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COMMUNICATION

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An intensive anatomy by whole-body dissection elective: A longitudinal study

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Abstract

Whole body dissection, once a long-held method of learning and teaching in anatomy medical education, has largely been replaced by cost and time-reduced methods of teaching. This paper reports on a longitudinal study of student knowledge acquisition and retention, following six annual intensive eight-week elective anatomy by whole body dissection (AWBD) courses implemented between 2010 and 2015, utilizing a modified team-based learning (TBL) pedagogy. A total of 160 students completed the intensive full-time courses. During each course, students, in groups of five or six, completed the dissection of a whole cadaver. Students were assessed by a standardized practical test involving the accurate identification of 20 different tagged anatomical structures. All students ($n = 160$) completed pre-course and end-course individual assessments. Seventy students were assessed again 1 month after the course ended. A further 71 students were assessed 7 months later. A marked increase in topographical relational anatomical knowledge was demonstrated. The median pre-course score was 9/20 (interquartile range 5). The median end-course score was 19/20 (IQR 2), a statistically significant increase ($p < 0.001$). The assessments for the 70 students reassessed 1 month after the course ended showed no significant statistical change. The assessments for the further 71 students assessed 7 months later also showed no significant statistical change. The results of this study demonstrate that AWBD, provides significant acquisition and maintenance of three-dimensional regional relational anatomical knowledge. As an elective, AWBD has a place in the medical curricula, particularly for students interested in a surgical or procedural based specialty career.

KEYWORDS
anatomy by whole body dissection, medicine, surgery, team-based learning

1 | INTRODUCTION

Whole body dissection, once a long-held method of learning and teaching in anatomy medical education, has largely been replaced by cost-effective methods such as prosection inspection and imaging. This trend has been accompanied by a reduction in dedicated anatomy medical curricula teaching hours within the modern medical curricula (Bergman et al., 2011; Craig et al., 2010; Elizondo-Omaña et al., 2005; Jeyakumar et al., 2020; Kerby et al., 2011; Leung et al., 2006; McLachlan et al., 2004; McLachlan & Patten, 2006;

Pawlina & Lachman, 2004; Ramsey-Stewart et al., 2010; Topp, 2004; Turney, 2007). The impact on anatomy content and delivery within the adoption of time-poor, four-year graduate medical programs is well documented (Brown & Storey, 2016; Chapuis et al., 2010; Eizenberg & Chapuis, 2014). Anatomy teaching within the modern medical curriculum emphasizes the teaching of systemic anatomy, rather than teaching relational 3-dimenstional relationships and the understanding of tissue planes. The aim is to provide medical graduates with a confident foundation for further specialist postgraduate surgical or procedural based specialty training (Brown & Storey, 2016; Chapuis et al., 2010; Eizenberg & Chapuis, 2014).

Within the context of Australian and New Zealand medical schools, Bouwer et al. (2016) investigated the impact of medical curricula change on the utilization and integration of dissection courses. Findings suggested that dissection remains a valuable but limited resource, offered by 12 of the 21 existing medical schools. The authors' recommendations included offering flexible, vertically integrated dissection courses, with focussed opportunities, supported by peer and team-based learning (TBL) pedagogies (Bouwer et al., 2016).

Although teaching hours vary, curriculum reform within Australian medical schools has led to anatomy being taught predominantly within the pre-clinical years, with prosected specimens being most commonly used (Jeyakumar et al., 2020). One exception to this is The University of Wollongong, which has reported offering 6 h of "dissection experience", voluntarily undertaken at the beginning of their Year 2 medical program (Larkin & McAndrew, 2013). While many surgeons and students recognize the benefits of dissection, particularly for those planning surgical and procedural based specialty careers, others perceive examination of pre-prosection specimens to be as effective (Eppler et al., 2018; Jeyakumar et al., 2020; Pais et al., 2017; Patel & Moxham, 2008). Notably, there remains a deficit in longitudinal reporting of *long-term* student knowledge outcomes of dissection courses, with no consensus regarding the place of dissection in the medical curricula (Wilson et al., 2018).

A recent meta-analysis of anatomy laboratory pedagogies by Wilson et al. (2018), reviewing studies published between 1965 and 2015, found no difference in *short-term* knowledge outcomes between dissection and alternative modalities, including prosection examination, simulation models and digital media (Wilson et al., 2018). However, the same article emphasized that student learning is optimized when the pedagogical strategy used is deliberate, and delivered using predefined objectives (Wilson et al., 2018). Further to this, the authors posit that the effects of particular pedagogical approaches, such as TBL, on the long-term retention of anatomical knowledge are not well understood (Wilson et al., 2018).

