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Checklist-based active learning in anatomy demonstration sessions during the COVID-19 pandemic: Perception of medical students

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SUMMARY

Human anatomy is an essential component of the medical curricula. Anatomy education has been significantly affected during the COVID-19 pandemic. The aim of this study was to explore student’s perceptions on a blended learning approach using Checklist-based Active Learning in Anatomy Demonstration Sessions (CALADS) as a method in comparison to the two previously used methods; namely face-to-face Structured Problem-Related Anatomy Demonstrations (SPRAD) and online anatomy learning. A comparative, cross-sectional, survey-based study was conducted. The survey was composed of 13 questions that explored preference of learning anatomy in demonstration sessions of 4th year pre-clerkship students who have had their anatomy learning through face-to-face SPRAD in year 2 (before the COVID-19 pandemic), online in year 3 (during the COVID-19 pandemic), and CALADS method in year 4. Descriptive statistics were used, and the level of significance was set at P < 0.05. The survey exhibited high internal consistency (Cronbach's α = 0.953). Validity of the survey was established through exploratory factor analysis. The preferred method for more than half of the students was the CALADS method. Face-to-face SPRAD came next and lastly came the online method. However, more students preferred the online method in comparison to face-to-face method for "learning radiological anatomy". There were no statistically significant differences between male and female students regarding any of the survey questions. CALADS method, as a hybrid, student-centered, interactive learning method of learning practical anatomy, was preferred by pre-clerkship students as a more effective method in understanding anatomy than face-to-face and online learning methods.

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Introduction

Medical colleges all over the world consider human anatomy as a fundamental component of their curricula. Understanding anatomy is crucial for healthcare professionals, irrespective to their area of expertise [1]. The strategy of anatomy teaching has evolved dramatically as medical education has shifted from the traditional discipline-based curriculum to problem-based learning (PBL) and integrated curricula [2].

Traditionally, teaching and learning in schools and universities takes place in the form of face-to-face meeting of the teacher and students in the classroom or lecture hall. Decades ago, distance educational programs in medical education started to be provided either completely online or in a hybrid mode that includes a mixture of face-to-face and online components. Recently, online and hybrid modalities have become more prevalent as a result of technological advances and student requirement [3].

The COVID-19 pandemic has a significant impact on medical education around the world due to the standard precautions that put in place for its prevention. Recently, teaching of anatomy has been significantly impacted due to alterations in the existing educational systems as a result of discontinuation of conventional teaching [4–6]. Because anatomy is considered as a crucial part of basic medical sciences, alternative methods were needed to overcome the current challenges in anatomy education [6]. It became obvious also that students should have a more active role in their learning as the direct contact between them and their teachers became less, and schools should shift their focus to a more student-centered education [7].

Among the available alternatives, blended learning modality was preferred by medical students in learning basic medical sciences, including anatomy [8–11]. It is defined as the systematic combination of face-to-face and online synchronous or asynchronous involvement to promote and improve purposeful communication amongst instructors and students and improve utilization of and flexibility in access to learning resources [12–14]. Based on previous research studies, the hybrid method combined the benefits of face-to-face and online classes [15,16]. Feedback availability and the chance for interaction are the two main useful advantages of hybrid method of anatomy learning [17]. Such two advantages are shown to enhance students’ self-confidence, enthusiasm, achievement and gaining skills [18].

At the Anatomy Department of the College of Medicine and Medical Sciences, Arabian Gulf University (CMMS-AGU), and under the circumstances of COVID-19 pandemic, we designed a different method of practical anatomy teaching in our department replacing our previous teaching modality (SPRAD) that is composed of two components: asynchronous online watching of recorded demonstration of anatomy lesson followed one week later by a face-to-face student-centered, active learning session, where students (in small groups) review what they have watched on the recorded video based on a unique checklist as a guide for achieving the learning outcomes of the lesson. We named this method; Checklist-based Active Learning in Anatomy Demonstration Sessions (CALADS).

Therefore, this study aims at exploring student’s perceptions of the CALADS method in comparison with the two previously used methods, namely face-to-face Structured Problem-Related Anatomy Demonstrations (SPRAD) and online anatomy learning methods.

Materials and Methods

Type of study

A comparative, cross-sectional, survey-based study.

Study setting

This study was conducted on pre-clerkship undergraduate medical students at the Anatomy Department of the CMMS-AGU in Bahrain during the academic year 2021-2022. The MD program at the CMMS-AGU is organized as Phases: Phase I (premedical—1 year), Phase II (pre-clerkship—3 years), and Phase III (clerkship—2 years). The bulk of basic sciences, including anatomy, are introduced thorough 9 organ system-based units during Phase I (premedical) and Phase II (pre-clerkship) of MD program as described in our previous paper [6].

