

Article

“Thank You for Your Sacrifice, I Will Try to Make Sure Your Donation Wasn’t in Vain”: Undergraduate Science Students’ Perceptions on the Use of Cadaveric Material in Learning Anatomy

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Abstract: Human-cadaveric material is a valuable resource for teaching anatomy, and a lot of research engaging medical students shows they benefit, in a variety of ways, from engaging with this material. However, more and more students who study anatomy are non-medical. Thus, they may have different educational foci than that of medical students, and, therefore, different perspectives on the value of human-cadaveric material as a learning resource. The aim of this study was to explore the perceptions of science students studying anatomy, in the use of learning using cadaveric material. Two cohorts of undergraduate science students studying anatomy (second-year, third-year) completed two surveys; one at the start and another following the completion of their semester-long courses that utilised prosections (second-year) and dissection (third-year) as a primary way of learning anatomy. Likert-scale and open-ended responses were analysed using a general inductive approach, and common emergent themes were identified. In total, 134 second-year and 77 third-year students completed the first survey, and 80 second-year and 36 third-year students completed the second survey. For the majority of students, their interactions with human material were positive and most of them cope well. Students acknowledged the opportunity and expressed gratitude for an invaluable learning resource. If at first the situation is confronting, with more experience, exposure, and staff support, most students find their initial concerns dissipate. This study identifies key areas of the learning journey that work well and others that can be improved, to better prepare students for learning with human material.

Keywords: anatomy education; science students; student perceptions; human dissection; prosections; body donation

1. Introduction

For hundreds of years, cadaveric material (used for dissection or prosections) has been considered to be the primary resource for teaching and learning anatomy [1], and research shows that students agree [2]. Over time, the majority of the literature that examines students’ experiences of learning with cadaveric material has focused on the perceptions of medical students (e.g., [3–9]). However, more and more students who study anatomy are non-medical [10–12].

Not only is the number of students studying anatomy growing, but there is also an increasing diversity of the courses in which anatomy is being taught, including allied health-professional courses (e.g., physiotherapy, podiatry, occupational therapy) neuroscience, and

biomedical sciences [10–12]. At the University of Otago, a large number of students learning with cadaveric material are those enrolled in a three-year-long, undergraduate course for a Bachelor of Science. In general, these students are exposed to the same fundamental elements as medical students, but instead of encountering full cadavers, they work with wet prosections and/or plastinates and, at the third-year level, dissect part specimens. Anecdotally, we have noticed that science students experience similar ideas and thoughts as medical students about working with cadaveric material; in laboratory sessions, they often ask lecturers and demonstrators questions about the donors, how they died, any remaining family, and what happens to them after dissection and/or their use in teaching. Despite these similarities, science students may not receive the same level of preparation and support as medical students prior to, and during, their experiences. Subsequently, these non-medical students may have different perspectives on the learning journey and the quality of support needed and received as well as identify unique educational facilitators and barriers.

This leads us to question whether differences in preparation and support (in comparison to medical students) alter science students' learning journeys and whether they are appropriately prepared to interact with human-cadaveric material. Therefore, the research questions in this study considered were: (1) Do science students feel adequately prepared for working with cadaveric material?; (2) How do they cope with this experience?; (3) What do they learn?; and (4) Do they feel supported over the duration of the course?

2. Materials and Methods

Study and survey design: In this cross-sectional study, all students who were enrolled in one of two courses (one second-year, one third-year), which utilise human tissue to learn anatomy, were invited via email to participate in two online surveys that explored their perceptions of learning with cadaveric materials. The surveys were based on a previous questionnaire used to explore the perceptions of medical students [3], comprised of a mix of quantitative and qualitative questions, asking students their opinions on learning anatomy using cadaveric materials. The wording of the questions was adapted to reflect the practical experiences of science students studying anatomy, and the final surveys can be viewed in Supplementary Materials. Student participation was voluntary, and they gave informed consent to be part of this study. The surveys were anonymous and distributed using Qualtrics (www.qualtrics.com, accessed on 1 January 2022). The first questionnaire was open between 23 February to 12 March 2018, and the second questionnaire was open between 21 May and 15 June 2018, and students were sent an email reminder after each week of being active. Ethical approval was granted by the University of Otago Human Ethics Committee (unique identifier: D18/040).

