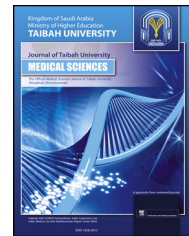




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Original Article

### Feedback from medical student on an interactive online anatomy practical using the Google Jamboard platform

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#### المخلص

**أهداف البحث:** أدى اضطراب كوفيد-19 في تعليم علم التشريح إلى إجبار الانتقال الشخصي إلى التعلم عبر الإنترنت. على الرغم من الاستخدام المتزايد للأدوات المعززة بالتكنولوجيا في الفصول الدراسية عبر الإنترنت، يواجه محاضرو التشريح صعوبة في جعل الفصول تفاعلية. ومن ثم، استكشفت هذه الدراسة قابلية استخدام لوحة بيضاء افتراضية على شبكة الإنترنت - لوحة غوغل جام بورد - في فصلين عمليين للتشريح عبر الإنترنت.

**طرق البحث:** تم إجراء دراسة ظواهر نوعية على 116 طالب طب في السنة الثانية من جامعتين ماليزية حكومية عبر تطبيقات المؤتمرات عن بعد التي سمحت بأنشطة المجموعات الصغيرة المتزامنة. تم منح كل مجموعة رابطاً مختلفاً لعشر شرائح جام بورد تحتوي على مخططات تشريح بسيطة وإرشادات لمهمة المجموعة. عند الانتهاء من المهام، عرض الطلاب مهامهم على الفصل بأكمله. تم توزيع نموذج التعليقات عبر الإنترنت في نهاية الجلسة العملية لاستكشاف تجارب الطلاب باستخدام الأداة.

**النتائج:** أنتج التحليل المواضيعي لاستجابات الطلاب سبعة مواضيع عكست فوائد التعلم المتصورة، والتحديات التي يواجهها الطلاب، والاقتراحات للتحسين المستقبلي.

**الاستنتاجات:** تشير النتائج إلى أن غوغل جام بورد أداة مفيدة لتعزيز التعلم التعاوني في تعليم التشريح الافتراضي. ومع ذلك، لا يزال تأثير هذه الأداة على تحقيق نتائج التعلم غير معروف. وبالتالي، هناك حاجة إلى مزيد من البحث على نطاق أوسع لتأكيد النتائج.

**الكلمات المفتاحية:** تعليم علم التشريح؛ كوفيد-19؛ غوغل جام بورد؛ التعلم التفاعلي؛ تعليم على الإنترنت

#### Abstract

**Objective:** The disruption caused by COVID-19 in anatomy education has forced the transition of in-person to online learning. Despite the increasing use of technology-enhanced tools in online classes, anatomy lecturers face significant difficulty in making classes interactive. Hence, this study explored the feasibility of a web-based virtual whiteboard, Google Jamboard (GJ) for two online anatomy practical classes.

**Methods:** This was a qualitative phenomenology study conducted on 116 second-year medical students from two Malaysian public universities via teleconferencing applications that allowed synchronous small-group activities. Each group was given a different link to 10 GJ slides that featured plain anatomy diagrams and instructions for the group task. Upon completion of the tasks, the students presented their tasks to the whole class. An online feedback form was distributed at the end of the practical session to explore the experience of the students when using the tool.

**Results:** Thematic analysis of student responses generated seven themes that reflected perceived learning benefits, challenges faced by the students, and suggestions for future improvement.

**Conclusions:** These findings suggest that GJ is a useful tool for promoting collaborative learning in virtual anatomy education. Nevertheless, the impact of this tool on the attainment of learning outcomes remains unknown. Hence, more widescale research is needed to confirm our findings.

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**Keywords:** Anatomy education; COVID-19; Google Jamboard; Interactive learning; Online learning

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## Introduction

The global disruption caused by Coronavirus disease 2019 (COVID-19) has profoundly affected essential activities and services, including the education sector, causing physical classes to be converted to online learning. In Malaysian medical schools, the implementation of online learning during the pandemic was very challenging, given the fact that the medical curriculum requires in-person training for competency attainment.<sup>1</sup> Similarly, in anatomy education, medical students are required to acquire a sufficient level of psychomotor and affective skills which are normally achieved through in-person hands-on activities, namely cadaveric dissection.<sup>2</sup>

