

Interactive Online Practical Histology Using the Poll Everywhere Audience Response System: An Experience During the COVID-19 Lockdown

Histología Práctica Interactiva en Línea Usando Poll Everywhere Audience Response System: Una Experiencia Durante el Confinamiento de COVID-19

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SUMMARY: The shift to online learning due to the COVID-19 pandemic sheds light on the need for innovative approaches to medical education, making it more interactive and effective. Histology is a challenging subject because it is known to be image intensive. In this study, we compared two methods of online teaching of practical histology: an interactive method using the Poll Everywhere Audience Response System and a traditional method without the use of Poll Everywhere. We performed a randomized controlled crossover trial. One hundred and forty students were divided into two groups. The first group was taught using the interactive method and the second group was taught using the traditional method. Each group was then taught using the other method for a second subject. Students' performance and preferences were assessed using tests and questionnaires. The examination scores were significantly higher for Poll Everywhere group. All students' responses were overwhelmingly in favor of the use of Poll Everywhere, with regard to their engagement, enjoyment, and morphology understanding, in addition to the applicability of the interactive approach. Interactive sessions of practical histology using applications such as Poll Everywhere can be an effective way to increase students' engagement, enjoyment, and knowledge retention during distance learning.

KEY WORDS: Histology; Medical students; Poll Everywhere.

INTRODUCTION

The education of anatomical sciences has gradually shifted from traditional teacher-focused to student-centered methods with less contact time (Chimmalgi, 2019). Advocates for shifting medical education from didactic to interactive lectures claim that interactive lectures are effective in increasing students' attention, knowledge retention, and engagement (Chilwant, 2012). The transition to online classes due to the COVID-19 lockdown has affected many disciplines, including histology. Sometimes, even practical histology classes have been conducted online. This required a greater effort to increase class interactions. Interaction inside the classroom is an area that focuses on improving the learning environment (Meguid & Collins, 2017). Histology is considered an image-intensive subject, and there are ongoing efforts to improve

medical students' skills in identifying normal tissue structures (Hightower *et al.*, 1999; Hortsch, 2017). We believe that online teaching can be effectively applied to practical histology by presenting image-enriched study material using supportive software. However, supplementary methods to increase students' engagement and attention are also needed. Student engagement is a major outcome that is emphasized by several outcome-centered methods, such as the various applications collectively known as the "audience response systems (ARS)" (Robertson, 2000; Miller *et al.*, 2003). In the electronic tool that we used, questions can be designed and embedded among PowerPoint slides. The results of audience responses are displayed immediately, giving the learners anonymous feedback.

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In this quantitative study, we aimed to assess the effectiveness of using Poll Everywhere as an example of ARS, and its effect on students' preference and performance in practical histology. This application can accommodate the participation of a large group of medical students in the same session. We used Microsoft PowerPoint™ presentations, and the sessions were live-streamed on Microsoft Teams™.

MATERIAL AND METHOD

During the COVID-19 pandemic lockdown, classes of all disciplines for Year 1 medical students at Al-Balqa Applied University (BAU), Al-Salt, Jordan, were conducted online. All ordinary classes were transformed into virtual meetings using the Microsoft Teams™ and Moodle™ platforms. The course on general histology was taught to Year 1 medical students during their second semester.

After obtaining ethical approval from the BAU faculty of medicine, medical students in Year 1 at BAU were chosen to participate in this study during their practical histology classes. All students completed the first 6 weeks of the general histology curriculum, which covered the following topics: Histological techniques and microscopy, eukaryotic cell components, cell division, extracellular matrix and cell junctions, and epithelial and connective tissue types. The student cohort represented novices enrolled in the course of general histology for the first time.

One hundred and forty students volunteered to participate. The students could stop participating at any time. The students were randomized and equally divided into two major groups: A and B. To assess class equivalency, the means of midterm exam of the two groups were compared, and there was no significant difference.

In the first week of the study, group A attended three sessions on bone histology, where PowerPoint™ presentations (dry labs) were used. Each session was live-streamed using the Microsoft Teams™. The same study material was given to group B. However, this time Poll Everywhere ARS-designed questions were embedded in the PowerPoint presentations. The application instructions were explained to the students before each Poll Everywhere session. Different types of questions were designed and embedded for the Poll Everywhere class: multiple choice, word cloud, clickable image, and rank order. At the end of the first week, an anonymous 20-point quiz on bone histology was provided to all students.

In the next week, muscle histology was covered in three sessions. The methods for teaching each group was swapped so that group A attended the sessions with Poll Everywhere while the sessions attended by group B were without the implementation of Poll Everywhere. At the end of the second week, an anonymous 20-point quiz on muscle histology was given to all the students.

