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Brief Report

Implementing PathElective as an organized means of supplementing pathology education in an osteopathic medical school—the New York Institute of Technology College of Osteopathic Medicine experience

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A B S T R A C T

Pathology is not traditionally chosen by medical students applying to residency. In osteopathic medical schools, limited access to dedicated pathology faculty further complicates this issue. Because of a lack of pathology experiences, osteopathic medical students may not be as familiar with a pathology career. The purpose of this brief report is to describe the pilot experience of implementing a pre-existing web-based, free virtual platform for pathology education as alternative, supplemental exposure to pathology for osteopathic medical students at our institution. We began to offer the online pathology elective for Academic Year 2022–2023. Using the online free service of PathElective, this course provided a valuable exposure to pathology with multiple modules in anatomic, clinical, and digital/molecular pathology, before and after assessments, recorded videos by pathology experts, handouts, and reading assignments. During the first week, three introductory modules were required followed by weeks 2–4, in which the students would complete a total of 10 modules of their own choice. In total, 14 students participated in this virtual rotation from August 2022–May 2023. All chose cardiac pathology as the most popular module. Three of the 14 students matched into pathology residencies. This small cohort of 4th year medical students at our osteopathic medical school successfully completed a virtual elective rotation with the resources of PathElective. We report the success of this experience and hope to continue monitoring progress.

Keywords: Clinical clerkship, Medical education, Online learning, Osteopathic medicine, Pathology, PathElective

Traditionally, few medical students in any given graduating class of a US medical school (allopathic and/or osteopathic) choose pathology for their residency. Data from the National Residency Matching Program indicate that for allopathic medical schools, approximately 1.3% of medical students matched in pathology programs in 2023, although this number increased slightly from 2019 when it was 1.1%.[1] The percentage for osteopathic (DO) medical students was also 1.3% in 2023, also with a slight increase from 2019 when it was 1.0%.[1] Many medical students may enjoy pathology but not pursue it as a career. Online exposure is especially useful when there are only few representative pathology faculty, as is the case in many DO schools not affiliated with a major academic medical center.

Although there was an increase in pathology residency positions filled by graduates of DO medical schools from 7.1% in 2011 to 12.1% in 2020, the actual percentage of DO medical students who have chosen pathology residency did not significantly change during the same time frame (from 1.06% to 1.14%).[2] In fact, in 2020 pathology was the third lowest filled Post graduate year - 1 (PGY-1) position among DO graduates by percentage out of 15 major medical specialties.[2] This may be explained partially by the fact that there are fewer DO medical graduates than allopathic (MD) medical graduates in general, and DO medical schools are more likely to be associated with community-based medical centers rather than academic-based medical centers.[2] This indicates that MD medical schools may be more likely to have dedicated pathology faculty from the pathology department of an affiliated academic medical center who are obligated to teach medical students. In community-based hospitals, the pathology department tends to be small and more devoted to service work only. However, at this time, the data on DO versus MD schools' affiliations with either type of institutions are limited, as is the percentage of these institutions with dedicated pathology departments, faculty, curricula, and electives available to either MD or DO medical students.[2]

A 2022 study from data across 14 DO medical school reported that the percentage of pathology residency positions filled by DO graduates did

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actually increase from 6.6% in 2011 to 11.4% in 2020,[3] similar to what was reported earlier. These numbers should be examined in the context of the increase in DO medical students graduating in the U.S. During the same time period, there was a 51% increase in DO medical school graduates mainly due to the installation of new DO schools.[3] Though there was also an increase in MD graduates from 2008 to 2020, the percentage increase was reported as only 20% in comparison.[3] This same study indicated that DO medical students received significantly less formal pathology exposure.[3] As noted, DO medical schools may not have clinically active pathologists as faculty since there often is not an affiliated academic hospital. Taken together, there may be a decrease or even absence of formative academic pathology departments, which decreases DO students' pathology exposure.[2] It is also important to note that both MD and DO medical schools have experienced changing curriculums so that pathology is usually no longer a separate subject but is integrated throughout the more formal didactic pre-clinical years. However, it has been reported that this change has not had a negative impact on pathology interest for both DO and MD medical students.[3,4]

