicine: 2 (5%)
- Interventional radiology: 2 (5%)
- Psychiatry: 1 (3%)

Projects addressed a range of health system gaps, spanning 8 specialties and a variety of patient populations. Projects' aims included providing inpatient or outpatient support, assisting public health efforts, creating patient and community or provider resources, and engaging in telemedicine (see Table 2).

All interested students were matched with 1 or more projects. The number of students assigned to each project ranged from 1 to 11. Mean project duration was 7 weeks (range, 1–20 weeks). Sixty (48%) students participated for less than

Table 1

Demographics of COVID-19 Response Curriculum Participants, University of California San Francisco School of Medicine, 2020

Students	No. (%)
Total number	126 (100)
Level	
Third year	87 (69)
Fourth year	39 (31)
Gender	
Female	83 (66)
Male	42 (33)
Nonbinary	1 (1)
Age	
20–25 years	47 (37)
26–30 years	59 (47)
31–35 years	18 (14)
> 36 years	2 (2)
Race	
White	45 (36)
Asian	40 (32)
Hispanic/Latinx	17 (13)
Multiple races	10 (8)
Black	8 (6)
Other	4 (3)
Declined to respond	2 (2)

Abbreviation: COVID-19, novel coronavirus disease 2019.

10 hours per week, 48 (38%) for 10 to 20 hours per week, 9 (7%) for 20 to 30 hours per week, 3 (2%) for 30 to 40 hours per week, and 6 (5%) for more than 40 hours per week. All students met the objectives of the curriculum and received a passing grade for participation.

Competency milestones

Student-identified clerkship-level competency milestones achieved through participation in their COVID-19 curricular project are presented in Table 3.[21] Of the 35 possible milestones, there were 12 milestones for which the majority of students reported development: practice-based learning and improvement milestone 2 (57%); interpersonal and communication skills milestones 1 (86%) and 4 (60%); and professionalism milestones 1 (73%), 2 (87%), 3 (64%), 4 (76%), 5 (80%), 6 (67%), 7 (68%), 8 (56%), and 9 (66%). The most commonly identified competency domains for which over half of students reported development of milestones

Table 2
University of California San Francisco School of Medicine COVID-19 Response Curriculum Project Topics and Departments