Although TBL is relatively new to medical education, it has rapidly gained global momentum as a student-centred and resource-efficient teaching pedagogy within medical and health professional education (Alberti et al., 2021; Burgess et al., 2014; Burgess & McGregor, 2022; Reimschisel et al., 2017; Sisk, 2011). It provides an evidence-based design to teach a large number of students using methods that foster knowledge recall, active small and large group discussion, feedback and knowledge application through authentic clinical problem-solving activities (Buhse & Della, 2017; Burgess et al., 2014; Michaelsen & Sweet, 2008; Reimschisel et al., 2017). According to current evidence, the pedagogy of TBL provides an effective means to improve students' academic performance (Reimschisel et al., 2017). Additionally, given its ability to transform small groups into teams and promote collaborative decision-making, TBL fosters many professional attributes required by healthcare workers (Burgess & Matar, 2020). TBL consists of three key phases: (1) the "preparatory" phase, where students are provided with specific materials to prepare prior to class; (2) the "readiness assurance" phase, where students are tested on their preparation and readiness for activities and provided with immediate feedback; and (3) the "application" phase, which lies at the heart of TBL, requiring student to apply their collective knowledge and skills to complete tasks and solve clinical problems together.

The aim of this study was to report on student assessment outcomes, including knowledge, acquisition and retention, based on six anatomy by whole body dissection (AWBD) courses (2010–2015), implemented utilizing a modified TBL pedagogy. Specifically, our research question was: How does an intensive AWBD course assist in knowledge acquisition and retention?

1.1 | Context

The University of Sydney offers a 4-year graduate entry medical program, with an intake of approximately 300 students per cohort. Since 2007, the program included at least 170.5 h of anatomy teaching centred on examination of pre-prosected anatomy teaching material, delivered during Years 1 and 2. In addition, from 2009 to 2017, an optional eight-week elective AWBD course was offered to final year medical students interested in a surgical or procedural career. During this period, a hybrid problem based learning (PBL) had provided a long-established form of teaching within the medical curriculum. As previously reported, TBL was chosen as the teaching pedagogy used in the AWBD course because of its student-centred approach (Burgess et al., 2012).

The objective of the elective dissection course was to teach by a comprehensive whole body dissection human relational regional anatomy, as required by senior students contemplating a surgical career. Student learning outcomes were to improve relational regional anatomical knowledge, produce a three-dimensional mind-map of the structure of the human body, enhance the application of anatomical knowledge to clinical problems, and increase understanding of surgical techniques and considerations. Student learning outcomes were assessed by correct identification of tagged structures in each region.

2 | MATERIALS AND METHODS

2.1 | Student participants

From 2010 to 2015, six eight-week AWBD courses were implemented annually. In total, 160 final year medical students

TABLE 1 Anatomical regions covered each week and pre-reading requirements from Cunningham's manual of practical anatomy (Romanes, 1986)

Region covered	Pre-reading requirements from Cunningham's manual of practical anatomy (Romanes, 1986)	Dissection directions
Week 1		
Pectoral region, breast, axilla	1: 20–34	Dissect #: 1–7
Back and free upper limb	1: 35–54	Dissect #: 8–12
Shoulder region, arm	1: 54–73	Dissect #: 13–16
Flexor compart, forearm, hand	1: 73–93	Dissect #: 17–20
Week 2		
Extensor compart, forearm, hand, osteology	1: 93–113	Dissect #: 21–29
Osteology of thorax, walls of thorax, thoracic cavity	2: 1–29	Dissect #: 1–6
Lungs, ant. Middle & post. Mediastinum, heart	2: 30–5	Dissect #: 7–13
Heart (cont.), sup. Mediastinum, joints of thorax	2: 57–82	Dissect #: 14–24
Skull, cervical vertebrae, scalp, temple, face.	3: 1–21	Dissect #: 1–3
Week 3		
Side of neck, back of neck, anterior triangle.	3: 21–43	Dissect #: 4–18
Cranial cavity, ant. Middle & post. Cranial fossae	3: 43–64	Dissect #: 19–29
Deep dissect. Neck, thyroid, parathyroids, major vessels & nerves	3: 64–86	Dissect #: 30–34
Deep dissect (cont.), prevertebral region, deep dissect face	3: 86–104	Dissect #: 35–43
The orbit, parotid region	3: 104–118	Dissect #: 44–50
Week 4		
Temporal and infratemp. Region, submandibular region	3: 118–135	Dissect #: 51–62
Mouth & pharynx, cavity of nose	3: 135–157	Dissect #: 63–72
Larynx, tongue, hearing and equilibration	3: 157–183	Dissect #: 73–85
Eyeball, vertebral canal, joints of neck	3: 183–206	Dissect #: 86–98
Week 5		
Hip, front of thigh	1: 123–136	Dissect #: 1–4
Deep dissect front of thigh, femoral triangle, adductor canal	1: 137–150	Dissect #: 5–11
Gluteal region, popliteal fossa	1: 151–165	Dissect #: 12–19
Back of thigh, hip joint, osteology of leg & foot	1: 165–181	Dissect #: 20–23
Week 6		
Front of leg, dorsum of foot, lateral side & back of leg	1: 181–196	Dissect #: 24–31
Back of leg (cont.), sole of foot (layers 1–6)	1: 197–214	Dissect #: 32–40
Joints of lower limb	1: 214–234	Dissect #: 41–52
Osteology of abdo., abdominal wall, inguinal region	2: 83–104	Dissect #: 1–6