After the completion of both interventions, students' preferences were anonymously assessed using a five-point Likert scale. The questionnaire elements were concentrated on the effect of the new method on students' understanding and knowledge retention in normal histology, in addition to their enjoyment and engagement in the class. Pearson's chi-square and independent t tests were applied, and a p value <0.05 was considered significant. Cohen's d was used to calculate the effect sizes. The Statistical Package for the Social Sciences (SPSS) software was used for analysis.

RESULTS

The results of the two tests for 140 first-year medical students were analyzed. Group B's mean overall quiz score on bone histology was significantly higher than group A (Group A mean: 13.71 (SD: 4.51); group B mean: 16.46 (SD: 2.77); p value = 0.000; Cohen's d: 0.69). By contrast, for group A, the quiz scores on muscle histology were significantly better than those in group B (Group A mean: 17.66 (SD: 1.98); group B mean: 15.80 (4.38); p value = 0.002; Cohen's d: 0.53). A total of 106 students responded to the questionnaire. There were 47 (44 %) males, and 59 (56 %) females, with a M:F ratio of 0.8:1. The mean age of the participants was 18.58 years (SD = 0.66). The responses to all the questionnaire elements were strongly in favor of the interactive approach (Table I). Only one (0.9 %) student did not want to continue using Poll Everywhere. Moreover, 87.7 % found Poll Everywhere to be user-friendly. A total of 89.6 % recommended using Poll Everywhere in other practical subjects. Over 91 % of the participants found that Poll Everywhere increased their attention in the class. More than 92 % strongly agreed or agreed that Poll Everywhere increased their enjoyment of the class. 88.7 % found that Poll Everywhere motivates them to learn. A total of 87.8 % found Poll Everywhere more encouraging for attending the class. 85.9 % strongly agreed or agreed that Poll Everywhere made them more confident about participating in the class. Of the participants, 87.7 % reported that Poll Everywhere makes them think deeply. Nearly 84 % found that Poll Everywhere increased their awareness of their strengths and weaknesses in practical histology. 78.3 % agreed or strongly agreed that Poll Everywhere improved their skills in practical histology (Table I).

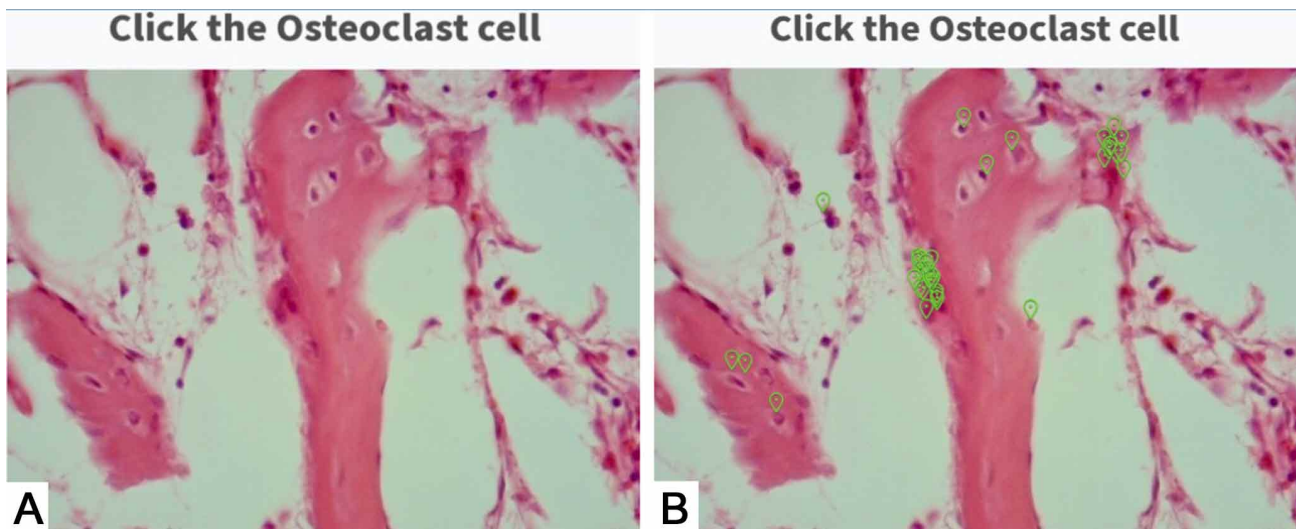


Fig. 1. A clickable image question showing two osteoclast cells before and after the responses.

Table I. Students' perceptions of using Poll Everywhere in online practical histology classes.