Prior to the COVID-19 pandemic, gross anatomy subjects in Malaysian medical schools were predominantly taught through face-to-face modalities, namely lectures, problem-based learning (PBL), team-based learning (TBL) and blended learning approaches.<sup>3–6</sup> Prior to COVID-19, practical anatomy sessions were commonly delivered through various hands-on activities, namely cadaveric dissection, along with the demonstration of anatomy models or prosected specimens, and assessment-based activities.<sup>7,8</sup> The use of e-learning, virtual simulation, and anatomy software was minimal due to financial constraints and was predominantly employed by private medical institutions.<sup>2,9</sup> However, ever since the COVID-19 lockdown, the implementation of online learning in Malaysian medical schools has increased significantly with the use of video teleconferencing applications (i.e., WebEx, Zoom and Microsoft Teams), learning management systems, game-based learning platforms (i.e., Kahoot, Mentimeter and Quizizz), and three-dimensional (3D) anatomy atlas software (i.e., Complete Anatomy and Visible Body).<sup>2</sup> Nevertheless, anatomy lecturers face significant difficulties in incorporating hands-on activities into online instructions; thus, they need to be creative in finding ways to promote interaction and active learning during formal classes.<sup>2</sup>

The nature of gross anatomy requires 3D visualization ability to develop a deep understanding of the fidelity and intricate relations of anatomical structures.<sup>10</sup> Since cadaveric dissection and other hands-on activities were limited during the pandemic, anatomy lecturers need to rely on technology to promote mental imagery.<sup>11</sup> For instance, the implementation of pre-recorded demonstration video using cadaveric specimens for practical classes, combined with synchronous tutorial class, Kahoot online quizzes, body painting, and anatomy clay model creation were carried out.<sup>12</sup> Other modalities used in online anatomy practical include dissection video incorporated with three-dimensional (3D) anatomy software and quizzes on cadaveric structures identification.<sup>13,14</sup> Undoubtedly, the impact of online anatomy practical classes has been substantial as it is

uncertain as to how the COVID-19 situation will unfold in the near future.<sup>15</sup>

Hence, this study explored the use of the Google Jamboard (GJ) application, a free digital whiteboard application that permits real-time collaborative work among students, in online anatomy practical classes. The GJ can be accessed through a website or mobile application and features several tools (e.g., sticky note, pen and textbox), thus allowing students to write or draw on the Jamboard.<sup>16</sup> Moreover, students can add images from other sources and utilize additional assistive drawing tools when using the mobile version of Jamboard. The instructor can create up to 20 slides per Jamboard, which allows access to 50 students simultaneously. However, the GJ application does not have an audio or visual sharing option. Therefore, this platform should be integrated with video teleconference applications, such as WebEx, Zoom or Microsoft Teams.<sup>17</sup>

Given the fact that GJ can promote collaborative and interactive learning, this study explored the usability of this application in online anatomy practical sessions in two Malaysian public medical institutions. The preclinical year students of these institutions have been taking online anatomy practical classes conducted using demonstration and discussion approaches ever since the pandemic. Considering their first encounter with the GJ application, we expected that the students would be able to provide comprehensive feedback on the use of GJ in an online anatomy practical session and reflect their experience undergoing the collaborative learning session.

## Materials and Methods

### Study design

A qualitative phenomenology study was conducted to explore the learning experiences of pre-clinical year medical students while taking online anatomy practical classes that utilized the GJ application. The GJ anatomy practical sessions were held online via two teleconferencing applications, the WebEx by Cisco and Zoom. Verbal consent was obtained from the students as permission for publishing their response data.

### Participants

A total of 116 second-year medical students from two Malaysian public universities: Universiti Sains Malaysia (USM) (n = 76) and Universiti Teknologi Mara (UiTM) (n = 40) were involved in this study. For both institutions, anatomy is taught in the first two years of the medical degree program. In consideration of the convenient sampling method, all students who attended the GJ practical session were invited to voluntarily complete a feedback form that explored their experience of learning using the GJ application during the online anatomy practical session. The use of the GJ application was repeated in the next online practical session until saturation of response was achieved. Sample saturation occurs when there is no new information about the topic under investigation, and similar incidents occur repeatedly.<sup>18</sup> For a qualitative study, a sample size of 7–89 people is recommended to achieve response saturation.<sup>19</sup> In

