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Short Communication

An integrated virtual pathology education platform developed using Microsoft Power Apps and Microsoft Teams

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ABSTRACT

The transition towards digital pathology and an extensive selection of video conferencing platforms have helped provide continuity to education even during the COVID-19 pandemic. Innovative approaches for pathology education, will likely persist beyond the pandemic, as they have powerful didactic potential. While there is a wide selection of software for use as educational tools, an environment to access all resources with ease is clearly lacking. In this technical note, we highlight our customized educational applications built using a low-code approach. Our applications, developed with Microsoft Power Apps, serve both educational and examination purposes and are launched using Microsoft Teams. Building applications using a low-code approach has made our applications very specific to our use and enabled daily distanced education. Combined with existing features on Teams, such as file sharing, meeting scheduling, and messaging, the applications serve as a unique and customizable pathology educational platform.

Introduction

The effect of the coronavirus disease (COVID-19) pandemic on pathology resident education has been significant. The pandemic has led to a disruption of lectures, seminars, case sign-outs, and resident in-service examinations. Fortunately, the field had already been making a slow transition towards digital pathology even before the COVID-19 pandemic. As a result, digitalized whole slide images (WSI) along with a wide range of remote sharing and video conferencing platforms, have made the learning experience for most residents tolerable to a certain extent.¹ Although, at the same time, these tools and shared educational content have been challenging to manage and organize. While there are innumerable online resources for video lectures and WSI,² along with each institution's own teaching collections of WSIs and slideshow presentations, an environment in which trainees can access all these resources with ease is still lacking.³

There are a few commercial e-learning platforms,⁴⁻⁷ that either have services to create a customized learning platform or provide tools to build one from preset modules. However, these are either expensive or may require sensitive patient data to be hosted by these services. Some of these are used by several medical schools in Canada and the United States.⁸ Other open source web server-based authoring tools and learning

management systems like Xerte, Canvas, and Moodle require knowledge of Apache and Git, and can be complicated to install.⁹⁻¹¹

In the absence of a "perfect" platform, low-code programs could be one of the solutions to creating customized e-learning platforms. Low-code is a software development approach where applications are mostly created using drag-and-drop functionality of applicable components without the need for writing extensive code and minimizing efforts for deployment.¹² Low-code development programs are mostly hosted online and permit users with minimal technical skills to develop applications, even those for mobile devices. There are several open-access as well as paid programs.¹³ Microsoft Power Apps is one such online visual tool for creating low-code applications.¹⁴ The Power Apps platform features tools to create online applications and their canvas-type apps provide end-user interfaces with a set of screens to interact with data. The platform allows multiple connections to different data including cloud-based sources such as Microsoft Excel spreadsheets or SharePoint lists hosted on a SharePoint site. Power Apps applications can then be imported directly into the Microsoft Teams environment. As several universities, including ours, already use these Microsoft services for file sharing and video conferencing, Power Apps can be used to securely connect and retrieve data from existing Microsoft services on an organization's secure server.

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Power Apps has been used before in creating e-learning applications, for example, the virtualized gamified pharmacy simulation.¹⁵ In this article, we demonstrate e-learning applications tailored specifically for pathology education created using Power Apps and integrated into Microsoft Teams. Our applications are created specifically for tasks such as teaching or conducting written examinations and scheduling oral examinations.

Materials and methods

Cloud services, anonymization, and institution approval

Microsoft 365 solutions, including Office 365 Services, SharePoint, Teams, and Power Apps are part of McGill University approved Cloud Services. Patient cases were given a generic case history, and diagnosis and all information were fully anonymized. Case data is stored on Microsoft Teams SharePoint list on a McGill University server, located in Canada. WSIs were prepared using Aperio XT and Aperio AT2 (Leica Biosystems Inc., Concord, Canada). Slide labels were removed and replaced with anonymized labels using Aperio StripLabel software. WSIs slides are hosted on a slide server on McGill University campus and accessed through on-premises version of MyObjective™ Digital Pathology Image Manager (Halton Hills, Canada) as seen in Fig. 1. Hyperlinks to the case folders in MyObjective™ were associated with the cases in the SharePoint list. Anonymized static images of gross pathology and cytopathology are stored in SharePoint folders. The process was approved by the Department of Professional Services of the McGill University Health Centre for use for educational purposes only.

Building applications

Customized canvas type apps were created with Microsoft Power Apps in a Microsoft Teams group with connections to data on SharePoint lists. In Power Apps, canvas apps are applications where there is an empty template or canvas, and the user adds their required content using a set of drag and drop components.¹⁶ Some of these available components include labels, images, text boxes, drop-down lists, buttons, timers, and Microsoft Stream videos, etc. The values of the components are populated through connections to the SharePoint lists. The buttons can be programmed to initiate activities such as opening a Uniform Resource Locator (URL) link or going to a specific data record. A screenshot of the available components

and their layout on one of the apps is shown in Fig. 2. Each component with a specific function is added as required to build features necessary for the app. It took about 1 month to create and beta test the apps. The apps were created by a pathologist (POF) and beta tested by one of the pathology residents (JE). Specific diagnostic content existed from pathologist slide collections.

