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Team-taught vs sole-taught anatomy practical classes: Enhancing the student learning experience

Laura Y. Whitburn
La Trobe University, Australia, l.whitburn@latrobe.edu.au

Meg Colasante
University of Melbourne, Australia, meg.colasante@unimelb.edu.au

Heath McGowan
La Trobe University, Australia, h.mcgowan@latrobe.edu.au

Diane L. Hughes
disey2008@live.com.au

Aaron C. McDonald
La Trobe University, Australia, a.mcdonald@latrobe.edu.au

See next page for additional authors

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Keywords

gross anatomy education, undergraduate education, exercise physiology education, exercise science education, physiotherapy education, team-teaching, practical classes

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Introduction

Anatomy is a core course in allied health degrees where an understanding of the gross anatomy of the human body is crucial for future clinical applications (Boon et al., 2002). Anatomy courses have typically centered around cadaver-based practical classes, as these are recognised to be fundamental to student comprehension of the three-dimensional nature of anatomy (Louw et al., 2009). The importance and value of these practical classes has also been expressed by students (Green & Whitburn, 2016; Mitchell et al., 2004).

Two modes of instruction have commonly been described for teaching of anatomy practical classes; sole-taught, where one demonstrator teaches a group of students (Whelan et al., 2016) or team-taught, where a larger group of students is taught by more than one instructor (Luetmer et al., 2018). Team-teaching has been variously described as a team of instructors working collaboratively to help improve student learning (Buckley, 2000) or as a model that involves two or more instructors collaborating in the planning and delivery of a course (Zhang & Keim, 1993). Team-teaching has also been described as involving faculty belonging to various disciplines (Luetmer et al., 2018; Smith et al., 2015) thereby comprising a multidisciplinary team. In this study, team-teaching was defined as "an approach in which two or more persons are assigned to the same students at one time for content delivery" as described by Gurman (1989).

Both sole- and team-taught formats have been reported to benefit student learning. However, it is unclear whether one is superior to the other in improving student engagement or outcomes. Diaz and Woolley (2015) demonstrated that, in a sole-taught format, a teaching style involving active, self-directed learning activities was perceived by students as more engaging and promoted more interaction with both peers and teachers, compared to a sole-taught didactic teaching style. A team-teaching environment facilitates student experience in working with an interdisciplinary team that could be helpful in their future years of practice (Luetmer et al., 2018) and can also help improve content knowledge (Buckley, 2000). Team-taught approaches have also been reported to foster student interaction by promoting dialogue and student participation (Yellowley & Farmer, 2006) as well as to help improve interpersonal skills (Johnson et al., 2000). Facilitating student interactions in which students discuss and problem solve together is an example of active learning and has been demonstrated to lead to more meaningful knowledge gains (Freeman et al., 2014).

The demand for allied health expertise in recent years has resulted in greater employment opportunities in these professions (Latman & Lanier, 2001) and increasing enrolments of a diverse population of students into allied health courses (McKenzie & Schweitzer, 2001). However, many universities, including those in countries such as Australia, have been facing a decline in resources, funding and teaching faculty (Yanamandram & Noble, 2006) resulting in a reduced number of resources and hours dedicated to cadaver-based practical classes (Berube et al., 1999; Diaz & Woolley, 2015). With cadaver-based practical classes playing a key role in contributing to student learning (Davis et al., 2014), a decline in the number of hours, and/or increase in class sizes for these practical classes may negatively impact students' experience, engagement and outcomes. It is therefore essential that the design and delivery of practical classes provides students with an engaging learning experience and the best opportunity to achieve their learning outcomes.

There are limited studies that have evaluated the impact of team-taught practical classes in anatomy courses. Bondos et al. (2008) describe that the team-teaching approach led to improved student satisfaction rates in a cohort involving science major students. Other studies on team-teaching evaluated student responses in an undergraduate marketing course (Yanamandram & Noble, 2006)

and in a cross-disciplinary honours course (Letterman & Dugan, 2004). Current literature on the benefits of team teaching in anatomy mainly includes medical students (Luetmer et al., 2018; Smith et al., 2015) with Smith et al (2015) reporting more engagement and/or improvement in communication skills as a result of team-teaching. Effective teaching is key to student learning (Schönwetter et al., 2006) and evaluating student perceptions and engagement could help identify and improve teaching practices (Bishop & Pflaum, 2005). However, to the authors' knowledge there are no reports evaluating allied health students' satisfaction with team-teaching as an effective mode of instruction in anatomy courses.

The aim of this study, therefore, was to compare allied health students' perceptions of anatomy practical classes delivered in two different formats; team-taught and sole-taught, and to evaluate the effect of these teaching formats on their learning experience.