Sample characteristics: To understand the impact of working with human materials to learn anatomy, it is important to appreciate the previous experience the study cohort may have had prior to the commencement of the study. In the first-year prerequisite courses, science students who are studying anatomy have the opportunity to interact with plastinated specimens, and to observe demonstrations of wet prosections, but do not handle the latter themselves. Students spend less than 30 h collectively over the year in teaching spaces where human material is present. The second-year course that is surveyed in the current study is a compulsory course for Bachelor of Science students with Anatomy as a major subject. Chronologically, it is the first of the courses taught at this level, and it is a pre-requisite for the third-year-level course. In this course students are exposed to and encouraged to touch and engage with prosected specimens to help them learn their anatomy [13,14]. The third-year course is an elective and has the most interaction with cadaveric material than any other at this level. In this course, students additionally undertake three dissections (upper limb, lower limb, and spine segment) in small groups, on isolated specimens. Students are not exposed to whole cadavers while learning anatomy in these courses. In terms of prior preparation, students taking the third-year course are invited to a *whakawātea* or “clearing of the way” ceremony prior to

the start of their course [15], and staff provide ad hoc information to students immediately prior to a laboratory if human material is to be present, which may extend to comments regarding the body-bequest programme. No other formal preparation is provided to this cohort of students, although staff are expected to supervise and role-model appropriate behaviour of the handling of the material.

Data collection methods: The first survey was conducted near the beginning of the semester, prior to interactions with the human material, and the second survey was conducted near the end of the semester, after students had been exposed to several opportunities to engage (second-year) with the material, and complete dissections (third-year). A small sample ($n = 6$) of postgraduate students who had previously taken the courses pre-tested the survey, and any adjustments based on their feedback were made prior to full distribution to the target cohort.

Data analysis: Data were extracted into Microsoft Excel (for Mac, version 16.60). For questions that produced quantitative data, descriptive statistics were undertaken (means, standard error of means (SEMs)), and results were interpreted in conjunction with corresponding qualitative data. For open-ended questions, a qualitative general inductive approach [16,17] was undertaken to derive main themes from the individual survey questions. Similarly themed questions were grouped together to answer the four main research questions (mentioned above). Thematic analysis was undertaken by two different reviewers, independently (K.F. and S.A.), and coding was checked by a third reviewer (N.F.). Any disparities were discussed until agreement was reached between the three reviewers.

3. Results

A total of 211 students completed the survey at timepoint 1, prior to starting classes (second-year, $n = 134$ (40.7%); third-year, $n = 77$ (50.7%)) and 116 students completed it at timepoint 2, after classes had finished (second-year, $n = 80$ (24.3%); third-year, $n = 36$ (28.8%)). The demographics of the students who participated are summarised in Table 1.

Table 1. Demographic information of participating students.

Survey		Second-Year		Third-Year	
		Pre-	Post-	Pre-	Post-
Total number of respondents (% of class)		134 (40.7)	80 (24.3)	77 (50.7)	36 (28.8)
Mean age, years (SD)		19.6 (2.4)	20.2 (2.9)	20.9 (4.2)	20.9 (2.5)
Gender n (%)	Male	27 (20.2)	61 (76.3)	31 (40.3)	16 (44.4)
	Female	106 (79.1)	18 (22.5)	46 (59.7)	20 (55.6)
	Other	1 (0.8)	1 (1.3)	0	0
Ethnicity * n (%)	NZ European/Pākehā	89 (66.4)	54 (67.5)	52 (67.5)	27 (75.0)
	Māori	8 (6.0)	4 (5.0)	13 (16.9)	5 (13.9)
	Pacific Peoples	5 (3.7)	4 (5.0)	5 (6.5)	1 (2.8)
	Asian	32 (23.9)	19 (23.8)	14 (18.2)	3 (8.3)
	MELAA	4 (3.0)	3 (3.8)	2 (2.6)	0
	Other Ethnicities **	6 (4.5)	1 (1.3)	1 (1.3)	1 (2.8)

* People who reported more than one ethnic group are counted once in each group reported. This means that the total number of responses for all ethnic groups can be greater than the total number of people who stated their ethnicities, and percentages add up to more than 100%. ** Other ethnicities include “British”, “Russian”, “German”, and “Australian”. Abbreviations: MELAA, Middle Eastern, Latin American, and African; SD, standard deviation.

3.1. Do Science Students Feel Prepared to Learn Anatomy Using Cadaveric Material?

Quantitative data from the research questions “Do you think handling cadaveric material/dissection will affect you?” and “Do you feel prepared?” showed that while approximately half of our students (at both second-year and third-year levels) felt prepared, the other half were unsure, or did not feel prepared prior to starting their laboratories (Table 2).

Table 2. Second- and third-year students’ self-ratings of preparedness, anticipation, and stress regarding entering and participating in laboratories that involved handling (second-year) and dissection (third-year) of human-cadaveric material.

