

## ORIGINAL ARTICLE

# Effectiveness and Student's Perception of E-anatomy Kit as a Tool for Gross Anatomy of Respiratory System Virtual Practical During Covid-19 Pandemic

Choy Ker Woon, Nurul Hannim Zaidun, Haszianaliza Haslan, Nurul Raudzah Bt Adib Ridzuan

Department of Anatomy, Faculty of Medicine, Universiti Teknologi MARA, Sungai Buloh Campus, Selangor, Malaysia

## ABSTRACT

**Introduction:** Anatomy is perceived to be an onerous subject as it contains complex information that necessitates three-dimensional visualization to comprehend. During COVID-19 pandemic, there was a paradigm shift to online distance learning including practical sessions. Innovative instructional techniques of learning anatomy are clearly needed. **Methods:** An e-Anatomy kit composing of 5 components: i) pre-recorded cadaveric demonstrations, ii) Complete Anatomy application, iii) interactive diagram labelling, iv) schematic diagram and v) mnemonics were designed to improve the Respiratory Module virtual practical experience of medical students from Faculty of Medicine, Universiti Teknologi MARA, Malaysia. The students were divided into 2 groups: the control group had regular discussion and the experimental group received an e-Anatomy kit. Pre- and post-test containing Anatomy questions as well as questionnaires regarding student perceptions were also given to the students. **Results:** There was significant difference between the means of pre- and post-test assessment in both control and e-Anatomy kit groups. There were no differences of post-test assessments between the control and e-Anatomy kit groups. However, in post-test assessments, the mean percentage difference of the e-Anatomy kit group is higher (15.8%) in comparison to the control group (10.3%). The students perceived the e-Anatomy kit as engaging, interesting and effective. **Conclusion:** e-Anatomy kit is an efficient and engaging approach as an alternative or adjunct to face-to-face anatomy teaching, especially under COVID-19 pandemic.

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## Corresponding Author:

Choy Ker Woon, PhD

Email: choykerwoon@uitm.edu.my

Tel: +60361267309

## INTRODUCTION

Anatomy is the foundation of professional training in medicine and basic medical sciences field (1). To lay a strong foundation for future clinical encounters and professional practice, medical students must grasp essential anatomical knowledge (2). Anatomy was traditionally regarded as a tedious, labor-intensive topic that was taught through surface learning methods and rote memorization (2). However, with the incorporation of innovative ideas in learning strategies, anatomy teaching is undergoing an evolutionary transition as an alternative to face-to-face anatomy teaching under the current contexts (3).

The widespread of COVID-19 caused a major disruption in medical education as some form of lockdown was declared (4). Students who lost access to dissection rooms lost access to a variety of other ideal learning modes, including prosections, models, pathology specimens, skeletons, and others (4). Indeed, this pandemic has further limited the students' contact time with Anatomy practical hands on session (2). During the pandemic, the majority of school systems around the world changed to a fully online learning style (5), demonstrating a gap in the conventional Teaching and Learning (T&L) in Anatomy during pandemic.

Students and teachers must adapt to online distance learning, and just giving an online atlas will not provide students a "appreciation for the weave of the human body" (6). In order to improve student engagement and learning results, anatomists must explore novel and stimulating, engaging, creative, purposeful, multimodal

techniques to foster proactive, deep learning, and develop long-term memory in students (2). New ways for teaching Anatomy that include technology are evolving, making learning more participatory, student-centered, and appealing to a wider range of students (7). In the T&L of Anatomy, a paradigm changes from a teacher-centered to a learner-centered approach has been noticed using new and interactive instructional tactics and methodologies (8), especially during pandemic.

In order to improve T&L of the Anatomy subject to pre-clinical medical students of Faculty of Medicine, we designed an e-Anatomy kit based on the curriculum of Anatomy and definitions of active learning by Felder and Brent (9). Felder and Brent (9) defined active learning as “anything course-related that all students in a class session are called upon to do other than simply watching, listening, and taking notes” (9,10). The “active and engaging learning technique” emphasizes the use of tasks, interactive presentations, assignments, and creative activities to move the focus of teaching away from knowledge transfer and toward knowledge construction by students (2). In this research, we chose the Respiratory System as part of the study as it is one of the core subjects in the medical curriculum. At the same time, this module was conducted for all Year 1 medical students of UiTM at the time when the research was done.