Methods and Materials

The methodology of educational design research was employed as an iterative, evidence-based approach for this project. Educational design research is recognised as useful for initiatives designed to improve curriculum related issues. It allows education researcher-practitioners to collaboratively "develop new knowledge that can help construct pioneering curricular solutions that will prove to be viable in practice" (McKenney et al., 2006).

Easterday and colleagues (2018) describe a range of iterative phases in the educational design research process; initial focus on the problem builds understanding, goals are defined, and a solution becomes clearer as the outline is conceived, the solution is built, tested, and then presented. The educators and researchers of this study followed this educational design research process as detailed in Table 1. The current study was approved by the University Human Ethics Committee (HEC18017).

Course structure

This study examined an intervention in a second-year undergraduate anatomy course, which covers regional anatomy of the vertebral column, lower limb and thorax. This course was delivered to allied health students across two campuses in Victoria, Australia: a metropolitan campus in the state capital, Melbourne, and a regional campus in central Victoria. Until recent years, the course was studied by students enrolled in the Physiotherapy degree only. In 2015, the course was also delivered to Exercise Science (metropolitan and regional campuses) and Exercise Physiology (regional campus only) students. Prior to the intervention described in this study the student cohort exhibited a bimodal distribution of marks, with the Exercise Science (and, to a lesser degree, Exercise Physiology) students demonstrating poorer learning outcomes and engagement than the Physiotherapy students. This was particularly evident at the metropolitan campus, where student numbers were much higher, and which also experienced a significant decline in course satisfaction scores (based on the official university student feedback surveys).

While details of this course have been described elsewhere (McDonald et al., 2021), briefly, this 12-week course utilised a blended delivery mode where most content was delivered using online videos and the main face-to-face learning activity was a weekly two-hour practical class centred on prosected cadaveric specimens but also included other anatomical materials such as medical imaging, plastinated cadaveric sections and models. Prior to 2018, these practical classes utilised a 'sole-taught' format of one demonstrator for each class at each campus.

Table 1

The Iterative Stages of the Anatomy Project Aligned to the Educational Design Research Process

Educational design research stages (Easterday et al., 2018)		**Anatomy project**
Problem	Focus the problem	The anatomy course taught in two campuses experienced change: 1) widened admittance rules; 2) metropolitan campus noted lower student satisfaction and success rates, compared to regional campus.
	Understand the problem	Cross-campus teaching team discussions focused on differences in student interactions (better engagement in the regional campus) and larger teaching variability secondary to greater staffing requirements at the metropolitan campus.
Solution	Define goals	Employ a team-teaching approach in the metropolitan campus to improve teacher-student interactions, students' learning experience, and teaching consistency.
	Conceive the outline of a solution	Implement change at the metropolitan campus *From*: sole-taught format of one demonstrator per student group (of approximately 20 students). *To*: team-taught approach; a team of demonstrators to teach a larger group of students (approximately 40 students) in an adequately sized lab.
	Build the solution	'Teams' comprise a lead demonstrator, a clinical demonstrator, and a near-peer demonstrator (described below).
	Test the solution	Exploration of student and teacher experiences and student outcomes for the course on both campuses, to inform the success or otherwise of the new design using the regional findings and previous year data as benchmarks.
Present	Present the solution to key stakeholders	Investigators present the solution outcomes: 1) to university/faculty sponsors to inform discussions on whether to continue the new format; 2) share with the wider scholarly community.

In 2018, the conceived solution, team-teaching in practical classes, was introduced at the metropolitan campus and this manuscript focusses on the student perceptions of the change in teaching format. 'Teams' were made up of a lead demonstrator (an experienced anatomy demonstrator e.g. a tenured anatomy lecturer), a clinical demonstrator (typically a physiotherapist, exercise physiologist or medical doctor, all with some anatomy teaching experience), and a near-peer demonstrator (a high achieving student who completed the course in the previous year and who demonstrated personal aptitude for teaching). Staff to student ratios remained approximately equivalent across the two campuses (approximately 1:17 for the team-taught metropolitan campus and 1:20 for the sole-taught regional campus). Near-peer demonstrators were not included in this ratio calculation because they had no prior teaching experience – coordinators believed it was important to maintain the same level of teaching expertise in the classrooms at both campuses. The lead demonstrator was responsible for introducing the practical classes and leading major group discussions. Throughout the class, all demonstrators in the team, as well as the demonstrators in the sole-taught format, aimed to interact with students by moving around the lab facilitating student discussion and responding to student questions. Consistency of teaching across campuses was achieved through distribution of a comprehensive demonstrator's guide and regular cross-campus demonstrator meetings led by the course coordinator. Further details of this course, including assessment tasks and learning resources have previously been detailed in Green and Whitburn (2016).