	Second-Year (n = 124) *					Third-Year (n = 73) *				
	Yes n (%)	Unsure/Somewhat n (%)	No n (%)			Yes n (%)	Unsure/Somewhat n (%)	No n (%)		
Are you prepared?	67 (54.0)	49 (39.5)	8 (6.5)			39 (53.0)	26 (36.0)	8 (11.0)		
Will it affect you?	25 (20.2)	35 (28.2)	64 (51.6)			17 (23.3)	21 (28.8)	35 (47.9)		
	Second-year (n = 123)					Third-year (n = 72)				
	0 (nil)	1	2	3	4 (very high)	0 (nil)	1	2	3	4 (very high)
Anticipation entering teaching space, n (%)	34 (27.6)	58 (47.2)	19 (15.4)	12 (9.8)	0	16 (22.2)	24 (33.3)	18 (25)	13 (18.1)	1 (1.4)
Stress entering teaching space, n (%)	28 (22.8)	29 (23.6)	22 (17.9)	35 (28.4)	9 (7.3)	18 (25.0)	20 (28.0)	19 (26.0)	13 (18.0)	2 (3.0)

* Please note, every question was voluntarily answered by each student completing the questionnaire. Therefore, sometimes students did not provide an answer for all questions.

When asked to rank their level of anticipation and stress towards entering the teaching space, approximately three-quarters of the second-year cohort that responded indicated that they were excited/very excited (1 or 2 on the Likert scale). A little over 15% of students were neither excited nor anxious/nervous. No one expressed having very high levels of anxiety or nervousness, but 9.8% of students revealed that they were experiencing some anxiety or nervousness (4 on the Likert scale) about entering the teaching space. The responses for levels of stress were more spread out across the scale, with similar proportions of students experiencing nil to high levels (1–4 on the Likert scale). A low percentage of students indicated high levels of stress prior to entering the teaching space (Table 2).

Similar trends were observed for the third-year students, with the largest percentage of students feeling excited about entering the dissection room to start their laboratories. However, overall, more students reported feeling anxious or nervous about entering the dissection room when compared to the second-year students. The level of stress that students ranked when they were asked to think about going into the teaching space paralleled the level of anticipation students were experiencing (Table 2).

Why Do Students Think They Are Prepared or Unprepared?

Several reasons were provided by the students explaining why they felt prepared to handle or dissect human material. Some of these answers were also the reasons why others felt unprepared (“not” or “unsure”). Similarly, although a large proportion of students indicated that they were prepared, when asked to explain why they felt prepared, sometimes similar concerns echoed those who were unprepared.

Reasons for feeling prepared:

Over half of the students who responded, indicated that they did feel prepared to handle dissections in their laboratory classes to learn anatomy. A large proportion of these responses showed that students recognised the human material as a good learning resource;

some believed this material was better than anything else that they could learn from, and many saw the benefits and enjoyed, or were interested in learning about anatomy from “real-life” tissue. If not explicitly mentioned as a resource, students still recognised that handling cadaveric material as part of their learning anatomy was a significant learning opportunity. These students also noted that they knew they would be supported by staff.

“I really enjoy looking and studying real human material, it’s so amazing holding something and realizing how much service that part of the body did, you can have a real 3D experience and feel thickness, sturdiness, colour, texture and many other things that you just can’t get from a book. I don’t think it would affect me because none of the remains are from people who died for us to see the tissue, they died, left their body for us to learn from, that was what they wanted when they passed away. Therefore I don’t think I should be anything but thankful to them”. Second-Year Science Student

Again, although not explicitly asked for, students would mention the themes of respect (for the body and the decision of the donor to donate), gratitude, and privilege (for the opportunity and experience) when answering about their level of preparedness in this instance.

“I have had a long-standing interest in Anatomy. I knew dissections form part of the education programme at Otago and have accepted that this is something to be grateful for and respected”. Second-Year Science Student

Previous experience:

A theme regarding previous experience emerged from the students’ responses regarding preparedness to handle human material, relevant to both second-year and third-year students. For those who felt prepared, it was due to the stepwise progression they had experienced in their previous years (academically and technically) that meant they were comfortable to interact with or dissect the human material.

For those who had indicated that they were unprepared, it was expressed that previous experience had not provided them with enough reassurance that they could easily handle the next step in their learning journey. For the second-year students, going from only looking at human material to having to touch and physically interact with dissections made them unsure of how they would react. For the third-year students, going from touching to dissecting human material was deemed “a big step-up”.