Navigating between applications

Once each app is built, it can be previewed and eventually imported as tabs in Microsoft Teams groups or integrated into a SharePoint site. The apps residing in Teams can be accessed by all or a list of specified users by sharing the app and adding users as members to the Teams group. Each approved user logs in using their university ID login credentials. As more apps are published, these are listed on Teams, providing seamless accessibility to users (Fig. 3).

Applications

The canvas apps created broadly fit into two categories, namely educational- and evaluation-related applications.

Educational apps

These include the Digital Pathology app (Fig. 4) which consists of histopathology cases that include key WSIs of hematoxylin and eosin-stained slides, special stains, and immunohistochemistry. Users will have to enter their login credentials in the MyObjective™ Digital Pathology Image Manager webpage to access WSIs. Cases are organized by systems or grouped into introductory pathology sets such as a Foundation Histology Bootcamp (developed by CO) for incoming pathology residents or collections for rotating medical students. One database features a series of videos on placenta and pediatric pathology (developed by MFC with KC) hosted on McGill University Microsoft Stream site. Users can select the required library of slides to view from the drop-down lists. Categorical filters can also be applied to focus on specific learning. A learning and quiz mode can also be selected. In the learning mode, a list of slides is displayed with their diagnoses. Each of them can be individually launched to open in a new tab on the browser (Fig. 5a). The diagnoses can also be toggled off by the user. The quiz mode is a self-administered quiz and displays random slides that can

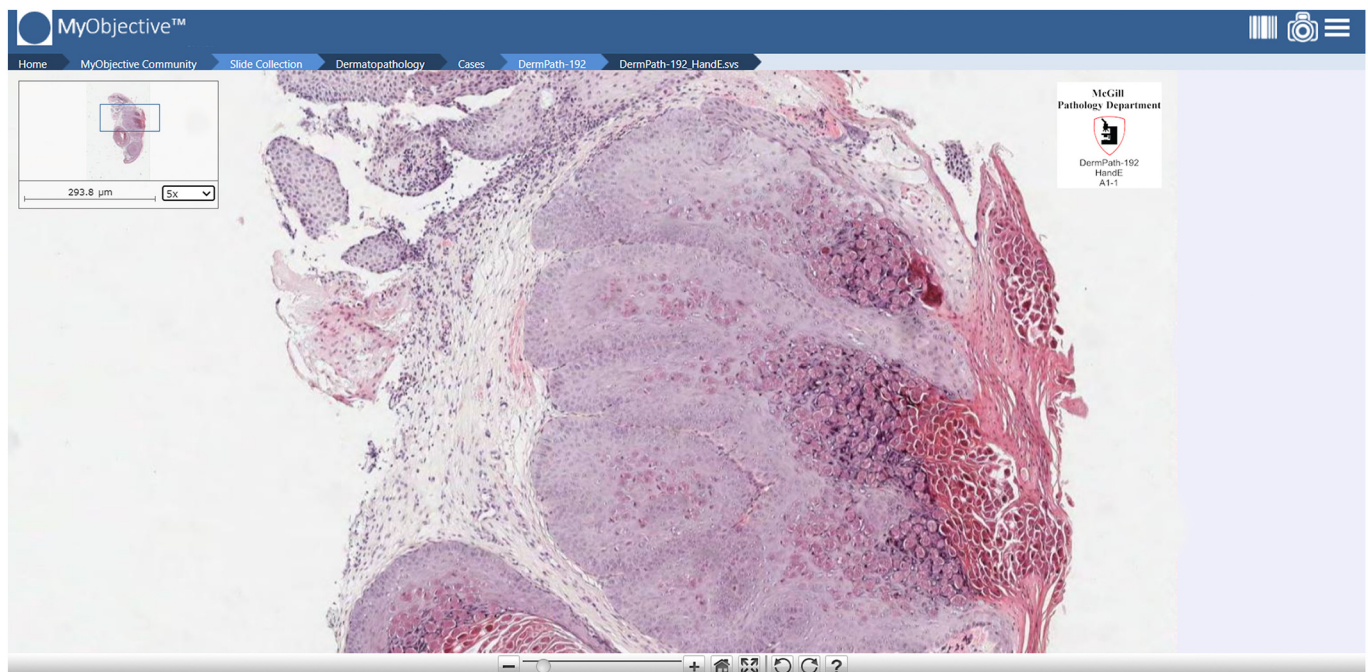


Fig. 1. Whole slide image hosted on MyObjective™ accessed using the app. Molluscum contagiosum, Hematoxylin and Eosin stain, 50X magnification.