Study context and the CALADS method

Before pandemic, for several years, face to face anatomy demonstrations at our department occurred through the SPRAD method. SPRAD is an in-house model designed in the academic year 2002–2003 for the needs of our problem-based & student-centered curriculum at CMMS-AGU. SPRAD is a program of weekly scheduled anatomy demonstrations for students in Years 2, 3, and 4. Every SPRAD session consisted of two-hour laboratory sessions, wherein, students were divided into four subgroups of 15-20 students and rotated through different stations on cadavers, prospected specimens, plastic models, Anatomage® table, and radiological and microscopic anatomy in the anatomy lab area [19]. During COVID-19 lockdown, all the face-to-face laboratory sessions were replaced by online sessions, wherein, anatomy demonstrations were recorded with a high-resolution camera with the help of Audio-Visual Unit of CMMS-AGU, wherein, the demonstrator pointed and explained all the structures on gross anatomy specimens and plastic models of the topics covered in the PBL problem. And these videos were uploaded in university’s official Learning Management System (Moodle®) followed by weekly review sessions via Zoom® platform to answer students’ queries as described in our previous paper [6]. After the lockdown measures started to ease up and the students were allowed to come to campus for practical lessons under strict preventive measures during the academic year 2021-2022, we innovated a new educational modality for anatomy demonstration called the “CALADS” method.

In the CALADS method, pre-recorded educational videos demonstrating the anatomy practical lessons were made available for all the students on the CMMS-AGU’s official Learning Management System (Moodle®) a week before the face-to-face session in the anatomy lab. Students were
instructed to watch the video before coming to the face-to-face session, in which the students work in groups. In each year (year 2–4), the students were divided into 4 groups of 46–47 students each. These 46 students were subdivided into 8 small subgroups according to the learning needs they had. Six faculty members supervised and interacted with the students in a ratio of 1:8. Under the supervision of a designated faculty member, students in each subgroup worked as a team to identify all the structures on their own, guided by the checklist. Checklist was prepared by the designated faculty member based on the learning needs of the studied problem, that contained in sequence, all the structures which should be identified in the gross specimens (pre-dissected cadaveric specimens, plastic, or plastinated) by the students and were given a copy to each small subgroup. A short, introductory pre-lab talk of 15–20 minutes also guided the students on how to use this checklist. This pre-lab talk was podcasted to all subgroups in separate partitions containing 75-inch 4K monitors. All monitors were connected together by 4K HDMI wires to have good resolution.

Faculty members were available all through the CALADS sessions to supervise and answer any questions and clarify any doubts the students might have. Following these sessions, free hours of self-study session (each session for 1–2 hours) were dedicated to the students during the same week under the supervision of a designated faculty member and lab technicians. All specimens studied during the week were available and each student booked the suitable slot for session as there were a limited number of students per session to maintain the social distancing due to COVID situation. The rate of students attendance in these sessions was about 40%.

**Study population**

The study targeted all year 4 medical students who have undergone their anatomy learning through face-to-face SPRAD in year 2 (before the COVID-19 pandemic), online learning in year 3 (during the lockdown due to the COVID-19 pandemic), and CALADS method in year 4.

**Sample size**

The study used a purposive sample that included all year 4 medical students (n = 187 students), both males and females, at the CMMS-AGU.

**Instrument and data collection**

To test students’ perception of the CALADS method in comparison with the other two methods, a survey was created by the authors through: a) reviewing similar studies and relevant literature, b) development and revision of the survey by all authors, and c) pilot testing the developed survey on a few students (15 students).

Since the instructional language used in our MD program is English and, the questionnaire was written in English. The survey was composed of 13 questions, with simple instruction to the students to tick in front of each question in relation to the preferred method (Table 1). The suitability of the developed survey was explored through reliability and validity studies. Reliability (internal consistency) was tested through measuring the Cronbach’s α. Face and content validity were established through revision by three experts in anatomy and a medical education expert, who pointed out some linguistic corrections and recommended reformulation of five items to give clearer meaning. The validated version of the survey form was printed and distributed to students at the end of unit, after completing all the lab demonstrations and self-study sessions related to that unit.

**Statistical analysis**

Statistical analysis of data was done using the Statistical Package for Social Science (SPSS) for Windows, version 25. Descriptive statistics were used, and data were presented as frequencies and percentages. Comparisons of responses were made by Chi² test. The level of significance was set at \( P < 0.05 \).

