Impact of Virtual and Cadaveric Dissection on Medical Students' Learning and Perceptions of Human Anatomy – A randomized control crossover study

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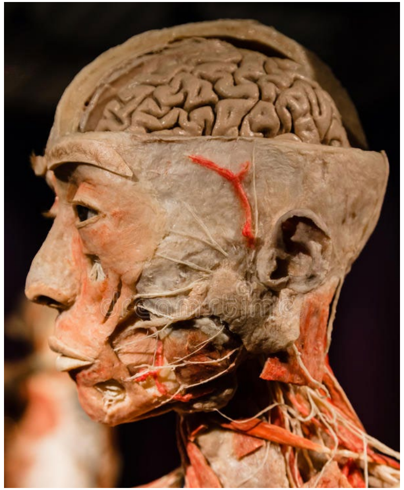
Traditional Methods of Teaching & Learning Anatomy

Cadaveric Dissection

Anatomy Museum



Plastinated Specimen

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Newer Methods of Teaching & Learning Anatomy

Anatomage is a lifesize virtual human body based on the crossectional images of donated bodies. A touch screen interactiv device with accurate real human anatom

The most technologically advanced anato visualization and virtual dissection equipment.

It also has a virtual library of 3 Dimension human organs & anatomical regions constructed from CT & MRI scans of real patient data. (Giant iPad)

Anatomage Table

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Studies involving Anatomage

A study conducted in <u>**Case Western Reserve** University School of Medicine</u>, *Cleveland, Ohio* ***(2019)*** *found that* ***students showed more*** ***<u>enthusiasm</u>*** ***in learning using Anatomage***, *& that* ***it may be an equivalent to cadaveric dissection***. *However, it had <u>small</u> sample size (n=16), possible selection <u>bias</u>.*

A study conducted in Umm Al-Qura University, Makkah, Saudi Arabia *(2021) found that students showed that many* ***students favoured the use of Anatomage together with cadaveric dissection*** *for the learning of Anatomy as it allowed and enhanced active learning. 89% of the participants felt that Anatomage allowed for a* ***good visualisation of anatomical structures***. *However, their study <u>did not evaluate and compare the performance of students performing a virtual dissection vs a cadaveric dissection.</u>*

A study conducted in Gujarat Adani Institute of Medical Sciences, Bhuj, India *(2017) found that* ***Anatomage was equivalent to cadaveric dissection for the learning of Neuroanatomy*** *as it allowed for a* ***3D visualisation of anatomical structures***. *However, their study <u>did not evaluate the use of Anatomage for learning of other regions of the body.</u>*

Literature Gap

There is **limited research** on how effective the Anatomage is for the study of Human Anatomy in the medical curriculum in terms of knowledge acquisition.

Most studies did **not** evaluate the Anatomage from the **student's** point of view using a **validated** survey instrument.

Furthermore, most studies did **not** compare the use of **Cadaveric** and **Virtual** dissection.

Purpose

- Compare **students' objective outcomes** of Pelvic & Brain anatomy between cadaveric (dissected / prosected) specimens, and Anatomage.

- Evaluate **students' perceptions** of learning human anatomy with these two teaching and learning tools in terms of perceived:
(i) learning satisfaction, (ii) self-efficacy, (iii) humanistic values, & limitations of the tools.

Hypothesis

Given that virtual dissection is easy to use and better at visualizing body parts in three dimension, we hypothesized that the students of virtual dissection (Anatomage) will perform better both in objective and subjective outcomes as compared to the cadaveric dissection

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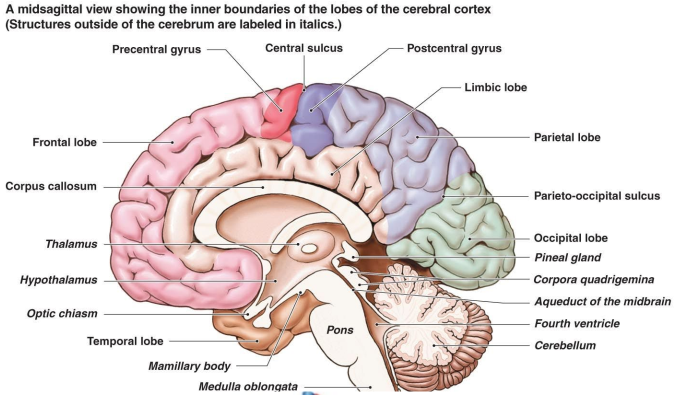
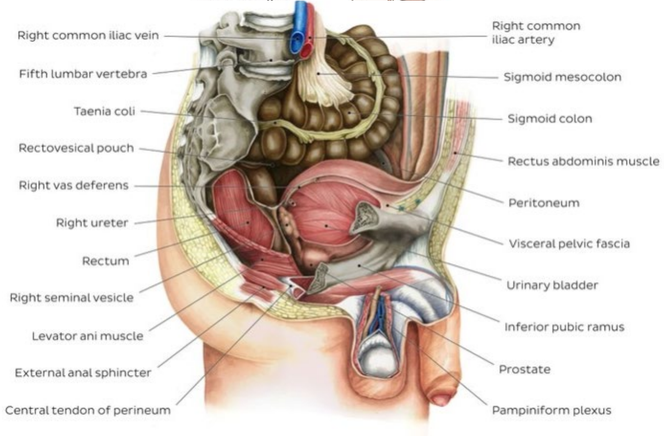
Anatomical Region of Study