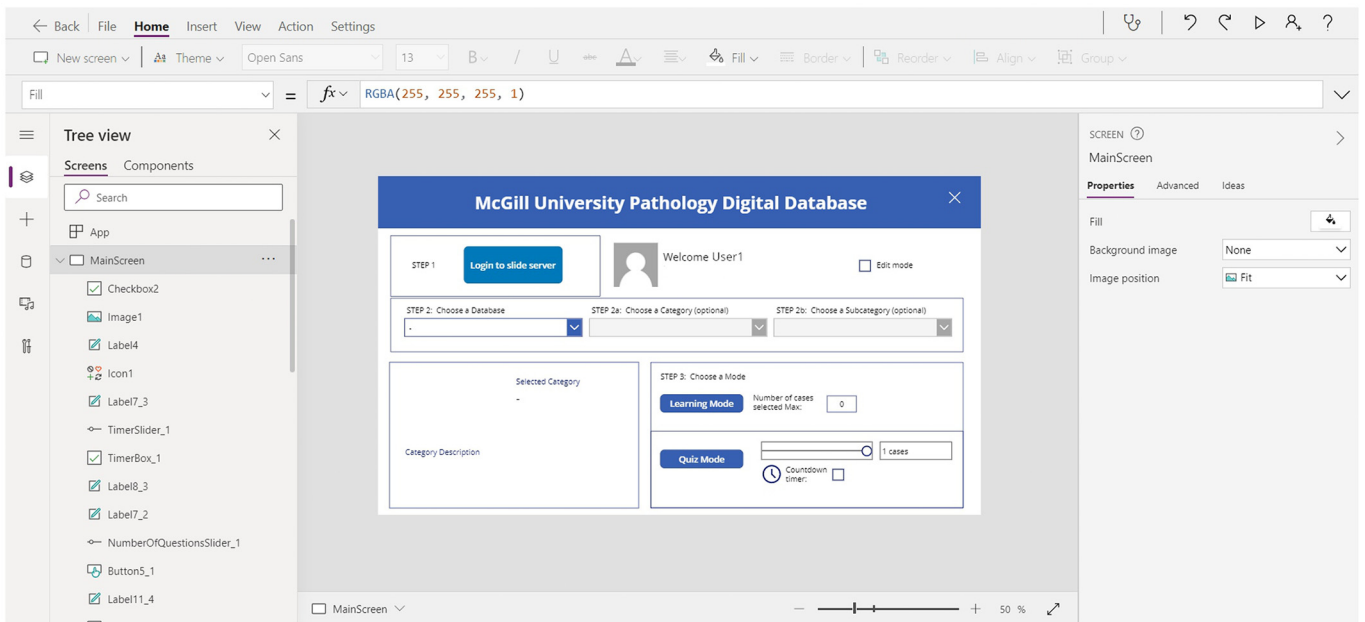


Fig. 2. Drag and drop components on Power Apps used in designing the digital pathology app.