TABLE 1 (Continued)

Region covered	Pre-reading requirements from Cunningham's manual of practical anatomy (Romanes, 1986)	Dissection directions
Male external genitalia, loin, abdominal cavity, omental bursae	2: 104–124	Dissect #: 7–17
Week 7		
Lesser omentum, spleen, coeliac trunk, stomach, mesentery, small bowel	2: 124–141	Dissect #: 18–25
Large bowel, duodenum, pancreas & portal venous system	2: 141–155	Dissect #: 26–33
Liver, coeliac plexus, suprarenals, kidneys & abdominal ureters	2: 155–172	Dissect #: 34–42
Diaphragm, post. Abdom. wall, IVC, aorta, nerves of post. Abdom. wall	2: 172–186	Dissect #: 43–47
Osteology & ligaments of lesser pelvis, male & female perineum	2: 187–202	Dissect #: 1–4
Week 8		
Anal & urogenital regions, pelvic viscera, ureters & bladder	2: 202–219	Dissect #: 5–16
Prostate & male urethra, uterus & female urethra, rectum & anal canal	2: 219–232	Dissect #: 17–19
Vessels, nerves, lymphatics, muscles & joints of pelvis	2: 232–244	Dissect #: 20–24

participated. The number of participants varied each year from 20 to 42 students, according to the availability of cadavers and facilitators. All of the six dissection courses were oversubscribed and selection of participants for each course was on a "first come first served" basis.

2.2 | Modified team-based learning structure

The Dissection Course followed Cunningham's Dissection Manuals (Romanes, 1986), with small modifications and some additions. The course preserved dissection material was obtained from the volunteer body donor program of the University of Sydney. All of the body as shown in the dissection schedule (Table 1) was dissected including the meninges, blood supply and macroscopic examination of the brain. Actual dissection of the fixed brain was not carried out. Each dissecting day of the 8-week course, students were required to complete the prereading as specified in the dissection schedule (see Table 1). The dissection instructions were transcribed from the manual to color coded dissection cards which were laminated so that they could be used at the dissection table and reused after cleaning, so avoiding damage to the manuals. Each day of the course was structured with specific learning outcomes, pre-readings and dissection tasks, using modified TBL methods described below.

2.2.1 | Course facilitators

Surgical trainees and senior surgeons acted as demonstrators and supervisors during each course. A minimum of one demonstrator and one supervisor were present at any time.

2.2.2 | Team formation

Permanent teams of five or six students were allocated (alphabetically) to each embalmed cadaver subject by the facilitator at the commencement of the course.

2.2.3 | Preparatory phase

Approximately 2 h of pre-class reading from the dissection manual was assigned for each day (Romanes, 1986). The pre-reading requirements are outlined in Table 1.

2.2.4 | Readiness assurance phase

Individual tests, including spot tests and practical assessments were held throughout the course, and students were provided with immediate feedback. In addition, students were informally "quizzed" by surgeons and demonstrators. This varied from the "classic" format of TBL, where individual tests are followed with the students taking the very same test as a team.