In the clerkship years, it was reported that MD medical students who considered pathology but did not ultimately choose it for residency participated less in pathology electives (3rd and 4th years) than those medical students who did make that choice.[4] For DO students, those who considered pathology were noted to have a statistically significant greater percentage of participation in pathology elective opportunities in their third and fourth years of medical school.[3] In addition, those students reported higher percentages of microscope use, either optical or digital, exposure to gross pathology specimen demonstrations, and involvement in pathology related research.[3] Additionally, a vast majority of both study groups did not require a pathology rotation.[3] There were some statistically significant differences noted when comparing pathology exposure for DO versus MD medical students.[3] Specifically, DO medical students had less exposure/participation in autopsy, microscope use, gross pathology specimens demonstrations, case-based presentations led by pathologists, andto pathology during other rotations.[3] The latter included following a specimen to the laboratory or reviewing slides with a pathologist.[3]

The decisions made by DO medical students in choosing a medical specialty in general are influenced by similar factors as those for MD medical students.[3,4] These include medical school characteristics (e.g., curriculum), student characteristics, student values, career expectations, and perceptions of a given specialty.[3,4] Interestingly, factors contributing to specialty choice for DO medical students versus MD medical students did show some differences.[3] These included that a higher percentage of DO students ranked lifestyle (student values and career expectations) more highly than did MD students.[3] In addition, reputation or prestige (perception) of a specialty was ranked as less important to DO medical students than to MD medical students.[3]

There are no known pathology residences affiliated with DO medical schools.[2] Therefore, another important factor to consider is the fairly recent merger (2020) of DO and MD residency training programs under the same Graduate medical education (GME) accreditation, which actually may have a positive impact on the percentage of DO medical graduates matching into pathology.[2] As reported, relative percentages of graduating DO medical students who matched into pathology programs before and after the transition period of the merger had the greatest increase (2.3%) in comparison to MD medical students (1.4% decrease) and international medical graduates (0.4 % decrease).[2]

As a result of the COVID-19 pandemic, Dr. Kamran Mirza and Dr. Cullen Lilley created an online, web-based, free platform known as www.PathElective.com, which is now an official publication of the Association of Pathology Chairs. The website was officially launched on July 1, 2020.[5] It consists of multiple free modules in different areas of anatomic, clinical, and molecular/digital pathology and includes video recordings by nationally recognized pathology experts as well as videos sourced from openly available web resources.[5] Besides the videos and high-quality supplemental resources (handouts, links to important websites, optional videos, reading assignments, etc.), prelesson and postlesson assessments are offered, and certificates of completion are issued. It was the first virtual pathology-elective forum providing comprehensive coverage of multiple pathology subdisciplines.[5] By 2021, published data revealed that the new virtual pathology elective demonstrated "high effectiveness and satisfaction among users."[5,6] The nature of this unique platform is extremely useful in "breaking the barriers of finance, distance, and time zones."[5] Because the resource is available to anyone with an internet connection, PathElective is available worldwide, and though between June 1, 2020, and October 1, 2020, the United States had the most users based on web traffic, other countries such as India, the Philippines, etc. took advantage of this learning experience.[5] It was noted that many users were pathology residents (41%), with practicing physicians coming in second at 20%, International Medical Graduates (IMGs) (17%), and US MD/DO medical students made up 13%.[5]

It has also been reported that social media/internet is another source for learning about the pathology specialty.[4] The role of social media in PathElective's success cannot be understated. Most users (55%) heard of the website via X, formerly Twitter, and 99% of those who used X, formerly Twitter, found it to beneficial.[5] An analysis of student performance, usage, and satisfaction regarding virtual education in general and PathElective specifically revealed that of the social media channels, most visitors to the site came from X, formerly Twitter.[6] The importance and impact of social media platforms such as X, formerly Twitter, as well as simulation in pathology medical education, has been studied and has shown to be an important avenue for reaching students and disseminating educational content.[6,7] Social media allows everyone, from new medical students to international experts, the ability to interchange and communicate.[7]