“I’ve done a few rat dissections before but never human tissue which I think will be quite different”. Third-Year Science Student

“It is understandable that we would be using dissections to study with, however, the level of interaction in 3rd year is a step up to the level of interaction in 2nd year”. Third-Year Science Student

Expanding upon this, the second-year students expressed concern that they were uncertain about what to do practically (i.e., how to handle the dissections correctly). Usually, these concerns were linked to not wanting to damage the tissue or being disrespectful as a result of their lack of ability. Similarly, the third-year students noted that their technical skills for dissection were non-existent or novice, and they did not “know enough anatomy” to ensure that they could make the most out of the learning experience with dissection. Students were also wary of “messing up” because of their inexperience in dissection.

“The potential risk of being unknowingly disrespectful—It is such a gift to be able to have these dissections and I would be terrified to jeopardise that”. Second-Year Science Student

“Hardest part will be knowing how to handle the dissections respectfully and appropriately”. Second-Year Science Student

The first time:

Many third-year students anticipated that the first incision into the first specimen would prove to be difficult, and they felt unprepared for this experience. One student explained that it was because they felt that it would be “like cutting their own skin”, and they were worried that they would not be able to participate. They also felt unprepared due to the timing of the first laboratory, held on the first day of the university academic year, and expressed that they felt they should have more time to “get used to the idea”. However, most people who identified these potential barriers also noted that they would be transient hurdles to work through.

Thinking about the person:

Those students who felt prepared were reassured by the fact that what they were doing to learn anatomy was what was wanted by the donors, and, as a result, they felt they would be able to detach emotionally. Across both year levels, unprepared or unsure students stated that their feelings came from the thought that it may be difficult to detach themselves from thinking about the person that the donor once was, which meant they may not be able to proceed with their learning. Sometimes, it was specified that the thought of being able to see, or have to dissect the humanising or identifying features of specimens was unsettling, as it would remind the students that what they were using was once a living individual.

“Coming to terms that the dissections were once people that each had a previous life”.
Second-Year Science Student

“Having to push away the thought that I’m touching a dead person and trying to not emotionally connect to that fact”. Second-Year Science Student

“Imagining that it was once a person and that everyone after death would become like this”. Second-Year Science Student

“The human connection, the physical body part was once a walking talking person who had experiences and memories and did great things but now they are just an arm for me to learn from”. Third-Year Science Student

“Trying to balance my thoughts between not thinking about the person the body belonged to (to focus on the task) but also keeping in mind that it is someone’s body”. Third-Year Science Student

Not sure what to expect:

Some of the responses from the students who stated they were unprepared or unsure about learning with human material showed that they were unsure of what to expect when they started their laboratories. In response to some questions, students referred to having to touch/dissect brains or whole cadavers, which was not the case for these courses.

Other reasons for feeling unprepared:

Although less common, it is important to report any other reasons why students were feeling unprepared for handling cadaveric tissue, so that as educators we can be aware of the type of support that may be required by some students. One individual found it difficult to get past the fact that they were unable to thank the donor for their body, despite being aware that by donating in the first place, this was what the donor wanted. Three others were aware that the hardest part of the exercise might be working through any emotional or physical reactions, such as fear, apprehension, and nervousness, to get on with the task at hand.

3.2. How Do Science Students Cope with Using Human Material to Learn Anatomy from?

Data from the quantitative survey questions regarding levels of stress show a reduction in self-rated stress levels among students (in both second-year and third-year courses) over time (Table 3).

Table 3. Comparison of levels of stress students experienced during their first laboratory session with human material with their final laboratory session.

	Second-Year (<i>n</i> = 80)					Third-Year (<i>n</i> = 35)				
	0(nil)	1	2	3	4 (Very High)	0(nil)	1	2	3	4 (Very High)
Level of stress during first session, <i>n</i> (%)	27 (33.8)	20 (25.0)	9 (11.3)	17 (21.3)	7 (8.8)	8 (22.9)	6 (17.1)	12 (34.3)	4 (11.4)	5 (14.3)
Level of stress at end of course, <i>n</i> (%) *	42 (56.8)	19 (25.7)	5 (6.8)	6 (8.1)	2 (2.7)	18 (51.4)	14 (40.0)	1 (2.9)	2 (5.7)	0

* Only 74 respondents of the survey answered this question.

Most students self-report as coping “fine” or with “no issues”, with some of those extending their explanations to being “excited” and “enjoying” the experience. There were four main ideas associated with what helped or hindered the ways students coped with using human material to learn anatomy from.