Deliberately chose:
- Gross Anatomy of the Pelvis & Perineum
- Gross Anatomy of the Brain

Why were these regions chosen?
- Challenging and Complicated
- Requires visuospatial understanding
- Recognition and appreciation of anatomical relationships from a 3 dimensional perspective.

Study conducted in **two** sessions (morning and afternoon) based on anatomical region





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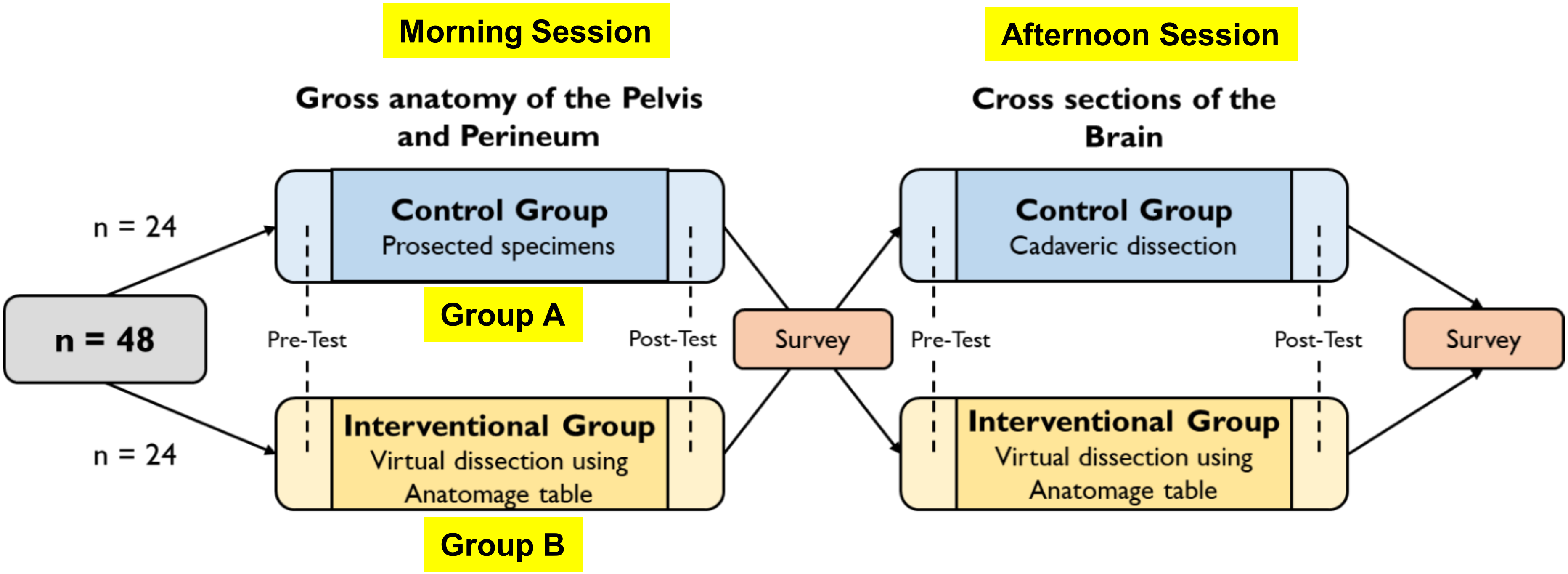
Methodology