Project topics	Department
Inpatient	
1. Discharge planning for socially complex patients	Internal medicine
2. Medication reconciliation for high-risk hospitalized patients to reduce medication errors and adverse drug events	Internal medicine
3. Engaging in video social outreach to patients hospitalized in respiratory isolation	Internal medicine
4–6.[a] Providing iPads to connect hospitalized patients with their support systems outside of the hospital	Internal medicine
Ambulatory	
7. Developing a hotline to connect people recently released from correctional facilities to medical care	Family and community medicine
8. Outreach to skilled nursing facilities to provide COVID-19 education and best practice updates	Public health
9. Developing and analyzing a global registry of rheumatic disease in patients diagnosed with COVID-19	Rheumatology, internal medicine
10. Coordinating a food pantry providing patients with nutritious foods and supplies to monitor pregnancy	Obstetrics–gynecology
11. Offering educational support to patients on clinic-administered intramuscular depot medroxyprogesterone acetate (Depo-Provera) who are transitioning to self-administered subcutaneous depot medroxyprogesterone acetate (Depo-Provera)	Obstetrics–gynecology
12. Performing COVID-19 screening calls for patients scheduled for visits at the Family Birth Center	Obstetrics–gynecology
13. Tracking discharged patients with housing instability and community barriers to housing for local government	Emergency medicine
14. Confirming and providing COVID-19 advanced care planning discharge instructions from the Emergency Department	Emergency medicine
15. Assessing needs of vulnerable outpatient COVID-19-positive patients and connecting patients to community services	Internal medicine
16. Outreach calls to provide social support for home-based primary care veterans	Internal medicine
17. Outreach and educational calls to medically and socially complex pediatric patients to provide education and build care plans	Pediatrics
18. Contacting vulnerable primary care patients in city primary care clinics	Internal medicine
19. Social outreach and COVID-19 education calls to veterans isolated at home	Internal medicine
Public health	
20. Contact tracing for the Department of Public Health	Public health
21. Coordinating community-based COVID-19 testing in a census tract region of the city	Infectious disease, internal medicine
22. Coordinating community-based COVID-19 testing in a suburb town	Infectious disease, internal medicine
Patient education	
23. Developing a multilingual resource platform for individuals with mental illness experiencing homelessness during the pandemic	Psychiatry
24. Developing online public health resources for the city and county and responding to questions from the mayor's office and the public	Public health
25. Collating and providing COVID-19 educational materials and resources to community food banks	Internal medicine
Clinician support	
26. Serving on a clinical task force to develop specialty-specific learning materials for hospital medicine	Internal medicine
27. Serving on a clinical task force to develop specialty-specific learning materials for interventional radiology	Interventional radiology
28. Developing and maintaining a COVID-19 decision support tool	Emergency medicine
29. Compiling social needs resources to build electronic health record charting support tools for providers	Pediatrics
Telemedicine	
30. Outreach calls to help set up video call platforms for obstetrics visits	Obstetrics–gynecology
31. Performing telehealth eye exams and creating educational materials for pediatric ophthalmology	Pediatrics
32. Video screening visits for the Veterans Affairs Respiratory Clinic	Internal medicine
33. Providing telemedicine previsit health screening and medication reconciliation to high-risk patients	Internal medicine
34. Outreach calls to help set up video visit platforms and provide social outreach to patients with rare and chronic conditions managed by interventional radiology	Interventional radiology
35. Geriatric social outreach and assessment of telehealth readiness and unmet needs	Internal medicine
36. Outreach to elderly patients with language barriers to prepare for telehealth visits with primary care provider	Internal medicine
37. Coordinating a telephone linked care hotline for veterans	Internal medicine
38. Helping home-based primary care veterans set up telehealth communication platforms	Family and community medicine

Abbreviation: COVID-19, novel coronavirus disease 2019.
[a]Separate projects run independently at all 3 health systems.

Table 3

Clerkship-Year MD Competency Milestones Explored by 126 Students Participating in the COVID-19 Response Curriculum, University of California San Francisco School of Medicine, 2020

Competency domains	No. (%) students[a]
Patient care	
Document patient encounters for reporting of information, assessment, and initial plan	45 (36)
Gather complete and focused histories from patients, families, and electronic health records	1 (1)
With appropriate supervision, manage patients with acute and chronic illness	16 (13)
Present patient information with an assessment, differential diagnosis, and initial plans	44 (35)
Observe, assist, or perform procedures and skills	10 (8)
Conduct a physical exam efficiently, interpreting abnormalities, and maintaining patient comfort	28 (22)
Medical knowledge	
Establish and maintain knowledge necessary for patient care including the etiology, pathogenesis, manifestations, treatment, and management of medical problems	54 (43)
Apply an inquiry-oriented and analytic approach to learning and patient care	33 (26)
Select, justify, and interpret diagnostic tests and imaging	10 (8)
Solve clinical problems using a systematic approach	2 (2)
Select and use the appropriate electronic decision support tool	1 (1)
Select basic preventative, curative, and/or palliative therapeutic strategies	8 (6)
Practice-based learning and improvement	
Reflect on and address impacts that personal biases, identity, and privilege have on interactions	38 (30)
Employ strategies for seeking, receiving, acting upon, and delivering feedback	72 (57)[a]
Locate, appraise, and apply scientific evidence in providing appropriate patient care	58 (46)
Interpersonal and communication skills	
Communicate effectively with patients, families, peers, and other team members	108 (86)[a]
Discuss challenging information with patients and families	42 (33)
Elicit and incorporate patient and family concerns, needs, and preferences into management plans	55 (44)
Anticipate, interpret, and respond to own and other people's emotions appropriately	76 (60)[a]
Professionalism	
Demonstrate respect, compassion, honesty, and integrity when interacting with patients, families, colleagues, and teams	92 (73)[a]
Demonstrate accountability, reliability, initiative, and responsiveness in interactions with patients, families, and colleagues	110 (87)[a]
Demonstrate sensitivity and responsiveness to how patients define aspects of their diversity and identity	81 (64)[a]
Navigate the balance of autonomy and need for supervision	96 (76)[a]
Practice ethically with integrity and commitment to social justice	101 (80)[a]
Adhere to institutional, regulatory, and professional standards and administrative expectations	84 (67)[a]
Balance needs of patient, patient care, and health care team with own needs	86 (68)[a]
Demonstrate ongoing reflection and learning about own professional identity formation	71 (56)[a]
Recognize own stress and respond appropriately, using resources to promote wellness and maintain professional behavior	83 (66)[a]
Systems-based practice	
Apply knowledge of health care system to coordinate patient care across and within health care systems	45 (36)
Identify risks to patient safety and apply strategies to deliver safe patient care	34 (27)
Incorporate understanding of strategies for promoting health care quality in health care systems in generating care plans for patients	29 (23)
Understand current and historical factors affecting health equity, structural inequalities in access to and quality of health, and apply this understanding to improve patient health	43 (34)
Interprofessional collaboration	
Incorporate knowledge of own role and roles of other health professionals in providing patient care	50 (40)
Communicate with other health professionals responsively and responsibly to support collaborative patient-centered care	54 (43)
Demonstrate respect for cultures, values, roles, and expertise of other health professionals	53 (42)