Therefore, we designed e-Anatomy kit which was composed of pre-recorded cadaveric demonstration and small group discussion using various tools such as gamification, 3D application by using Complete Anatomy application or app, diagram labeling, schematic diagrams and body painting as an alternative to combat problem faced during Anatomy T&L during pandemic. In this study, the aims were to evaluate the effectiveness of the e-Anatomy kit and to report students’ perception about the e-Anatomy kit. We hypothesized that using an e-Anatomy kit would make anatomy instruction more exciting, dynamic, and engaging for students, as well as aid deep learning, effective retention, and clinical application of knowledge. Furthermore, these solutions address issues related to teaching Anatomy, such as a scarcity of cadaveric materials (11), and an abundance of content in the Anatomy curriculum (12,13). This is also in line with the Malaysian Ministry of Education’s educational developments, as outlined in the Malaysian Education Blueprint 2015–2025 (Higher Education), which includes initiatives to make online learning an integral part of higher education and lifelong learning (14).

## MATERIALS AND METHODS

### a. Study design, population, and subjects

The data collection was done using convenience sampling method. The target population consisted of Year 1 Medical students from the Faculty of Medicine,

Universiti Teknologi MARA (UiTM). The advertisement for participation in this study was distributed via the official Telegram channel of the Department of Anatomy. Participation was voluntary, and prior to the study, an online briefing between the interested students and lecturer in-charge was done and verbal consent was obtained. Any student may feel free to withdraw from the study without penalty. The inclusion criteria include: i) consented to participate in this study, ii) Year 1 medical student, iii) both gender. The exclusion criteria include, i) repeated Year 1 students. Students who were unwilling to take part can withdraw from the study at anytime without penalty and underwent the usual method of teaching. Ethical approval for the study was obtained from the Research Ethical Committee of UiTM [Reference number: REC/05/2021 (MR/336)].

A quasi-experimental study was conducted via online using WEBEX platform. In this study, we compared the understanding level of Anatomy of Respiratory System between two groups of students; with and without exposure to the e-Anatomy kit. All the participants were randomly divided into two groups and the test for both groups were run simultaneously. This study was done during second semester of Year 1, during one day of gross practical session of Respiratory module.

### b. Virtual practical using e-Anatomy kit.

e-Anatomy kit was designed as a tool for virtual practical of Gross Anatomy of Respiratory System during the COVID-19 pandemic, consisting of (i) pre-recorded cadaveric demonstrations, (ii) Complete Anatomy app, (iii) interactive diagram labelling, (iv) schematic diagrams and (v) mnemonic as shown in Table I. Students were brief about the steps and components in the e-Anatomy kit prior to the practical session.

Firstly, pre-recorded video demonstrating respiratory system on cadaver highlighting gross anatomy of thoracic cage, intercostal muscles, diaphragm, sagittal section of wet specimen of the head and neck showing the nose, nasopharynx, larynx and laryngopharynx and lung were shown to the students for 20 minutes.

Secondly, a demonstration using the Complete Anatomy 2022 app was performed. The Complete Anatomy app is subscribed yearly by the Faculty of Medicine starting from the year 2020 till date by one of the local companies who is a sole distributor for the app. This app is regarded as an online resource and acts as one of the Anatomy resources that we use for Anatomy T&L specifically for preclinical years. The students have to register before they can start downloading and using the app via their formal students’ email. All users registered to use the app will adhere to the rules and regulations set by the Department. For example, the Department will monitor the usage of the app and the report will be sent to us by the company. The postgraduate students of the faculty