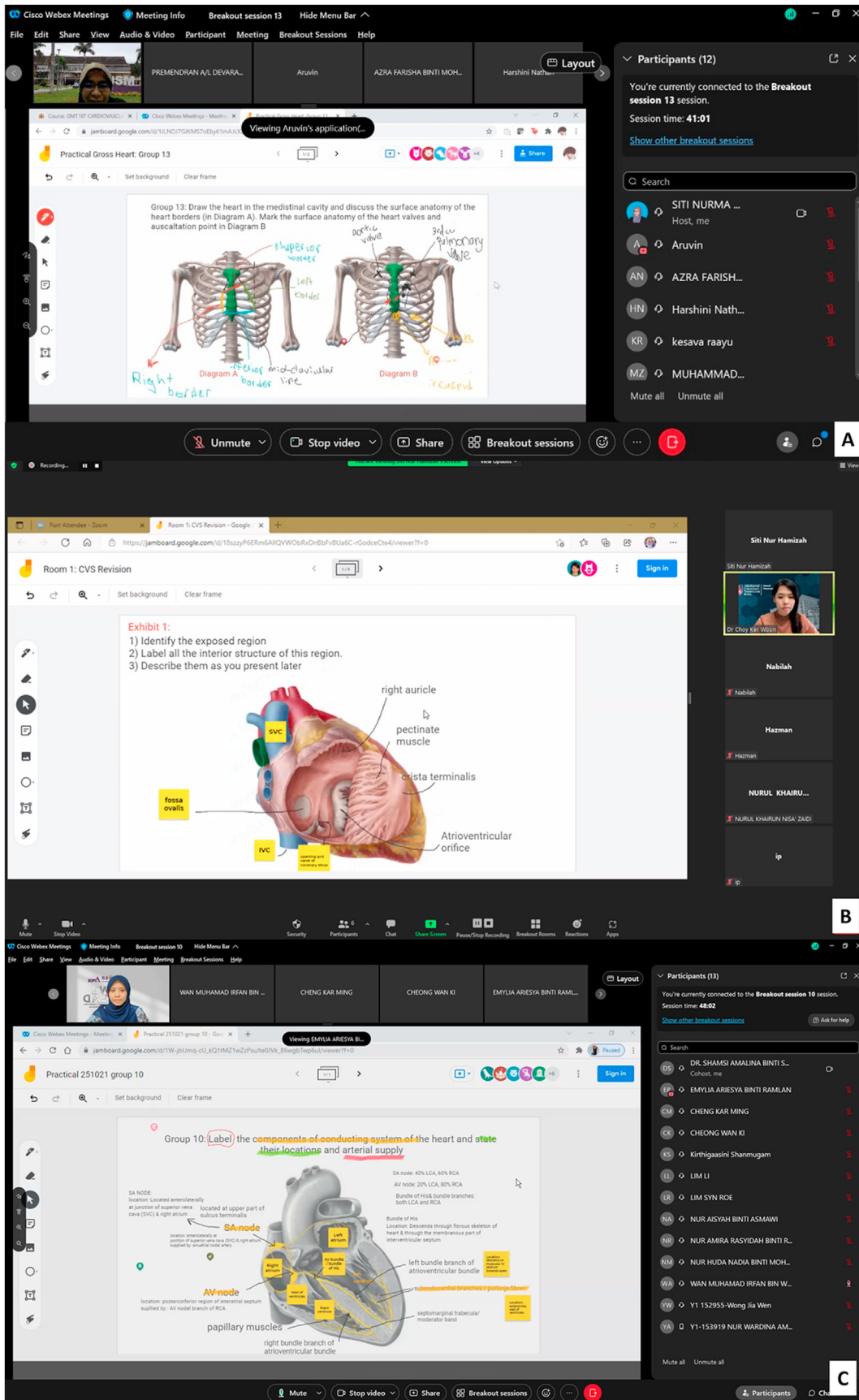


Figure 1: Examples of Google Jamboard slides labelled by the students of different groups.

this study, three GJ practical sessions were conducted to achieve the saturation response.

#### *Google Jamboard online anatomy practical session*

At the beginning of the GJ online anatomy practical, the students from both institutions met on the WebEx through the Cisco online or Zoom platforms, respectively. The tutor began each session with a brief explanation of the learning outcomes and activities, including the use of the GJ application. To avoid interruptions and miscommunication throughout the discussion session, general guidelines for the session were emphasized.

The students were divided into several small groups consisting of nine to twelve students per group, and each group entered a breakout room that enabled them to conduct small-group discussions. Each group was given a different link to the application, with each link leading to 10 Jamboard slides containing plain anatomy diagrams and learning instructions. Within each small group, the tutor requested that the students use the tools on GJ to label the anatomical structures presented in each Jamboard slide (Figure 1). The students were given 10 min to complete each task. To ensure continuous active discussion among the group members, the tutors went from one group to another throughout the entire session and provided opportunities for students to ask questions. Upon completion of diagram labelling via GJ, the students returned to the main hall of the WebEx and ZOOM platforms and presented their tasks to the whole class. The session ended with a debriefing session by the lecturers. Each practical session lasted for two hours.