Better over time:

In addition, most students stated that their ability to cope with the human material improved over time, and there were a number of further explanations as to why this happened. Being able to cope with the human material improved after the first sessions for many students, and this was reported as being because they did not know what to expect prior to starting in the teaching space with the human material. Noted examples included that they found the smell of the environment or the temperature within the teaching spaces to be confronting, or they were not sure how they might react to the first exposure to the human material. These unknown experiences caused transient anxieties but were diminished within the first moments of entering the teaching space or following the completion of the first laboratory, as they found out what was expected of them and what sort of environment they would be working in; things became more familiar and part of their normal learning. Another common anxiety was due to their lack of experience in dissection or handling of the materials, so this, with experience, got better the more they participated in the laboratories.

Thinking about the donor:

Thinking about how the person the donor used to be was both helpful and a hindrance for the students. At first, some students found that working with human material could be confronting, especially when dealing with particular specimens or parts of the body (i.e., faces, fingernails, tattoos), because it made them think about the person when they were alive. It also made them consider the person’s families and the lives they lived. However, most of these students could deal with the experience by detaching themselves from those thoughts and approaching the material as a learning tool, knowing that it would help them with their studies. Specific to the third-year students, once they realised that they were not dealing with whole cadavers but rather sectioned parts of a cadaver, they noted that this helped them cope with using the sectioned parts in their studies and proceed with dissections. They were able to better distance themselves from the idea that the tissues they were working on had come from someone who had once lived.

“... it was actually a real person. Made it feel less real that it was not the whole body we received, it was just the portion we were working on”. Third-Year Level Science Student

Other students found it difficult to deal with human material at first but managed this anxiety by actively thinking about the person and, in particular, knowing that those individuals wanted their bodies to be used in this way. They stated that by not using their bodies to learn from would be a form of disrespect to the donor and their families.

“Fine. I have had moments feeling a little odd knowing that they used to walk and talk and have families and Christmas etc. When I start to think too much I

refocus and place a very clinical scientific mind to ensure to keep me learning and not overthink things". Second-Year Science Student

"I felt fine with handling the prosections- although occasionally the texture of the muscle and skin did feel a bit confronting. The people who donated their bodies wanted them to be used to learn and that helps with the confrontational aspects". Second-Year Science Student

Difficulties in learning:

However, some students provided negative feedback about their experiences. This minority of students found the human tissue confronting and not useful for their learning, especially without sufficient guidance and support from staff. These students usually refrained from interacting with the materials.

"Apart from the demonstrations at the start of the labs, I have very minimally interacted with the prosections. To be honest I avoid them as much as possible as they freak me out a bit. I prefer plastinations over prosections but still only look, not interact". Second-Year Science Student

"Good. But difficult to get any learning value without guidance". Second-Year Science Student

Having done their dissection course, the third-year students who described negative experiences reflected on their learning and portrayed doubts that the dissection of human material was the best thing they could have done for their learning. They did not "get as much out of it" as they anticipated, found it unnecessary, and were dubious about whether they would donate their own bodies knowing what would happen to them. One student postulated that it was probably because there was a lot of uncertainty involved in the experience, which was a reflection of their lack of academic knowledge and technical abilities in dissection. Another student noted that in an attempt to avoid being disrespectful, they found their dissection group did not "explore" as they did not want to damage the tissue—which this student found to be restrictive and against the whole reason for dissection, and, therefore, it was not as useful for learning as other methods.

Limitations of abilities:

A lack of technical or academic ability was frequently noted by both the second-year and third-year students, albeit for different factors. For example, third-year students were apprehensive about dissection as it was often their first time, and out of respect for the donors, they were at first hesitant to dissect because they did not want to cause unnecessary damage. For the second-year students, this was often their first time touching the specimens, and for the same reasons as the third-year students, they wanted to make sure they knew how to handle the specimens properly to avoid damaging them. As they gained more technical and academic ability, their confidence increased, and they became more comfortable with learning anatomy using human material.

3.3. What Do Science Students Learn from Working with Cadaveric Material?

Four main themes arose regarding what science students learnt from working with cadaveric material: (a) appreciation for real life anatomy; (b) the value of human material as a learning tool; (c) respect and gratitude for the donor; and (d) learning how to learn.

Appreciation for real-life anatomy:

Unsurprisingly, students learnt "anatomy" from working with the prosections and dissections. However, respondents specified that their participation in the handling of human tissue meant they were given the chance to appreciate how different anatomy is in real-life compared to the schematics shown in textbooks, as they were provided with an integrated view of how everything in the body fits together, how it is all relatively located and how no two specimens are the same.