[a]Milestones developed by over 50% of students.

were professionalism (all milestones), interpersonal and communication skills (half of milestones), and practice-based learning and improvement (one-third of milestones).

Student motivation

Students described 2 central motivations for participating in the curriculum: fostering their identity as physicians-in-training and patient engagement.

Identity as physicians-in-training. The most prominent motivation mentioned by participants was a "desire to contribute," arising from a sense of responsibility tied to their identity as physicians-in-training. Students strongly identified as a part of the health care system, feeling simultaneously called to action but lacking opportunities to participate and develop as clinicians. Recognizing the increased demands and decreased support clinical health care workers were facing, many learners were motivated to alleviate health care worker burden. Students also described a sense of responsibility to use specific skill sets, including language abilities, laboratory training, or proficiency from employment before medical school. Sample learner quotes include:

> I felt compelled to contribute to pandemic response as a member of the larger medical profession. I was saddened by our removal from the clinical environment and was searching for another mechanism by which to help the health system. (Third-year student, Department of Medicine, UCSF Health)

> I felt pretty trapped when we were pulled from clinical rotations…. It was hard to reconcile this desire to help and put forth my best effort to aid in the effort to provide thorough, equitable, and quality care to people in need. (Third-year student, Department of Medicine, SFVA)

> I wanted to use my time to be helpful, especially when it's clear that many physicians, nurses, and other health care workers are sacrificing so much. (Third-year student, Department of Psychiatry, ZSFG)

Patient engagement. Students were eager to engage with patients to maintain connection and mitigate isolation for both patients and students. Specifically, some participants recognized how social distancing and hospital visitor restrictions could detrimentally affect patients' emotional wellbeing. Learners were

also motivated to join the curriculum to address patient health needs, as they worried about the many burdens felt by patients, such as limited health care access and the substantial health threat of COVID-19. Others joined out of concern about the disproportionate impact of the pandemic on vulnerable patients, including older adults, racial minorities, women, and those with limited English proficiency or lower economic means. Sample student quotes include:

> With COVID-19 restrictions, families and loved ones have been separated from patients at a time when they are most in need of love and support. I was primarily drawn to this [curriculum] because of its tangible impact on patient experience and patient care during such difficult times. (Third-year student, Department of Medicine, UCSF Health)

> I wanted to be able to address disparities in the COVID-19 pandemic. (Third-year student, Department of Medicine, ZSFG)

> I want to care for people when they are most vulnerable and support them through the hardest times. (Third-year student, Department of Medicine, SFVA)

Student learning

Students' qualitative survey responses conveyed 6 central learning themes: interprofessional teamwork, community resources, technology in medicine, skill-building, quality improvement, and specialty-specific learning (Table 4).