The use of X, formerly Twitter, for medical/pathology education can be challenging in the way that physicians/pathologists may be reluctant to obtain material because of patient privacy and protected health information.[8] There are also technical issues in obtaining images for X, formerly Twitter, and posting content and general "social media inertia."[8] For pathology, some of these challenges may be overcome, which include sharing original content with a watermark, using images in the public domain, using digital pathology or a smartphone to photograph original microscopic slides, using hashtags, learning how to edit video-audio material, annotating pictures using software or Microsoft Power point, and using good images, reliable information, and quality articles for reference, among other tools available.[8] A unique use of X, formerly Twitter, by the creators of PathElective is "Twitter Homework," in which students have to tweet or retweet one item a day related to Pathology.[9,10]

PathElective also uses PathPresenter as a tool in providing students with a digital means of evaluating histology without the need for a microscope. The emergence of digital pathology has been and continues to be important in online education, which allows for "asynchronous learning" so that medical students and residents can access materials on their own time affording both learners and educators more flexibility in their education.[7] Because of the challenges posed by the COVID-19 pandemic, there have been opportunities to make curricular changes, which include the incorporation of virtual teaching platforms, social media, and learning management software.[9] The medical students (and residents) of today have different needs and have a higher proclivity to utilize virtual/online resources to augment their medical education.[11,12] This shift in perception about medical student learning has been brought to the forefront with the pandemic, and medical educators across the country are having to adapt. PathElective has made it easy for both students and educators to participate in pathology learning because of the platform's accessible user interface. In the words of Dr. Mirza, "Adaptability in pedagogy allows educators to think outside the box, be nimble on their feet, and continually work to make sure trainees are learning in the best way possible. It allows incorporating social media or other not-so-typical tools for successful teaching … (it) also allows educators to be more inclusive of all types of trainees … students with different preferences, different educational backgrounds, or even different preferred pronouns."[9]

At the New York Institute of Technology College of Osteopathic Medicine (NYITCOM) in Old Westbury, Long Island, New York, we saw a chance to expose fourth-year students who are either very interested in pathology or just curious about pathology. Early in 2022, the senior faculty pathologist and the Dean of Clinical Education met with the PathElective co-founders mentioned earlier to discuss using their platform and the other vast resources of PathElective to create a fourth-year virtual pathology rotation at NYITCOM. With their guidance and after approval by the curriculum committee, a four-week pathology rotation tailored to our needs was initiated for the 2022–2023 academic year. Students had the opportunity to explore in-person pathology experiences at hospitals through Visiting Student Learning Opportunities (VSLO), but this virtual, online elective rotation offered them an alternate pathology experience that was structured yet flexible.

Starting in August of academic year 2022–2023, the online pathology elective was offered, limited to two to three students per slot (four week rotation). The pathologist met with each student via Zoom on the first day of the rotation with orientation and directions, and during the first week, three introductory modules were required to be completed (recommended by Dr. Mirza): "Illustrations of Histology" (10 lessons), "Introduction to Anatomic Pathology" (3 available lessons), and "Gross Pathology" (6 lessons). The second through fourth weeks had the same format, but the students chose modules of their own interest. The pathologist was available to the students as needed (via Zoom, email, texts, phone), and at the end of each week, students were required to attend at least one Zoom session to review post-assessments and to have deeper discussions about the content reviewed independently. The post-assessments were saved by the students and were sent ahead of time to the pathologist for review. After going over the post-assessments with each student, the end-of-week discussions also revolved around other pathology topics as well as pathology as a career. These discussions were mostly student-driven and lasted 1 to 2 h. Therefore, in addition to the three introductory modules, the students were required to complete a total of 10 modules, resulting in a total of 13 modules in a 4-week rotation period. The syllabus detailed the contents of each module (number of lessons, numbers of videos per lesson, etc.) as they were available and updated. The title and successful completion of each module were recorded throughout the academic year for each student.