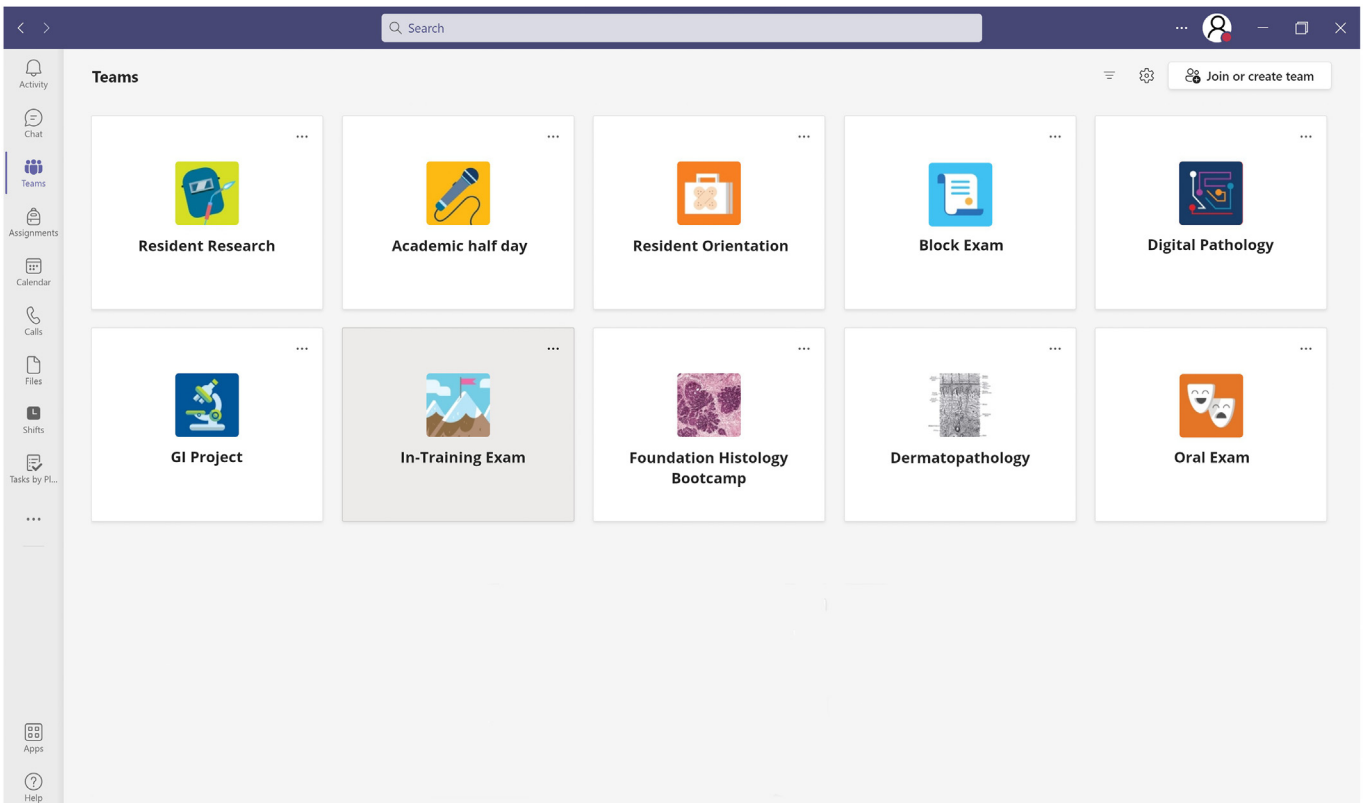


Fig. 3. Published apps created using Power Apps integrated with Microsoft Teams.

be viewed with a field to populate answers to the test question (Fig. 5b). The residents enter their answers, which when submitted, are automatically evaluated against the correct answers that are stored in the database (Fig. 5c).

Evaluation apps

These apps are built to remotely administer the block and yearly in-training exams for residents. There are individual apps for the written (block, in-training) and oral exams. The apps for the block and in-training