Interprofessional teamwork. Medical students described learning from interprofessional team members, including social workers, laboratory technicians, nurses, and pharmacists. Specifically, they witnessed how the roles of each team member are coordinated to produce an efficient team, maximizing patient health. The importance of collaboration and communication within and across teams was impressed upon learners who recounted how teamwork had been successful or could have been improved. Learners also engaged with the clinical support processes that enable the clinical workplace to function. They detailed a newfound understanding of the complexities and efficiencies, or lack thereof, of many health systems processes, including managing orders, lab processing, and consulting other services.

Community resources. Many participants reported learning about

the workflow, processes, and impact of community resources on patient care. Students described expanding their knowledge about the services provided by community programs, government programs, and not-for-profit organizations, noting how these services are necessary for adequate and equitable health care and help to address disparities exacerbated by the pandemic. Learners also commented on how complicated accessing these services can be and how little training medical school provides regarding this process. Further, many responses detailed a new understanding of skills needed for delivering medical care in the community, including establishing connections, building institutional trust, and developing targeted programs to support specific communities.

Technology in medicine. Students described participating in various health care technology initiatives and gaining an appreciation for how telehealth can meet patient needs. They articulated how telehealth allowed patients who might otherwise have been unable to access care, due to burden from travel, work, and/or childcare, to quickly and relatively easily connect with their health care provider. Learners also chronicled how technology such as virtual platforms could be employed to combat patient isolation, including connecting hospitalized patients unable to have visitors with their family members and providing social connection to lonely elderly community members.

Skill-building. In their new and varying roles, participants sharpened their patient communication and public health skills. Specifically, they practiced difficult communication when they delivered bad news, such as positive COVID-19 test results, to patients. They applied complex communication skills to obtain the best possible medication history, provide contraception counseling, and conduct medical histories and physical examinations by telehealth. Learners further developed their public health skills by participating in contact tracing, translating health materials for the public, and working with epidemiologists. Students also articulated the profound impact empathy can have on patients' emotional wellbeing and learned that any member of the clinical team can

Table 4

Sample Quotations for Student Learning Themes Developed During the COVID-19 Response Curriculum

