



Designing and Implementing a Virtual Anatomic Pathology Elective During the COVID-19 Pandemic

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Abstract

The COVID-19 pandemic transformed conventional undergraduate medical education, converting previously in-person clerkships into virtual experiences. In order to allow students to gain exposure to the field of pathology, make connections with pathologists, and provide opportunities for letters of recommendation, the authors quickly developed a Virtual Anatomic Pathology Elective at the University of Minnesota. We succeeded in developing the foundation of a Virtual Anatomic Pathology Elective that allows for the rotation to be accessible not only to our medical students but also to international medical graduates and medical students from different programs. In 1 month, we were able to create a 4-week elective that was available before the start of the 2021 residency application season. We provided students with the closest possible experience to an in-person Anatomic Pathology Elective by developing an introductory week of lectures and assignments that provided structure for the rotation, introduced the field of anatomic pathology, and demonstrated the role of pathologists in health care. Furthermore, students attended virtual resident lectures and grand rounds, participated in virtual sign-out sessions, and presented an interesting case to the faculty at the end of their rotation. The goal was ultimately to customize the curriculum to students' interests by making the rotation applicable to those applying to pathology as well as to other specialties (eg, general surgery, internal medicine, dermatology). Overall, we were able to design and implement a novel Virtual Anatomic Pathology Elective which we know can be effectively reproduced by other medical schools.

Keywords

anatomic pathology, virtual elective, COVID-19, medical education, undergraduate medical education, medical student

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Introduction

The COVID-19 pandemic disrupted the standard methods of undergraduate medical student education in the United States. In the spring of 2020, the majority of medical schools paused in-person clinical experiences in favor of online learning following the guidance of the Association of American Medical Colleges (AAMC).¹ At the University of Minnesota—Twin Cities campus, all in-person instruction was suspended and the medical school converted entirely to virtual learning in March 2020 without the opportunity for return to the clinical environment until late June 2020.² This temporary suspension was due

to a multitude of uncertainties and limitations imposed on medical education by the pandemic. For instance, at that point in time, the mechanism of transmission of the severe acute

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respiratory syndrome coronavirus 2 virus was unknown, there was finite personal protective equipment available for health care workers, and the resources for widespread and accurate testing were limited. In addition, institutions were concerned about providing a safe and effective learning environment for trainees.³

The closure of in-person learning posed a variety of challenges across undergraduate medical education. However, third- and fourth-year medical students were particularly impacted by this rather sudden inability to access the clinical environment. Notably, the pause of in-person clerkships occurred at the time when third-year medical students began finalizing their career choices and preparing their applications for residency. Additionally, students often pursue “away experiences” (sometimes used as audition rotations) during this time in order to increase their competitiveness for programs and network within their specialty of interest. However, any plans for away rotations were canceled as per the recommendations of the AAMC and various specialty organizations.⁴

For pathology applicants, the conversion of traditionally in-person pathology clerkships to the virtual format posed a unique set of challenges. Firstly, pathology is not a required rotation at most medical schools. Therefore, students interested in pathology will not have exposure to the anatomic pathology (AP) or clinical pathology (CP) departments at their institutions until late in their third or early in their fourth year of medical school aside from their preclinical pathology curricula. Therefore, many students interested in applying to pathology for the 2021 residency application cycle did not have the opportunity to participate in an in-person pathology rotation prior to the COVID-19 pandemic. Secondly, many osteopathic (DO) and some allopathic (MD) medical schools do not host their own pathology residency programs, requiring their students to pursue away rotations in order to gain exposure to rotations in CP or AP. Thirdly, pathology is one of the most popular specialties for international medical graduates (IMGs), with IMGs constituting 48.7% of filled pathology residency positions in the 2020 match.⁵ However, in order to be a competitive applicant as an IMG, it is often important to have clinical experience in the United States through an observership experience.⁶ Unfortunately, similar to away rotations, these observerships were canceled, preventing IMGs from gaining the critical experience needed to match into pathology residencies in the United States.