**Table 1: Components and contents of e-Anatomy kit for****Anatomy of Respiratory system.**

No	e-Anatomy kit		Time allocation (minutes)
	Components	Contents	
1	Pre-recorded cadaveric demonstrations	<ul style="list-style-type: none"> <li>Anatomy of thoracic cage, wet specimen of intercostal muscles and diaphragm.</li> <li>Sagittal section of wet specimen of the head and neck showing anatomy of the nose, nasopharynx, larynx and laryngopharynx.</li> <li>Anatomy of trachea, lungs and pleura.</li> </ul>	20
2	Complete Anatomy app	<ul style="list-style-type: none"> <li>The respiratory organs and its anatomical position.</li> <li>Identification of the external nose and nasal cavity.</li> <li>Pharynx, larynx and the trachea.</li> </ul>	15
3	Schematic diagram	<ul style="list-style-type: none"> <li>Lateral wall of the nasal cavity.</li> </ul>	30
4	Mnemonic	<ul style="list-style-type: none"> <li>Vertebral level of the opening in the diaphragm and its major content.</li> <li>The mnemonic is "I Ate 10 Eggs At 12pm"</li> </ul>	10
5	Interactive diagram labelling	<ul style="list-style-type: none"> <li>Quiz with diagram using Classpoint app to label the component of the thoracic cage and lungs including their fissures, borders, and root; and diaphragm including its openings and parts.</li> </ul>	15

also use this app for their postgraduate programmes especially during the Basic Sciences Courses which involves Anatomy subject. Both undergraduate and postgraduate students also use this app for their revision and exam preparation.

For this e-Anatomy kit, the demonstration was done to ensure that the students were familiarized with the anatomical orientation of the respiratory organs such as lungs. Virtual dissection exposing nasal cavity was done using this app to further exposed structures in the Respiratory System. It took around 15 minutes to complete this session.

Next, students were taught on how to draw the schematic diagram of the lateral wall of the nasal cavity and its opening. The lecturer in-charge showed the diagram using animated powerpoint and explanations were done simultaneously. Structures such as frontal sinus and sphenoid sinus, followed by concha, meatus and sinuses were drawn and outlined. Approximately 30 minutes were needed in this session.

Fourthly, mnemonic was given to the students related to the vertebral level of the opening in the diaphragm and its major content, which took around 10 minutes. The mnemonic are, "I Ate 10 Eggs At 12pm", representing inferior vena cava as "I", T8 vertebral level as "ate", T10

vertebral level as "10", oesophagus as "eggs", aorta as "at" and T12 vertebral level as "12pm". In short, the mnemonic is interpreted as, there are 3 openings at the diaphragm at the vertebra level of T8 which contained inferior vena cava, at vertebra level of T10 which contained esophagus and vertebral level of T12 which contained aorta.

Lastly, an interactive picture labelling was done as a quiz using the Classpoint application. Students were given a code to join the app and a few exhibits were shown. Random students were asked to label the exhibits followed by discussion. This session took around 15 minutes.

c. Experimental protocol and research grouping. A short briefing was given to all students regarding the flow of the virtual practical. All the students were given a pre-test before being allocated into two groups. The pre-test contains 20 questions with diagrams on the topic of "Gross Anatomy of Respiratory System " followed by equal random division of the students into 2 groups. Then, for the experimental group, the virtual practical session was done based on the e-Anatomy kits format. The same 20 questions were administered at the end of the virtual practical.

Group 1: Control group receiving virtual practical by using active discussion method, without the e-Anatomy kit.

Group 2: Experimental group received the e-Anatomy kit. The discussion during the session was based on the e-Anatomy kit format. The components, contents and its time allocation were as shown in Table I.

The marks are not taken for summative assessment. Effectiveness of virtual practical class was assessed using the pre- and post-test scores. Total allocated time for practical sessions for both groups was about 1.5 hours. Three days after the practical session, both control and experimental groups received the recorded content of the e-Anatomy kit.