Participants

As reported previously (McDonald et al., 2021), the metropolitan campus had a larger cohort of students in both years. Two hundred and sixty-five students were enrolled at the metropolitan campus (118 physiotherapy and 147 exercise science) in 2017 with 292 students (114 physiotherapy and 178 exercise science) in 2018. Seventy-three were enrolled at the regional campus (32 physiotherapy and 41 exercise science/physiology) in 2017 with 81 (36 physiotherapy and 45 exercise science/physiology) in 2018. The majority of students were enrolled as undergraduate students after completing secondary school, with both genders represented approximately equally. While grades on a prerequisite first-year anatomy course were higher for the physiotherapy students, there was no difference in grades for 2017 and 2018 cohorts (McDonald et al, 2021).

Data collection and procedure

This study was part of a larger research project that also aimed to evaluate students' outcomes and staff experiences. Only information relating to students' perceptions and experiences are presented here.

Data regarding students' perceptions and experiences of the teaching formats were collected via three methods: 1) a project-specific questionnaire, 2) individual and group interviews, and 3) targeted Likert scale and open text responses in the university-administered feedback surveys. These multiple data collection methods allowed for triangulation of data sources, to strengthen the validity of the findings by allowing the weaknesses of one source to be compensated by another (McKenney et al., 2006). All correspondence with participants regarding the research was conducted by a member of the research team who was not an anatomy demonstrator (non-teaching investigator) to emphasise to students that participation in the study was anonymous and not related to their performance in their anatomy course.

A link to the project-specific questionnaire was emailed to students in the final week of the 12-week semester. This online survey included Likert scale and open text questions relating to their experiences of interactions with the practical class teaching staff. The questions were tailored to the teaching format at each campus.

Students were also invited to participate in an interview to further explore their experiences within the different teaching formats. Interviews were conducted on each campus after conclusion of the official examination period for the semester. Each interview consisted of between one and four students (based on their availability to attend) and lasted between 15 to 45 minutes (depending on the number of participants). A semi-structured interview protocol, tailored for regional/metropolitan students, guided questions on student experience in having one/multiple demonstrators, examples of how this helped learning, how it could be improved, and further comments. Additional questions for the metropolitan students focused on how each different demonstrator added to the experience. Each interview was digitally recorded and subsequently transcribed verbatim to allow for analysis.

Finally, perceptions of the course overall were evaluated using standardised questions on the university-administered feedback surveys. Only two open text questions were asked in these surveys and both were thematically analysed: "What were the best aspects of this course?" and "What aspects of the course were most in need of improvement?" Of the eight Likert scale questions, two were relevant to this study and were therefore also analysed. They include the questions "I found the resources provided to be useful" and "Overall I was satisfied with the quality of this course". These online surveys were administered by the university in weeks 10 and 11 of the 12-week semester. This study utilised both 2017 and 2018 survey data allowing for comparison before and after the intervention.

Both the regional and metropolitan response rates for the university-administered surveys were higher than the University average of 18%. The response rates at the regional (sole-taught both years) campus were 66.7% in 2017 (49 students) and 74.4% in 2018 (60 students). The metropolitan (team-taught in 2018) campus response rates were 43.2% in 2017 (114 students) and 50.5% in 2018 (147 students). Response rates to the project-specific questionnaire (2018 only) were 37.8% (regional, sole-taught, 31 students) and 20.5% (metropolitan, team-taught, 60 students). A total of 11 students participated in a group or individual interview: four students from the regional campus (three female and one male), and seven at the metropolitan campus (five female and two male).

Data analysis

All quantitative data analyses were conducted in GraphPad Prism (GraphPad Prism version 6.00 for Windows, GraphPad Software, La Jolla California USA). Prior to analysis of the project-specific questionnaire responses, data were separated and evaluated by campus. Two-tailed Mann-Whitney U tests were conducted in conjunction with Kruskal-Wallis one-way analysis of variance (ANOVA) with Dunn's multiple comparisons post-hoc testing to determine any significant difference in the answering of project-specific questions. Data from the university-administered feedback surveys were subjected to an aligned rank test to assess normality (Oliver-Rodríguez & Wang, 2015). Where data met normality requirements, we then performed a two-way ANOVA with post-hoc comparisons assessed using Tukey's test.

Qualitative responses to the open text questions in the surveys and questionnaires, and to interview questions, were thematically analysed. Descriptive and focused coding methods were used (Saldaña, 2016), and the coding procedure recommended by Creswell and Poth (2018) was followed. NVivo Software (Version 11, QSR International Pty Ltd 2015) was utilised to assist with qualitative data management. Responses to the open text questions in the project-specific questionnaires were initially coded independently by two investigators. Coding was then checked using NVivo Coding Comparison query and a very high level (>98%) of inter-coder reliability was confirmed. A coding framework was then developed for use by a research assistant to code the open text data from the university-administered surveys, and this was subsequently checked by two investigators. Interview data was initially coded by the non-teaching investigator and checked by another investigator. The three analysing investigators then sorted related codes into descriptive categories across the three forms of data, which finally allowed for meaningful themes and patterns to emerge from the data.

