Short Communication

Zooming for cells: Tele-education of histopathology residents during the COVID-19 pandemic

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Abstract
The recent COVID-19 pandemic moved education into the virtual world. We surveyed the effectiveness of conducting virtual tutorials via Zoom with attached microscope for pathology residents. Eleven respondents from the Department of Anatomical Pathology, Singapore General Hospital completed the survey. Many noted that the clarity of the slide images was equal to that of the usual slide sessions (91%). The audio reception was acceptable (100%). We found that 93% were satisfied with using Zoom, with 18% showing high satisfaction. We see this technology as a good add-on to face-to-face teaching, as it allows participation of residents posted away from teaching hospitals, and that this method of instruction should be kept as we move past the pandemic and its restrictions. We also see this as an alternative to the use of scanned digital slides, as not all teaching centers have a digital slide scanner, in addition to the issues of viewing restriction and storage of digital slides that need to be considered.

Keywords
Education, histopathology, online teaching, Zoom

Introduction
Coronavirus disease 2019 (COVID-19) was first reported in Wuhan, China in December 2019.1 Despite severe lockdown measures, the virus continued to spread globally, resulting in the World Health Organization declaring a pandemic on 12 March 2020.

Coronaviruses are enveloped RNA viruses that can cause respiratory, enteric, hepatic and neurologic disease in humans. Although zoonotic in origin, COVID-19, which is linked to a seafood and wet animal wholesale market in Wuhan, now shows sustained human-to-human transmission.2

To curb the transmission, the Singapore government has implemented a series of measures such as wearing of face masks, work-from-home, staggered work hours and social distancing. In addition, Prime Minister Lee Hsien Loong announced the implementation of a circuit breaker and extended circuit breaker period. All these measures, aimed at curtailting the community spread within Singapore, also impacted many industries. As such, we have seen an advent of online tools and media that replaced face-to-face interaction.

Histopathology as a medical specialty is very reliant on physical glass slides, and the teaching of histopathology residents is usually done by the educator (usually a consultant) showing a glass slide on a microscope while the students (which are the residents) view the same glass slide through a multi-header attachment (Figure 1). This usually means that the students are required to be in the same room as the educator physically. However, during the COVID-19 pandemic, where social distancing is vital to curb the spread of infection, teaching via the usual multi-header method is not recommended. Hence, the SingHealth pathology residency program decided to harness digital technology to implement a virtual tutorial session.

The use of digital technology for pathology education is not new. There are many pathologists who use social media platforms such as Twitter, Facebook, YouTube and many others to share pathology educational content, such as images of interesting cases and diagnostic teaching points.3,4 There are also organizations such as the United States & Canadian Academy of Pathology (USCAP)5 and College of American Pathology (CAP)6 who gave free complimentary access to what is usually paid contents of recordings of their interactive microscopy sessions during the COVID-19 pandemic.

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However, although very useful as an educational tool, there are limitations to these existing digital technologies. Mainly, they allow mostly passive gains of knowledge without active participation of learners to view the slides themselves and formulate their own approach to the diagnosis or their differentials. There is also no opportunity for feedback, for the learners to articulate what has been learned and for the educator to point out the strength and weaknesses of any argument and to clarify any confusing points. Active participation and feedback have been noted to be extremely important for improving the effectiveness and efficiency of learning by adult learners in the healthcare professions.7,8 Furthermore, although there is some scope for active participation on certain social media platforms such as Twitter and Facebook, where the learner could directly communicate with the educator and other learners, most of these are based on static pictures of small selected areas of the glass slide, and may be hindered by the staining intensity and suboptimal focus.

Methodology

To overcome these weaknesses as well as to allow real-time viewing of histology slides without being in the same physical room, the current set up was proposed (Figures 2, 3). A microscope camera (INFINITY1-3c, 3.1 Megapixel USB 2.0 Microscopy Camera, https://www.lumenera.com/infinity1-3.html) was attached to a single-header microscope (Olympus BX43). This microscope camera was attached to an internet-enabled laptop via a USB cable. A computer program which could receive the view of the microscope camera (Infinity Analyze, https://www.lumenera.com/infinity-analyze-and-capture-for-windows.html) was installed on the internet-enabled laptop, as well as the Zoom Desktop App (https://zoom.us/download). This would allow the glass slide seen through the microscope camera to be viewed on the laptop screen, which would then be “screen shared” on the Zoom Desktop App (Figure 4).