In the face of these concerns, we saw an opportunity to design and implement a Virtual AP Elective at our institution. Pathology as a field provides the unique opportunity to transition to a virtual format, as it is traditionally more separate from the clinical environment and relies more on the interpretation of imaging and clinical notes than on patient interaction in comparison to other clinical electives. Additionally, while the field of pathology had already been transitioning to using whole slide imaging and digital pathology technology, these initiatives were expanded by many institutions during the pandemic. In March 2020, the College of American Pathologists and the Centers for Medicare & Medicaid Services secured a

remote work waiver for pathologists to review slides remotely, and many residency programs have converted to the digital format either temporarily or permanently.^{7,8} Additionally, the increase in popularity of conferencing and screen sharing software such as Zoom^a and whole slide imaging sharing platforms like PathPresenter (<https://pathpresenter.net/>; accessed November 8, 2020) have made it possible to participate in didactics, tumor boards, and even sign-out sessions virtually without leaving your home.⁹

The primary goal of the Virtual AP Elective at the University of Minnesota was to provide residency applicants with the opportunity to experience participating in an AP rotation prior to the residency application deadline, allowing them to make necessary connections with pathologists, develop research projects, and obtain letters of recommendation. A secondary goal was to make this elective available to IMGs and medical students from other institutions who needed exposure to the field or wanted to experience AP at the University of Minnesota. Importantly, we also wanted to take this opportunity to redesign and make the virtual elective useful to not only pathology applicants but also students pursuing other fields (eg, dermatology, surgery) by making the elective customizable to the students’ career goals.

Herein, we describe our process of developing the curriculum for the Virtual AP Elective, implementing the elective, and the challenges that we encountered converting the elective to a virtual format.

Materials and Methods

The Virtual AP Elective (LAMP 7116) was developed in June 2020 with the input of the multiple pathologists from the AP department, the course director KA, chief residents including CA, the director of the preclinical pathology curriculum DP, and a fourth-year medical student and former post-sophomore fellow at the University of Minnesota EH.

A course outline was first designed in order to best emulate the in-person AP elective. The in-person AP elective (LAMP 7150) was a 4-week rotation with a course capacity of up to 3 students, which we chose to replicate for the best translation of the in-person experience. During the in-person elective, students were expected to participate in the grossing of specimens, microscopic examination, interpretation, and reporting of the surgical pathology cases. They often were paired with the resident or fellow on service for real-time teaching. Additionally, they often had various unplanned opportunities, such as being involved in medical autopsies and participating in spontaneous multiheaded scope sessions. They were required to attend all resident conferences and present a final short case-based presentation at the conclusion of the rotation. The student’s final grade was determined by attendance at conferences, engagement in sign-outs and discussions, professionalism, and the quality of their final presentation. The final grade was also heavily reliant on feedback from faculty, fellows, residents, and staff.

Table 1. Initial Design and Example Schedule of the Virtual Anatomic Pathology Elective.*

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	Lecture: Course introduction and introduction to the field Meeting with course director (overview, expectations)	Lecture: Pathophysiology of disease Lecture: pathology specimens: bedside-to-bench	Pathology Grand Rounds Resident lectures Lecture: basics of writing pathology reports	Resident lectures Lecture: autopsy	Lecture: Staging/grading tumors Assignment due: pathology report
2	Student assigned readings/cases for the week [†] Virtual sign-out [‡]	Virtual sign-out [‡]	Pathology grand rounds Resident lectures Assignment due: staging/grading tumors Virtual sign-out [‡]	Resident lectures Virtual sign-out [‡]	Assignment: unknown case 1 Virtual sign-out [‡]
3	Check-in with course director Student assigned readings/cases for the week [†] Virtual sign-out [‡]	Virtual sign-out [‡]	Pathology grand rounds Resident lectures Virtual sign-out [‡]	Resident lectures Virtual sign-out [‡]	Assignment: Unknown case 2 Virtual sign-out [‡]
4	Student assigned readings/cases for the week [†] Virtual sign-out [‡]	Virtual sign-out [‡]	Pathology grand rounds Resident lectures Virtual sign-out [‡]	Resident lectures Virtual sign-out [‡]	Assignment: final presentation Virtual sign-out [‡]

*Students also were expected to attend consensus conferences and multidisciplinary conferences (breast, liver, orthopedics, pulmonary, gastroenterology, etc) as available.

