

Pushed Across the Digital Divide: COVID-19 Accelerated Pathology Training onto a New Digital Learning Curve

Lewis A. Hassell, MD¹, JoElle Peterson, MD¹ and Liron Pantanowitz, MD²

Abstract

Bringing digital teaching materials into residency training programs has seen slow adoption, expected for many new technologies. The COVID-19 pandemic dramatically shifted the paradigm for many resident teaching modalities as institutions instituted social distancing to prevent spread of the novel coronavirus. The impact of this shift on pathology trainee education has not been well studied. We conducted an online survey of pathology trainees, program directors, and faculty to assess pre- and post-COVID-19 use of, and response to, various digital pathology modalities. Responses were solicited through both social media and directed appeals. A total of 261 respondents (112 faculty, 52 program directors, and 97 trainees) reported a dramatic and significant increase in the use of digital pathology-related education tools. A significant majority of faculty and program directors agreed that this shift had adversely affected the quality (59% and 62%, respectively) and effectiveness (66%) of their teaching. This perception was similar among learners relative to the impact on quality (59%) and effectiveness (64%) of learning. Most respondents (70%-92%) anticipate that their use of digital pathology education tools will increase or remain the same post-COVID. The global COVID-19 pandemic created a unique opportunity and challenge for pathology training programs. Digital pathology resources were accordingly readily adopted to continue supporting educational activities. The learning curve and utilization of this technology was perceived to impair the quality and effectiveness of teaching and learning. Since the use of digital tools appears poised to continue to grow post-COVID19, challenges due to impaired quality and effectiveness will need to be addressed.

Keywords

adoption curve, COVID-19, digital pathology education, digital pathology tools, learning effectiveness

Received October 08, 2020. Received revised December 02, 2020. Accepted for publication December 20, 2020.

Introduction

Teaching in pathology has long followed a mentored learning apprenticeship model that relied extensively upon the use of current materials and collaborative, face-to-face management of cases, and laboratory problems. Although digital teaching materials have been widely adopted for presentation of undergraduate pathology,¹ allowing higher quality, and greater microscopic interactions and in many settings demonstrably improved learning outcomes, the same cannot always be said for postgraduate pathology training.^{2,3} A number of programs with geographic challenges instituted digital pathology and remote learning methods to resolve many of these issues.⁴

Others adopted and encouraged the use of digital slides⁵ either as personal learning tools or in some cases as part of systematic

¹ Department of Pathology, University of Oklahoma Health Sciences Center, OK, USA

² Department of Pathology, University of Michigan, Michigan Medicine, OK, USA

Corresponding Author:

Lewis A. Hassell, Department of Pathology, University of Oklahoma Health Sciences Center, Biomedical Sciences Building, Room 451, Oklahoma City, OK 26901, USA.

Email: lewis-hassell@ouhsc.edu



study.^{6,7} However, these were often the exception rather than the norm.⁸ A number of reasons are cited for the lag in uptake of digital education platforms into pathology training programs, including cumbersome interfaces with digital slides, expense in time of personnel and equipment for scanning and storage, and various other organizational and information technology issues.⁹

Over the 2 decades since whole slide scanners have been commercially available, several sizable slide repositories have been established, with variable ease of access and curation of associated diagnoses and metadata.¹⁰ The Digital Pathology Association (DPA) has long championed the use of digital slides for a host of purposes, including education at many levels such as undergraduate, residency, and postgraduate training.¹¹ Some journals have published digital slides as an adjunct to fixed photographs, and studies have demonstrated that these virtual materials offer superior results in terms of learning and application.¹² However, the digital divide in terms of education exploiting these tools versus that wedded to traditional methods still persists in many departments worldwide.

The COVID-19 pandemic led to widespread social distancing measures that severely limited face-to-face teaching, both in large classroom groups and in one-on-one encounters typical of anatomical pathology training across a double-headed microscope. The adjustments from individual institutions and national organizations brought on by these measures indicated an awareness of the potential loss to a generation of trainees of a large portion of their training experience and mentoring.¹³ The proliferation of virtual grand rounds, online lectures, and webinars and a virtual explosion of social media pathology-related teaching offerings are evidence of enormous effort to compensate for the change in teaching and learning paradigm. We postulate that this sudden shift in teaching methods, materials, and modalities has had an adverse effect on learning and teaching quality and effectiveness as many people and programs have had to quickly acquire and/or repurpose technology, as well as ascend a learning curve. However, we also believe that this effort will bring in its wake a more permanent shift to leveraging these potentially more efficient teaching and learning digital methods. The aim of this study was to therefore survey the pathology community to determine the potential impact of this shift to employing digital tools on pathology trainee education.