Finally, the quantitative and qualitative data findings were integrated. The quantitative findings were compared to the emergent themes from the qualitative data, in order to expand and explain these themes. For example, the data from the university-administered surveys demonstrating an increase in the quality rating of the course at the metropolitan campus was integrated into the theme *Team-taught practical classes: enhancing the student learning experience*, where the qualitative data provides an explanation for this finding.

Results

Overall, the findings indicate that students across the metropolitan team-taught and regional sole-taught practical classes valued their learning experiences. This includes a significant improvement in the metropolitan students' satisfaction following the introduction of team-teaching and continuity of the regional students' satisfaction. The broad themes to emerge across the findings relate to key factors contributing to the students' satisfaction within their contrasting teacher-configured environments, that is, within the sole-teaching and team-teaching models.

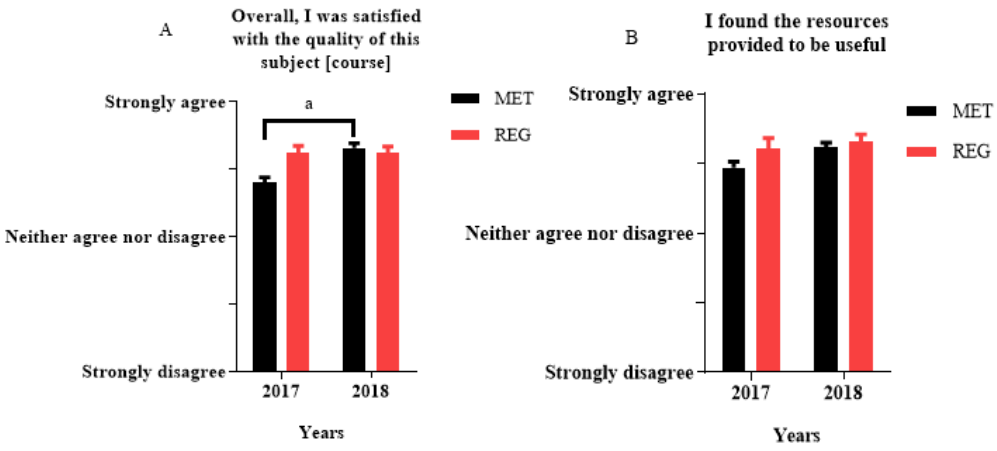
First discussed is the comparison between the sole- and team-taught practical classes, in relation to the improved metropolitan student learning experience following the intervention. The focus turns to key factors underpinning this improvement for the team-taught practical classes, that of the provision of diverse perspectives, followed by the various demonstrator characteristics that the metropolitan students valued. The factors of confidence levels and approachability are then compared between both teaching configurations, finishing with the opportunities for students to interact with their respective demonstrators and to ask questions.

Comparing the practical classes: Improved metropolitan student learning experience

The university-administered survey data demonstrated a significant improvement in team-taught (metropolitan) students' perceptions of the quality of the course from 2017 to 2018 (Figure 1, interaction effect, $p < 0.01$), making satisfaction levels comparable between campuses.

Figure 1

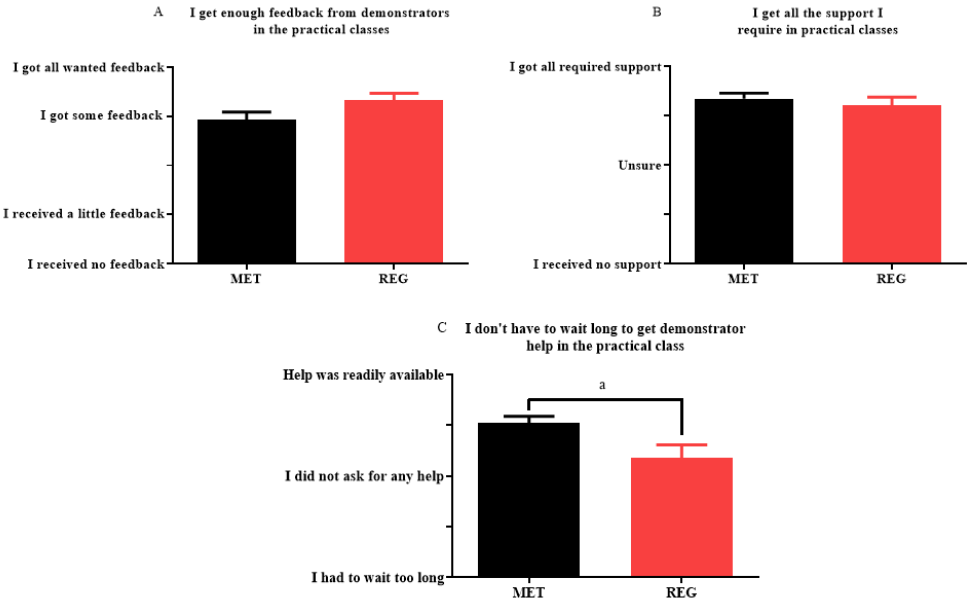
Course Satisfaction Scores (University-Administered Survey): *The introduction of team-teaching at the metropolitan (MET) campus improved the student perceptions of (A) the quality of the course in 2018 based on responses to the question "Overall, I was satisfied with the quality of this subject [course]", while scores were maintained at the regional (REG) campus across the two years (interaction effect: [a]$p < 0.01$). This was despite the (B) resources over both campuses and both years being unchanged.*