Item	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
Perceptions of effectiveness					
You recommend keep using PolLEV.	1 (0.9)	0 (0)	12 (11.3)	27 (25.5)	66 (62.3)
PolLEV is user-friendly.	1 (0.9)	2 (1.9)	10 (9.4)	37 (34.9)	56 (52.8)
Using PolLEV increases classes' overall value.	1 (0.9)	0 (0)	14 (13.2)	31 (29.2)	60 (56.6)
Using PolLEV during the class is distracting.	36 (34)	31 (29.2)	13 (12.3)	15 (14.2)	11 (10.4)
Using PolLEV helps me pay attention more in class.	1 (0.9)	2 (1.9)	6 (5.7)	34 (32.1)	63 (59.4)
I benefit from seeing other students' responses.	1 (0.9)	1 (0.9)	13 (12.3)	39 (36.8)	52 (49.1)
Learning with PolLEV Improves my understanding of course contents	2 (1.9)	1 (0.9)	7 (6.6)	39 (36.8)	57 (53.8)
I recommend using this method in theoretical lectures.	1 (0.9)	2 (1.9)	17 (16)	25 (23.6)	61 (57.5)
I recommend using this method in other practical lectures.	1 (0.9)	3 (2.8)	7 (6.6)	21 (19.8)	74 (69.8)
This method can replace the ordinary teaching method of practical histology.	5 (4.7)	9 (8.5)	23 (21.7)	16 (24.5)	43 (40.6)
Perceptions of enjoyment and engagement					
Using PolLEV increases enjoyment of lectures.	1 (0.9)	0 (0)	7 (6.6)	24 (22.6)	74 (69.8)
Using PolLEV makes me more confident to participate.	1 (0.9)	1 (0.9)	13 (12.3)	25 (23.6)	66 (62.3)
PolLEV encourages me more to ask questions in lectures.	1 (0.9)	3 (2.8)	24 (22.6)	34 (32.1)	44 (41.5)
Using PolLEV motivates me to learn.	1 (0.9)	1 (0.9)	10 (9.4)	36 (34)	58 (54.7)
Using PolLEV encourages me to attend class.	1 (0.9)	1 (0.9)	11 (10.4)	34 (32.1)	59 (55.7)
Class time pass more quickly when PolLEV is used.	1 (0.9)	2 (1.9)	22 (20.8)	31 (29.2)	50 (47.2)
Perceptions of deep learning					
Using PolLEV helped me think more deeply	1 (0.9)	1 (0.9)	11 (10.4)	39 (36.8)	54 (50.9)
Using PolLEV Helped me better prepare for quizzes and tests	1 (0.9)	0 (0)	20 (18.9)	33 (31.1)	52 (49.1)
Instructors used results to reinforce material not understood.	2 (1.9)	3 (2.8)	25 (23.6)	36 (34)	40 (37.7)
I gain increased awareness of strengths and weaknesses by this method.	1 (0.9)	0 (0)	16 (15.1)	40 (37.7)	49 (46.2)
PolLEV Improves my skills in practical histology.	1 (0.9)	2 (1.9)	20 (18.9)	37 (34.9)	46 (43.4)

DISCUSSION

The COVID-19 pandemic forced students to stay away from their universities (Kamanetz, 2020), which made e-learning the only available substitute for face-to-face teaching (Lederman, 2020). The amount of literature on the use of ARS, specifically Poll Everywhere, on undergraduate medical and dental students is limited. Moreover, this is the first study that uses a randomized controlled methodology

with a crossover design to determine the advantages of using such an application. In addition, histology is a challenging discipline for both students and teachers. However, for Histology, PowerPoint is easy to use, and it also supports the use of the Poll Everywhere application during the live stream of the class. Meguid & Collins studied the perceptions of undergraduate dental students' perceptions of the Poll