Methods

An online survey was conducted of pathology trainees, program directors, and faculty to assess pre- and post-COVID-19 use of, and response to, various digital pathology modalities. Responses were solicited through both social media (Twitter and Facebook) and via directed appeals through the Association of Directors of Anatomic and Surgical Pathology (ADASP) and the Association of Pathology Chairs/Residency Program Directors Section (APC/PRODS) listserv during the period of July 17 to August 21 (see Supplemental Appendix 1). No remuneration was offered aside from access to the generated data. The survey

defined digital teaching tools to include digital slides (whether in teaching conferences, teaching slide sets, or lectures), streaming live video microscopy, video lectures using presentation slides, video lectures using digital slides, virtual conferences with interactive capability such as Zoom, and virtual conferences with limited interactive capabilities (Facebook live, webinars). Results were tabulated and evaluated using the Qualtrix StatsIQ toolbox.

Results

A total reach of 2458 views of the Twitter notice were recorded, with 56 “engagements,” 15 of which were clicks on the associated survey link. Directed emails were sent to 100 members on the ADASP list and 348 on the PRODS list. An unknown number of secondary “forwards” of the ADASP and PRODS appeals may have included residents and faculty within member institutions.

A total of 261 responses were recorded including 97 from pathology trainees, 112 from pathology faculty, and 52 from program directors or associate directors. The trainees included roughly similar numbers from all years PGY1-4 (15-23%) and (24%) from PGY5 and above. Faculty averaged 14 years in their role (range 0-35 years), while program directors averaged 7 years in their role.

The survey results showed a sizable shift in use of digital pathology tools from rarely/never to often/always among the faculty respondents (Figures 1 and 2). This was most evident in the case of the use of streaming microscopy and interactive virtual conferencing. Also of note was the strong preference for more interactive streaming/videoconferencing tools in the post-COVID era (such as Zoom) compared to less interactive tools such as Facebook live.

Learner shifts in use of digital resources pre- and post-COVID echo the shift among faculty (Figures 3 and 4). Notable among the trainees’ adaptations to the pandemic was the dramatic increase in their use of lectures, slide files, or other electronic materials from outside their own institution and the corresponding drop in the portion of residents reporting they never used these materials. Residents also appeared to show a more marked increase in the use of digital slides than the corresponding increase among faculty.

A majority of faculty respondents indicated that this shift was perceived to adversely impact both the quality and the effectiveness of their teaching. Cumulative percentages agreeing with the adversely impacted statements were 59% for quality and 66% for effectiveness. Similarly, trainees agreed that the change had adversely impacted the quality (59%) and effectiveness (64%) of their learning. Program directors also tended to agree that the effectiveness of learning was adversely affected (62%) and felt that there was an adverse effect on the quality of learning in their programs (67%).

Free-text responses were also solicited as to obstacles encountered and general observations on the topic raised by the survey (see Supplemental Appendix 2). A total of 158 such responses were recorded (after excluding noninformation