[†]Students were assigned cases to review each week based on their specialty interest after meeting with the course director. Pathology areas of focus included gastroenterology, liver, breast, gynecology, dermatology, among others. They also were encouraged to watch associated histology videos and read relevant chapters in Robbins and Cotran Pathologic Basis of Disease.¹⁰

[‡]Each week's virtual sign-out schedule was discussed with the student at the beginning of weeks 2 to 4.

In order to convert the rotation to the virtual format, we created a formal structure for students to feel engaged within the department in an online environment. This included a week-long introduction to the field of AP with multiple lectures and formative assessments. The students would also meet with the course director during this week in order to discuss their career goals and design the rotation based on those goals. The remaining 3 weeks of the rotation were customized based on the student's interests, including 1-week blocks of sign-out and weekly unknown sessions. They also were encouraged to watch introductory histology videos pertaining to their pathology subspecialty focus for the week and read relevant associated chapters in Robbins and Cotran Pathologic Basis of Disease.¹⁰ Additionally, students were required to attend virtual resident lectures, pathology grand rounds, and present an interesting case at the end of the rotation (Table 1).

Specifically, the introductory lectures included a variety of topics that were relevant to medical students pursuing a career in pathology as well as other specialties. These included (1) a course welcome that introduced the field of pathology and addressed misconceptions of the field, (2) an overview of the pathophysiology of disease, (3) a description of the processing of pathology specimens after they are obtained at the bedside or in the operating room, (4) an overview of the basics of writing and interpreting pathology reports, (5) an introduction to autopsy pathology, and (6) the basics of pathologic staging/grading of common tumors.

These lectures were complemented by several supplementary formative assessments, including an assignment where students were given a case to practice writing their own gross

and microscopic pathology report as well as an assignment where they would practice staging and grading a common tumor (eg, colon cancer, breast cancer, endometrial cancer, or melanoma). Students were also given 2 unknown cases during their rotation. These were available to students a week in advance, and they would go through the case with a pathology resident at the end of weeks 2 and 3 of the rotation (see Supplemental Material 1 for an example assignment). While we were able to utilize some of the gross and microscopic images from our institution, we also utilized resources provided from the Virtual Slide Library by the University of Leeds,¹¹ the Surgical Pathology Unknowns Conference at Johns Hopkins Pathology,¹² and Pathology Outlines.¹³ At the conclusion of the rotation, students would present an interesting case, approved by the course director, to AP faculty, fellows, and residents. Additionally, an optional assignment included pursuing a research endeavor or writing a case for the second-year pathology laboratory course (see Supplemental Material 2 for a more in-depth description of each assignment).

Due to the implementation of strict physical distancing guidelines and elimination of double scoping, the majority of sign-out sessions were conducted virtually over secure University of Minnesota Zoom accounts. These sign-outs were between only the student and pathologist in order to create a directed learning environment and occurred in the late morning through the early afternoon as determined via email or virtual conversation. Additionally, students were invited to sit-in on sign-out sessions between residents and attendings. Particular care was taken to ensure HIPAA compliance. None of these virtual sign-out sessions were recorded. Additionally, the cases

Table 2. Comparison of Enrollment in the In-person Anatomic Pathology Elective (LAMP 7150) in the Late Summer Through Fall 2019 Versus the Virtual Anatomic Pathology Elective (LAMP 7116) in the Late Summer Through Fall 2020.