Overall improvement in the quality of the course was not perceived to be due to unequal feedback from demonstrators (Figure 2A) or unequal support provided during practical classes (Figure 2B).

Figure 2

Demonstrator Feedback, Support Wait Time (Mean ± SEM): *Demonstrator feedback (A, project-specific questionnaire) and support (B, project-specific questionnaire) across both the metropolitan (MET) and regional (REG) campus were perceived to be the same in 2018. Students at the team-taught metropolitan (MET) cohort indicated that help from a demonstrator (C, project-specific questionnaire) was more readily available, compared to the regional (REG) cohort ($^{a}p < 0.05$).*



Team-taught practical classes: Diverse perspectives

One key factor to emerge in relation to the enhanced learning experience in the team-taught practical classes related to the provision of diverse perspectives. Participating students from the metropolitan campus describe an enriched learning experience facilitated by a diverse teaching team within the one class. For example, "perspectives from different teachers and students, from different professions, makes it interesting" (university-administered survey).

The different perspectives and teaching styles of each demonstrator led students to interact with, and utilise, each one for different purposes:

> *Each one I… went to for different reasons... the students [near-peer demonstrators] I'd go to ask, 'All right this kind of content, what kind of content will I need to remember' ... The second [clinical] demonstrator I found was a very good resource for practical knowledge… But the lead demonstrator was very good at explaining concepts and teaching. (Interview)*

> *It's fantastic to have lots of different teachers because … you go between them, listen to different versions of the same explanation. Sometimes the way one person explains, it clicks really well. (Interview)*

Having access to multiple demonstrators in team-taught practical classes provided students with the opportunity to seek an alternative explanation to help clarify their understanding. This was facilitated by opportunities to 'listen in' on conversations between demonstrators and other students, as well as the ability to seek out conversations that were useful to the student.

Team-taught practical classes: Demonstrator characteristics

Extending from the key factor of diverse perspectives above, the findings from the metropolitan students reveal a further granularity. Within the compilation of the teaching team, three distinct teacher characteristics emerged.

The characteristics identified for the **lead demonstrator** can be collectively described as the *nurturing expert.* The students used various nurturing qualities to describe the lead demonstrators, such as patience, encouragement, respect, and a "calm demeanour and reassurance" (project-specific questionnaire).

Such qualities help create a positive, trusting relationship between the student and lead demonstrator, influencing students' confidence to ask questions and take on academic challenges. For example, *"[e]ven though she knows so much more than us, she does not make one feel stupid or shy to ask questions"* (project-specific questionnaire), and *"I really appreciated it when she challenged my knowledge in a way that was not demeaning"* (project-specific questionnaire).

Students appreciated the teaching techniques that lead demonstrators used to promote deep and independent learning. This included "*guiding us to answer our own questions*" (project-specific questionnaire) by directing questions back to the students "*to prompt our thinking as oppose[d] to giving us the answers immediately*" (project-specific questionnaire). Lead demonstrators *"had a really great way of breaking things down that were quite complex"* (interview). Students recognised that these techniques "*instil logical reasoning processes which help with understanding anatomy rather than rote learning*" (project-specific questionnaire).

For the **clinical demonstrator**, characteristics emerged to describe the *inspiring clinical contextualiser.* Clinical demonstrators were valued for their quality of being an inspirational role model to students who can provide real-world context. Students valued the ability of clinical demonstrators to draw on their clinical experiences to bring "*a different dynamic to the prac classes*" (project-specific questionnaire) to help contextualise the anatomy content. For example,

> *The second [clinical] demonstrator, I learnt quite a lot in terms of practical… I'm someone who learns anatomy best by knowing how you can practically apply it.* (Interview)

> *…he is a practising physio and shares with us students [various] injuries and their causes [and] how to treat them. He brings first-hand experience to his teaching which inspires many of us.* (Project-specific questionnaire)

This teaching technique added a deeper dimension to the course content and may assist with knowledge retention and engagement.