TABLE 2 Test examples

ANATOMY DISSECTION COURSE AWBD Pre-Course Test Answer Sheet
Accurately name the following tagged anatomical structures
STATION 1
A…Left tibialis anterior tendon
B…Left common peroneal nerve
C…Left popliteal vein
D…Right profunda femoris artery
E…Right pudendal nerve
STATION 2
A…Portal vein
B…Left gastric artery
C…Left ureter
D…Falciform ligament
E…Right gonadal vein
STATION 3
A…Left superior thyroid artery
B…Left lingual nerve
C…Left maxillary artery
D…Right vagus nerve
E…Left phrenic nerve
STATION 4
A…Left flexor carpi radialis tendon
B…Recurrent branch of left median nerve
C…Right flexor pollicis longus tendon
D…Right median nerve
E…Right radial nerve
ANATOMY DISSECTION COURSE AWB End-Course Test
Accurately name the following tagged anatomical structures
STATION 1
A…Right radial nerve
B…Right pectoralis minor muscle
C…Right radial artery
D…Right flexor digitorum profundus tendon to digit five
E…Right biceps brachii tendon and bicipital aponeurosis
STATION 2
A…Left hypoglossal nerve
B…Right recurrent laryngeal nerve
C…Marginal mandibular branch of left facial nerve
D…Left phrenic nerve
E…Right Inferior thyroid artery
STATION 3
A…Left obturator internus tendon with superior and inferior gemelli
B…Left pudendal nerve
C…Left semimembranosus muscle
D…Left peroneus longus muscle
E…Left sural nerve
STATION 4
A…Common hepatic duct
B…Left gastric artery
C…Superior mesenteric artery
D…Inferior mesenteric vein
E…Neck of the pancreas

2.2.5 | Application phase

Group dissection tasks for each day were clearly outlined on color-coded spreadsheets. Each schedule for the day listed the area to be dissected, the required pre-reading of the text, and the dissection tasks to be carried out each day. The areas dissected each week are shown in Table 1. All students in their small groups, dissected a whole cadaver according to the classical Cunningham's dissection manuals, volumes 1–3 (Romanes, 1986), and the schedule provided. To assist teams with the tasks, the dissection instructions were transcribed onto laminated color-codes, and images were projected.

Surgical-quality instruments were provided so that dissection tasks could be carried out effectively. Supervisors and demonstrators provided guidance and feedback on the dissections as they were being undertaken and on completion.

2.3 | Study design

All student assessments were by a standardized, timed, written practical examination, whereby each student on rotation was required to accurately identify five tagged major anatomical structures in each of four expertly prepared cadaver prosections, derived from different anatomical regions of the body. An example of a pre- and post course answer sheet is provided in Table 2. Marks were recorded as a score out of 20.

2.3.1 | Knowledge acquisition and retention

All 160 students were assessed before the course commenced (pre-course assessment) and at the end of the course (end-course assessment). Seventy students returned for a post-course assessment one-month after the end of the course. A further 71 students returned for a post-course assessment seven-months after the end of the course, just before their graduation. Nineteen students, because of commitments out of Sydney, were unable to return for post-course testing. Examples of pre- and end-course tests are provided in Table 2.

All spot tests in these courses were by accurate identification of 20 physically tagged anatomical structures in at least four wet prosected specimens selected from a reference collection of specimens, specially prepared and kept for assessment purposes. Students were allowed to touch specimens and move structures with forceps in the identifications. Care was taken with each yearly cohort of students to not repeat identification of the same structure in the subsequent assessments of that cohort. The spot tests used within each course for pre-course, end-course and post-course assessment were not identical.

2.4 | Statistical analysis

The results of each student's assessment scores were analyzed statistically. The primary outcome measure was the total test score out of 20. The statistical analysis examined the effect of test time point on test scores; specifically, pre-course compared with end-course; matched end-course compared with one-month post-course; and matched end-course compared with seven-months post-course.