“To visualise structures, how compact everything is, that everything has a specific function, to appreciate our bodies and their functions so much more”. Second-Year Science Student

“The relative anatomical positions of various structures, how they interact, and how structures actually look”. Second-Year Science Student

“That there is variability and that pictures don’t truly represent what the body is like”. Second-Year Science Student

“How interlinked everything in the body really is, in textbooks the vein, artery and nerve are all separate and nicely colour coded, and in the body they’re all bundled up together and look pretty much the same”. Third-Year Science Student

“I have really enjoyed dissecting, and found it really valuable. It’s one thing to learn a series of bullet points describing something, but to get a more full appreciation of the structure I think dissection is invaluable. You understand how surrounding structures relate to one another, and get an appreciation of the physical properties (like how hard, flexible or ridged, or how even relative size)”. Third-Year Science Student

The value of human material as a learning tool:

Intertwined in the students’ appreciation for learning real-life anatomy from real human tissue was the realisation of the value of cadaveric material as a learning tool. As the human material provided them with more details, and they had to apply their theoretical learning to real-life tissue, students found they were able to learn and understand more deeply than they did from other approaches to anatomy. This was supported by the quantitative data that were extracted from a question that asked them to rank the resources that were of most value to their learning (Figure 1).

By incorporating human tissue as a resource into the anatomy curriculum, students felt they were also given the opportunity to learn how to handle dissections and dissect human-cadaveric material in the correct and proper manner, technically and ethically. It also helped them realise specific tactile aspects of the materials.

“... it gives you an opportunity to feel and see the way muscles, tendons and nerves and what not are like in the flesh. Gave me a better understanding that I don’t think I would’ve been able to get from looking at photos”. Second-Year Science Student

Respect and gratitude for the donor:

The students often mentioned about how, reflecting back on their experience with dissection, interaction with the human material often increased the level of respect and gratitude they had for the individuals who donated their bodies for teaching and research. Many stated they were already appreciative and always conducted themselves in a way that would be respectful to the donor and their families, having learnt their anatomy from the dissections or from dissecting. However, they commented that this experience also gave them a chance to reflect more on the selfless act of the donor and gain a greater understanding of what it means to donate one’s body in order for someone else to learn. This theme of respect and gratitude, alongside the theme of appreciation and opportunity, were recurring themes throughout the survey, regardless of what question was being asked.

“We need to respect the bodies that have been donated to science to aid our understanding” Second-Year Science Student

“I still believe that using the cadaver material is what the person wanted and so it is our responsibility to utilise it the best way possible and to learn as much as we can, while treating it with respect”. Third-Year Science Student

Learning how to learn:

Learning anatomy in this manner elucidated for several students their best and favoured methods of learning (or not). Some realised they were visual learners, while oth-

ers found they learnt best undertaking “hands-on” tasks (i.e., picking up the prosections). Of these, two students found that the prosections were not the best way for them to learn, as they did not have the theoretical foundation or understanding of anatomy in place prior to their interactions. Two others specified that preparation prior to the laboratories with prosections was necessary to make the most of their educational value.

“I understand things better when its more hands-on”. Second-Year Science Student

“I don’t always benefit from the prosections unless I put in the work before”.
Second-Year Science Student