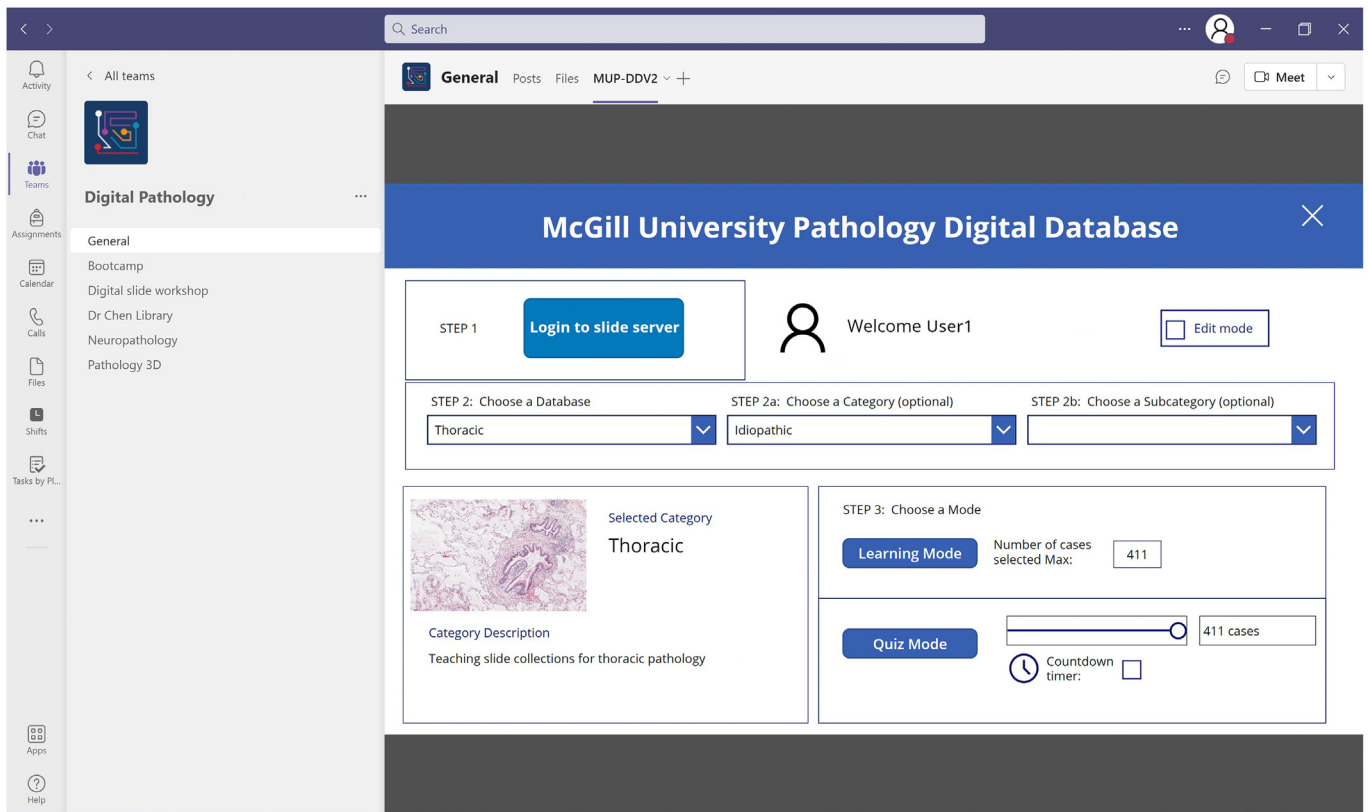


Fig. 4. Overview of the Digital Pathology app.

exams are similar. The oral exam app serves more as a scheduling application both for the pathologist (examiner) and residents.

Written examination apps. The written exam apps can only be accessed at a specific schedule that is decided by the moderator, who ideally is the pathologist overseeing the examination. The schedule and questions on the exam are entered in a SharePoint list. The in-training exam interface is

shown in Fig. 6. At the scheduled time, using Power Apps controls, residents can access each of the exam sections. Residents can view each question and enter their answers (Fig. 6b, 6c). The field for typing answers does not have a character limit and will scroll to accommodate extensive answers. Although there is no limit to the number of questions on an exam, it is usually kept at about 25 short-answers, 30 static images, and 30 rapid slide questions. Each block is usually scheduled for 60 min. WSI

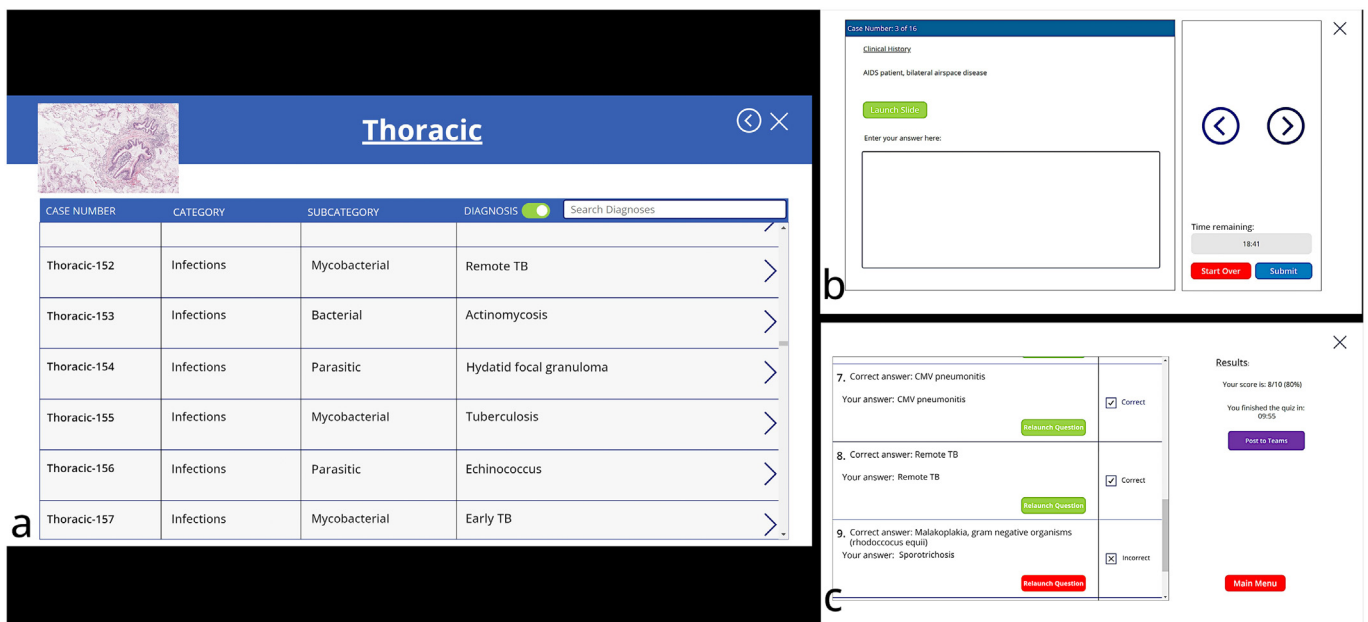


Fig. 5. Digital Pathology app showing: (a) List of whole slide images with their diagnoses than can be launched, (b) quiz mode within the app, and (c) display of the users evaluated answers.