Internal consistency was analyzed using Cronbach’s α. There were no missing data. Validity of the survey was tested through exploratory factor analysis (EFA). Factor identification was done through principal component analysis with Varimax rotation. Factor extraction was based on the Kaiser criterion that considered a factor with an Eigenvalue of more than 1 as a common factor [20], the Cattell criterion to identify the inflexion point indicated by the Scree plot [21], and the cumulative percentage of variance extracted (in humanities research, the explained variance is usually only 50–60%) [22].

The criteria that were used to analyze the retained factor solutions [23] were: a given factor must contain at least three variables with loading of 0.30 or more (suggested cut-off point), all the variables which load on the same factor carry the same conceptual meaning, and a variable that loads on a different factor measure a different construct.

**Ethical approval**

The study was approved by the Research and Ethics Committee (REC) of the CMMS-AGU (Approval #: E42-PI-1-22). All participants were given the liberty not to fill in the survey without any consequences. However, filling in the survey was considered as a consent to participate in the study.

**Results**

Out of the 187 year 4 students, 146 responded to the survey (n = 146), with a response rate of 78%. Reliability (internal consistency) study revealed a high reliability of the survey (Cronbach’s α = 0.953). To test the validity of the survey, exploratory factor analysis has been conducted. Results indicated the appropriateness of the data for factor analysis [Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)] was 0.933 and Bartlett’s Test of Sphericity \( \chi^2 (78, N = 146) = 1522.909, P = 0.00 \).

Factor extraction results revealed that the 13 items of the survey could be grouped under a single factor with an Eigenvalue = 1.00. This emerging factor accounted for 64.2%
Table 1  Exploratory factor analysis of the survey.

| Item No. | Item Text                                                                 | Factor 1 | h²  |
|---------|---------------------------------------------------------------------------|----------|-----|
| 12      | Which teaching/learning method better motivated you to study anatomy?     | 0.856    | 0.733 |
| 13      | Which teaching/learning method you preferred for effective learning of anatomy? | 0.848    | 0.718 |
| 11      | Which teaching/learning method you think enhanced your performance in exams? | 0.838    | 0.702 |
| 3       | Which teaching/learning method gave you better understanding of the relations of different body structures? | 0.834    | 0.696 |
| 4       | Which teaching/learning method you think helped you better build your anatomical knowledge and skills? | 0.831    | 0.690 |
| 2       | Which teaching/learning method best facilitated the identification of the anatomical details of different body structures? | 0.819    | 0.671 |
| 9       | Which teaching/learning method was more engaging for you to attend the demonstration sessions? | 0.817    | 0.668 |
| 10      | Which teaching/learning method you think improved the communication between instructors and students? | 0.801    | 0.641 |
| 1       | Which teaching/learning method helped you to better achieve the learning outcomes? | 0.775    | 0.601 |
| 7       | Which teaching/learning method was more interactive?                     | 0.753    | 0.567 |
| 5       | Which teaching/learning method increased your ability to better understand clinical anatomy? | 0.750    | 0.563 |
| 6       | Which teaching/learning method increased your ability to better understand radiological anatomy? | 0.749    | 0.561 |
| 8       | Which teaching/learning method was more engaging for you (i.e., keeping you more focused and attentive all the time)? | 0.728    | 0.529 |

Variance (%) 64.2%
Eigenvalue 8.341

h² = item communalities.

a Total final items are 13 items. None of the items were deleted. Items are sorted from the item with the highest loading to the item with the lowest loading.

b Factor label is "Factor 1: Student preference" (n = 13 items).

Figure 1  Scree plot of exploratory factor analysis showing a single factor extraction.
of the total variance. Factor rotation results showed that none of the 13 items of the survey needs to be removed from the analysis, as all items had a loading of > 0.30 on the factor (Table 1 & Fig. 1). Three-fourths (74%) of the study participants were females, while the other fourth was males. Country-wise, around one third of the students were Kuwaiti (30.8%). Next were the Bahraini students (24.7%) followed by Saudi students (23.3%). The remaining percentages were either Omani students (17.8%) or students from other Arab nationalities (3.4%).

Fig. 2 shows the distribution of students in clusters according to their preferred teaching method. Percentage in each cluster represent the students who have chosen that teaching method in response to all or nearly all questions. The figure shows that CALADS was chosen as the preferred teaching method by most of the students. The remaining percentage of students were those who have chosen different methods in response to different questions where their preference was not clearly directed to a specific teaching method.