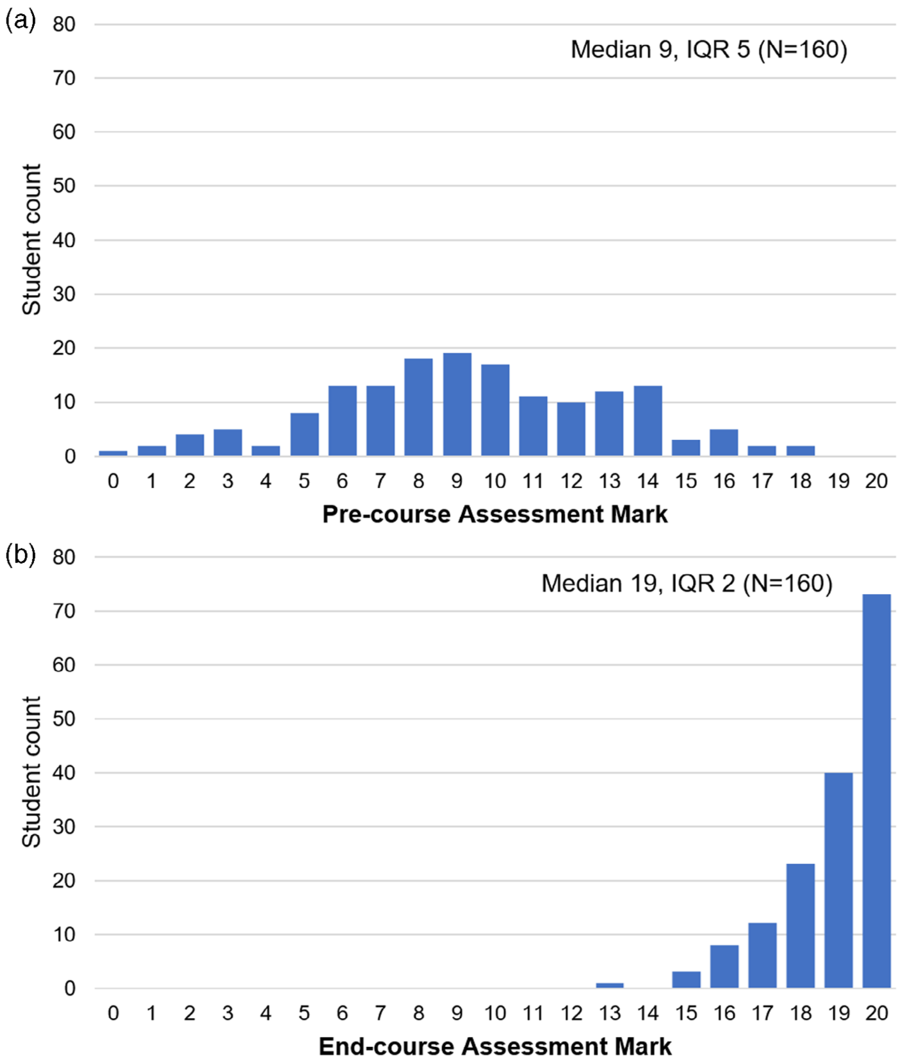

FIGURE 1 (a) shows the cumulative marks of 160 students at the pre-course assessments for the six dissection courses. (b) shows the marks of the same 160 students at the end-course assessments. The difference is statistically highly significant ($n = 160$, $z = -10.98$, $p < 0.001$, Wilcoxon signed ranks test)

The data were significantly skewed at each point. Accordingly, measures of central tendency for assessment scores were presented as median values together with interquartile ranges (IQRs). Because of the significant skew to the distribution of scores, nonparametric techniques were employed for analysis and the Wilcoxon signed ranks test was used for the three comparisons. The Mann–Whitney *U* test was used to explore differences in end-course scores for those students able to return for a one-month or seven-month post-course test and those who were unable to return.

3 | RESULTS

The results of the pre-course assessments and the end-course assessments for all 160 students are represented by the graphs in Figure 1A,B. The median pre-course assessment mark was 9/20 (IQR 5; range 0–18) and the median end-course assessment mark was 19/20 (IQR 2; range 13–20). There was a highly significant statistical increase between the two assessments ($n = 160$, $z = -10.98$, $p < 0.001$). The proportion of students scoring 19 or 20/20 in the pre-course test was 0% and in the end-course test was 71%.

The distribution of scores for the one-month post-course assessment, are represented by the graphs in Figure 2A,B. The median matched end-course score was 19/20 (IQR 2; range 13–20) and the median one-month post-course score was also 19/20 (IQR 1; range 10–20). There was no significant statistical change between these two scores ($n = 70$, $z = -0.94$, $p = 0.35$). The proportion of students scoring 19 or 20/20 in the end-course test was 69% and in the one-month post-course test was 77%.

The distribution of scores for the seven-months post-course assessment, are represented by the graphs in Figure 3A,B. The median matched end-of-course score was 19/20 (IQR 2; range 13–20) and the median seven-month post-course score was also 19/20 (IQR 2; range 14–20). There was no significant statistical change between the two scores ($n = 71$, $z = -1.85$, $p = 0.06$). The proportion of students scoring 19 or 20/20 in the end course test was 68% and in the seven-month post course test was 62%.