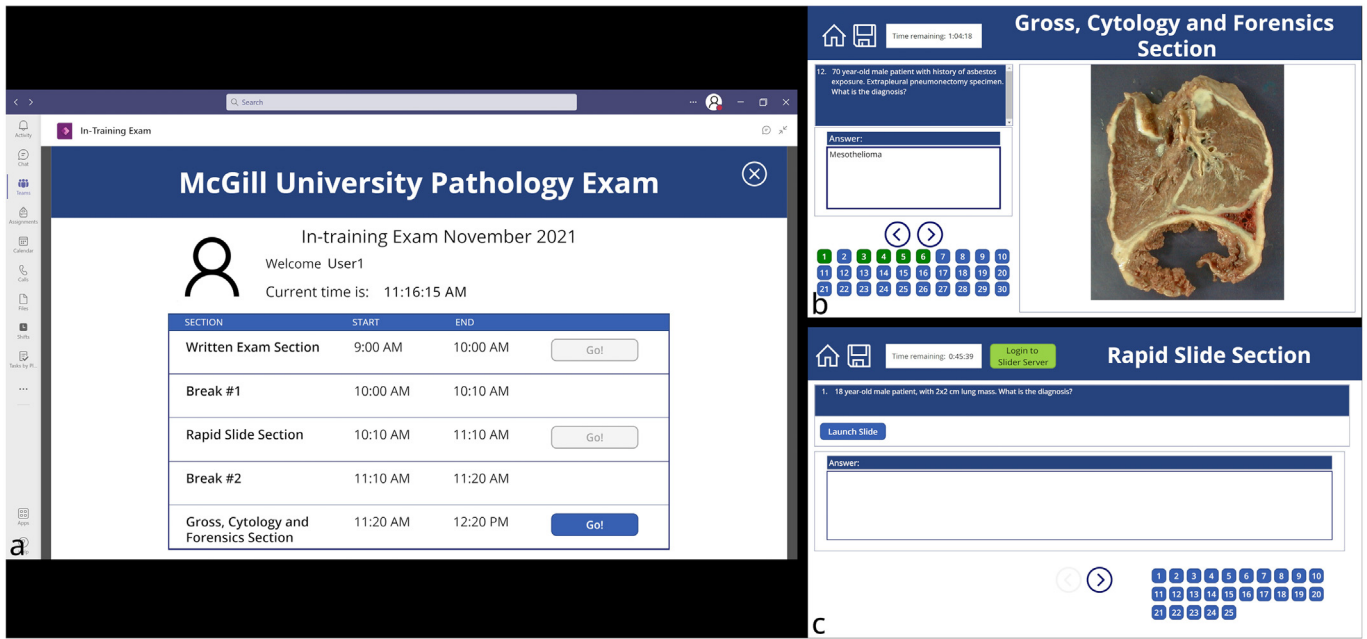


Fig. 6. Written examination app: (a) Overview of the written examination app showing the examination schedule, (b) example of a gross pathology question showing a parasagittal section of a right extrapleural pneumonectomy specimen, with gross diagnosis of mesothelioma of the pleura, and (c) example of a slide-based question.

open on a browser tab external to the Teams interface, while other static images are embedded within the app with links to SharePoint files (Fig. 6b). The response of each resident is automatically stored in the SharePoint list, which can be exported for correction by the app moderator. Alternatively, answers can be emailed to the residents for self-evaluation.

Oral examination app. The oral examination app is a scheduling application along with unique links to view WSIs and links to Microsoft Teams video calls. The start screen on the app is an option to identify the role of the user.

Residents will have a schedule with buttons to open WSIs and a Teams video call with each examiner (Fig. 7a). Like the other apps, the user is initially logged into the app with their unique credentials. For pathologists (examiners), there is a schedule listing every resident and their allotted examination time (Fig. 7b). The pathologist also has access to the WSI link. The video call link for the pathologist stays the same, however the resident joins several calls, rotating between different pathologist examiners. An oral examination usually has 10 stations with 1 WSI in each. Residents review each WSI for 10 min before being questioned by the examiner. The feedback and score are entered in Microsoft Forms by the examiner and discussed with the resident after the exam.

Results

Both the educational and examination apps have been used in our department since April 2020. Our department has a server on which all WSIs are hosted and can be accessed securely using MyObjective™ (Fig. 1). These have been used almost daily for sign-out sessions and didactic activities. The total number of WSIs at the time of writing this manuscript categorized by specialty is listed in Table 1.

Written examinations were initially used for biannual competency assessment and the oral examination app was used annually. Individual objective scores are given to each resident and discussed 1–2 days after the exam. Due to the app’s ease of use and structure, senior residents have organized monthly system-based and resident-led block examinations for their curriculum. At the end of each written exam, the answers entered by all residents are automatically registered on SharePoint (Fig. 8). The moderator can export and evaluate them. The answers are also emailed to each resident for their reference.