### c) Questionnaire

A self-administered questionnaire based on the student's perception about the usage of e-Anatomy kit during the virtual practical of Respiratory System were obtained. Instructions were given to the student to stay back after the post-test to answer the questionnaires. The questionnaires were distributed using Google form and links were given immediately after the post-test in the Webex platform. Students were dismissed upon completion of submission as indicated by Google form recording. The questionnaire was adapted from previous published papers (15,16). The questionnaire has been validated by a group of review expert for content validity. A five-point Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree and

1 = strongly disagree were allocated for each section in the questionnaire. The questionnaire consisted of 3 parts which were:

Part A : Consent Form

Part B : Demographic Data

Part C : Students' perception on i) Usefulness of e-Anatomy kit, ii) Ease of use of e-Anatomy kit and iii) Behavioral intention of e-Anatomy kit

#### d. Statistical analysis

All analyses were performed using Graphpad prism software. A paired t-test was used to establish whether there is a significant difference between pre- and post-test scores while an unpaired t-test was used to compare the differences between control and experimental groups. Frequencies and percentages from the questionnaires were calculated to ascertain the students' experience with the e-Anatomy kit.

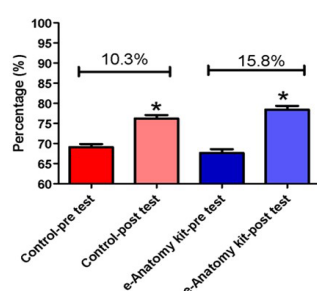
## RESULT

#### a) Demographic data

A total number of 182 students participated in this study. Eight (8) students were excluded from the study because they did not complete either pre- or post-test assessment or both assessments. There were 89 students in the control group, with 22 male and 67 female. There were 85 students with 26 male and 59 female in the e-Anatomy group. The participants' age was ranged between 20 to 22 years old.

#### b) Effectiveness of e-Anatomy kit usage in virtual practical for Gross Anatomy of Respiratory System

In the control group, the minimum mark for the pre-test assessment was 50 % while the value was slightly higher in post-test assessment, 60 %. However, the maximum marks were similar for both pre-test and post-test assessment. In the e-Anatomy kit group both minimum (62%) and maximum (100%) marks of the post-test assessment showed higher value in comparison to the minimum (42%) and maximum (88%) mark of pre-test assessment (Table II). There was a significant difference between the means of pre-test and post-test assessment in both control and e-Anatomy kit groups (Fig. 1).



\* p<0.05 compared to pre-test

Fig 1: The percentage of marks obtained from pre-and post-test for both control and e-Anatomy groups.

Table II: Pre- and post-test scores for the control and e-Anatomy kit groups.

	Control		e-Anatomy kit	
	Pre-test	Post-test	Pre-test	Post-test
Minimum	50	60	42	62
Maximum	92	92	88	100
Mean $\pm$ SEM	69.08 $\pm$ 0.81	76.20 $\pm$ 0.80	67.69 $\pm$ 0.92	78.42 $\pm$ 0.89
Differences between mean (%)	10.3%		15.8%	

However, the percentage of mean difference of the e-Anatomy kit group was higher (15.8%) in comparison to the control group (10.3%) (Table II, Fig. 1). Comparing the mean difference between the control and e-Anatomy kit groups, it showed no significant difference in both pre-test and post-test assessments.

#### c) Students' perception of e-Anatomy kit

Perception on the e-Anatomy kit was done on three domains which were perceived usefulness, perceived ease of use and behavioral intention. For perceived usefulness domain, more than 80% of participants strongly agreed that e-Anatomy kit enabled them to understand more of Anatomy subject, enhanced their interest in Anatomy subject, increased capability to identify Anatomy structures, enhanced learning experience, increased knowledge and fulfilled their learning outcomes. A percentage of 90.91% of participants strongly agreed that the mnemonics, schematic and labelling diagrams components of the e-Anatomy kit were very useful in the Anatomy practical session while the value slightly lower, 80.68% for the Complete Anatomy app component (Table III).