	LAMP 7150 (2019)	LAMP 7116 (2020)
August	2/3	2/2
September	0/2	0/2
October	1/2	2/2
November	1/2	1/2
December	2/2	2/2

were referred to by their case number, not the patient name or any other patient identifying information, and Personal Health Information was not shared on the screen.

Simultaneously, a virtual library of teaching cases was developed using the Proscia^b digital pathology platform that was subsequently used for teaching by the pathology staff during virtual sign-out sessions and various assignments for this course. Additionally, students were required to attend virtual didactic sessions offered to the pathology residents, pathology grand rounds, and encouraged to attend any additional virtual conferences (such as tumor boards and ad hoc learning sessions).

The course was graded in an honors/excellent/satisfactory/no pass (HESN) format. The pathology report and staging/grading tumor assignments, unknown cases, and virtual sign-outs were all threshold or formative assignments that were graded as pass/no pass based on adequate completion and/or participation (Supplemental Material 3). The students were graded on an HESN basis with the final Global Rating Scale evaluation form that was filled out by the course director who worked closely with the student as well as an evaluation of the final presentation. These forms sought to evaluate student progression throughout the rotation, engagement during virtual sign-out sessions and unknown cases, completion of formative assessments, and attendance to virtual conferences and didactics (Supplemental Material 4). Students could achieve honors by reaching $\geq 85\%$ in the course. Additionally, students interested in honors could opt for the optional assignment described above.

Student feedback was obtained through a general survey offered on all clinical clerkships in MedHub^c as well as a course-specific survey in Canvas.^d

Results

The course was first available to students in August 2020 after review and approval by the University of Minnesota Medical School. The course has been filled 3 of the first 5 months it has been offered, with a notably higher fill rate compared to the same time period in the previous year (Table 2). Seven students have been through the course, with a total of 9 students being enrolled before submission of this publication. Of the 9 enrolled students, 5 were students from the University of

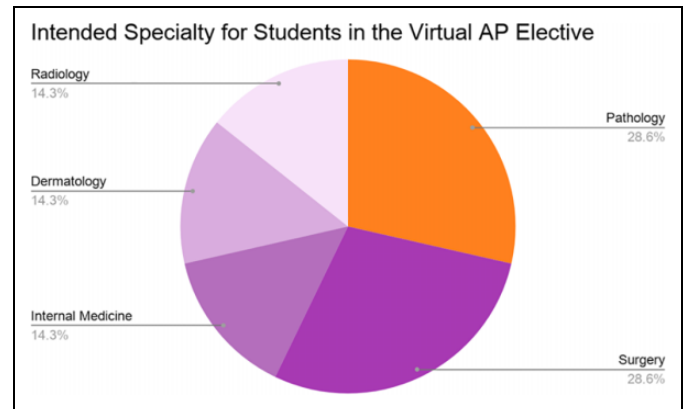


Figure 1. A graphic representation of the proportion of the intended specialty of all students who had taken the Virtual Anatomic Pathology Elective between August and December 2020 ($n = 7$).

Minnesota (5/9, 56%), 3 were students from outside MD/DO institutions without their own pathology rotations (3/9, 33%), and 1 was an IMG (1/9, 11%). Of the 7 total students who have completed the course, 2 were applying for pathology residencies (2/7, 29%), and 5 were applying for other specialties, including surgery (2/7, 29%), internal medicine (1/7, 14%), radiology (1/7, 14%), and dermatology (1/7, 14%; Figure 1).

To date of publication, we have received feedback from 4 students who have completed the course (Table 3). Student feedback has been overwhelmingly positive, with notable enthusiasm for the newly developed lecture material and the “Staging/Grading of Tumors” lecture in particular. Overall, 100% of students felt that the course informed them of the role of pathologists on the medical team and 75% of students stated that this course made them consider pathology as a career. Notably, 100% of students surveyed felt that the course catered to their own specific career goals and that was often highlighted in the written feedback from students. For example, the student interested in dermatology spent all 3 weeks of sign-out on dermatopathology. Additionally, we developed 2 different dermatopathology-oriented unknown cases (including a case of mycosis fungoides and a case of desmoplastic melanoma) as well as a staging/grading of tumors assignment involving a case of melanoma. The student was also able to choose an interesting dermatopathology case to present for his/her final assignment of the course.