To determine if there were biases in terms of "returning students", end-course assessment scores were compared for those with

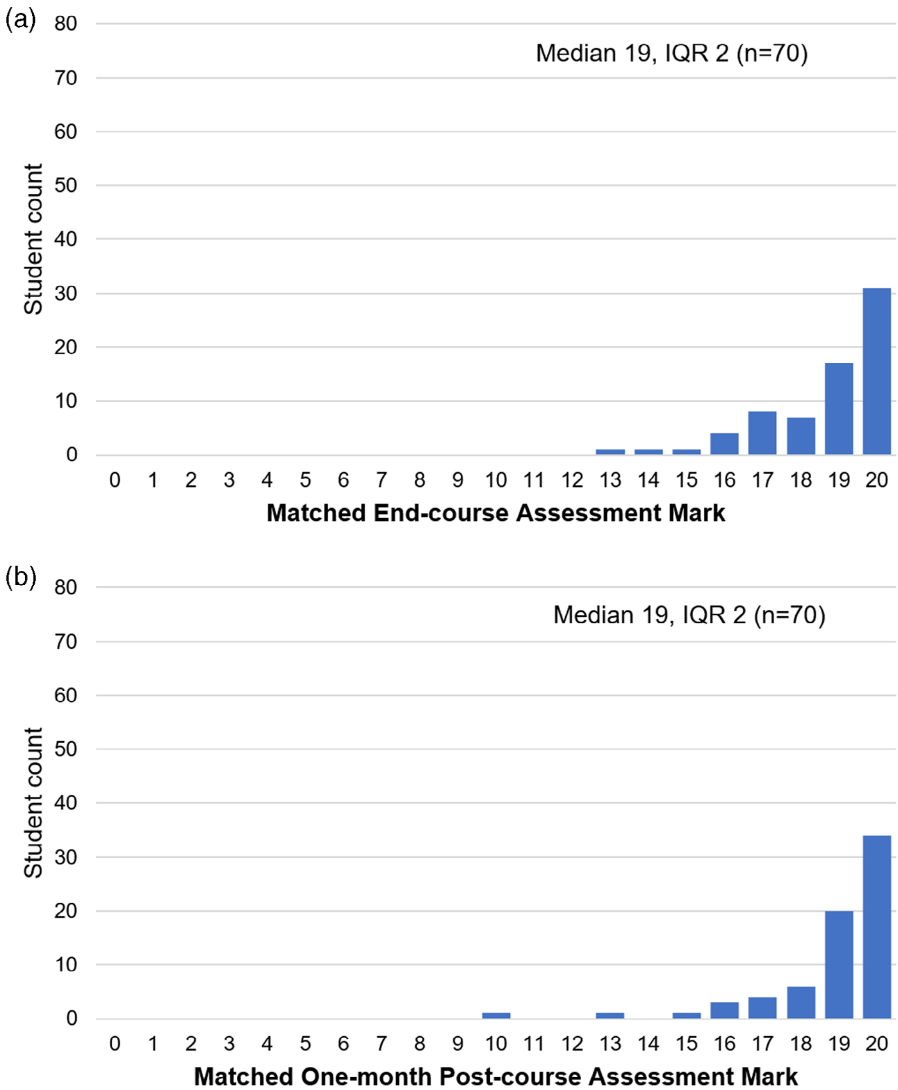

FIGURE 2 (a) shows the matched end-course assessments for the same 70 students. (b) shows the marks of the 70 students at the one-month post-course assessments. There is no statistically significant difference between the two assessments ($n = 70$, $z = -0.94$, $p = 0.35$, Wilcoxon signed ranks test)

and without post-course tests. There was no difference in end-course score for the students who did and did not return for the one-month post-course follow-up (each group with a median of 19/20 and IQR 2; $p = 0.58$); nor for those who did and did not return for the seven-months post-course follow-up (each group with a median of 19/20 and IQR 2; $p = 0.80$).

4 | DISCUSSION

This is the first study reporting on students' long-term anatomical knowledge retention, using the cumulative analysis of data from six AWBD elective courses within a medical curriculum. The statistically significant increase from pre-course to post-course, and maintenance in topographical anatomical knowledge demonstrates the value of an intensive AWBD course utilizing TBL teaching methods. Notably, we found no significant statistical difference between end-course, 1 month post-course, and 7 months post-course. Our study results indicate that anatomical knowledge for students streaming towards a surgical career can be demonstrably improved by a short intensive elective whole body dissection course, held in the final year of the medical program. The pedagogical aspects of TBL, with pre-assigned reading to prepare for dissection, repeated testing, small group peer learning to complete the dissection tasks assisted student learning and long-term retention of knowledge. We now consider development of students' anatomy knowledge utilizing the three key phases of TBL as a conceptual lens.