A total of 14 fourth-year medical students participated in the elective virtual rotation over the course of the first academic year offered (2022–2023). Interestingly, three students out of four (75%) from our medical school who eventually matched in pathology residencies in 2023 participated in AY 22–23, in addition to doing in-person rotations at outside hospitals. Only one other graduating medical student from our school who matched in pathology did not participate in the elective course (military match). The remaining PathElective students matched in anesthesiology (1), emergency medicine (2), family medicine (1), radiology (1), internal medicine (4), and preliminary medicine, PGY-1 (1). Additionally, there was one medical student who had applied for radiology but did not match and then decided to apply for pathology residency in the next Electronic Residency Application Service (ERAS) cycle. This choice was influenced in part by this PathElective online rotation. Therefore, 4 out of 14 medical students (29%) who opted for the PathElective virtual rotation applied to pathology residencies. Three of them are PGY-1 pathology residents, as of this writing. Recently, the fourth one was also accepted to a pathology residency.

Fig. 1 is a bar graph illustrating how many of each module was chosen and completed by the 14 students, excluding the 3 modules required in the first week. All 14 chose cardiac pathology, followed by 13 for coagulation, and 13 for pediatric pathology. The modules least frequently chosen (1 student each) were molecular pre-requisite, lab management, and dermatopathology. All three students who were applying to pathology residencies chose cardiac pathology, neuropathology, and pediatric pathology. The only modules not attempted by any of the students were digital pathology, cytopathology, and renal pathology (added later).

Many, if not all the students, stated that they chose the modules not just because it interested them but because they felt they could use extra review

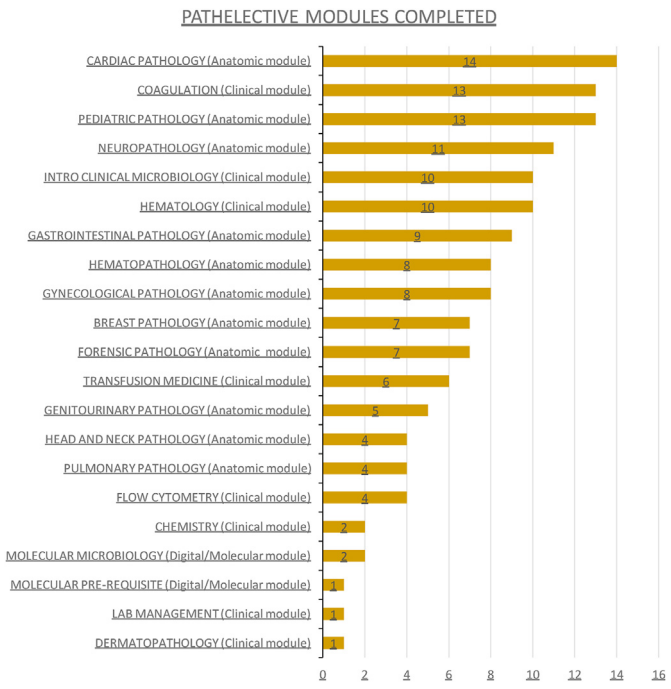

Fig. 1. PathElective modules completed by 14 medical students who participated in the online pathology elective rotation using PathElective at the New York Institute of Technology, College of Osteopathic Medicine from August 2022 to May 2023.

in that particular topic. This may help supplement their pre-clinical knowledge and point to areas of the pre-clinical curriculum that may need more emphasis. The feedback for the course was mainly anecdotal during this pilot year since fourth-year electives' course evaluations by medical students are optional at our institution, though we plan to change that for this rotation in the future. We also plan to continue collecting data to help our overall curriculum by noting the number of module choices not just because they are popular but as a reflection perhaps of where we need to supplement or add to what the medical students learn in the general pre-clinical curriculum. If, over the years, we see that many students, both those going into pathology and those matching in other fields tend to choose certain modules more than others, there may perhaps be a need to fill in gaps in their pre-clinical years. This will be further studied by noting not only which specialty the student applies to/matches with (which is already done) but also asking each student why they choose a particular module—interest, need more exposure, etc.

The course was well received and the Dean of Clinical Education stated:

> *"My staff and I recently reviewed the online course offerings as we prepared for the new academic year. Although the virtual pathology elective is new you have really breathed life into it. The course is well structured and seems to be a wonderful addition as we emerge from the pandemic. I look forward to seeing how it grows as we continue to collaborate with (PathElective) on this unique project"* (email Nelson Eng, DO. March 22, 2023).