We also conducted a survey of residents, fellows, and faculty in order to gain their perspectives regarding teaching medical students in this new format. Five total responses were recorded ($n = 5$), including 3 faculty, 1 fellow, and 1 resident. The time commitment dedicated to medical student teaching was approximately equivalent when comparing the virtual to the in-person elective. For the virtual course, 2 respondents reported spending 1 to 5 hours per week on teaching and 3 reported 5 to 10 hours per week. On the other hand, for the in-person course (prior to COVID-19), 3 respondents reported

Table 3. Summary of Course-Specific Feedback From Students.*

#	Question detail	Options	Aggregate responses (n = 4)
1	How difficult did you find virtual sign-out?	Very difficult (1); Somewhat difficult (2); Average (3); Somewhat easy (4); Very easy (5)	3
2	Can you suggest other assignments which might be helpful in preparing for virtual sign-out or for the rotation? If so, please indicate here.	Free text	N/A
3	How difficult did you find the “detective cases”?	Very difficult (1); Somewhat difficult (2); Average (3); Somewhat easy (4); Very easy (5)	3
4	Did you find the “detective cases” useful for your learning?	True; False	True (4)
5	The resources provided were useful in learning the material.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.5
6	The assignments facilitated learning the material.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.5
7	The “Course Introduction and Introduction to the Field” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.25
8	The “Pathophysiology of Disease” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.75
9	The “Pathology Specimens: Bedside to Bench” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.5
10	The “Basics of Writing Pathology Reports” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.5
11	The “Autopsy” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	4.25
12	The “Staging/Grading Tumors” lecture was helpful.	Strongly disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly agree (5)	5
13	How clear were the course expectations?	Extremely clear; Somewhat clear; Not very clear	Somewhat clear (2); Extremely clear (2)
14	Do you feel that the course catered to your specific career goals?	Yes; Somewhat; No (if no, please comment)	Yes (4)
15	If you do not feel that this course catered to your specific career goals, please comment.	Free text	No responses
16	Did this course inform you of the role of pathologists in medicine?	Yes; Somewhat; No	Yes (4)
17	Did this course make you consider pathology as a career?	Yes; Somewhat; No	Yes (3); No (1)
18	General course comments.	Free text	N/A

Abbreviation: N/A, not available.

* In total, 4 students responded to the survey at the time of publication.

spending 1 to 5 hours per week teaching medical students, 1 respondent reported 5 to 10 hours per week, and 1 respondent reported 10 to 15 hours per week. Overall, it was not difficult to integrate the student into the department virtually. On a scale from 1 to 10, with 1 being not difficult and 10 being extremely difficult, the average score was 3.2, with the range being from 1 to 6. Additionally, the respondents commented on several benefits to the virtual format, including (1) greater feasibility to look at cases with multiple people; (2) students had more flexibility to attend more sign-outs, tumor boards, and other teaching sessions for multiple subspecialties; and (3) safety was maintained for students and staff. The reported drawbacks included (1) less natural relationship building and mentoring, (2) lack of exposure to fields reliant on in-person instruction (eg, gross pathology, autopsy, cytology, frozen section, etc), and (3) inability for the student to learn how to navigate the slides on a physical microscope. Ultimately, all surveyed

reported that they had a positive experience working with the medical students in this virtual format.

Discussion

The COVID-19 pandemic has forced the academic medicine community to re-evaluate undergraduate medical education and the utility of virtual learning experiences. While virtual learning overall poses its own unique set of challenges for medical students,¹⁴ we encountered several challenges unique to transitioning AP to the virtual space. A summary of the similarities and differences between the virtual and in-person elective can be seen in Figure 2, and a comparison of the benefits and drawbacks of each format can be seen in Table 4.