Table III: Perception of the participants on e-Anatomy kit under perceived usefulness domain. Scoring done using Likert scale with 1 is for "strongly disagree", 2 for "disagree", 3 for "neutral", 4 for "agree", and 5 for "strongly agree"

Perceived usefulness	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
1. Using this application in my practical session would enable me to understand more on the anatomy subject.					
· e-anatomy kit in general			3.41	15.91	80.68
· Complete Anatomy app	1.14	11.36	25.00	62.50	
· Labelling diagram			3.41	18.18	78.41
· Schematic diagram			1.14	12.50	86.36
· Mnemonics			1.14	9.09	89.77

CONTINUE

Table III: Perception of the participants on e-Anatomy kit under perceived usefulness domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree (cont.)

Perceived usefulness	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
2. Using this application in the anatomy practical will enhance my interest.					
· e-anatomy kit in general			3.41	15.91	80.68
· Complete Anatomy app 3D4 Medical apps			7.95	21.59	69.32
· Labelling diagram			1.14	13.64	85.23
· Schematic diagram			1.14	9.09	89.77
· Mnemonics			1.14	7.95	90.91
3. I find this learning tool helpful					
· e-anatomy kit in general				12.50	87.50
· Complete Anatomy app			5.68	20.45	73.86
· Labelling diagram				14.77	85.23
· Schematic diagram			1.14	9.09	89.77
· Mnemonics				10.23	89.77
4. I find this application enhance my capability to identify structures of human body					
· e-anatomy kit in general			18.18	18.18	82.95
· Complete Anatomy app		4.55	19.32	19.32	76.14
· Labelling diagram			11.36	11.36	88.64
· Schematic diagram			14.77	14.77	85.23
· Mnemonics			13.64	13.64	86.36
5. The features in this application are extremely helpful for my learning experience					
· e-anatomy kit in general				11.36	88.64
· Complete Anatomy app			4.55	17.05	78.41
· Labelling diagram				12.50	87.50
· Schematic diagram				7.95	92.05
· Mnemonics				7.95	92.05

CONTINUE

Table III: Perception of the participants on e-Anatomy kit under perceived usefulness domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree (cont.)

Perceived usefulness	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
6. Using this application in my practical session increase my knowledge in anatomy.					
· e-anatomy kit in general				11.36	87.50
· Complete Anatomy app			5.68	11.36	81.82
· Labelling diagram				14.77	85.23
· Schematic diagram				9.09	90.91
· Mnemonics			1.14	9.09	89.77
7. I am confident in my Anatomy theory exam when I use this application in the anatomy practical session.					
· e-anatomy kit in general			2.27	28.41	69.32
· Complete Anatomy app			7.95	30.68	61.36
· Labelling diagram			3.41	19.32	77.27
· Schematic diagram			1.14	23.86	75.00
· Mnemonics				21.59	78.41
8. I am confident in my Anatomy practical exam when I use this application in the anatomy practical session.					
· e-anatomy kit in general			1.136	23.86	75.00
· Complete Anatomy app			2.273	6.82	62.50
· Labelling diagram			1.136	22.73	76.14
· Schematic diagram			1.136	25.00	73.86
· Mnemonics			1.136	21.59	77.27
9. The features in this application fulfil the learning outcomes for Anatomy curriculum.	-	-	-	-	-
· e-anatomy kit in general			1.14	15.91	82.95
· Complete Anatomy app			7.95	17.05	75.00
· Labelling diagram			2.27	14.77	82.95
· Schematic diagram			1.14	12.50	86.36
· Mnemonics			1.14	18.18	87.50

CONTINUE



**Table III: Perception of the participants on e-Anatomy kit under perceived usefulness domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree (cont.)**

Perceived usefulness	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
<b>10. Overall, this application is very useful in my anatomy practical session.</b>					
· e-anatomy kit in general			2.27	10.23	87.50
· Complete Anatomy app			2.27	15.91	80.68
· Labelling diagram				9.09	90.91
· Schematic diagram				9.09	90.91
· Mnemonics				9.09	90.91

For perceived ease of use more than 80% of participants strongly agreed that this application was easy to use, had easy access to this application anywhere they study, and the features were clear and easy to understand. Highest percentage of participants, 94.32% strongly agreed that mnemonics was easy to use, followed by schematic diagram 92.05%, labelling diagram 90.91% and Complete Anatomy app 78.41% (Table IV).