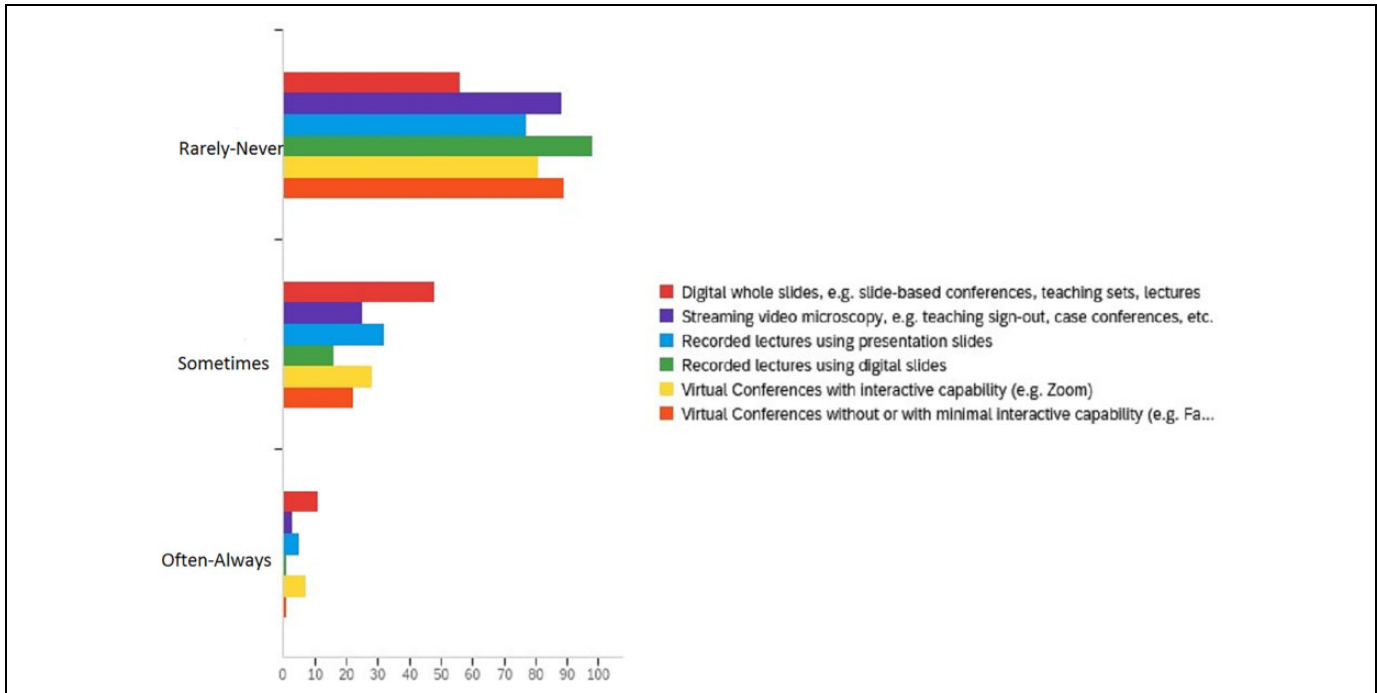


Figure 1. Frequency of use of digital tools by faculty pre-COVID-19.

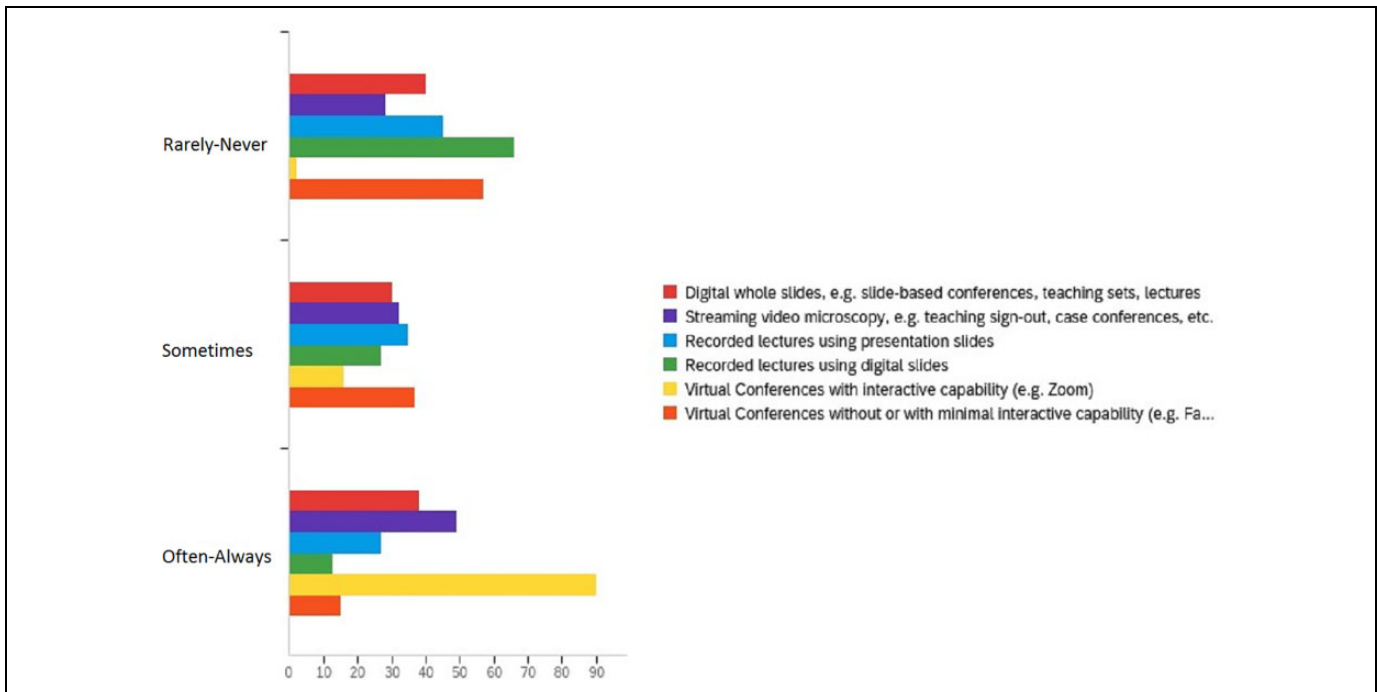


Figure 2. Frequency of use of digital tools by faculty post-COVID-19.

containing responses like “none” or “NA”) indicative of a high level of engagement on the survey topic. The barriers mentioned centered around the digital tools (eg, lack of hardware or appropriate software), training and learning curves, interoperability of resources such as slide files, cameras and software, and social adaptations or difficulties with the new

modalities themselves (eg, changes in teaching and learning styles, appropriate behaviors, etc).