#### *Measurement of the student perception of Google Jamboard during practical session*

A survey feedback form was distributed via the Google form platform at the end of the practical session to explore the perception of students with regards to the use of GJ for online anatomy practical classes. The students were also asked to reflect on their experiences of the collaborative learning session through the GJ platform.

#### *Thematic analysis*

Feedback from the students on the use of GJ for online anatomy practical classes was analysed using the thematic analysis proposed by Saldana (2009). ATLAS.ti software version 22 (Scientific Software Development, GmbH, Berlin, Germany) was used to convert the feedback into electronic representations and the analysis was carried out independently by three researchers: the first author (SAS), the second author (CKW) and the last author (SNH). First-cycle coding, known as open code (OC), was performed using the text analysis tool in ATLAS.ti software, in which the transcripts were divided into smaller codes depending on the phrases expressed by the participants.

Second-cycle coding was performed to unite OCs with comparable properties and linkages into a single category (AC). The OC framework was examined at this point for any connections, overlaps or duplicates. Following that, the researchers collaboratively studied the content and

interrelationships between the ACs during the final coding cycle and grouped them into numerous common codes, known as the select code (SC). During the coding procedure, the researchers kept track of trends and categories in a memo, which they then used for comparison and triangulation during the data analysis. This effort is important to ensure the transferability and dependability of the data.<sup>20,21</sup>

## **Results**

The thematic analysis generated seven SCs that comprised 21 ACs and 92 OCs. In general, the seven SCs reflected the learning benefits and problems faced by the students during the GJ learning session. The SCs also reflected the suggestions that need to be considered to overcome the challenges and ensure the smooth running of the learning sessions. The seven SCs included cognitive learning, collaborative learning, interactive learning, innovative learning, high usability, setback and challenges, and prerequisite and requirement. Throughout the analysis, all students wrote in simple English or Bahasa Melayu Language and there were no vague or redundant sentences that could impair the clarity of the sentences. Furthermore, all researchers analyzed each transcript independently, and the findings were discussed among the team members to achieve final consensus.

#### *Theme 1: Cognitive learning*

Cognitive learning in this context refers to the ability of the online anatomy practical GJ session to stimulate attention focus, prior knowledge and understanding of the learned materials. One student described how the GJ activities had made her stay focused on conducting the allocated learning tasks:

“It was a great method for a practical class. I found it interesting, and it was easy for me to keep my focus while doing the task assigned to us using the GJ application.” (Student 21, University A)

Another student described GJ activities as becoming more engaging when the materials were learned in small groups compared to learning in the whole class.

“Although it was a bit lagging at first, the task became easier when we were assigned to smaller breakout rooms. It was more engaging to do the GJ activities in small group.” (Student 29, University B)

One student described how the GJ practical session enhanced his understanding of the learned topic.

“The session allowed me to discuss with my friends. After listening to my friends’ explanations, I understood the topic better. Apart from that, the questions in the GJ allowed me to test my knowledge on the anatomy of the heart and blood vessels, which had strengthened my understanding.” (Student 18, University A)

One student perceived that the GJ practical session complemented the online lecture method in enhancing student understanding:

“It was a very helpful way for us to review what we learned during the lecture.” (Student 4, University A)

Another student felt that the GJ activities facilitated her learning through the stimulation of prior knowledge:

“I really like the use of GJ because it helped me to actively recall the things that I have learned before the class.” (Student 39, University B)

### *Theme 2: Collaborative learning*

In this study, collaborative learning represented a joint effort by the students to perform group activities. Some students described GJ activities as an enjoyable way to stimulate peer interaction and strengthen their communication skills.