As Mirza, Lilley et al. pointed out, the use of the PathElective as an adjunct to the curriculum affords medical students equal opportunity to all aspects of anatomic, clinical, and digital/molecular pathology.[5] This is especially helpful at DO medical schools that may not have a major academic center affiliation or do not have many pathology faculty. The PathElective course also offered other resources, and one student in our third year joined the Pathology Interest Group.

As we were still acclimating to this new experience this pilot year, we did not take advantage of PathTwitter, which is something to consider in order to further engage the students and others in the PathTwitter community. This would help with making contacts and expanding

pathology fund of knowledge. X, formerly Twitter, use has been found to be helpful in networking and career development, and pathology education.[10] In one study, medical students who used X, formerly Twitter, with PathElective reported that its use increased their knowledge and helped in being able to find reliable pathology information.[10] However, another PathElective tool, PathPresenter, was well received by our students who found the images clear, sharp, and user friendly. This was especially helpful in the pediatric pathology module. Therefore, we found PathPresenter to be more useful in this course at this time.

While it is true that by the start of their fourth year most medical students have chosen their residency specialty, there are still a few who waver until even as late as two to three months into the fourth year. We have experienced this at our institution and have had a few students who chose PathElective in the early slots (July, August) before ERAS applications are due to see if pathology may be for them. Though not common, we have found that the pathology residency choice is still alive in fourth year and is also helpful at any point in the fourth year to those students who already had chosen pathology. The latter found the course to be helpful in both reinforcement and knowledge acquisition (as per multiple Zoom meetings during academic year 2023–2024). As mentioned, during the time frame of our small study, we had a student who decided on pathology after he did not match in radiology. Obviously, pathology was not his first choice, but he did indicate that the PathElective virtual rotation was both helpful and motivating for him (as per emails and Zoom meetings March–August 2023). He has now since matched into a pathology residency.

The idea of offering PathElective in the third year of medical school at our institution might be considered. This would, of course, help expose more students to the field of pathology and give them earlier insight. However, there is presently no accommodation for an official elective in our third-year curriculum. The traditional core third-year curriculum at our institution mandates internal medicine, surgery, obstetrics/gynecology, pediatrics, psychiatry, emergency medicine, and family medicine (especially important at DO schools that emphasize primary care). However, students with a high interest in pathology could take the PathElective course during the academic pause (vacation) to explore the field. This has been an option for students interested in fields such as orthopedics, dermatology, neurology, etc.

In addition, the possibility of offering modules from the elective in conjunction with other rotations (e.g., surgery, internal medicine) as extra credit for high honors might be considered. Currently, honors and high pass at NYITCOM is based on a combination of the medical student's performance on the shelf exam (Comprehensive Osteopathic Medicine Achievement Tests [COMATs]) and rotation evaluations, which are structured around the seven core competencies. The COMATs assess DO medical students' knowledge in core DO medical and foundational biomedical sciences principles, as per the National Board of Osteopathic Medical Examiners (NBOME). The NBOME also issues the Fundamental Osteopathic Medical Competency Domains document, which represents expert consensus on requirements and measurable outcomes for seven core competency domains related to the practice of DO medicine. Adding a high-honors designation or extra credit for additional work completed would require agreement from the entire academic affairs team but is worth exploring as indicated by our dean of Clinical Education.

In the past ten years, only one or two medical students have expressed a desire for a pathology interest group at NYITCOM out of a class size ranging from 300 to 400 medical students. Most interest groups have many medical student participants who are needed for officer positions as well as activities and outreach. Our student life coordinator also felt that the only pathologist on the faculty at that time was already overburdened by many teaching, research, and service responsibilities, as well as additional administrative issues. With the addition of a second pathologist a few years ago and, more recently, a third pathologist, the idea of a pathology interest group at our institution has again been raised and is being explored. In addition, since 2008, the number of pathology matches at our institution has shown a slight uptick. Between 2008 and 2024, the matches ranged from 0 in some years to a high of 5 students in both 2023 and 2024 out of a graduating class of approximately 400 since 2020. The average number of pathology matches at our institution since 2008 is 2.3; however, prior to 2020, the number of students per graduating class was approximately 300, which increased to approximately 400 in 2020 with the addition of a second site. These numbers may also support the development of a pathology interest group at our institution within the near future.