The primary challenge we encountered was converting sign-out to a virtual format that was still engaging for medical students. Anatomic pathology sign-out is critical to residency

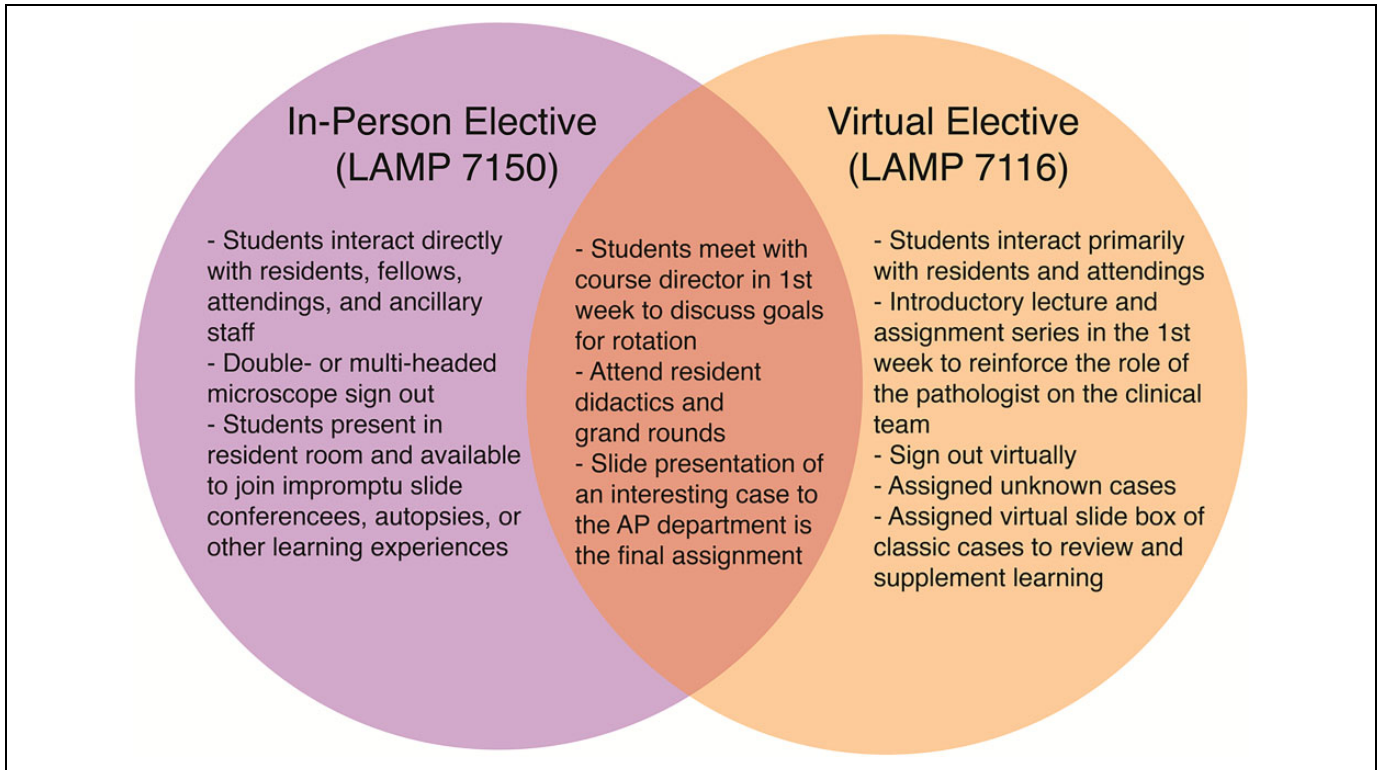


Figure 2. Comparison of the in-person and Virtual Anatomic Pathology Electives offered by the University of Minnesota.

Table 4. A Description of the “Pros” and “Cons” of the In-person Elective (LAMP 7150) in Comparison to the Virtual Elective (LAMP 7116).