“I love it! GJ made it easier for all group members to work together at the same time.” (Student 2, University B)

“It was a nice way to learn from and interact with our friends.” (Student 6, University A)

“GJ practical session allowed more active interaction compared to previous semester practical session where we will just listen to Dr.’s explanation.” (Student 19, University A)

Several students believed that the GJ practical session managed to stimulate peer discussion and develop good teamwork among the team members, despite the online format of the activities:

“The GJ activities provide opportunity for everyone to answer the questions. Although we were online, I think we had good teamwork because we discussed among ourselves and did the activities together.” (Student 16, University B)

“I enjoyed it very much because everyone was engaged and voluntarily throwing out their ideas.” (Student 49, University A)

Two students felt that GJ practical session allowed the synchronization of activities among the team members when the activities were performed in a small group:

“It was much easier for us to do the labelling of the diagrams in a small group compared to when we were in the large group, as everyone were doing the same thing at the same time, which can be a little bit of confusing.” (Student 33, University B)

“The session was fun and interactive. I love how Dr. divided us into several small groups for us to brainstorm among ourselves on the questions, followed by discussion with the whole class. GJ allows us to write our answers simultaneously.” (Student 40, University B)

One student expressed her appreciation that the GJ practical session provided a platform for them to make new

friends, as they were the first-year students who enrolled in medical schools during the COVID-19 pandemic and had not met each other physically.

“It is a nice method for me to learn new things, and I got to meet new friends, which I have not met or communicated with before.” (Student 55, University A)

### *Theme 3: Interactive learning*

In this study, interactive learning refers to the active participation of students in performing hands-on activities during the GJ online anatomy practical session. One student reflected on how she had been actively involved in the activity despite previous online practical sessions, which were mainly non-interactive.

“I definitely like and support the idea of having GJ activity. Since most of the practical sessions were done online and, in the afternoon, staying focused is not easy. However, in this session, I could see myself actively joining the practical session. It was not like before, when we just listened to the demonstration by the lecturers.” (Student 26, University A)

One student stated that the drawing and activity toolbars of the GJ application facilitated interactivity among the students.

“The use of GJ is very convenient and easy because there are a lot of features that can be used while doing the task, such as sticky notes and laser pointer. We can easily discuss and do the activity concurrently.” (Student 34, University B)

One student expressed her excitement about being able to synchronously perform learning activities with her team members:

“Really enjoy using it since it was my first time, and I really like it very much because everyone with the link can participate to do the task given. Interestingly, we accessed GJ at the same time.” (Student 46, University A)

### *Theme 4: Innovative learning*

Innovative learning in this study refers to the new learning approach that was introduced in anatomy practical classes. Two students described this method as unique and effective in stimulating discussion during an online anatomy practical session.

“GJ is a new learning method to me. It’s very unique, as it is different from other sessions. I think it is quite useful because we could discuss it in a small group.” (Student 15, University A)

“GJ is very good for online practical because we can discuss with our teammates and see what our friends’

answers. So, if there is a mistake, we can straightaway discuss what should be the correct and the best answer.” (Student 39, University B)

#### *Theme 5: High usability*

In general, the GJ online anatomy practical sessions had good usability, as they were perceived to be fun, user-friendly, and beneficial for learning anatomy, particularly in practical sessions of the subject. Two students perceived the GJ application as easy to use, despite having no prior exposure to the application:

“At first, it took some time to get used to GJ, but once I got the hang of it, it was easy to use.” (Student 18, University B)

“It was my first-time using GJ, but I think learning using it was very convenient.” (Student 36, University B)

One student described GJ as a convenient tool for learning because it has many features that allow students to have visual collaborations among team members.

“It was very convenient and easy to use since there are a lot of features for us to work on the diagrams together. It also allowed us to jot down the notes.” (Student 34, University B)

Three students perceived learning through the GJ practical session as an enjoyable new learning experience. One of them was motivated to use GJ for his future learning.

“The practical session using GJ was interactive, fun. With GJ, it was easy to work in a small group.” (Student 56, University A)

“The practical session provided me a chance to do self-learning and connect with my mates and learn together; it was a fun practical.” (Student 39, University A)

“New experience. Totally love to do more!” (Student 58, University A)

Two students perceived the GJ online practical session as beneficial for practical learning, as it provides a platform for them to share their opinions and perform hands-on activity in an online session. One student felt that the session had facilitated her active recall of her prior knowledge.

“The session was effective because we had the chance to give our opinion during the discussion, as we are learning in a small group instead.” (Student 26, University B)

“It was a very interactive and effective way for us to directly discuss the topic and perform some activities. We were able to test our understanding and knowledge by doing hands-on activities.” (Student 32, University A)

#### *Theme 6: Setback and challenges*

Despite the positive perceptions of students with regards to the GJ online anatomy practical, the students raised their

concerns about the challenges that they faced throughout the practical sessions. One student felt that the use of GJ in the online anatomy practical failed to stimulate discussion due to uncoordinated students’ involvement.

“To me, the session was not effective, as we were not familiar with each other yet. It might work better if students already know each other.” (Student 1, University A)

One student conveyed his disappointment in the passive response of their team members during the practical session, despite being given the opportunity to conduct hands-on activities using the GJ application.