Theme	Representative comment
Interprofessional teamwork	
Clinical work processes	• "I've also learned so much about what happens when you order a lab test! As a physician, you just put the order in and it magically comes back in the computer a day or two later, but there are SO MANY steps and such a complex, efficient and accurate system that needs to be in place in order to make that happen." Fourth-year student, Department of Internal Medicine, UCSF Health
Interprofessional team members	• "One learning point that I am taking away from the COVID Response Elective about health care and health systems is the incredible value of the interprofessional team in helping to manage and coordinate care for patients." Third-year student, Division of Geriatrics, UCSF Health • "The tremendous power of interprofessionalism, when health care professionals come together from all fields it makes for a diverse and rich experience that is unforgettable." Fourth-year student, Division of Infectious Disease, ZSFG
Communication and collaboration	• "Successful advocacy for public health requires the work of multiple team members from multiple different backgrounds." Fourth-year student, Department of Internal Medicine, UCSF Health
Community resources	
Value of services: Services are necessary for adequate and equitable health; Services address health care disparities	• "It was sometimes heartbreaking to talk to contacts who did not have the means or ability to isolate (sole caregivers, workers without job security, for instance). It reaffirmed for me how deeply I believe in building a stronger safety net and societal infrastructure that can support all people and how advocacy on a broader scale will be part of my career." Fourth-year student, Department of Internal Medicine, ZSFG • "Health care and health systems disparities have always existed in the U.S., but COVID-19 has further exacerbated them. It is striking to see how vulnerable and underserved communities have become 'hotspots' for the coronavirus." Fourth-year student, Department of Public Health, ZSFG • "Whether related to insurance, finances, language, transport, or health literacy, patients face so many barriers in accessing medical resources and follow up care. There are many gaps in our system that may only be apparent once the patient leaves the clinic or hospital. I learned about the critical role of anticipating barriers, searching for solutions in advance, and following up from the side of the provider or provider's office. We cannot let our vulnerable patients fall through the cracks." Fourth-year student, Department of Family and Community Medicine, ZSFG
Processes of social services: Complexity of social service systems; Community medicine	• "[This city] has a network of mental health care clinics and resources for patients (including patients with no insurance), but there is often a wait list to obtain these services." Third-year student, Department of Psychiatry, ZSFG • "Learned how it may look like resources exist on paper—but how hard it can be for a patient to take advantage of those resources, due to numerous barriers and obstacles in a system." Fourth-year student, Department of Family and Community Medicine, ZSFG • "I have learned a lot about the bureaucracy of non-profit and government resources. It takes an enormous amount of energy and time to navigate what programs are available, what are their requirements, and what are their limitations. If I have learned anything, it is a renewed respect and gratitude for social workers and case managers who deal with these systems every day." Third-year student, Department of Family and Community Medicine, ZSFG
Technology in medicine	
Value of telehealth technology to combat patient isolation	• "An effective and efficient clinic visit does not have to take place in person. There is much that can be done via telehealth in terms of managing patient needs, answering any questions, and setting future goals." Third-year student, Department of Family and Community Medicine, ZSFG • "I think one learning point that I will take away is that health care workers do have a role in tech innovation in health care." Fourth-year student, Department of Internal Medicine, UCSF Health
Skill-building	
Patient communication	• "I've learned a lot about delivering bad news to patients (e.g., a positive COVID-19 test) during the clinical training I received through this elective. While I had received similar training in the past, it was very helpful to be able to relate that preclinical training to an actual situation" Third-year student, Department of Internal Medicine, SFVA • "I'm learning how to have end of life discussions." Third-year student, Department of Internal Medicine, ZSFG
Public health	• "I've learned about the importance of translating medical knowledge to the community. I think I have really experienced how important it is for the work we do to be community based—that means seeking to get public health information out to people in an accessible culturally sensitive manner." Third-year student, Department of Family and Community Medicine, ZSFG
Therapeutic empathy	• "A physician can be helpful just by exercising humanity, medical knowledge is not everything." Third-year student, Division of Geriatrics, UCSF Health • "No matter what my skill level, I can still make a difference in someone's life." Third-year student, Department of Family and Community Medicine, ZSFG
Quality improvement	
	• "Continue to trial-and-error processes. Plan to make a change, implement it, observe the outcomes of that change, and adjust accordingly." Third-year student, Department of Internal Medicine, SFVA • "Recognizing the limitations of our knowledge while continuing to work with the information that we have is key to efficient mobilization. Remaining adaptable as our knowledge grows is important to creating high quality care systems." Third-year student, Department of Obstetrics and Gynecology, ZSFG • "Quality health care is both reactive and proactive." Third-year student, Department of Internal Medicine, UCSF Health
Specialty-specific learning	
Specialty exploration	• "As someone who's interested in palliative care, checking in on patients and supporting them through the physical ailments as well as spiritual concerns, I have learned a lot along the way." Third-year student, Department of Family and Community Medicine, ZSFG

Abbreviations: COVID-19, novel coronavirus disease 2019; SFVA, San Francisco Veterans Affairs; UCSF, University of California San Francisco; ZSFG, Zuckerberg San Francisco General hospital.

offer this substantial benefit to patients. By genuinely listening and providing compassionate support, they learned to develop a therapeutic alliance with patients.

Quality improvement. Learners engaged in quality improvement at the level of teams, departments, and systems as they conducted Plan-Do-Study-Act cycles,[24] continually reviewing and updating their projects based on feedback and outcomes. Students were enthusiastic and encouraged by this fast-paced, iterative process and expressed interest in participating in quality improvement work in their future professional endeavors.