The respondents were also asked to predict their future use of these same digital tools once the pandemic no longer imposed the same social distancing and other constraints on interaction. The distribution of responses to this question

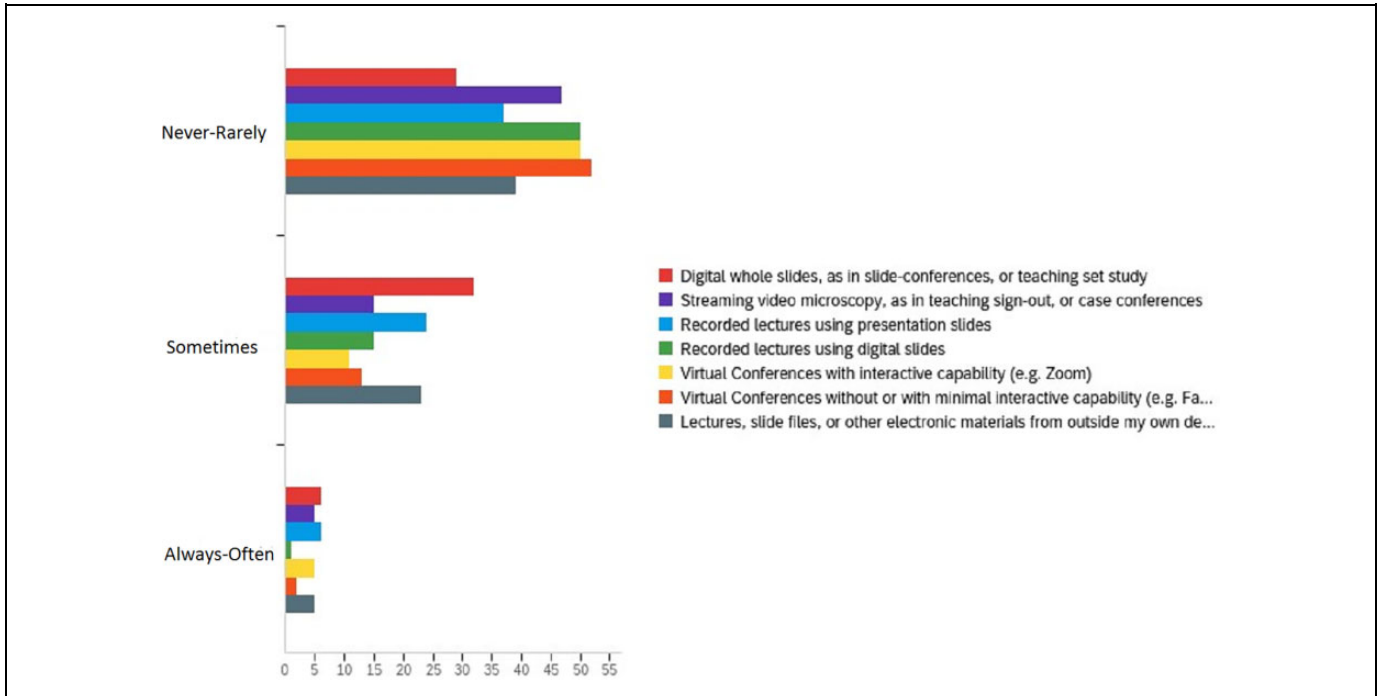


Figure 3. Relative frequency of use of digital resources by trainees pre-COVID-19.