“For me, using the GJ did not satisfy me enough in understanding and having discussion with others, as I rarely know the members in the group. I asked something during the discussion, but none of them gave any quick response. I didn’t think that we had an active discussion on that practical day. I think it can be modified by changing the grouping. Maybe it can just be done by following the PBL group.” (Student 73, University A)

Two students indicated that they had difficulty navigating the GJ application because they were not familiar with the application.

“It’s a bit hard to use because we are not familiar with it. I can’t find the correct tool for me to write down the answers in the beginning.” (Student 57, University A)

“In general, the practical session was okay, but it was a bit hard to control the annotation key of the GJ.” (Student 10, University B)

Some students complained about the technical problems that they faced during the GJ practical session, despite perceiving that the session was beneficial.

“It was a good way to have group discussion during practical using GJ. But because of the internet connection problem, sometimes the Jamboard became too messy.” (Student 5, University A)

“I thought it was difficult to write on the board simultaneously with other friends due to poor internet connections in my area.” (Student 34, University A)

“I like the idea of sharing the thoughts among my groupmates. However, it was quite disappointing that there was lagging while using the website, causing difficulties for most of us to contribute to writing on the board.” (Student 59, University A)

Some students perceived that the implementation of the GJ online practical session was not organized.

“Too many people working on the board at one time caused it to be messy.” (Student 9, University A)

“It was quite fun, actually, but a little messy because at first we received a wrong link so we got them mixed up among each other.” (Student 16, University A)

*Theme 7: Prerequisite and requirement*

To enhance the efficacy of the GJ online anatomy practical in promoting student learning, the students suggested several prerequisites and requirements for the session. Proper planning, dynamic groups and good technical support might ensure the smooth running of the session. A few students suggested that the lecturers should plan the design of the questions according to the capacity of the GJ display and allocate enough time for each question to optimize student activities.

“Although it was very convenient for a small group discussion, but the Jamboard was just small page and we need to adjust accordingly if want to write a lot of information” (Student 32, University B)

“It was easy to use GJ, as it enhanced our communication skills with the group members. The team was very responsive. But the only lack was that we did not have enough time to discuss our answers with the lecturers.” (Student 24, University B)

The students in University-A enrolled in the medical schools during the COVID-19 pandemic and had limited opportunities to get to know each other, except among their PBL group members. Therefore, the students complained of not having a good team dynamic during the small group work, in which they were randomly assigned. A student suggested that group allocation should be according to the PBL group to ensure good group dynamics.

“I think GJ was not efficient, as most of my team members were not willing to get involved in the discussion. Besides, we were not familiar with each other, as we had never met since we enrolled in medical school due to pandemic, and the group was formed randomly. It would have been better if the breakup session had followed the PBL groups. And I think personally, I prefer the old practical sessions, as the Jamboard session could be a chaos, as everyone was doodling on the same page without even communicating. Besides, a long time was used for the presentation and discussion. Since no one is willing to talk, I just wait for the time to pass. This is not equivalent to the efficacy of the session. That is my opinion, personally.” (Student 27, University A)

One student also highlighted the importance of having good coordination among team members during the activities. A student suggested a briefing of ground rules should be communicated before the session.

“It was fun to discuss with the groupmates, but I was having difficulty typing something on the Jamboard. If my groupmate clicks the same textbox, all the things I wrote will disappear.” (Student 35, University B)

One student highlighted the importance of having a good internet connection to ensure smooth running for the session.

“Even though this session was new for us, I think it was fun. GJ is a learning platform that allows us to interact with each other and share our opinions. But those who

did not have a strong internet connection would have problems using it.” (Student 24, University A)

**Discussion**

The use of digital tools and applications in anatomy education has markedly increased amid the COVID-19 lockdown, as these instructional tools allow the continuation of education provision.<sup>2,15</sup> Indeed, the GJ application provides a platform for interactive learning in remote anatomy classes, including practical sessions.<sup>17</sup> This study explored feedback from medical students from two public universities in Malaysia on the use of the GJ application during online anatomy practical sessions. The findings clearly indicate that students benefitted from the GJ online anatomy practical, as they perceived it as an innovative learning method that promoted collaborative learning. The sessions were perceived as a new learning experience, as they could easily understand the anatomy content through various hands-on activities. Nevertheless, this study also echoed the students' concerns about the challenges that they faced during the GJ online anatomy practical session and outlined their suggestions for future improvement.