Specialty-specific learning. Participants explained how specific projects enabled them to explore their specialty interests, including in pediatric ophthalmology, radiology, obstetrics–gynecology, and emergency medicine. This filled a gap in students' available opportunities to explore their career interests and allowed them to develop relationships with faculty in specific specialties.

Lessons Learned

While clerkships are widely recognized as the central mechanism for clinical learning,[5–7] students can have rich workplace learning experiences in nontraditional workplaces. Traditionally, clinical skills and competencies are learned through an apprenticeship model in direct patient care, but the curriculum we developed demonstrates how virtual clinical workplaces and project-based teaching strategies can also enable clerkship students to develop competencies and achieve valuable workplace learning. This is not to suggest that clinical clerkships can successfully be conducted entirely remotely or in a project-based format, but instead that traditional clinical clerkships could be extended to include other learning opportunities and clinical settings (e.g., quality improvement, telemedicine, public health). For example, with the return to traditional clerkships, students could continue to be involved in telehealth outreach to vulnerable patient populations to address their health needs.

We found that an advantage of this curricular structure was the flexibility afforded to students to guide their own learning. Students primarily set their own schedules and often conducted projects remotely. Almost half of the projects required less than 10 hours per week. Many medical schools have recently focused on adapting curricular structure to support student wellness,[25] and as medical schools move curricula to virtual settings, we caution against overloading students with rigid, lengthy virtual learning and inducing virtual platform fatigue.[26] Our findings indicate that students can achieve important learning when they are empowered with flexibility in their education and schedule and when the learning opportunities match their interests and serve the community.

This curriculum enabled students to learn important clinical doctoring skills and health systems science knowledge that are missing from clinical clerkships as they are currently designed.[27,28] Some of the themes students' learning embodied, such as interprofessional teamwork and clinical skill-building, are typically included in undergraduate medical education. However, familiarity with community resources, technology in medicine, and quality improvement, described by students and recognized by educators as essential components of medical education in preparing students to be effective physicians, have been less consistently included as learning objectives in the traditional clerkship curriculum.[11,29–31] We posit that a curricular model such as the one we describe here could be incorporated to complement traditional clerkship experiences as a means of including these important health systems science topics throughout undergraduate medical education.[27,28]

Observations and Conclusions

Our application of Kern's framework to a novel COVID-19 curriculum sheds light on the student experience of COVID-19 curricula and may guide future curricular innovations in the context of a sudden and massive global or national event affecting medicine and medical education.

Our COVID-19-adapted curriculum achieved our primary goal of providing students with opportunities to engage in clinical workplace learning to advance the medical school's educational competencies. A majority of students reported development in clerkship-level competency milestones in our target competency domains of professionalism and practice-based learning and improvement, and surprisingly in interpersonal and communications skills as well.[21]

Our thematic analysis of individual student experiences demonstrated that students cultivated important skills, including interprofessional teamwork, knowledge of community resources, technology in medicine, quality improvement, skill-building, and specialty-specific learning. Specialty-specific learning matched to career interests was a difficult aim to achieve during the pandemic otherwise but was possible with this curriculum.

Strengths of our program evaluation include our intentional design of the evaluation strategy at the start of the curriculum and our systematic methods of thematic analysis. Multiple researchers reviewed each survey response and iteratively discussed and reevaluated the themes and subthemes we developed. A limitation of our evaluation is the lack of additional assessments to supplement data on students' self-reported learning. However, as students received a passing grade for participating in the curriculum, there was no incentive for students to overreport learning that did not occur.

As we transition back to prior curricula or continue with newly created educational formats, we must heed these lessons and intentionally design educational experiences that maximize student growth and prepare students to be effective physicians. This includes creatively providing workplace learning opportunities, integrating topics central to health care delivery, such as community resources, technology in medicine, and quality improvement, and empowering students with flexibility in their learning environment.

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