The **near-peer demonstrator** drew descriptions that characterised them as the *relatable study advisor.* Near-peer demonstrators were a popular addition to the practical classes. They were highly valued due to their relatability quality, with a unique insight into the challenges of completing the course and could thus empathise with the students. For example:

> *The student teacher/helpers were the best part of this subject [course]. They are so helpful and make the subject that much easier since they give a student's perspective on the subject.* (University-administered survey)

> *[name] gave us hints and tips on how to remember things and study - this was really useful to see how another student who did really well in the subject did that, and it helped me a lot.* (Project-specific questionnaire)

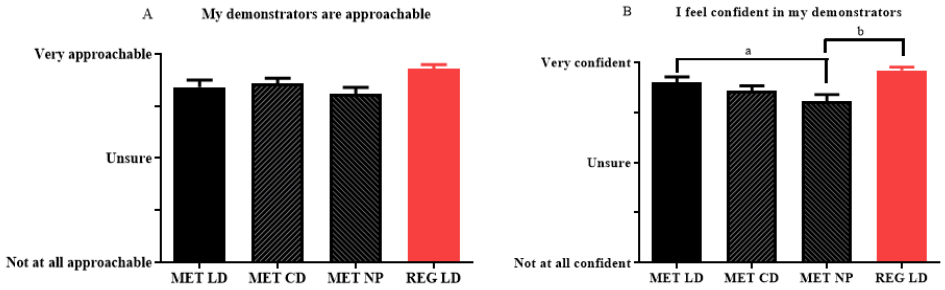
Near-peer demonstrators were able to draw on their own recent experience of completing the course to provide effective study advice and tips.

Team-taught and sole-taught practical classes: Confidence levels and approachability

Demonstrators across both campuses were perceived to be highly approachable (Figure 3A). There was also a high level of confidence for all demonstrators in both sole- and team-taught practical classes as indicated by the results in Figure 3B. However, statistical analysis did indicate that there was a perception by students that the near-peer demonstrators may not have had the comparable knowledge as the other demonstrators, and therefore the confidence in the near-peer demonstrators was lower than lead demonstrators at both the metropolitan and regional campuses ($p < 0.05$ and $p < 0.01$ respectively).

Figure 3

Demonstrator Approachability and Confidence (Project-Specific Questionnaire) (Mean ± SEM): *All demonstrators were perceived to be approachable (A) whereas confidence (B) in the near-peer demonstrators (MET NP) was significantly lower than the metropolitan lead demonstrators (MET LD; $^{a}p < 0.05$) and the lead demonstrators from the regional campus (REG LD; $^{b}p < 0.01$). LD = lead demonstrator, CD = clinical demonstrator, NP = near-peer.*



Despite the statistical indicators that near-peer demonstrators were perceived as less knowledgeable as compared to other demonstrator types, and despite their lack of teaching experience, the metropolitan students valued the efforts of the near-peer demonstrators. For example: "*[t]hey try their best to provide answers to the questions with the knowledge they have*" (project-specific questionnaire).

Students acknowledged the efforts of the near-peer demonstrators to ensure they were providing correct responses to student queries:

> *If, say, the student demonstrator didn't really know an answer or weren't confident in the answer, they would go see the lead demonstrator or the other demonstrator and get clarification, then come back and clarify the answer. (Interview)*

Team-taught and sole-taught practical classes: Opportunities to ask questions

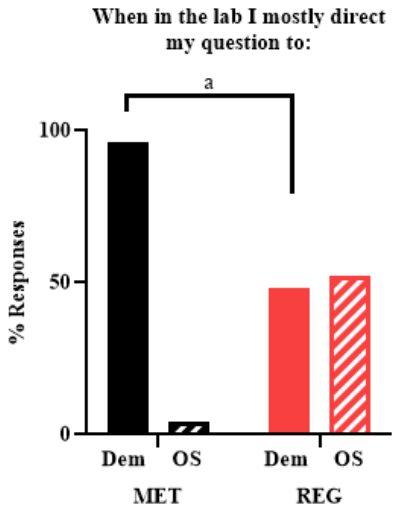
The better availability of in-class assistance is shown by students' responses to the project-specific questionnaire item relating to the perceived wait time before getting help from a demonstrator. Team-taught students were more satisfied with the wait time before receiving help from a demonstrator (Figure 2C).

Furthermore, comparing the two campuses, a large difference was found in who students directed questions to during the practical sessions. This included whether students directed queries to their classmates. Students in the sole-taught practical classes (regional campus) directed their questions to both demonstrators and other students equally (Figure 4) whereas students in the team-taught practical classes (metropolitan campus) overwhelmingly asked questions of their various demonstrators in preference to other students. This finding is likely

associated with the perceived shorter wait time and better availability of demonstrator help at the team-taught campus.