It is evident from this study that the use of GJ in online anatomy practical sessions promoted collaborative virtual learning, which is potentially important for learning performance. It has been argued that collaborative learning promotes the development of higher cognitive skills, problem-solving skills and attitudes toward autonomous learning.<sup>22</sup> Although a collaborative virtual environment is not uncommon, its implementation can sometimes be costly and requires prior preparation by tutors, especially when it is conducted via video-based instruction, gamification and virtual reality simulations.<sup>23</sup> Given the fact that GJ is accessible through a computer or a mobile device, this application is suitable for synchronous online group activities, provided that students have a good internet network connection.<sup>24</sup> Indeed, the virtual whiteboards of GJ, known as Jams, are accessible by everyone with the link, and thus allow them to edit the Jams and contribute to the discussion.<sup>16</sup> Various types of group activities can be conducted using the GJ application, as it features several tools that allow synchronous drawing, labelling and note writing.<sup>25</sup> Furthermore, diagrams and images can be exported from other sources and students can manipulate these diagrams to fit the purpose of their learning.<sup>17</sup> The use of the laser pointer tool in the GJ application could enhance visual cues during group discussion, thus making discussion more effective.<sup>17</sup> Apart from these features, the GJ web version is available for free for a maximum of 20 slides and does not require a high-technology tool or complex preparation prior to class, thus making it a user-friendly learning tool for collaborative virtual learning.

Some students in this study perceived learning through GJ online anatomy practical sessions as an engaging learning experience that promoted their understanding of anatomy topics. In this practical session, students were exposed to different learning experiences rather than routine online anatomy practical sessions, which lacked hands-on activities. In fact, the GJ online practical session aligned with three out

of four stages of Kolb's experiential learning theory, as the students were exposed to a new learning experience that required them to navigate the GJ application (concrete experience); were required to complete several guided tasks and questions through group discussion and reflection (reflective observation); presented their task in the big group (abstract conceptualization); and generated final conclusion and reflected on the impact of the activities on their future learning.<sup>26</sup> The findings of this study supported the fact that new knowledge could be generated from the transformation of experience, as the students perceived that they could easily understand what they had learned after completing several group activities. The hands-on activities indeed provided them with a concrete experience that could have promoted cognitive engagement, stimulated their motivation and affection toward learning, and subsequently bridged their perceptions of the actual learning gaps.<sup>27</sup> Furthermore, with reflective observation and abstract conceptualization, students were able to link the hands-on activities with the learning outcomes and conceptual content of the topic, thus allowing them to reflect on their own thinking processes and tangible outcomes of their learning.<sup>27</sup> In the cognitive load theory context, this reflection activity is an effortful metacognitive process, known as germane load, that could have contributed to the higher perceived ability to understand the instructional content.<sup>28</sup>

Nonetheless, to ensure a successful GJ session, several social aspects of learning need to be considered. For instance, three important elements that ensure the smooth running of any collaborative virtual learning are visual socialization skills (i.e., communication), virtual collaboration skills (i.e., behavioural rules and feedback), and technical skills (i.e., the ability to navigate the digital tool).<sup>29</sup> In this study, some students echoed their concern about not being able to communicate well with their group members, to whom they were not close, or who were too passive during the discussion. Consequently, there was uncoordinated involvement from the group members when navigating the Jams, which further complicated the group task. A previous study reported that group member familiarity is important in an online learning environment, as familiar students spend less time regulating their task-related activities and developing group dynamics, thus leading to better group performance.<sup>30</sup> Similarly, introverted students, although reported to be more active in asynchronous online sessions compared to face-to-face classes as they have enough time to gain confidence and respond to a task, may have difficulty interacting in a synchronous session.<sup>31</sup> Since the GJ online anatomy practical sessions were synchronously conducted, the students needed to interact with their group members in real time. Hence, introverted students might be reluctant to be involved in the discussion. In fact, previous studies have proven that students are less compelled to participate in an online learning environment when compared to an in-person session for various reasons.<sup>32,33</sup> Moreover, the lack of body language and facial expression during the GJ online anatomy learning environment could have prevented effective communication, as these two elements play a role in the emotional perceptions of social interaction.<sup>34</sup>

Nevertheless, the students' receptivity toward the GJ application varied, as it was largely dependent on their familiarity with the application. Although there was much feedback on the perceived ease of the use of the GJ application, some

students felt that learning via the platform was not optimized, as they had little acquaintance with the application prior to the practical session. These students faced difficulty at the beginning of the class, as they took time to become familiar with the features of the GJ application. It has been argued that a student's familiarity with a learning tool, including an online application or software, determines their willingness and receptivity to use the tools.<sup>35</sup> This could be explained by cognitive load theory, which emphasizes the increased cognitive burden of learners when they are exposed to additional information that is not related to the actual instructional content (i.e., as in this study, the students need to learn how to navigate the GJ application concurrent with learning the anatomy content).<sup>36</sup> This condition could lead to ineffective learning.