Flow Diagram of the Overall Methodology

Demographics and Timeline of the Study

43 Year-1 undergraduate medical students (MBBS):

- 17 Male
- 26 Female
- Age: 19 to 22

Time	Activity
9.00AM - 9.20AM	Pre-Test MCQ (10 Questions)
9.20AM - 10.20AM	Virtual Dissection and Prosected Specimen Practical
10.20AM - 11.00AM	Post-Test MCQ
11.00AM - 11.10AM	Pelvis & Perineum Survey
12.00PM - 12.20PM	Pre-Test MCQ (10 Questions)
12.20PM - 1.20PM	Virtual Dissection and Cadaveric Dissection Practical
1.20PM - 2PM	Post-Test MCQ
2PM - 2.10PM	Brain Anatomy Survey

Pre-Test

Pre-Test

Conducted <u>before</u> commencement of Practical Session

10 MCQs with 5 Options, (20 Minutes)

<u>Direct</u>-recall Questions (Majority Qs Level 1 Bloom's Taxonomy)

Purpose

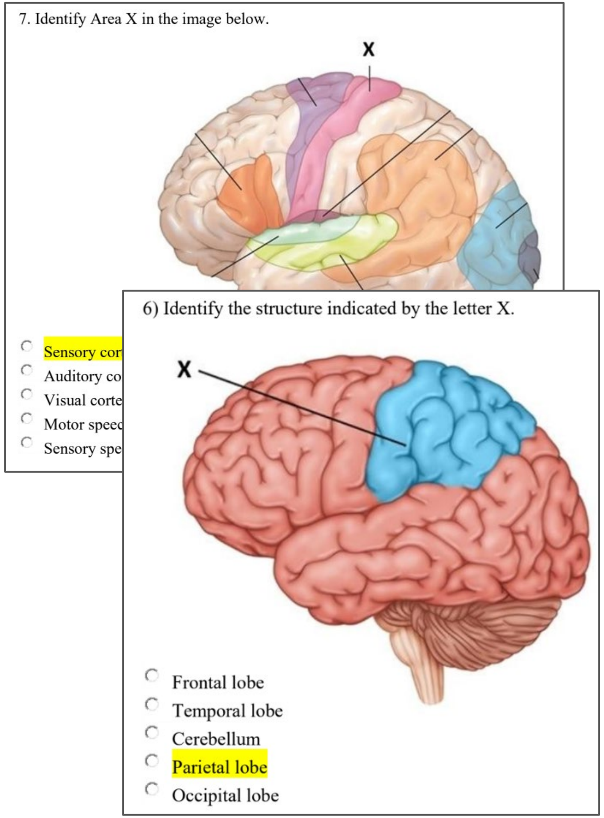
Estimate student's <u>baseline</u> knowledge of:

(i) Anatomy of the pelvis & perineum

(ii) Anatomy of the brain.

*<u>No</u> feedback and answers provided to the students on their pre-test performance.

* Exam like conditions



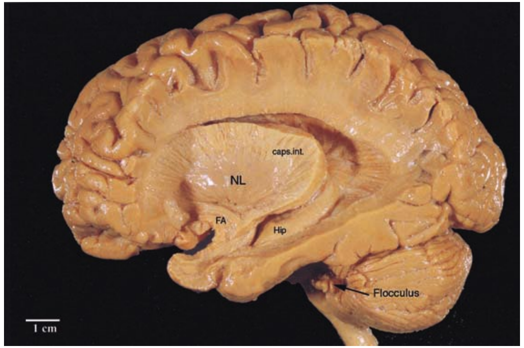
Self-learning

Students given learning tools based on group allocation:

(i) Pelvis+Perineum Mid-sagittal & Axial section (male/female)

(ii) Brain : Axial, Coronal and Sagittal Sections

(iii) Anatomage Table



Practical Handouts with learning objectives + clinical relevance

- to guide dissection (virtual \ cadaveric)
- details on what structures they could identify in:
  - (i) Pelvis & Perineum
  - (ii) Brain

Duration:

- **15 mins** given for students to get familiar with the tools or equipment prior to the self learning session
- **60 minutes** of self learning using learning resources provided