4.1 | The "preparatory" phase

Scaffolding students' learning outside of the classroom is critical for creating clear "in-class" expectations (Jakobsen & Knetemann, 2017). A well-established routine of pre-class readings was established throughout each dissection course, and aligned with the learning outcomes for each day. The daily pre-class reading requirements shifted the burden of learning content to out-of-class preparation. This freed up time in-class time for students to apply knowledge, and helped to foster students' individual accountability, motivating students to attend class prepared to contribute effectively to teamwork required

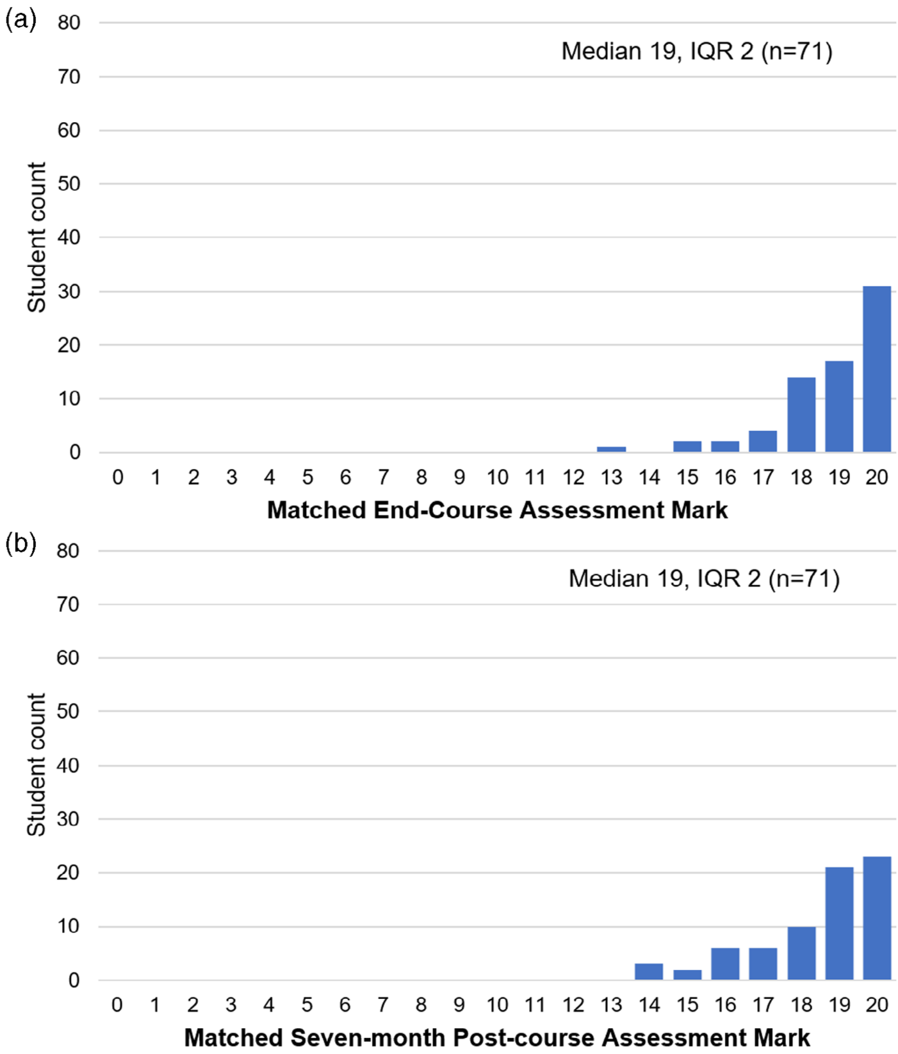

FIGURE 3 (a) shows the matched end-course assessments for the same 71 students. (b) shows the marks of 71 students at the seven-months postcourse assessments. There is no statistically significant difference between the two assessments ($n = 71$, $z = -1.85$, $p = 0.06$, Wilcoxon signed ranks test)

to daily dissection tasks. Evidence suggests that outcomes of the flipped classroom model include a more positive learning environment, with increased student collaboration and capacity for attention (Jakobsen & Knetemann, 2017).

4.2 | The "readiness assurance" phase

The "testing phenomenon" evidences that students who take tests in between initial learning and final examination achieve higher scores than those who do not (Glover, 1989).