Figure 4:

Target of student questions (project-specific questionnaire)*: Regional (REG) students directed questions to both demonstrators (Dem; solid bars) and other students (OS; shaded bars) equally, whereas metropolitan (MET) students are more likely to direct a question to one of three available demonstrators before another student ([a]p < 0.0001).*



The opportunity to receive help when needed from multiple sources, each with a different perspective and way of explaining, may have contributed to the success of the team-taught format.

Overall, and as might be expected, the opportunities to ask questions were enhanced for the team-taught metropolitan students compared to the sole-taught regional students. Students' in team-taught practical classes perceived that demonstrator help was readily available, because "*with 3 tutors, it was easier to approach whichever tutor was available*" (university-administered survey).

The primary limitation of the sole-taught format was having no additional demonstrators to direct questions to; students were highly reliant on the one demonstrator, as expressed in a regional group interview:

> *I think the only complaint that all of us are having is that we wish we had more time with them [sole teacher] …I think none of us are complaining about the teacher, we're complaining that we didn't have more of them.*

Responses following the above comment from other students in this interview concurred with both teacher quality (e.g. “they’re great, they're always happy to help”) and the need to ask questions.

Having only one demonstrator facilitate the class meant that some students had to wait for the opportunity to ask questions, in order to be respectful of other student-teacher interactions. Once the opportunity arose to engage the demonstrator in a conversation, students were highly aware of the needs of other students who may be waiting, and therefore did not want to monopolise the demonstrator’s time with their “many questions,” while “*just one teacher… [is] trying to… help everybody*” (interview).

A further issue potentially holding students back from seeking help in the sole-teacher format relates to fear of judgement. While the regional students highly regarded their sole demonstrator, some students articulated a sense of feeling apprehensive about asking questions for fear of being judged for their lack of understanding. For example,

> *[the] anatomy lecturers are amazing, they are very, very, very, very intelligent people, and I think sometimes… they lack the perspective of coming from us… they try to put out, ‘there's no dumb questions’, but then sometimes I feel like I was asking a dumb question. (Interview)*

The factors of waiting for a single teacher to be available, and a potential sense of fear of judgement, may explain why sole-taught students would direct their questions equally to other students and to their demonstrator (Figure 4).

Discussion

This study has demonstrated the benefits of team-taught anatomy practical classes for allied health students. The findings suggest that team-teaching can provide a richer learning experience for students, when compared to sole-taught students in the same course and this finding is consistent with the improved learning outcomes associated with this intervention, particularly for the lower academically credentialled Exercise Science cohort at the metropolitan campus (McDonald et al, 2021). Although team-teaching has been the utilised in anatomy practical classes in medical schools (Smith et al., 2015), the composition of our teams was unique in combining a lead demonstrator, clinical demonstrator and near-peer demonstrator within the one classroom. The results of our study suggest that the success of the team-taught format related to the diversity of the teaching team.

Students valued the opportunity to engage with demonstrators with different perspectives on the content: an experienced anatomist (lead demonstrator), a clinician with experience in the field of their course, and a recent successful student (near-peer demonstrator). Previous literature has shown that interactions with multiple staff with different expertise creates a more engaging classroom (Little & Hoel, 2011) and also stimulates increased discussion (Yellowley & Farmer, 2006). Our findings support and expand on this in the context of the anatomy classroom, and in addition reveal the specific characteristics in each demonstrator that students felt most contributed to their learning.

Lead demonstrators (at both campuses) were valued for their depth of anatomy knowledge, as well as their skill at facilitating students to engage in active learning practices, that is, activities

that involve students in doing things and in thinking about what they are doing (Bonwell & Eison, 1991). Although students in other tertiary contexts have reported mixed preferences towards active learning approaches (Deslauriers et al., 2019) active learning leads to more meaningful knowledge gains (Freeman et al., 2014). Lead demonstrators (at both campuses) were also valued for their nurturing characteristics that helped to cultivate a supportive learning environment. Positive, trusting relationships between students and demonstrators influences students' confidence to ask questions and take on academic challenges, as well as influencing engagement, motivation, deep-learning approaches and achievement (Hagenauer & Volet, 2014).

Clinical demonstrators in the team-taught format were valued for providing an alternative viewpoint to lead demonstrators. Multiple explanations of complex concepts is recognised to be an important benefit of team-teaching (Liebel et al., 2017). The value of clinical demonstrators was in drawing on their clinical experience to contextualise the anatomical content in an authentic way. This ability to link the anatomy to students' future professions was reported to be inspiring and may help enhance internal motivation in students.