**Table IV: Perception of the participants on e-Anatomy kit under perceived ease of use domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree**

Perceived ease of use	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
<b>1. Learning using this application would be easy for me</b>					
· e-anatomy kit in general			1.14	12.50	86.36
· Complete Anatomy app		1.14	9.09	29.55	60.23
· Labelling diagram			2.27	17.05	80.68
· Schematic diagram				10.23	89.77
· Mnemonics				5.68	94.32
<b>2. I find it easy to access this application anywhere I study.</b>					
· e-anatomy kit in general			1.14	17.05	81.82
· Complete Anatomy app		1.14	4.55	28.41	65.91
· Labelling diagram				14.77	85.23
· Schematic diagram				13.64	86.36
· Mnemonics				13.64	86.36

CONTINUE

**Table IV: Perception of the participants on e-Anatomy kit under perceived ease of use domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree (cont.)**

Perceived ease of use	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
<b>3. The features of this application are clear and easy to understand</b>					
· e-anatomy kit in general			2.27	10.23	87.50
· Complete Anatomy app			5.68	15.91	78.41
· Labelling diagram				9.09	90.91
· Schematic diagram				7.95	92.05
· Mnemonics				5.68	94.32

For behavioral intention domain, a percentage of 81.82% of participants strongly agreed they increase the occurrence of using this app during practical sessions. 87.5% of participants strongly agreed that they would recommend others to use this app. However only 77.27% of the participants strongly agreed to consider using this app after movement control order (MCO) is lifted, with the highest percentage of participants would consider using the labelling and schematic diagram, 89.77% (Table V).

**Table V: Perception of the participants on e-Anatomy kit under behavioural intention domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree**

Behavioral intention	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
<b>1. I would consider using this application even after the MCO is lifted.</b>			3.41	19.32	77.27
· e-anatomy kit in general			6.82	22.73	70.45
· Complete Anatomy app			1.14	15.91	82.95
· Labelling diagram			1.14	9.09	89.77
· Schematic diagram				10.23	89.77
· Mnemonics			3.41	19.32	77.27
<b>2. I increase the occurrence of using this application during my practical session.</b>					
· e-anatomy kit in general			1.14	17.05	81.82
· Complete Anatomy app		1.14	4.55	28.41	65.91
· Labelling diagram				14.77	85.23
· Schematic diagram				13.64	86.36
· Mnemonics				13.64	86.36

CONTINUE

**Table V: Perception of the participants on e-Anatomy kit under behavioural intention domain. Scoring done using Likert scale with 1 is for “strongly disagree”, 2 for “disagree”, 3 for “neutral”, 4 for “agree”, and 5 for “strongly agree (cont.)**

Behavioral intention	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
<b>3. I would recommend others to use this application</b>					
· e-anatomy kit in general			2.27	10.23	87.50
· Complete Anatomy app			5.68	15.91	78.41
· Labelling diagram				9.09	90.91
· Schematic diagram				7.95	92.05
· Mnemonics				5.68	94.32
<b>4. I would recommend others to use this application</b>					
· e-anatomy kit in general				14.77	85.23
· Complete Anatomy app			9.09	21.59	69.32
· Labelling diagram			1.14	10.23	88.64
· Schematic diagram				9.09	90.91
· Mnemonics				6.82	93.18

Narrative feedback was categorized according to the three domains with 58 participants gave overall positive feedback on perceived usefulness. A number of 19 participants gave overall positive feedback on perceived ease of use with 1 overall negative feedback. For behavioural intention, there are only 2 overall positive feedback comments with no overall negative feedback (Table VI).