A key feature of the AWBD TBL was the repeated testing, where students completed spot tests, were frequently "quizzed" by surgeons and demonstrators, and were provided with immediate feedback. Contemporary theories of learning acknowledge that simply learning new material will not assist in future knowledge recall. Rather, knowledge needs to be consolidated in the memory (National Research Council, 2000). Through repeated testing, the associated retrieval practice encourages students to access newly learned knowledge, which in turn helps to promote later retrieval of the same knowledge (Schmidt et al., 2019). The process of memory reconsolidation occurs when previously consolidated knowledge is again recalled to once more be actively consolidated, strengthening and adjusting the knowledge stored in long-term memory (Lee, 2008). Although other studies have used the in-course assessment system to score anatomical knowledge (Eppler et al., 2018), we instead relied on the formal pre- and post-course tests to assess student knowledge acquisition and long-term retention outcomes. However, we suggest that the repeated, informal assessments used throughout the course contributed to these positive outcomes. As Eppler et al. (2018) reported, in-class quizzes help to motivate students to prepare for dissection tasks.

4.3 | The "application" phase

Situated approaches in education utilize authentic contexts to help students develop a deeper understanding of knowledge that they can readily transfer to various situations (Durning & Artino, 2011). The application phase in the dissection course occurred when students completed each day's assigned dissection tasks in their small groups, requiring collaboration among team members. Transfer of learning occurs as students apply what has been learnt in one context, to another (Schmidt et al., 2019). The cognitive process in understanding and memorizing the architecture of three dimensional anatomical structures is enhanced through active dissection involving tactile handling and development of an appreciation of the form (Granger, 2004; Marks Jr., 2000). Peer group discussion is known to be one of the strongest activators of prior knowledge, helping to restructure and improve knowledge acquisition (Burgess & Matar, 2020; Smith & Mathias, 2011). Additionally, the teacher provides a powerful variant in most educational settings. Although evaluation of the quality of dissection tasks by surgeons within this study were conducted informally, other studies have reported formal evaluations as acting as a stimulus for student performance (Eppler et al., 2018; Hofer et al., 2011; Kumar et al., 2010; Nwachukwu et al., 2015). Certainly the feedback-rich environment of TBL, where students receive immediate feedback assists student learning (Schmidt et al., 2019). A recent study reported a positive correlation between the evaluation of dissection accompanied by formative feedback, and higher scores on final course assessments (Nwachukwu et al., 2015). Surgeons (supervisors) and surgical trainees (demonstrators) were able to emphasize the clinical and surgical applications of the regions as they were dissected, to aid acquisition of clinical anatomical knowledge. Additionally, within the context of dissection, it has been suggested that the guidance and experience of surgeons as facilitators helps to foster surgery as a career path (Hammer et al., 2015; Kozar et al., 2003).

5 | LIMITATIONS

A limitation to this study is that there was not a contemporary comparator group whose knowledge and acquisition was measured following traditional, less intensive dissection methods alone. Additionally, AWBD participants were self-selected and may have been a biased sample. A randomized allocation to either traditional alone or traditional plus intensive training would overcome any potential selection bias. However, the pre-course did provide reasonable data. In Years 1 and 2 of their course, students spent 175 h learning anatomy, from lectures and self-directed examination of prosected specimens, without any dissection at all. Despite this, they could only produce the pre-course results that we have recorded. After volunteering for an elective 8-week whole body dissection course they managed to improve their anatomical knowledge, as we have recorded in our results. These students, most of whom were intent on a surgical career stream, had recognized their deficiency, and had volunteered for this elective extra-curricular course. Although this study did not report on student perception, previous individual publications evidence student satisfaction (Burgess et al., 2012).

6 | CONCLUSION

Teaching human anatomy to medical students by traditional dissection methods in the crowded and shortened modern medical curriculum is a topical issue, with both students and surgeons often bemoaning the lack of dissection (Bunjo et al., 2020; Chapuis et al., 2010; Craig et al., 2010; Farey et al., 2014; Jeyakumar et al., 2020). Our study results demonstrate that AWBD, using TBL as a student-centred pedagogy, provides further acquisition and maintenance of three-dimensional regional relational anatomical knowledge to which these students had been previously exposed by inspection of prosected specimens. Although not all medical graduates require the detailed three-dimensional, relational, topographical anatomical knowledge required by those contemplating a surgical career, the current almost complete abandonment of cadaver dissection in the modern medical curriculum, even as an elective for students who require this knowledge, is regarded by many as a significant problem. The concept of additional anatomy training being used to prepare students streaming towards a surgical or procedural based specialty career has been previously suggested (Orsbon et al., 2014). Our results show that delivery of an intensive elective AWBD program, that utilizes efficiencies of a modified TBL format, has a place in the modern medical curricula, especially for those students contemplating a surgical or procedural career.

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