Teaching sessions ranged from 1 to 2 hours, with the educator as the host and the residents as the participants in the Zoom sessions. The educators would “screen share” the Infinity Analyze program, allowing the residents to see the same microscope view as the educators. Most educators would show the whole glass slide, and zoom in to certain important areas for diagnosis. They then named residents to answer their questions or formulate an approach to the diagnosis, giving some time for discussion before moving on to the next case. Some educators also “screen shared” PowerPoint slides to further expand the teaching points.

A self-designed questionnaire survey was given to the participants to evaluate the effectiveness of this new teaching method in the background of the COVID-19 pandemic. The survey was designed to have both qualitative and quantitative components. Quantitative questions used a 5-point Likert scale, followed by analysis with conventional statistical methods. Qualitative questions included “what do you think are the limitations of this system,” “what could be improved” and “what are the good points of this system.” Answers to qualitative questions were then subsequently coded for common themes during analysis.

An informal interview of the educators asking similar qualitative questions was also performed.

Results

Eight Residents, two Medical Officers and one Fellow from the Department of Anatomical Pathology, Singapore General Hospital completed the survey (Table 1). Most of them use smartphones (64%) to view the teaching sessions, while
Figure 4. Comparison between the image seen on Zoom (A) versus the image seen under the microscope at 400× magnification (B).

Table 1. Survey quantitative responses.

|   | Survey Questionnaire (11 respondents)                                                                 |
|---|-------------------------------------------------------------------------------------------------------|
| I | How convenient do you find logging into Zoom Meeting application?                                      |
|   | Very easy (Score 5)                                                                                   |
|   | Easy (Score 4)                                                                                         |
|   | Regular (Score 3)                                                                                      |
|   | Difficult (Score 2)                                                                                    |
|   | Very difficult (Score 1)                                                                               |
|   | 45%                                                                                                    |
|   | 45%                                                                                                    |
|   | 9%                                                                                                     |
|   | 0%                                                                                                     |
|   | 0%                                                                                                     |
| II| How clear are the slide images shared during the session as compared to physical classroom session?   |
|   | Very clear                                                                                             |
|   | Not bad                                                                                               |
|   | Okay                                                                                                   |
|   | Not clear                                                                                             |
|   | Very not clear                                                                                        |
|   | 9%                                                                                                     |
|   | 18%                                                                                                    |
|   | 64%                                                                                                    |
|   | 9%                                                                                                     |
|   | 0%                                                                                                     |
|   | 9%                                                                                                     |
| III| How is the audio reception during the session?                                                         |
|   | Very audible                                                                                           |
|   | Not bad                                                                                               |
|   | Audible                                                                                                |
|   | Not audible                                                                                            |
|   | Can’t hear at all                                                                                      |
|   | 0%                                                                                                     |
|   | 36%                                                                                                    |
|   | 64%                                                                                                    |
|   | 0%                                                                                                     |
|   | 0%                                                                                                     |
| IV | How effective is the faculty teaching via Zoom Meeting?                                               |
|   | Very good                                                                                             |
|   | Good                                                                                                   |
|   | Neutral                                                                                                |
|   | Poor                                                                                                   |
|   | Very poor                                                                                             |
|   | 9%                                                                                                     |
|   | 64%                                                                                                    |
|   | 27%                                                                                                    |
|   | 0%                                                                                                     |
|   | 0%                                                                                                     |
| V  | Does the faculty clearly and effectively communicate & teach via Zoom Meeting?                         |
|   | Very good                                                                                             |
|   | Good                                                                                                   |
|   | Neutral                                                                                                |
|   | Poor                                                                                                   |
|   | Very poor                                                                                             |
|   | 27%                                                                                                    |
|   | 45%                                                                                                    |
|   | 27%                                                                                                    |
|   | 0%                                                                                                     |
|   | 0%                                                                                                     |
| VI | How effective is the faculty in challenging and stimulating resident’s intellectual capacity via Zoom Meeting? |
|   | Very good                                                                                             |
|   | Good                                                                                                   |
|   | Neutral                                                                                                |
|   | Poor                                                                                                   |
|   | Very poor                                                                                             |
|   | 27%                                                                                                    |
|   | 55%                                                                                                    |
|   | 18%                                                                                                    |
|   | 0%                                                                                                     |
|   | 0%                                                                                                     |
| VII| In comparison Zoom Meeting to physical classroom teaching style, how would you rate the virtual teaching session? |
|   | Very good                                                                                             |
|   | Good                                                                                                   |
|   | Neutral                                                                                                |
|   | Poor                                                                                                   |
|   | Very poor                                                                                             |
|   | 9%                                                                                                     |
|   | 36%                                                                                                    |
|   | 45%                                                                                                    |
|   | 9%                                                                                                     |
|   | 0%                                                                                                     |
|   | 9%                                                                                                     |
| VIII| In overall, how satisfied are you using Zoom Meeting as a learning tool?                               |
|    | Very satisfied                                                                                        |
|    | Satisfied                                                                                             |
|    | Okay                                                                                                   |
|    | Dissatisfied                                                                                          |
|    | Very dissatisfied                                                                                      |
|    | 18%                                                                                                    |
|    | 27%                                                                                                    |
|    | 55%                                                                                                    |
|    | 0%                                                                                                     |
|    | 0%                                                                                                     |
|    | 100%                                                                                                   |
|    | 0%                                                                                                     |
others use laptops (27%) and/or tablets (9%). Many found it convenient to log into the Zoom Meeting application (90%), and noted that the clarity of the slide images shared through Zoom about equal to that of the usual multi-header slide sessions (91%). The audio reception during these sessions was acceptable (100%) with the educator able to clearly communicate and stimulate the learner’s intellectual capacity via these Zoom Meetings. In total, 93% of respondents were satisfied with using Zoom, with 18% showing high satisfaction.