Table 2 shows that the students had a preference for the CALADS method, which is evident from their responses to all survey questions where more than half of them chose CALADS in response to each question. Regarding the other two methods, face-to-face was preferred by more students than online method, except in question 6, where more students preferred the online method in learning radiological anatomy.

Table 3 shows that there is nearly equal preference between male and female students regarding the three methods. There were no statistically significant differences between males and female students in any of the survey questions. The preferred method for both of them was the CALADS method, followed by face-to-face, and online comes last except for radiological anatomy for which more students preferred the online method to the face-to-face method.

Discussion

This study aimed to assess medical students’ perception of anatomy teaching methods, particularly demonstrations, before and during the COVID-19 pandemic. Before the pandemic, anatomy demonstration sessions in the MD program of the CMMS-AGU used to follow a unique method called “SPRAD”, which was a face-to-face approach that took place entirely at the anatomy lab [19]. In the current study, we innovated a new educational modality in anatomy demonstrations that depends mainly on using a checklist to standardize the identification of the anatomical structures among the smaller groups of students indicated by the social distancing measures of COVID-19.

To the best of our knowledge, only one study was conducted on using checklists in practical anatomy sessions, particularly in face-to-face demonstrations [24]. This study reported that the checklist-based face-to-face gross anatomy laboratory demonstrations improved the practical scores of students, who recommended the use of checklist for their future anatomy courses.

The present study adds to the literature by implementing a different anatomy blended learning method; CALADS. Cluster analysis of our findings revealed that the majority of students prefer the CALADS method, which was evident from their responses to all survey questions. This preference of the CALADS method may be explained by the fact that the CALADS method motivated the students to identify the anatomical structures and their relations by themselves through sheer interaction and active engagement in small groups and helped them to understand clinical and applied anatomy. These findings are congruent with a few recent studies that have been conducted on hybrid approach and revealed that the students had good opportunity to learn the anatomical course content due to self-directed learning strategies and interaction with instructors and peers, respectively [8,25]. In their study on the comparison of hybrid, face-to-face, and online learning, Kurthen and Smith [26] speculated that hybrid learning may become a teaching tool of the future, as it combines the advantages of traditional in-class and online teaching. Also, in a recent study, Atwa et al., [10] concluded that blended learning remains an acceptable solution for learning in medical schools in the post-COVID era. Moreover, Valleé et al., [27] concluded that blended learning demonstrated consistently better effects on knowledge outcomes when compared with traditional learning in health education.

Among the other two methods, students preferred the face-to-face SPRAD over the online method in learning practical anatomy. The only exception was in relation to learning radiological anatomy, where more students preferred the online method. Radiological anatomy in our department, during the COVID-19 pandemic, was taught through the pre-recorded video, which gave an opportunity for the students to revise the high-resolution radiological contents as and when needed. Before COVID-19, it was explained in one of the stations (face-to-face) by one of the faculty. This finding is in alignment with a previous study conducted on radiology and medical imaging students, which reported that more than half of the students recommended the delivery of radiological anatomy using the online learning methods [28]. Moreover, a study conducted on 224 radiologists in 31 different countries in cooperation with the European Society of Radiology (ESR) also revealed that the majority of radiologists prefer the online method in delivering the radiological concepts [29]. These preferences towards online learning of radiological anatomy could be because it is highly visual in nature on multimedia devices, where the students can zoom-in and zoom-out freely to see fine details in radiographs. Moreover, it has been shown that technology-based
learning of radiological anatomy eased up the intricacies associated with it [30].

It is worth noting that the CALADS method was preferred by around half of our students although it is a hybrid method (not a purely online one) in learning radiological anatomy. This is in congruence with the results of two studies, which reported that blended learning was probably a better approach than just the online one in learning radiology [31,32].

The current study showed that there was nearly equal preference between male and female students regarding the three methods of learning and their preference towards CALADS method. There were no statistically significant differences detected between males and female students in any of the survey questions. This agrees with the findings of a study by Quinn on learning preference in gross anatomy course, where she found no gender difference [33]. Moreover, although males differ generally from females in what is important for student learning (where males tend to be achievement-oriented, and females tend to be social interaction-oriented) [34—36], absence of significant gender difference in our findings might be explained by the fact that our new CALADS method incorporates self-learning, active learning, guidance by a checklist to increase productivity, and social interaction in group learning, so it is appreciated by both male and female students alike.