Notwithstanding these challenges, the students suggested some prerequisites and requirements that may ensure a more efficient GJ practical session in optimizing student learning; for example, proper planning, dynamic groups and good technical support. To ensure that students can benefit better from the session, lecturers need to properly plan and design the learning session so that the students will have enough time to get familiarized with the learning environment. Good instructional design is of utmost importance in a synchronous online collaborative environment, given the fact that tutors and students are not present physically and have to communicate through a virtual platform. Indeed, a study conducted on synchronous distance learning reported that ill-defined instructional design could result in significant variation in the learning process among various groups.<sup>37</sup> Furthermore, tutors need to consider allowing a socially constructed group to ensure group dynamics. A previous study reported that a learning session and discussion in a constructed group was more efficient because the students felt comfortable expressing their opinions and views when compared to those in a natural group, who were less enthusiastic.<sup>38</sup> Ultimately, it is important to provide good technical support, namely a stable internet connection network and suitable teleconferencing application that can allow small group discussion. This effort would ensure the smooth running of the GJ session and lead to successful experiential and collaborative virtual learning.

Nevertheless, this study had several limitations that need to be considered. This study demonstrated the perceptions of students regarding utilization of GJ as a tool when used in online practical session for anatomy. Despite the fact that some students claimed that it was an effective and efficient way of learning, the effectiveness of the practical session using GJ cannot be concluded. The ability to retain knowledge by applying GJ in practical session were not evaluated in this study. Additionally, GJ received more positive than negative feedback from students, but their perception on GJ in comparison to other methods or tools used for practical sessions were not compared. Hence, the preference and superiority of GJ in comparison to other methods used for online practical sessions in anatomy cannot be concluded. In addition, this study did not control for confounding factors as a consequence of convenient sampling. Hence, students with prior exposure to GJ application may have perceived a positive learning experience when compared to those without prior exposure to GJ application. Conducting a well-designed interventional study that utilizes probability



sampling is required in the future to explore the effectiveness of this method.

Furthermore, this study included student participants from two public universities that offered medical courses in largely identical settings. In the future, it will be advantageous to recruit medical students from private medical schools, particularly those with global connections with international medical institutions. Such studies may provide a better generalization of the perceptions of students and lecturers with regards to GJ usage in online practical sessions. Finally, this study concentrated solely on the use of the GJ application. Given the fact that the GJ application is not a stand-alone tool in promoting real-time live interaction, future studies should also explore the impact of various teleconferencing tools in promoting a successful remote anatomy practical session. The use of other teleconferencing software that allows live discussion and file sharing through breakout rooms are pertinent features in ensuring successful remote learning.

### Conclusion

Overall, this study strengthens the idea that the GJ application is a highly useable tool that can promote experiential and collaborative virtual learning in anatomy education. Indeed, the use of GJ in practical anatomy is a pertinent move to enhance hands-on activities during the COVID-19 pandemic, especially in developing countries that are disadvantaged by a lack of financial support for virtual and augmented reality simulation. Despite some technical setbacks during the learning sessions, the introduction of GJ in the anatomy practical sessions was well received by many students. Although this study focused on students feedback on the GJ online anatomy practical session, the findings may well have a bearing on the implications of this application for online anatomy learning. The study has raised an important question about the effectiveness of the GJ application in enhancing knowledge acquisition and retention, as well as the development of psychomotor skills and affective learning in anatomy learning. Hence, more widescale research using controlled trials is needed to confirm the postulation.

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### Conflict of interest

The authors have no conflict of interest to declare.

### Ethical approval

Since the sessions were part of formal teaching and learning activities scheduled on the academic calendar, the requirement for USM ethical approval was waived by the Human Research Ethics Committee, USM. Otherwise, ethical approval from Research Ethics Committee, UiTM was obtained [REC/05/2022 (ST/MR/93)].

### Authors contributions

SAS conducted and provided research materials, analysed data, and preparing first draft. CKW conducted and provided research materials, collected and analysed data, and preparing first draft. SNH designed the study, conducted and provided research materials, collected, analysed and interpreted data, preparing first and final draft of article. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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