In-person elective (LAMP 7150)	Virtual elective (LAMP 7116)
Pros	
<ul style="list-style-type: none"> • More interaction with ancillary staff in the pathology department • Able to better contextualize the pathology department and the day-to-day life of a pathologist in an “in person” space • More spontaneous learning opportunities 	<ul style="list-style-type: none"> • More flexibility in the schedule for both students and teaching staff • More opportunities to customize the curriculum to students’ specific interests • More learning resources for students to review • Able to maintain safe social distancing
Cons	
<ul style="list-style-type: none"> • Less foundational teaching material and assignments to reinforce the material • Less structure to the rotation • Less customization to students’ career interests (no subspecialty-specific assignments, etc) 	<ul style="list-style-type: none"> • Less frequent interaction with faculty, residents, fellows, and staff • More difficult to coordinate sign-outs and spontaneous learning opportunities • Slightly greater time commitment for faculty, especially when initially setting up the elective • Loss of informal relationship building and mentorship • Missing experience that is exclusive to in-person teaching (navigating the microscope, grossing, autopsy, cytopathology, etc).

training, and in-person medical students are often invited to join among residents, fellows, and attendings around the multi-headed microscope. However, in response to COVID-19 physical distancing measures to decrease the transmission of the virus, these impromptu learning opportunities were converted to virtual experiences that could not emulate the discussion and educational value of the in-person experience.⁸ This extended to the University of Minnesota, where all residents were signing out virtually during the pandemic. While virtual sign-out is

categorically not as valuable as the in-person experience, it provided us with the opportunity to allow medical students to directly observe and engage with the AP division while in-person instruction was suspended. Based on feedback from surveyed students, the virtual sign-out experiences were among their favorite opportunities to learn from the attendings and residents. One weakness identified, however, was the lack of structure afforded to students in remote sign-out. Often sign-out times were dictated based on the availability of the

attending pathologist and/or resident in the context of a complex calendar of administrative meetings, didactic teaching, and the variable caseload each day. In person, it was easy for the student to be included, as they were often paired with a resident or fellow in the shared resident room. However, virtually, it was more difficult to keep the student up-to-date on the sign-out times and they were sometimes not given adequate notice to prepare. This also extended to other educational opportunities for students, such as sporadic didactic sessions or autopsy cases that students were unable to attend due to the spontaneity of these events or the virtual nature of the elective. In our student survey, 2 of 4 respondents reported that course expectations were only “somewhat” clear, likely in part due to the novelty of the virtual environment of the rotation. In order to address this concern, we ensured that the expectations were clearly stated in the course description and syllabus. We also scheduled an initial meeting with the course director to address any questions as well as refine the curriculum to each individual student’s specific career goals.

Sign-out continues to be virtual for pathology residents at the University of Minnesota due to increased understanding of the transmission of COVID-19 and the success of the virtual format. While some attendings still participate in remote sign-out sessions accessible to students, other attendings have transitioned to assigning students cases to preview from a “virtual slide box” repository newly developed at the University of Minnesota. This virtual slide box contains classic pathology cases of high educational value that the student can preview on his/her own time and review at a dedicated time with a pathologist. This format benefits the students’ learning by allowing their experience to be more structured and allows them to dedicate time reviewing characteristic cases of pathologies that they will likely encounter in their future practice. However, this format also limits the diversity of cases that students would see in a traditional sign-out and prevents students from having a comprehensive understanding of the daily practice of an anatomic pathologist. In order to maintain customization to students’ interests, we are currently working on expanding our virtual slide box with classic and valuable educational cases from all AP subspecialties that can be assigned to students to review based on their specific career goals.