Next to the overall positive outcomes of CALADS method, the second preferred method of teaching was face-to-face method in our study. Our results are in line with a few recent studies, which postulated that the student’s preference of face-to-face anatomy teaching was significantly higher when compared to online modalities [37,38]. Though the current circumstances do not permit traditional cadaveric teaching in person, our CALADS method has advantages of hands-on exploration of gross anatomical structures on cadavers, plastic models in small groups with peers and instructors, respectively. Such interactivity proved to enhance student’s learning without compromising the elements of high-quality anatomy curriculum [18].

The main limitation of this study could be the small sample size and that the cohort who preferred the CALADS method have had their face-to-face and online
Table 3: Comparison of male and female students in regard to the preferred mode of teaching/learning anatomy demonstrations.

| No. | Question                                                                 | Males (n = 38) | Females (n = 108) | Sig. |
|-----|--------------------------------------------------------------------------|----------------|-------------------|------|
|     |                                                                           | Face-to-Face   | Online | CALADS | Face-to-Face | Online | CALADS |      |
|     |                                                                           | n (%)          | n (%)   | n (%)   | n (%)        | n (%)  | n (%)   |      |
| 1   | Which teaching/learning method helped you to better achieve the learning outcomes? | 10 (26.3%) | 9 (23.7%) | 19 (50%) | 20 (18.5%) | 59 (54.6%) | 0.59 |
| 2   | Which teaching/learning method best facilitated the identification of the anatomical details of different body structures? | 11 (28.9%) | 6 (15.8%) | 21 (55.3%) | 13 (12%) | 55 (51%) | 0.63 |
| 3   | Which teaching/learning method gave you better understanding of the relations of different body structures? | 9 (23.7%) | 7 (18.4%) | 22 (57.9%) | 15 (13.9%) | 59 (54.6%) | 0.60 |
| 4   | Which teaching/learning method you think helped you better build your anatomical knowledge and skills? | 11 (28.9%) | 6 (15.8%) | 21 (55.3%) | 17 (15.7%) | 56 (51.9%) | 0.92 |
| 5   | Which teaching/learning method increased your ability to better understand clinical anatomy? | 12 (31.6%) | 7 (18.4%) | 19 (50%) | 31 (28.7%) | 57 (52.8%) | 0.91 |
| 6   | Which teaching/learning method increased your ability to better understand radiological anatomy? | 7 (18.4%) | 12 (31.6%) | 19 (50%) | 31 (28.7%) | 58 (53.7%) | 0.92 |
| 7   | Which teaching/learning method was more interactive? | 11 (28.9%) | 5 (13.2%) | 22 (57.9%) | 14 (13%) | 57 (52.8%) | 0.83 |
| 8   | Which teaching/learning method was more engaging for you (i.e., keeping you more focused and attentive all the time)? | 11 (28.9%) | 8 (21.1%) | 19 (50%) | 20 (18.5%) | 57 (52.8%) | 0.93 |
| 9   | Which teaching/learning method was more engaging for you to attend the demo sessions? | 8 (21.1%) | 7 (18.4%) | 23 (60.5%) | 14 (13%) | 59 (54.6%) | 0.37 |
| 10  | Which teaching/learning method you think improved the communication between instructors and students? | 10 (26.3%) | 7 (18.4%) | 21 (55.3%) | 8 (7.4%) | 56 (51.9%) | 0.08 |
| 11  | Which teaching/learning method you think enhanced your performance in exams? | 8 (21.1%) | 7 (18.4%) | 23 (60.5%) | 18 (16.7%) | 56 (51.9%) | 0.47 |
| 12  | Which teaching/learning method better motivated you to study anatomy? | 9 (23.7%) | 8 (21.1%) | 21 (55.3%) | 13 (12%) | 61 (56.5%) | 0.34 |
| 13  | Which teaching/learning method you preferred for effective learning of anatomy? | 10 (26.3%) | 6 (15.8%) | 22 (57.9%) | 16 (14.8%) | 65 (60.2%) | 0.97 |

Sig: Significance.
demonstrations in the previous two study years, not in the same year with the CALADS method. So, further in-depth work is required to explore all the aspects of the CALADS method and its effectiveness in terms of student assessment and student future performance in medical school. In conclusion, the results of our study concluded that the CALADS method, as a hybrid, student-centered, interactive learning method of practical anatomy, preferred by the majority of students in terms of self-assessment of engagement and perceived learning effectiveness. Based on our results, we recommend using CALADS as a method for learning anatomy in the post-COVID era to encourage student motivation and interactive learning.

Disclosure of interest

The authors declare that they have no competing interest.

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