Everywhere system during their anatomy module. A high percentage of the students in their study showed increased participation and motivation to learn, and mentioned that the new method made them think deeply and clarified the points that they needed to focus on. We obtained overwhelmingly positive responses, supporting the findings of Meguid & Collins. More than 88 % of the participants strongly agreed or agreed that the new method increased their motivation. In addition, more than 87 % mentioned that it helped them to think more deeply. Nearly 84 % of the participants found that Poll Everywhere sessions highlighted their strengths and weaknesses. Even for fellowship programs, as seen in Castillo *et al.* (2020) study on the didactics of medicine fellowship, a significantly higher student satisfaction was obtained when Poll Everywhere was used. Histology, an image-intensive topic, is challenging for both learners and educators (Al Khader *et al.*, 2020). However, interactive teaching and e-learning can effectively improve students' performance, and technology can be easily implemented in an image-enriched teaching approach. For example, from a radiology perspective, in a study by Groth *et al.* (2018), a significantly higher performance in interpreting brain emergency CT was revealed when they used interactive and e-learning approaches. Although the online method of teaching practical medical sciences is debatable, in a study by Khan *et al.* (2021), a significant proportion of the students showed satisfaction with online teaching of practical preclinical subjects. In spite of the absence of direct interaction, the students in that study found the method used more enjoyable, engaging, and motivating for learning. About 65 % of the students in our study thought that the online approach using Poll Everywhere can replace the ordinary teaching method of practical histology. This can be explained by the overwhelmingly positive responses to all the other questionnaire elements. Moreover, nearly 90 % thought that the new approach could replace the traditional methods used for other practical sessions, such as anatomy and pathology. We can also invest in this method for teaching histology and histopathology in an integrated approach, since the use of histopathology examples in practical histology teaching can increase students' satisfaction (Al Khader *et al.*, 2021). Figure 1 illustrates how the students can develop additional findings based on the same example, besides their initial answers. This can significantly increase students' attention to microscopic details that remain unidentified when performing the exercise alone. This may improve their morphological skills. This is clearly supported by the fact that 59.4 % of the students strongly agreed and 32.1 % agreed that Poll Everywhere helped them pay more attention to the class. Interestingly, only one to five students gave negative responses to most of the questionnaire elements. The issue that was raised by about 25 % of the students is the distraction that can be caused by the use of this application. However, a

feature in Poll Everywhere, which is considered an advantage in comparison to many other ARS types, is that there is less waste of time associated with the distribution and collection of remote controls. Students can easily use their mobile phones to respond to the questions (Gewirtz, 2012). In addition, there is no risk of loss of remote control and paying its cost accordingly (Meguid & Collins). Although Poll Everywhere includes a larger range of question types in comparison to the other remote-based systems, which only utilize multiple choice questions (MCQs). This makes the use of the system more flexible in the class, the MCQs remained the most preferred question type by the students, followed by clickable images. An important point to mention is that clickable image questions have gained the highest response rate from the students, which highlights the importance of this type of question for practical histology and that this was enjoyable for the students. Interestingly, nearly 92 % of the students found that Poll Everywhere increased the enjoyment of practical histology sessions. Active participation enhanced students' knowledge retention, motivated them to study, and even affected their behaviors. These findings have been highlighted in many other studies worldwide (Kaur *et al.*, 2011; Miller *et al.*, 2013; Luetsch & Burrows, 2016; Khalid & Ahmad, 2019). For both topics taught in this study, the interactive approach group gained significantly higher quiz scores. Comparable to other studies, a high percentage of the students in this study found that the use of Poll Everywhere is more motivating for them to learn. The motivating environment created by this interactive approach can positively affect students' behavior by making them more confident and not afraid of assessments (Sarwar *et al.*, 2014). About 86 % of the participants in this study reported that the interactive approach makes them more confident in problem solving. About 72 % of the participants found that the approach is effective in making lecturers reinforce the material that is not understood. Most of them also perceived the importance of this approach in increasing their awareness of the different weaknesses and strengths of their learning abilities. This highlights that this method is a combination of an outcome-focused approach and student-centered learning provided in a real-time assessment tool for both the teacher and the student, by which both can concentrate their efforts for a better outcome.

CONCLUSIONS

Interactive sessions of practical histology using applications such as Poll Everywhere can be an effective way to increase students' engagement and enjoyment in online classes, in addition to its positive effect on students' ability to better understand morphology.

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RESUMEN: El cambio al aprendizaje en línea debido a la pandemia de COVID-19 determinó la necesidad de enfoques innovadores para lograr que este método de educación médica sea más interactivo y efectivo. La histología es un tema desafiante debido a que se considera intensivo en imágenes. En este estudio, comparamos dos métodos de enseñanza en línea, en clases de laboratorio de histología: un método interactivo con el uso de Poll Everywhere Audience Response System y un método tradicional sin el uso de Poll Everywhere. Realizamos un ensayo cruzado (crossover) controlado aleatorio. Se dividieron cuarenta estudiantes en clases de laboratorio de histología en línea interactivas o tradicionales. Luego, a cada grupo se le asignó el segundo método para un segundo tema. El rendimiento y las preferencias de los estudiantes se evaluaron mediante pruebas y cuestionarios. Los puntajes de las pruebas fueron significativamente más altos para los grupos de Poll Everywhere, y las respuestas de los estudiantes fueron a favor de usar Poll Everywhere en lo que respecta a su participación, agrado y comprensión de la morfología como también del enfoque interactivo. Las clases de laboratorio de histología interactivas que utilizan aplicaciones como Poll Everywhere pueden ser una forma eficaz de impulsar la interacción de los estudiantes durante el aprendizaje a distancia.

PALABRAS CLAVE: Histología; Estudiantes de medicina; Poll Everywhere.

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