As our apps run on Microsoft Teams, other standard features available on Teams for work can also be easily accessed. The file and chat features are often used both by residents and pathologists. Related files, specific to each organ system are posted on the corresponding app. For example, several histology related PowerPoint presentations are often posted on the

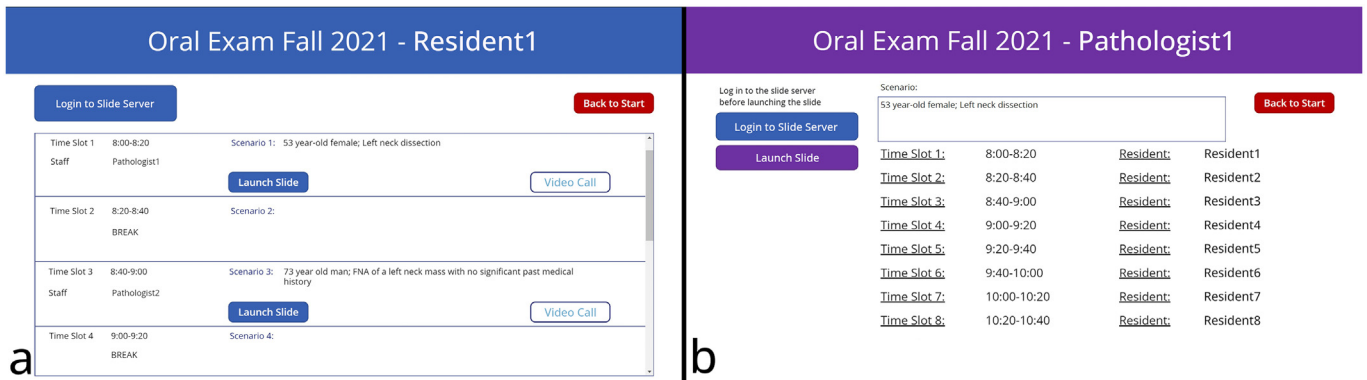


Fig. 7. (a) Resident’s schedule on the oral examination app, (b) Examiner’s schedule.

Table 1
Total WSIs currently hosted on the server categorized by specialty.

Pathology specialty	Number of cases	Number of slides	Size (GB)
Bone and soft tissue	285	327	209
Breast pathology	16	33	16
Cardiovascular pathology	90	126	75
Dermatopathology	709	768	160
General pathology	495	512	354
Gastrointestinal pathology	1364	990	517
Genitourinary pathology	443	650	342
Gynecopathology	427	1205	734
Head and neck pathology	209	270	127
Hematopathology	112	803	290
Hepatobiliary pathology	326	793	111
Histology bootcamp	220	230	113
Medical student electives	101	104	54
Neuropathology	154	479	166
Pediatric pathology	350	571	285
Placental pathology	97	111	94.3
Pulmonary pathology	411	621	364
Renal pathology	106	298	21.7
Total	5915	8891	4033

Files tab in the Foundation of Histology bootcamp (Fig. 9a). Likewise, messages and announcements are easily posted on Teams in the Posts tab (Fig. 9b).

Discussion

A large part of pathology education relies on patient data including gross images, glass slides, and now digital images. Strict adherence to maintaining patient privacy is essential. For apps containing sensitive data, it is more secure to host data on-premises rather than on the cloud.¹⁷ All the images and WSI in our apps were fully anonymized. While customized applications can be built by third-party vendors, building apps using a low code approach is easy and can cost significantly lower. Our institutional pricing for Power Apps is about \$5 USD/month for each user. Almost every available third-party educational platform requires uploading all content online. As data security is a priority for our department, building our own custom apps was the best solution. McGill university has vetted the Microsoft 365 family of products and approved their cloud services for use as they fulfill the university’s cloud directive.¹⁸ A combination of Microsoft Power

QuestionNumber	QuestionType	QuestionStem	QuestionImage	QuestionLink	Resident1	Resident2	Resident3	Resident4
3	W	List FOUR (4) features of Down Syndrome.				1. prominent epicanthal folds 2. sandale gap 3. heart defects (e.g. VSD) 4. single palmar crease	1. Single palmar crease; 2. Epicanthal fold; 3. Flat nasal bridge; 4. Inperforate anus.	Intellectual dis- umbilical herni congenital hea diseases. Facie nose, short ne Trisomy 21
4	W	What causes "decoy cells" in urinary cytology?				polyoma virus infection post kidney transplant	Oval fat bodies.	BK virus in an immunocompr patient
5	W	List the FOUR (4) major categories of urine cytology reporting assuming the specimen is adequate according to the Paris system.				1. negative for high grade urothelial carcinoma 2. atypical urothelial cells (AUC) 3. high grade urothelial carcinoma (HGLUC) 4. suspicious for high grade urothelial carcinoma	1. Positive for malignancy; 2. Indeterminate for malignancy; 3. Negative for malignancy; 4. Reactive and inflammatory changes.	Negative for H (High grade ur carcinoma) AUC (atypical carcinoma)
6	W	A. List THREE (3) cytologic features of high grade urothelial carcinoma on urine cytology according to				A. 1. Nucleus to cytoplasm ratio of 0.7 or more 2. Hyperchromasia that is severe or moderate	A1. Atypical mitoses; A2. High nucleocytoplasmic ratio; A3. Prominent nucleoli. B. 25 cells.	A. high NC rati hyperchromasi chromatin, irre nuclear memb B. 10 cells in th tract and >10

Fig. 8. Written examination results of residents viewed on SharePoint.