Another limitation was that this course is offered to only 2 students at a time. This was due to the amount of organization that is required to make the course customizable to each student’s career goals. In the future, we hope to improve this process and have a more diverse set of predesigned cases that would facilitate the involvement of additional students. Additionally, we were unable to offer this course to more outside medical students and IMGs due to interest in the course from medical students from the University of Minnesota, who were given preference. This is despite the fact that, even without formal advertising of the elective, the primary demand for this course was from students from outside institutions without pathology electives and IMGs. However, we feel that this virtual elective will serve as a valuable resource to outside medical students and IMGs by eliminating the need for travel-related

expenses, removing the visa requirement for IMGs and decreasing the required onboarding paperwork due to the lack of HIPAA-sensitive information encountered in the virtual rotation. Therefore, as we have already garnered significant outside interest by creating a novel and customizable Virtual AP Elective, we hope to expand the course capacity and continue recruiting outside students through websites like the AAMC’s Visiting Student Learning Opportunities program.

Despite these challenges, in the process of developing this curriculum, we discovered that the virtual format provided us with the unique opportunity to increase medical student exposure to pathology as a field. In recent years, applications to pathology residencies have been declining, likely in part due to inadequate education, insufficient exposure, and misunderstanding of the role of pathologists in health care.¹⁵ Therefore, the opportunity to increase awareness to the field by offering a completely virtual elective can be used to recruit future pathologists from across the country and globally. In fact, due to the limited need for patient interaction in pathology in comparison to other medical specialties, pathology may be one of the best suited fields for this virtual format. This allows pathology departments to promote their virtual electives not only to students already interested in pathology but also students applying to other specialties who will carry the appreciation and understanding of pathology with them into their future careers. As seen at the University of Minnesota, around 70% of the students enrolled in our Virtual AP Elective were interested in non-pathology specialties. Increasing exposure to the role of a pathologist in the clinical environment can also increase interest in the field. In fact, 75% of those who responded to our end-of-course survey stated that our course made them consider pathology as a career.

Similar to the University of Minnesota, pathology departments across the world have converted the crisis of the COVID-19 pandemic to an opportunity for developing their own virtual electives in both AP and CP.¹⁶⁻¹⁸ Additionally, the online resource “PathElective” developed at Loyola University Chicago Stritch School of Medicine provides a comprehensive and free elective for medical students to learn pathology from world-renowned pathologists in a virtual format.¹⁹ This virtual space offers students access to learn from pathologists in a variety of settings, network with different pathology departments, and collaborate globally with other interested medical students. Additionally, it removes potential financial and travel barriers for away rotation experiences for medical students and observership experiences for IMGs. As summarized by Mukhopadhyay et al, the large online presence of pathology as a field puts it in a unique position to harness technology and not only continue to offer elective experiences to students but also reinvigorate the traditional model of undergraduate medical student education.⁹

These changes to the curricula are also likely to remain postpandemic. For example, at the University of Minnesota, the lectures and assignments that we developed out of necessity to replicate the in-person AP experience were highly regarded by students as augmenting their understanding of pathology.

This experience has also inspired us to continue to build and improve our repository of educational slides for both pathology residents and medical students to use as learning resources, which will only continue to expand in the future and enhance learning opportunities. Postpandemic, we will likely take these components of the virtual course and combine them with in-person sign-out sessions to make a hybrid classroom fully customizable to students' career goals.

Conclusion

At the University of Minnesota, we were able to design and implement a Virtual AP Elective for medical students during the COVID-19 pandemic. In translating the in-person elective to the virtual format, we were able to identify what aspects of the rotation needed to be changed and expanded upon in order to improve the medical student experience. While there were several changes in adopting this virtual format, the increased flexibility for students allowed us to make the elective more customized to students' individual career goals. Additionally, the virtual environment allowed us to increase exposure and accessibility to the field of pathology by making the elective available to students outside of our institution. Students responded with overwhelmingly positive feedback to these changes and postpandemic these changes will continue to be integrated to augment the in-person course.

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Sources and Manufacturers

^a Zoom Video Communications, Inc; San Jose, CA.

^b Proscia Inc; Philadelphia, PA.

^c MedHub Inc; Minneapolis, MN.

^d Canvas LMS, Instructure; Salt Lake City, UT.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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