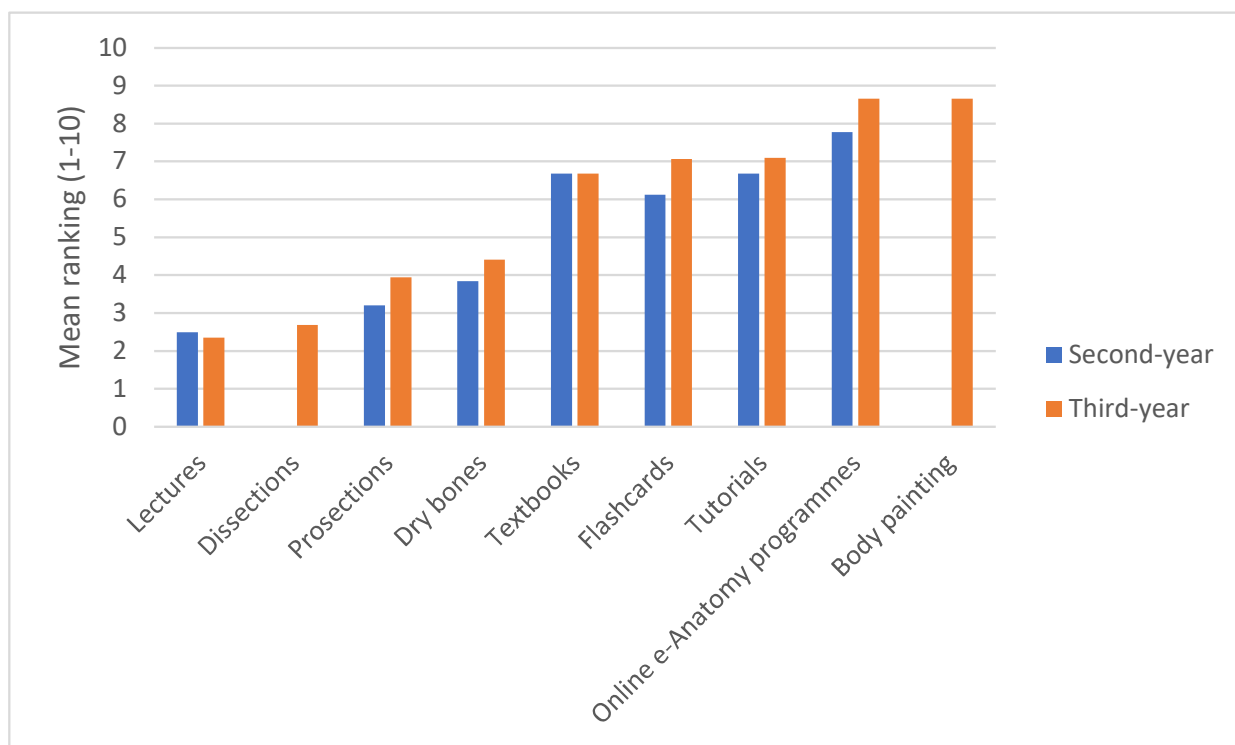


Figure 1. Mean ranking results of what anatomy learning resources students find most helpful. Note: Only the third-year students use dissection and body painting as learning resources in these courses. Lower mean ranking reflected a more helpful resource.

3.4. Do Students Feel Supported?

In general, students feel supported during their journeys learning anatomy using cadaveric materials. Throughout the survey responses, science students frequently discussed how staff had helped support their journeys through using human material to learn anatomy from.

“We are doing it in an environment that is for learning and development with plenty of teachers and demonstrators to guide us in dissections”. Third-Year Science Student

Staff were a positive influence on students’ anxieties around not knowing what to do or how to do it “right”, demonstrating the instrumental role staff play in helping students cope. Staff were seen as role models for how to be respectful, and they were able to talk about the process behind the donor programme and provide students with reassurance that this is what the donors and their families expected their bodies to be used for. Staff were described as being helpful in supporting students to gain technical and academic abilities, which then helped them feel more confident and comfortable using the materials to learn from. Sometimes they identified times when they wished there was more staff support (for dissection), highlighting the importance of this aspect of learning with human material.

“... but seeing the demonstrators and other teaching staff handling it with care [inspired] me to be able to handle prosections as well”. Second-Year Science Student

“I still feel that the best part was when the lab demonstrators... who guided me into considering and learning using the prosections”. Second-Year Science Student

Often, students noted that they felt they would not have got as much out of the experience or learnt as much as they did, without the help of the staff. The second-year students more frequently mentioned staff support compared to the third-year students, which may reflect the differing approaches to learning anatomy between the classes—in the third-year level, the experiential learning is based around doing the dissection, whereas in the second-year level, the students are still focusing on learning core anatomical concepts.

Finally, students appreciated the time that staff took to explain to them the concept of the body-bequest programme and set the scene for appropriate behaviour when using the human material.

“Probably the opportunity and the way that the lab dems knew so much about the material itself (how old, preparation etc.) it was really interesting to learn about the process”. Second-Year Science Student

4. Discussion

Exploring the science students' experiences and feelings about working with cadaveric material not only gives a multifaceted view of their perspectives of an experience that previous studies show to be both confronting and challenging [18] but also helps to discern the value of learning anatomy with these materials, in their own words.

Dissection is, for the majority of students in these classes, a positive experience and most cope well with the act of interaction with or the dissection of human material. They acknowledge the opportunity and express their gratitude to the donors and their families, who have provided them with this invaluable learning resource. Even if, at first, the situation is confronting or they experience varying levels of anxiety, over time, with more experience, exposure, and staff support, most students find their initial concerns improve or disappear, paralleling what has been observed in medical students [18].

At times, our data showed differences between the second-year and third-year students. For example, when reporting stress and anxiety upon entering the different teaching spaces, second-year students appeared more at ease than the third-year students. This may be reflective of the difference in environments. The environment that the second-year students work within is a general-use teaching space. Students are likely to have been learning in this general teaching space prior to having to learn using human materials in this course. In comparison, the dissection room is a specialised teaching space, which few of these students would have visited previously. Moreover, not only do science students interact with and dissect human material in this space, but there are also whole-body cadavers stored for dissection in other courses run by the anatomy department (i.e., medicine, and dentistry). Another example was that more of the second-year students reported negative experiences than the third-year students. This may reflect the fact that the second-year level is a core, compulsory course for the Anatomy and Medical Laboratory Science degrees, while at the third-year level, students choose to take the course.