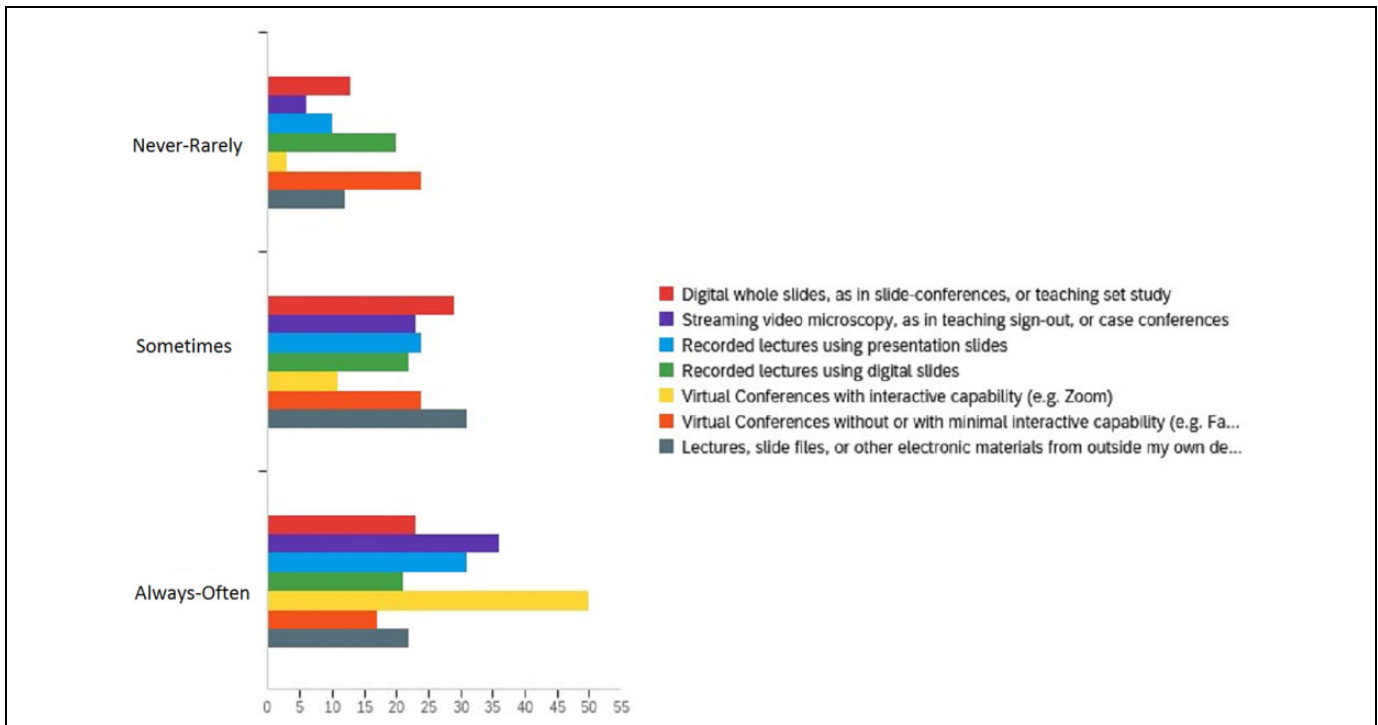


Figure 4. Relative use of digital resources by trainees post-COVID-19.

among faculty members for various digital tools is depicted in Figure 5. It is notable that the use of every digital tool is predicted to remain the same or increase once the restrictions of the pandemic subside. The rationale behind this sentiment is encapsulated in several of the free-text responses that mention

the added capabilities teaching via these digital tools offers in terms of time expended, multitasking (eg, when the topic diverges from an area of interest), elimination of geographical and travel constraints on events/attendance, and recording capability for asynchronous participation and archiving.