When asked about the pros of this teaching method, many of the respondents commented that this system was a good replacement in the current COVID-19 pandemic, especially in being able to practice social distance while continuing glass slide-based pathology education. For example, one respondent wrote “It is great that we are making an effort to continue teaching despite the current circumstances. In a way, these sessions are a means to reduce the negative impact of COVID on our learning.” Another theme raised was that the responders noted that this set up allowed greater attendance, especially from those posted to a different hospital or those who volunteered to aid in fever screening during this period. As one respondent commented, “Projecting on Zoom... facilitates a greater audience (e.g. those who are posted out...). Personally, I benefitted from this as I could view the teaching during my FSA (Fever Screening Area) posting.”

When asked about the cons of this teaching method, and what could be improved, many respondents raised similar themes, mostly hardware related. The main themes included poor internet connection bandwidth (including unstable WiFi), poor image resolution and poor audio. There was also a lag time between the learners hearing the audio question and seeing the correct glass slide image, hence it took a longer time for fewer cases to be discussed. As succinctly summarized by a respondent, “Slow connection, lagging in voice and pic, takes longer time for less cases to be discussed.”

Some of the educators echoed similar themes as the learners in an informal interview. They felt that the benefits of this method included being “COVID-19 risk free,” and that attendance was improved, “residents posted out can also join.” In terms of the limitations of the method, the educators noted that “internet stability is an issue” with some sound and visual lag noted when asking questions. They also felt that they are uncertain of the degree of engagement, as “participants might just log on without video and we do not know if they are actively listening.” Furthermore, some technical skill was required for use of the microscope camera viewer; as one educator noted that “Infinity camera takes constant adjustment for best projection. Time consuming and hampers teaching.”

Discussion

The COVID-19 pandemic has made us reappraise how we go about performing many of our daily activities. Histopathology education is no exception. This novel method of teaching using a microscope camera and Zoom has allowed us to continue our real-time virtual face-to-face teaching with active participations from learners while limiting the risk of COVID-19 transmission. As we explore the use of technology in our institution, we have found that the residents and faculty have been quick to pick up and use technology.