Now as we emerge from the pandemic, PathElective remains an important platform not just to expose medical students to pathology but also to note trends of interest and need at our institution. We hope to continue to gather data on the number of students who choose PathElective, which modules are chosen (number and topic and why), and their interests and ultimate choices in residencies. Accumulation of these data over the years will be helpful since our pilot year only included 14 students, admittedly a small cohort. We also plan to implement our own in-house course evaluations in an attempt not just to measure the popularity of certain pathology subspecialties but also to see if trends indicate the need for supplemental pathology in the pre-clinical years. At our DO medical school during the pilot year 2022–2023, there were only two actively teaching board-certified pathologists. Therefore, this has been an invaluable opportunity to expose fourth-year students to a specialty that needs more recognition. We are indebted to the co-creators of PathElective for this free, web-based resource and their recommendations on how to implement a virtual pathology elective at our DO medical school. PathElective is an invaluable resource that continues to evolve.

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Declaration of competing interest

The authors declare that there are no competing interests.

References

1. National Resident Matching Program. *Results and Data: 2023 Main Residency Match®. The Match.* Washington, DC: National Resident Matching Program; 2023. Accessed August 2023 https://www.nrmp.org/about/news/2023/05/nrmp-releases-the-2023-main-residency-match-results-and-data-report-the-most-trusted-data-resource-for-the-main-residency-match/.
2. Schukow CP, Herman M, Mirza K. Osteopathic physician trainees and pathways to pathology. *Acad Pathol.* 2023;10(2), 100071. doi:10.1016/j.acpath.2023.100071.
3. George MR, Johnson KA, Berg MP, et al. Factors influencing US osteopathic medical students to choose pathology as a specialty. *Acad Pathol.* 2022;9(1), 100034. doi:10.1016/j.acpath.2022.100034.
4. McCloskey CB, Johnson K, Brissette M, et al. Factors influencing US allopathic medical students to choose pathology as a specialty. *Acad Pathol.* 2020;7, 2374289520951924. doi:10.1177/2374289520951924.
5. Lilley CM, Arnold CA, Arnold M, et al. The implementation and effectiveness of PathElective.com. *Acad Pathol.* 2021;8, 23742895211006829. doi:10.1177/23742895211006829. Published 2021 Apr 9.
6. Lilley CM, Arnold CA, Arnold MA, et al. Virtual pathology elective, real education: the PathElective.com experience as a model for novel pathology pedagogy and a primer for curricular evolution. *Arch Pathol Lab Med.* 2023. doi:10.5858/arpa.2022-0259-OA, 10.5858/arpa.2022-0259-OA.

7. Hassell LA, Absar SF, Chauhan C, et al. Pathology education powered by virtual and digital transformation: now and the future. *Arch Pathol Lab Med.* 2023;147(4): 474–491. doi:10.5858/arpa.2021-0473-RA.
8. Tushir A, Duy Nguyen T, Biehl C, Mirza KM. Challenges and opportunities in using twitter as a pedagogical tool in pathology and laboratory medicine education. *Am J Clin Pathol.* 2022;157(6):836–843. doi:10.1093/ajcp/aqab219.
9. Wiencek JR, Chambliss AB, Bertholf RL, et al. A paradigm shift: engagement of clinical chemistry and laboratory medicine trainees by innovative teaching methods. *Clin Chem.* 2022;68(5):619–626. doi:10.1093/clinchem/hvac036.
10. Hamnvåg HM, McHenry A, Ahmed A, Trabzonlu L, Arnold CA, Mirza KM. #TwitterHomework during pathology electives: transforming pathology pedagogy. *Arch Pathol Lab Med.* 2021;145(11):1438–1447. doi:10.5858/arpa.2020-0391-OA.
11. Holaday L, Selvig D, Purkiss J, Hortsch M. Preference of interactive electronic versus traditional learning resources by university of Michigan medical students during the first year histology component. *Med Sci Educ.* 2013;23:607–619. doi:10.1007/BF03341688.
12. Finn E, Ayres F, Goldberg S, Hortsch M. Brave new E-world: medical students' preferences for and usage of electronic learning resources during two different phases of their education. *FASEB Bioadv.* 2022;4(5):298–308. doi:10.1096/fba.2021-00124.