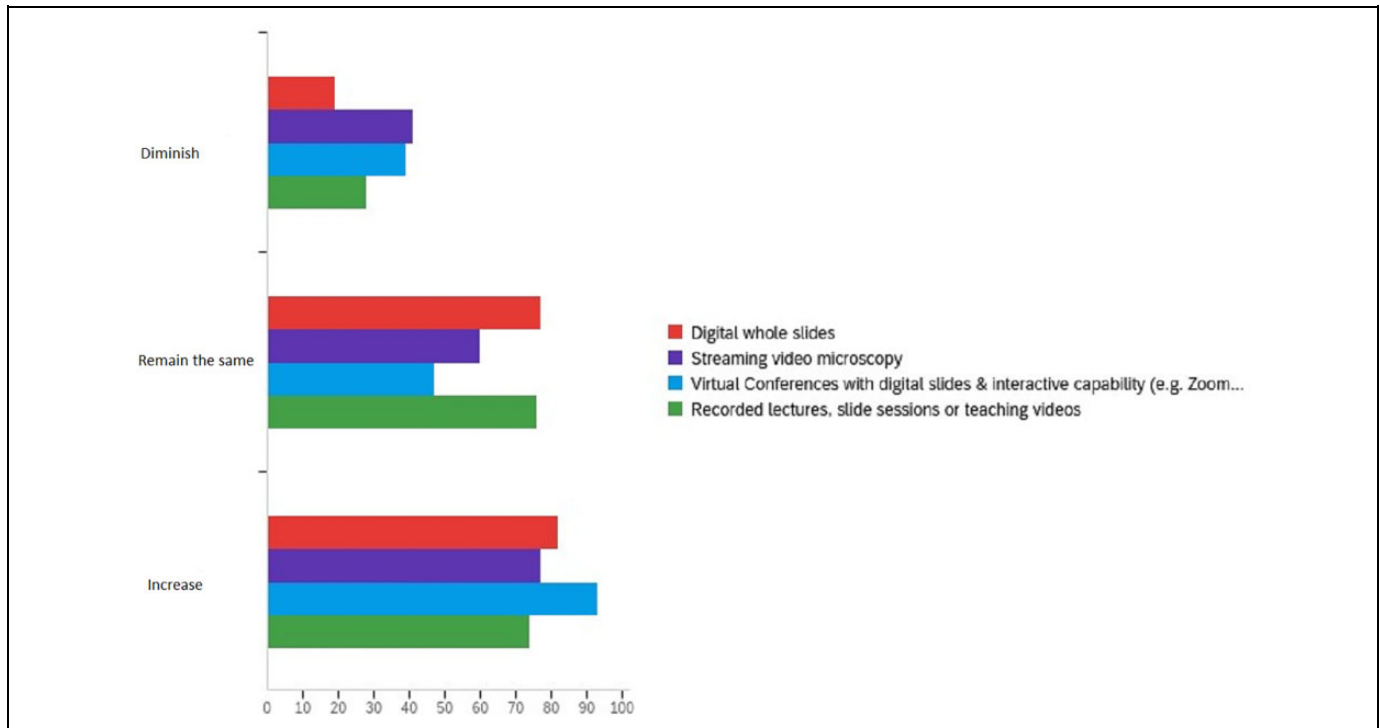


Figure 5. Respondents' assessment of future use of digital educational tools post-COVID-19.

Discussion

The novel coronavirus pandemic of 2020 is a singular, unprecedented period in the lifetimes of everyone currently engaged in pathology practice, teaching, or learning.¹⁴ COVID-19 has disrupted patterns of interaction on most levels of society, including the interpersonal behaviors of pathology faculty and trainees. Remarkably, and very admirably, dedication to the educational mission appears not to have abated, even as social distancing restrictions placed constraints upon face-to-face teaching individually and in groups. Our survey data indicate that an array of digital tools have been employed during the pandemic to carry on teaching pathology trainees. For most pathology educators, this has meant a rather sudden introduction and shift to the use of these digital tools which were not previously their norm. As might be expected with such a sudden change in methods, there has been an accompanying perception, held fairly evenly among a majority of faculty, and trainees that this has resulted in a decrease in the quality and effectiveness of pathology teaching and learning.

Our survey did not specifically solicit an explanation of why this perception was held (or not), although some of the free-text comments provide insight into some of the reasons. One reason may simply be related to the challenging learning curve associated with a new method or tool. While not overly complicated, the technology employed to teach from digital slides, streaming microscopy or from behind a computer screen presenting to a virtual audience can take time to master, a learning curve which may be measured more in months and years than weeks, depending on the frequency with which one uses these

new methods. As an example of this, one need only look at the advanced features in the cloud-based peer-to-peer platform called Zoom such as gallery view, annotation, hand raising, screen control tools, polling or breakout rooms, and recording which rarely are used but may enhance engagement and direct feedback, and hence the perception of quality or efficacy. Related to this are various information technology and infrastructure gaps that were also under stress from many other directions. For example, the supply chain for webcams was stressed by a surge in demand as more and more workers tele-commuted from home.

A further reason expressed in several comments from respondents in this study is the limitations inherent in the technology itself. The disconnection visually, as well as in time, in some modalities, between teachers and learners results in less immediate feedback and therefore adjustments of tone, pace, or content by the instructor. This can, in turn, lead to further disengagement on the part of the learners. Although frequently used platforms such as Zoom do offer visual windows into the learning audience many, if not most, participants either lack the capability for video transmission or choose to not use that feature for didactic sessions. Audience clues to understanding are thus conveyed poorly, potentially diminishing the efficiency and quality of the learning experience.