Our multidisciplinary tumor boards, peer review learning sessions, various departmental meetings and our teaching sessions are now being conducted virtually, and we have seen an increased in attendance when compared with before COVID-19. This is likely attributed to the ease of logging into the sessions and the prevalence of mobile smartphones. We have also seen that distance is no longer an issue in being able to attend the teaching sessions, as now residents who have been posted away from the teaching hospital, or are helping in other departments during this time of crisis, are still able to participate.

In our study, we noted a few common weaknesses in this method of teaching. The main issue raised was the need for better network connectivity. This has been an ongoing obstacle after the implementation of internet separation in the public health sector as a consequence of the SingHealth cyber-attack in which personal particulars of 1.5 million patients were stolen. This meant that many of the teaching sessions, on both the side of the educators and the participants, were reliant on personal mobile internet, wireless hotspots or the few internet-enabled laptops available in the department. Although this may be improved when nationwide 5G networks are available in Singapore in a few years, in the meanwhile there may be a need to discuss with the hospital IT services on improving the healthcare WiFi network bandwidth.

Improving the network connectivity would aid in improving both the image resolution and the audio, especially the lag time between the audio question and seeing the glass slide image. Also, the presenter needs to know how to adjust the microscope camera viewer settings (saturation, contrast etc) in real time during their teaching sessions, something many were unfamiliar with. This would require a short teaching session on how to use the system. An alternative approach would be to scan the glass slides into our digital pathology system and transfer the scanned slides (without the patient’s data) onto a web-based application hosted outside of the institution firewall which then can be “screen shared” on the Zoom teaching sessions. However, the trade-off is the need to prepare the glass slides for teaching much earlier and the increased manpower required for scanning of these glass slides. A microphone attachment closer to the presenter has been suggested to improve audio quality, which could be trialed.

As we leverage on technology, we must also be aware of the possible threats to the Personal Data Protection Acts 2012 (PDPA) and access to the session by uninvited parties. Recently, in a local school, hackers were able to access a Zoom class and disrupt the learning. In our settings, we worry about the leak of confidential patient details. This may be ameliorated by ensuring no identifiable patient data are shown or mentioned during the Zoom teaching sessions, ensuring that the Zoom desktop application is up to date and by activating the security features of the Zoom program.

Regardless, this method of teaching allowed real-time interaction between the educator and a large group of learners. Learners are able to actively participate during teaching.
sessions to formulate their own approach to the diagnosis or their differentials, and to learn from each other’s mistakes. Educators can give immediate feedback, point out the strength and weaknesses of any argument and clarify any confusing points. There are also plans to improve this method based on the survey responses, including using glass slides scanned onto a cloud digital pathology system, using a microphone attachment and allowing review of the glass slides before or after the teaching sessions.

We see that with further improvements, especially in terms of the hardware, this method could be used as an adjunct to the usual physical face-to-face teaching, as it allows participation of residents posted away from teaching hospitals. We also see this as an alternative to the use of scanned digital slides, as not all teaching centers have a digital slide scanner, and that there are issues of viewing restriction and storage of digital slides that need to be considered. We feel that this method of instruction should be kept as we move past the pandemic and its restrictions.

Conclusion

In conclusion, this was a novel method of teaching histopathology residents using digital tools at a time when physical distancing is vital to overcoming the COVID-19 pandemic. Although there were some limitations to this method, including the speed of the internet and the computing power of the laptop/smartphone used by the residents, this may be further improved with future technology including better hardware and the implementation of 5G internet. Beyond COVID-19, there are advantages to this set up, including allowing residents who are posted away from teaching hospitals to participate in these virtual tutorial sessions and to allow educators from other places, including overseas, to give online tutorials to learners in our institution and around the world. We also see this as an alternative to the use of scanned digital slides, as not all teaching centers have a digital slide scanner; in addition to the issues of viewing restriction and storage of digital slides that need to be considered.

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Author contributions

TPY and NLM were involved in protocol development. NLM took the photos and did the data collection. TPY and LWQ were involved in the drafting of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

Availability of data

The survey data generated and analyzed during the current study are available from the corresponding author.

Ethical approval

Not applicable as no identifiable patient data were used during the implementation of Zoom teaching and during the survey of the participants.

Informed Consent

Not applicable.

Trial Registration (where applicable)

NA.

Declaration of Conflicting Interests

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