**Table VI: Narrative feedback from students categorized into perceived usefulness, perceived ease of use and behavioral intention (Adapted from Felszeghy et al. 2019) (18).**

Category	n	Representative of feedback concerning three domains of perception on e-Anatomy kit
A) Perceived usefulness		
Overall positive	60	“It is useful and helpful in memorising and understanding the structure.”
Overall negative	0	“I think its great, especially the diagrammatic and labelling because I think it increase my memory and easier to recall the diagram during me answering the questions. Love it so much!! Thank you, Dr!”

CONTINUE

**Table VI: Narrative feedback from students categorized into perceived usefulness, perceived ease of use and behavioral intention (Adapted from Felszeghy et al. 2019) (18). (cont.)**

Category	n	Representative of feedback concerning three domains of perception on e-Anatomy kit
A) Perceived ease of use		
Overall positive	23	“A fun and interactive way of learning.”  “It was very fun and interesting, but the most important part is it was so easy to understand.”
Overall negative	1	“It is fun and easy to understand but internet problem experience may downgrade this anatomical kit a bit”
B) Behavioural intention		
Overall positive	2	“If possible, can we have the practical video? So that we can replay and watch the video again”
Overall negative	0	

## DISCUSSION

During this COVID-19 pandemic, medical educators were thrown into exploring the various technologies related to medical learning including the Anatomy app. With an increased quality of instructional videos, accuracy of the anatomical image and the availability of 3D images (17), one just cannot resist thinking that these technologies helped them in understanding human anatomy (18). In our research, both groups showed significant improvement in the post-test compared to the pre-test score. There were no significant differences comparing the post-test of both groups. However, the degree of improvement from pre-and post-test for the experimental group is higher compared to the control group, suggesting that the e-Anatomy kit was better compared to conventional virtual practical sessions. In addition, the majority of students perceived that e-Anatomy kits are useful, effective and interactive, which have lifted the interest of the students in learning human anatomy, specifically the Respiratory System module.

Schematic diagrams have been incorporated in the e-Anatomy kit, as creating visualizations is vital to scientific thinking (19). It is a widely used method for communicating scientific ideas which ranges from replicating a schematic representation to drawing three-dimensional (3D) observations in a simpler way (20). This method can be a suitable tool to stimulate student thinking, in which it involves students to identify and accumulate necessary pieces of information that they learn during classes and construct a ‘mental model’ (20). Previous study demonstrated that drawing enhanced the memory of the students who drew anatomical

regions before and after the dissection (21). Besides, the schematic diagrams enhanced the students' Anatomy results and helped them in memorizing the subject (22). However, a previous study mentioned that millennial generation learners nowadays are lacking the interest in drawing and learning from the diagrams, which is due to their obsession with 3D technologies (20). This certainly will be one of the challenges to the educators to incorporate this method as part of the teaching and learning of Anatomy in the future.

Other than schematic diagrams, mnemonic is also one of the teaching methods that has been used in Anatomy T&L. Mnemonic is considered a rhyme that can be used by the students as an important learning strategy. It includes word associations, visual images and stories (23). It requires integration of visualization, imagination and creativity (22). By using the mnemonics, it can help provide a basis of knowledge that can be developed and built throughout the study, however the mnemonics are not enough for understanding, application or analysis (24). The students also can recall information more easily using the mnemonics and help students to memorize facts with long lasting memories (24). This method results in an enjoyable learning process (22), more engaging way of learning (25) and helps the students' performance (26), which is according to the students' perception in the e-Anatomy kit.

Our study also demonstrated that the usage of Anatomy applications such as Complete Anatomy app is less favorable in understanding the subject which was shown by the questionnaire compared to the other modalities such as mnemonics and schematic diagrams. Longer downloading time for the apps for underprivileged students with low mobile data is also one of the challenges faced. Our finding was in line with a study by Eladl et al. (27) who also used the Complete Anatomy app version 2018 and other Anatomy apps which includes Netter's Anatomy Atlas, Gray's Anatomy Student Edition and Anatomy TV which demonstrated fewer positive feedback such as the level of details displayed in the apps, relations of apps content to the clinical aspects and its flexibility to cater to students' different learning styles. Another online resource such as 3D atlas is not supported in getting deep Anatomy knowledge, however it is helpful for the quick identification of anatomical structures (28). Complete Anatomy app is preferred to be used secondly after the hands-on prosection as Anatomy teaching and learning tool for Upper Extremity Anatomy course for occupational therapy students (29). Besides, it also found that the mobile learning app (eMed-App) is suitable for high-achiever students that have been motivated to use the online application compared to low performing students who still need to learn Anatomy conventionally (30). Combination usage of Complete Anatomy app with other modalities as included in the e-Anatomy kit as well as 2D atlas would be useful in Anatomy T&L, which should not replace the Anatomy