The use of digital slides along with streaming microscopy appears to have been widely adopted and poised to continue broad use.^{6,15,16} The conjunction of the pandemic with the launch of robust teaching platforms with vetted digital slides such as the Digital Anatomic Pathology Academy (DAPA) (from PathPresenter and the DPA), at the spring

2020 United States and Canadian Academy of Pathology (USCAP) meeting was highly fortuitous. Usage on the platform skyrocketed from daily users in the tens and hundreds, to well over 4000 daily users at times, while total users skyrocketed to over 150 000 from 172 countries (R Singh, MD, private communication, September 16, 2020). Interactive multimedia and meeting tools (eg, Zoom, MSTeams) also witnessed broad increases in use within pathology both for teaching and many other functions. Again, this shift is not predicted to abate after the pandemic eases.

Our study and survey has several limitations, including response bias, the subjective nature of responses sought, and sample size. We were unable to define a true response rate, since we chose to distribute with the capability to forward the survey link. We did impose a limitation on responses from a given URL that would have reduced the risk of multiple responses from a single individual. Recall bias with regard to the use of the various digital educational tools, and the effectiveness/efficiency of teaching and learning prior to and since the onset of the pandemic, is also a potential confounder. Certain early painful experiences may have been expected to be more readily recalled than uneventful ones and thus may have colored the subjective appraisal overall.¹⁷ Finally, we included predictive statements in the survey, which may not be reflective of what is truly likely to happen. However, our survey was administered at a point over 4 months into the pandemic, so it might be assumed that most respondents had enough experience to see the relative merits of the “new normal” as a consequence of COVID-19 in their education lives. More explicitly, our survey also tends toward anatomic pathology and morphology instruction and learning than toward clinical laboratory skills, except for that portion that could be included in didactic sessions. Although resident exposure in clinical lab settings was curtailed in most if not all programs with initial onset of the pandemic, we did not solicit a comparable audience of faculty participants from the clinical pathology side.

We believe that the results from the predictive assessment solicited in our survey warrant close scrutiny and a vigorous response by educators in pathology, and possibly other fields. The combination of an overall appraisal that the current digital tool usage results in a diminished educational experience, and the prediction that such tool use is more than likely to remain at its current state or to further increase in prevalence of use, poses a challenge to pathology educators. We believe that this challenge includes the need for careful study of factors associated with the efficacy of various learning and teaching modalities. Immediate attention to helping pathology and other faculty to fully master and optimize the use of these tools should be included in faculty development and master teaching efforts in every pathology training program.^{18,19} National or departmental efforts to identify, model, and share best virtual practices should be undertaken without delay.⁷ Although a host of such articles appeared soon after the pandemic necessitated the shift to virtual teaching for most primary, secondary, and university courses,²⁰ few tailored to the specific nature of pathology graduate training have appeared.²¹ However, some observations from undergraduate medical education exist, due

largely to the early transition to virtual digital slide-based pathology labs in most medical schools.²²

There was a positive by-product of the pandemic on pathology education, derived from both individual and organizational efforts to compensate for the sudden loss of didactic teaching sessions common in most training programs. An outpouring of virtual sessions under the auspices of varied pathology societies such as the College of American Pathologists, American Society of Cytopathology, and others generated a wealth of high-quality online educational lectures, panel discussions, and case presentations available at minimal or no cost. These were often initially available as live events, with some capability for questions and answers. These online offerings were also archived as publicly available video sessions.²³ Often, the DAPA video sessions also included direct links to the digital slides themselves for further individual study.²⁴ With this new wealth of digital resources, a next useful step would be the collation, curation, and organization of these online materials to provide ongoing utility in training, both domestically and internationally. This effort, together with virtual rotations and electives aimed at undergraduates,^{25,26} could then perhaps form a foundation to begin to ease the shortage of qualified pathologists in the developing world, as well as hasten the journey to competency of US-based trainees. If such pipe dreams are realized, the pandemic may prove to be a great blessing in the disguise of a calamity.

Authors' Note

This article was competitively selected by *Academic Pathology's* Editors, from among abstracts submitted in response to a Special Call for COVID-19 Papers, to receive an article processing fee waiver sponsored by the Association of Pathology Chairs.

Acknowledgments

The authors acknowledge the assistance of Mel Limson and the APC/PRODS Council.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Liron Pantanowitz is a consultant for Hamamatsu.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article

Supplemental Material

Supplemental material for this article is available online.

References

1. Dee FR, Meyerholz DK. Teaching medical pathology in the twenty-first century: virtual microscopy applications. *J Vet Med Educ.* 2007;34:431-436.