Although science students are treated as a different cohort of students to medical students, those science students who learn anatomy with human tissue (prosections or dissection) perceive that they achieve similar learning outcomes and cope in similar ways to medical students [3–8].

There may be a couple of reasons for such similarities between students studying anatomy and medical students. Firstly, it is likely they have a shared interest in understanding the human body. Moreover, a large proportion of our science students who study anatomy, although they are being taught to become research scientists in their degree programme, are using anatomy as a stepping stone to gain postgraduate entry into medicine or other health-science professional courses. Therefore, they may have similar learning

goals and attitudes as those who are learning in medical school. Next, the attributes that students learn from using human materials are transferrable regardless of their career goals. For example, learning how to learn, applying theoretical knowledge in a practical situation (and vice versa), and respect for the human nature of studying aspects of human biology. Finally, it is possible that the mere nature of the material incites natural interest, and fascination with the dead promotes connections between the living and the dead, thus requiring support.

Although we observed many similar learnings from our science students as medical students, there were a few noted differences. Firstly, science students rarely mentioned thinking about their careers, whereas medical students have been observed to make connections between what they are studying and how it might influence them in their future practice or how dissection influences the type of specialty they would consider in time [3]. Moreover, although science students state that handling/dissection human materials prompts them to think about the person that the donor once was, they rarely thought beyond this aspect of the concept of death and dying or how their experiences may have prepared them better for dealing with the dead. The concept of teamwork was also not a major theme that emerged from the analysis of science students' perceptions. These aspects of learning appear to be applicable to medical students, and the differences may be explained by the different stages in their tertiary education that these two cohorts are at. Moreover, medical students undertake more dissection than science students, and their curriculum includes a lot of small group work where teamwork is actively encouraged. Perhaps the truncated time of the science dissection course is not long enough for students to realise that they are learning professional attributes, such as teamwork, as well. If the majority of students in the anatomy degree are focused on gaining entrance into medical school, it is possible that they have not thought of how what they are learning now may be helpful in their careers, as they do not yet have a clear pathway for their future professions.

Another interesting observation that was made in this study was that although the majority of students decided that "yes" they were prepared for interaction with or dissection of cadaveric materials, when they were asked to explain their reasons, they indicated several learning and coping barriers that echoed those who felt unprepared or unsure. This may suggest that although students feel prepared, until they physically start participating in the experience and finding out for sure how they feel, as educators we should be constantly vigilant of their reactions.

Limitations: The response rate for the first survey was 40% (second-year) to 50% (third-year), thus, it is recognised that it is possible that not all student opinions and experiences have been captured in this study. Moreover, it is recognised that there are a lower number of students who participated in the follow-up survey (especially for the third-year level), which limits the applicability of this study's results to a larger cohort of students. The reduced number is likely explained by the timing of the second questionnaire; at the end of the semester, students' priorities are different, as they are preparing for upcoming assessments and examinations. It is also this time of the year that course and teaching evaluations take place, thus, students are likely to be experiencing questionnaire fatigue. However, it was important to allow the students to spend some time in the teaching space and work with the materials, so that their opinions and perceptions of what they feel and experience are well developed and clear, so it was deemed that the timing of the follow-up questionnaire was appropriate for capturing these attitudes.

5. Conclusions

From the results of this study, we have been able to identify some areas of the learning journey that may be improved to refocus the support we, as educators, provide, to better prepare students for learning with human material, especially at different stages of their learning, to help improve the student experience.

These strategies are:

- Reassuring students that staff are here to support them and providing them with direct information about where to go to find specialised staff support.
- Explaining to students what to expect and how it could make them feel.
- Reassuring students that with time, more exposure, and more experience their confidence will improve, which will mean that they will feel more comfortable engaging with this learning resource.
- Explicitly identifying the support strategies and processes that the department has in place, i.e., providing students with more information about the body-bequest programme and what happens at different stages of the learning process. Then, dedicating time in class to answering questions relevant to this point. Informing students of how the department gives thanks to the donors and their families, on behalf of everyone, highlighting the department's Thanksgiving Service for the donors' families, and inviting these students to participate in and/or attend that event.
- Giving students a chance to develop relevant technical skills prior to their first sessions with human materials.

Finally, by identifying that just under 50% of students felt unprepared prior to their first laboratory experience with human material (at both second-year and third-year levels), we can target this vulnerable time in the student experience with the aforementioned strategies.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/educsci12070451/s1>.

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