specimens in the laboratory (28).

Interactive diagram labeling in e-Anatomy kit is a form of game-based learning method. Game-based learning methods significantly affect the student's attitude towards the taught subject (31). Game-based learning stimulates excitement (31), develops more engagement from the student (32,33) and increases study motivation among students and increases their focus on the concept being taught in the class (34-36). Study by Barros et al. (2022) showed that game-based learning such as Kahoot! demonstrated positive feedback among the students and it also serves as a parameter to predict their final performance in the Human Anatomy course which also covered the Respiratory System (35). Besides, mobile educational games such as Kahoot!, Quizlet, Quizalize and Quizizz affect students' attitudes towards themselves and educators. It also showed that the games increased their learning management skills, retention ability of the information learnt, attentiveness and motivation in the laboratory sessions compared to conventional teaching methods (36). Game based learning was also suitable as a rehearsal tool that increased the value of the traditional teaching and learning method (33).

The role of schematic diagrams in e-Anatomy kit gained better retention of knowledge in the long term (34). Although integration of these methods in this research however showed no significant result between the post-test of score between of the control and experimental group, this method has found to be perceived as useful, easy to use and majority of the students are keen to use this e-Anatomy kit as part of learning even after pandemic. From this research, it is a good to know that, despite the massive information available on the internet such as the web-based gamification and interactive apps, the simple game-based labelling guided by the lecturers might be used to boost up the motivation of students to human anatomy and hopefully contribute to the study habits that is shown previously to increase success and better grade in exam significantly (37,38).

Our recent study demonstrated that the post-test of the e-Anatomy kit group showed insignificant results compared to the control group, however there was an increment of 5.5% in the e-Anatomy kit group compared to the control group. We postulated that these results might be due to several contributing factors. We found that there is a lack of engagement from the students that might be due to internet disconnectivity that some of the students experienced. This leads to the poorer peers' interaction between students as well as between students and the lecturers due to internet disruption that arose throughout the practical session. Two-way communications are crucial in online learning as both students and lecturers need to be focused and have to be proactive throughout the practical sessions, which is easier to achieve in face-to-face practical class before COVID-19. Those challenges must be overcome



by the students in order to ensure they can attend the practical session without the interruption. Therefore, internet disconnectivity, low students' engagement and less interaction might contribute to the insignificant results. Besides, the students also would not be able to experience the sense of practical session in the remote learning setting.

However, there is a degree of difference between control and e-Anatomy kit group which might be classified as synergistic effect/interaction. Our recent study showed that a combination of a few methods applied during the practical session is better than the single method. We postulated a few reasons, which includes delivery of fun and active learning experienced by the students following incorporation of a few methods in the e-Anatomy kit. These improvements might be due to students' interest in learning the subject which resulted in full understanding of the Respiratory System module.

### Limitations

The post-test in the study is a one-off assessment without consideration on the re-assessment of knowledge at different time frames. Therefore, knowledge retention capacity of the students are not reflected.

### CONCLUSION

The components in the e-Anatomy kit highlighted the active and engaging learning strategy which can be used as an effective learning tool in Anatomy, serving as an adjunct to conventional cadaveric practical session. This study also boosted in student's cognitive engagement and learning experience. and The outcomes of this research potentiate the possibility of integration between the e-learning and traditional method are combined into a single method which might achieve higher success in assisting students to learn human anatomy.

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