2. Bruch LA, De Young BR, Kreiter CD, Haugen TH, Leaven TC, Dee FR. Competency assessment of residents in surgical pathology using virtual microscopy. *Hum Pathol.* 2009;40:1122-1128.
3. Hassell LA, Fung KM, Chaser B. Digital slides and ACGME resident competencies in anatomic pathology: an altered paradigm for acquisition and assessment. *J Pathol Inform.* 2011;2:27.
4. Pantanowitz L, Szymas J, Yagi Y, Wilbur D. Whole slide imaging for educational purposes. *J Pathol Inform.* 2012;3:46.
5. Foster K. Medical education in the digital age: digital whole slide imaging as an e-learning tool. *J Pathol Inform.* 2010;1:14. doi:10.4103/2153-3539.68331
6. Rodrigues-Fernandes CI, Speight PM, Khurram SA, et al. The use of digital microscopy as a teaching method for human pathology: a systematic review. *Virchows Arch.* 2020;477:475-486.
7. Evans AJ, Depeiza N, Allen SG, Fraser K, Shirley S, Chetty R. Use of whole slide imaging (WSI) for distance teaching. *J Clin Pathol.* 2020;0:1-4. doi:10.1136/jclinpath-2020-206763
8. Fung KM, Hassell LA, Talbert ML, Wiechmann AF, Chaser BE, Ramey J. Whole slide images and digital media in pathology education, testing, and practice: the Oklahoma experience. *Anal Cell Pathol (Amst).* 2012;35:37-40.
9. Hassell LA, Glassy E. The (not yet) willingly adopted tool. *J Pathol Inform.* 2013;4:13.
10. Digital Pathology Association. Whole slide imaging repository. Published 2015. Accessed September 18, 2020. <https://digitalpathologyassociation.org/whole-slide-imaging-repository>
11. Mukherjee MS, Donnelly AD, DeAgano VJ, Lyden ER, Radio SJ. Utilization of virtual microscopy in cytotechnology educational programs in the United States. *J Pathol Inform.* 2016;7:8.
12. Yin F, Han G, Bui MM, et al. Educational value of digital whole slides accompanying published online pathology journal articles: a multi-institutional study. *Arch Pathol Lab Med.* 2016;140:694-697.
13. College of American Pathologists. Virtual lecture series for pathology residents. Published 2020. Accessed September 18, 2020. <https://www.cap.org/calendar/virtual-lecture-series-for-pathology-residents>
14. Ahmad Z, Rahim S, Ud Din N, Ahmed A. Practice of academic surgical pathology during the COVID-19 pandemic. *Am J Clin Pathol.* 2020;154:724-730. doi:10.1093/ajcp/aqaa158
15. Shahriari N, Grant-Kels J, Murphy MJ. Dermatopathology education in the era of modern technology. *J Cutan Pathol.* 2017;44:763-771.
16. Saco A, Bombi JA, Garcia A, Ramirez J, Ordi J. Current status of whole-slide imaging in education. *Pathobiology.* 2016;83:79-88.
17. Redelmeier DA, Katz J, Kahneman D. Memories of colonoscopy: a randomized trial. *Pain.* 2003;104:187-194.
18. Sahota M, Leung B, Dowdell S, Velan GM. Learning pathology using collaborative vs. individual annotation of whole slide images: a mixed methods trial. *BMC Med Educ.* 2016;16:311.
19. Horn AJ, Czarnecki D, Lele SM. Interactive case vignettes utilizing simulated pathologist-clinician encounters with whole slide imaging and video tutorials of whole slide scans improves student understanding of disease processes. *J Pathol Inform.* 2012;3:34.
20. Minero E. 8 strategies to improve participation in your virtual classroom. Edutopia.org; 2020. Accessed September 18, 2020. <https://www.edutopia.org/article/8-strategies-improve-participation-your-virtual-classroom>
21. Mukhopadhyay S, Booth AL, Calkins SM, et al. Leveraging technology for remote learning in the era of COVID-19 and social distancing. *Arch Pathol Lab Med.* 2020;144:1027-1036.
22. Saxena R, Crum R. Learning digitally in a pandemic. *Thepathologist.com.* 2020. Accessed September 18, 2020. <https://thepathologist.com/outside-the-lab/learning-digitally-in-a-pandemic>
23. Virtual Pathology Grand Rounds #virtualpathGR. Published 2020. Accessed September 18, 2020. <https://www.youtube.com/channel/UCbJhATZrVy2Nhq2V4WBaVZw>
24. Lewis Hassell. Medullary carcinoma of colon. 2020. Accessed September 18, 2020. <https://www.youtube.com/watch?v=2wQ5zvCaEJM>
25. PathElective. *Pathelective.com.* Published 2020. Accessed September 18, 2020. <https://www.pathelective.com/>.
26. Samueli B, Srer N, Jotkowitz A, Taragin B. Remote pathology education during the COVID-19 era: crisis converted to opportunity. *Ann Diagn Pathol.* 2020;49:151612.