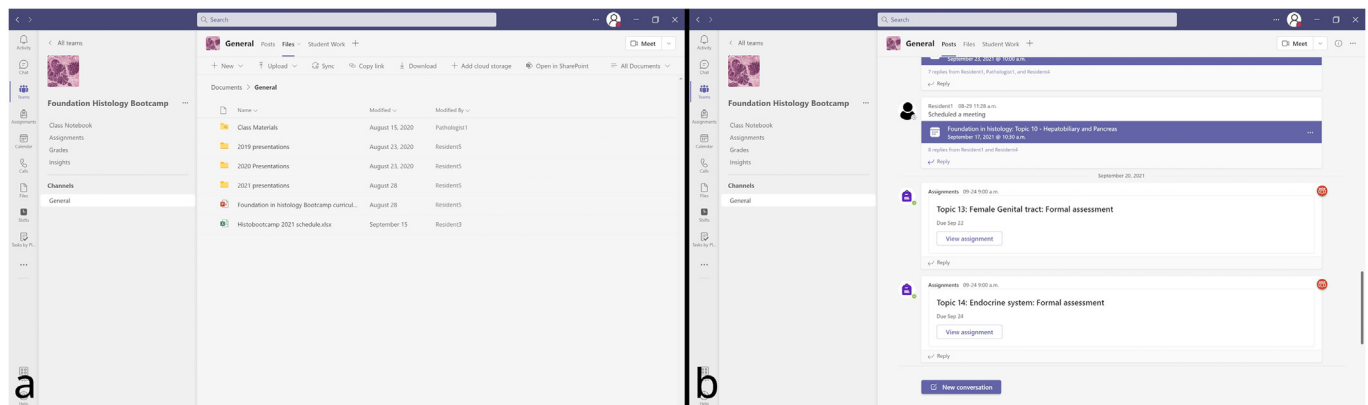


Fig. 9. (a) Files tab on the Foundation Histology Bootcamp app showing uploaded content, (b) posts tab on the app showing posted schedules and assignments.

Apps, SharePoint, and Teams was deemed appropriate for our departmental use. Although Power Apps is a subscription-based service, the ability to customize applications and run them on existing Microsoft services have made it justifiable despite the costs incurred. Similarly, the costs of on-premises licenses for WSI viewing were considered well founded.

Both the educational and examination focused apps have been extremely valuable during the pandemic both for our residents as well as faculty. Our apps serve as an effective online platform not only during work from home scenarios, but also when residents are on external off-site rotations or electives. The examination app enables a unique way to conduct examinations for pathologists, as scheduling on the app is flexible, allows for remote communication and all examination content is available on the same page within the app.

Some of the challenges involved with creating this platform of customized apps include the initial learning curve using Power Apps. However, being a low-code application, the commands are simple and can be quickly learned and integrated. Once the structure of the app and SharePoint lists are created, new data can be easily added, or schedules can be quickly revised. Lastly, the apps are heavily dependent on the Microsoft environment, so using them would only be possible if one's educational institution has access to Microsoft 365 services and the trainee has institutional credentials.

Conclusions

We have built customized apps using Microsoft Power Apps and Teams, that are specific to the pathology residency curriculum at our university. As our university extensively uses Microsoft 365 services, our apps are easily accessible to all residents and help consolidate learning, examinations, file sharing, and video calls in one platform. The flexibility of this platform allows for a rich and diverse repository for virtual pathology education. Overall, our residents and faculty have had a very favorable experience using the apps.

In future, we intend on performing user satisfaction surveys and comparing the app workflow to those without them. We are also building an app focused on continuing medical education for use by pathologists in the department. We are also exploring incorporation of more educational videos and 3D models as content for junior residents on grossing of surgical pathology specimens.

Financial support and sponsorship

This work was supported by an internal grant from the Department of Pathology, McGill University.

Conflicts of interest

Dr. Fiset reports honoraria for expert consultation from Amgen, EMD Serono, AstraZeneca, Bristol Myers Squibb, Merck, Pfizer, and Hoffmann-La Roche. He also received grants from AstraZeneca, Bristol Myers Squibb, the Cancer Research Society and the Canadian Institute of Health research, outside the submitted work.

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