Near-peer demonstrators were valued by students due to their relatability. Peer teaching with medical students has been found to contribute to a positive, non-intimidating learning environment (Agius et al., 2018) and has previously been identified to improve student satisfaction rates in anatomy (Shields et al., 2015). In addition to improving staff to student ratios, this could be due to the fact that near-peer instructors have similar perspectives and social skills as the students within a classroom (Hall et al., 2014) which could create a less intimidating environment (Evans & Cuffe, 2009). Students in sole-taught practical classes who did not have near-peer demonstrators reported a perceived lack of relatability to their lead demonstrators, which resulted in feelings of apprehension for being judged for asking a question. This may be explained by the 'expert blind spot', which suggests that teachers with subject-matter expertise tend to make incorrect assumptions about how their novice students come to learn (Nathan et al., 2001). Due to their recent experience of being a student themselves, near-peer demonstrators may have better social and cognitive congruence with students in the classroom (Hall et al., 2014) and thus more able to provide learner assistance tailored to the needs of a novice.

A notable finding from sole-taught students was the effect of having one demonstrator on student interactions: students in the sole-taught practical classes directed more questions to their peers than students in the team-taught practical classes. In this regard, sole-taught practical classes may encourage more peer-to-peer interaction, which is in contrast to other studies that suggest that team-taught practical classes are more effective at generating student interaction (Yellowley & Farmer, 2006). This may have been an artefact of the perceived longer wait time to speak to a demonstrator within sole-taught practical classes, which results in students relying on each other for assistance. It is also likely to be influenced by the nurturing characteristics of the lead demonstrators, which helped sole-taught students to feel confident to engage with their peers during class.

Our findings demonstrate that both sole- and team-taught anatomy practical classes can provide students with a positive learning experience. Students at the smaller regional campus were highly satisfied with the sole-teaching provided at their campus. However, at the larger campus where a bigger teaching group was required, team-teaching was able to enhance satisfaction scores and was reported by students to have contributed greatly to their learning experience. While sole-taught students can be highly satisfied with their sole demonstrator, team-taught

students greatly value the multiple perspectives offered by a diverse teaching team, and our findings suggest that near-peer demonstrators can help compensate for the 'expert blind spot' that may occur when a lead demonstrator teaches in isolation. Successful team-teaching involves cooperation between team members and a mutual respect for each other's opinions and contributions. This is particularly important within a team that includes members with differing levels of content knowledge and teaching expertise. Students recognised the cooperative and respectful functioning of teaching teams at the metropolitan campus. The effective functioning of the teaching teams within this study allowed for role modelling of behaviour that facilitates life-long learning: respecting diverse perspectives and valuing the opinion of others. This is yet another value of team teaching and is not necessarily discipline specific.

Also worth noting is the cost effectiveness of team teaching. In our model, sessional staff in the team-teaching model were paid in a tiered system where the lead demonstrator (who also carried more responsibility for running the class) was paid at a higher rate that other demonstrators. This resulted in team teaching being more cost effective than the sole teaching model used at the regional campus.

Strengths and limitations

Strengths of this study are in the design: comparison of the two teaching formats was achieved between students who were sitting the same course at the same time where classes and content were identical. Triangulation of qualitative data (by using project-specific questionnaires, university-administrated surveys, as well as interviews as data collection methods) allowed for the capture of different dimensions of students' experiences. This also allowed for validation of findings, particularly of interview data for which participation rates were smaller than anticipated. Utilising and comparing both quantitative and qualitative data elucidated more information and allowed for a more comprehensive evaluation of students' experiences of the two different teaching methods in this study. Finally, the findings relating to student perceptions are consistent with the parallel study of student outcomes that demonstrated improved learning outcomes, particularly for lower academically credentialled Exercise Science students at the metropolitan campus (McDonald et al., 2021), however, results presented here could not separate student cohorts due to anonymity of the data collection. Possible campus differences may have confounded findings in this study, and students at the sole-taught campus may have been influenced by the knowledge that their metropolitan peers were receiving a newly implemented teaching format. In addition, although they were not originally included in the staff to student ratios, the near-peer demonstrators may have effectively altered ratios in favour of team-taught students: 1:12 (including near-peers) for team-taught students versus 1:20 for sole-taught students. The decision not to include near-peer demonstrators in teaching ratios was made by course coordinators because of their lack of teaching experience. Coordinators believed it was important to maintain the same level of teaching expertise in the classrooms at both campuses. The findings, however, suggest that despite their lack of teaching experience, near-peer demonstrators are highly valued by students and are able to contribute to their learning due to their relatability.

Conclusion

This study identified that a team-taught format of anatomy practical classes may provide a richer learning experience than a sole-taught format for allied health students. The results also suggest that the diverse composition of the teaching team may enhance the positive benefits derived

from this approach. Future research comparing sole- and team-teaching of students at the same campus would strengthen the findings of this study. Further research into the effects of team teaching in different groups of allied health students would be beneficial. It would also be interesting to determine if this diversity in teaching staff could benefit students studying anatomy in a generic science degree.

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