Post-Test

Post-Test

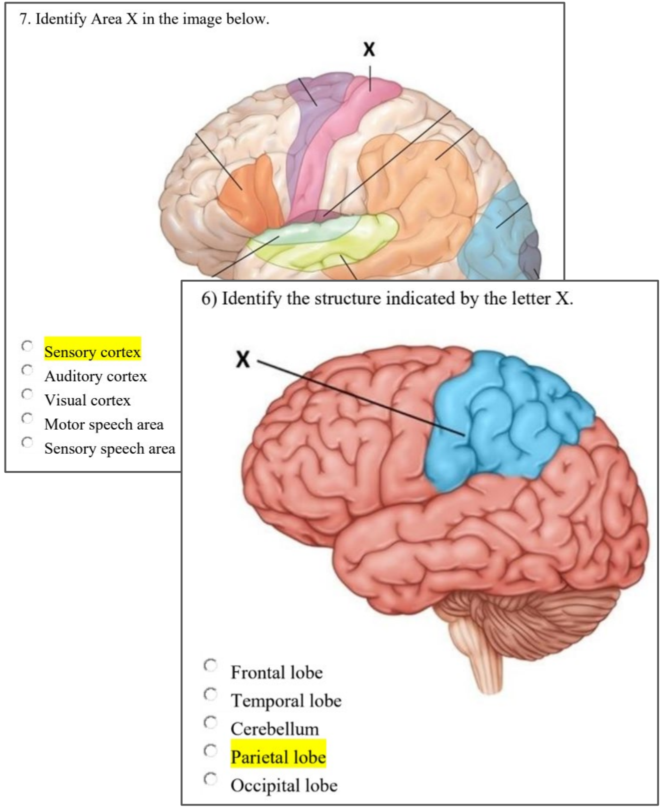
Conducted <u>after</u> the self-learning session

10 + 10 MCQs (40 Minutes)

Order of Pre-Test MCQs including options were **shuffled**

Purpose:

To evaluate if the students gained new anatomical knowledge following the self-learning session

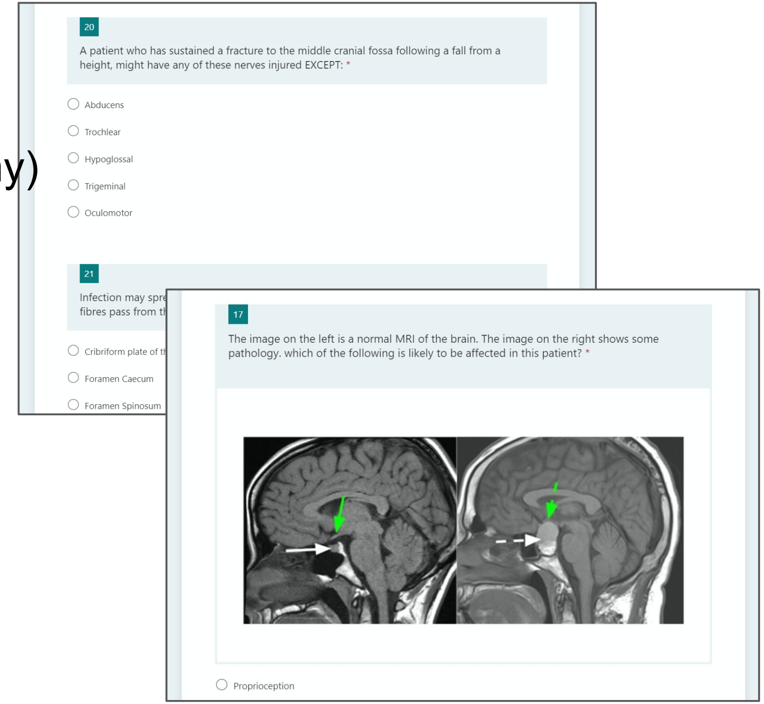


Post-Test also included 10 "new" MCQs

10 new Post-Test MCQs
Application-based Questions (Level 3 Bloom's Taxonomy)

Purpose

1. To investigate if the Anatomage or Traditional methods helped with the application of anatomical knowledge rather than a mere identification of the structures.
2. To avoid sensitizing students to test questions and minimize recall bias



Source: MCQ Questions were adapted from the University of Michigan Medical School, USA, BlueLink (Dr. Kathleen Alsup and Dr. Glenn Fox).

Survey

Online survey form consisting of **two Components**

A. 5-Point Likert Scale

1=Strongly Disagree 5=Strongly **Agree**

Total of 20 Questions,

<u>Comprising of four Sections</u>

1. Learning Satisfaction (n=8)
2. Humanistic Values (n=4)
3. Self-efficacy (n=6)
4. Limitations of learning tools (n=2)

B. **Free-Text Comments**

Total two Questions

1. Strength & Weakness of Learning Approach
2. Area of Improvements / Suggestions

Survey instrument: Chandrasekaran, R., Radzi, S., Kai, P. Z., Rajalingam, P., Rotgans, J., & Mogali, S. R. (2021). A validated survey instrument measuring students' perceptions on plastinated & three dimensional printed anatomy tools. ASE.

Data Collection → Data Analysis

A. Demographics
- Age
- Sex
- Year of Study in Medical School

Descriptive statistics

B. Pre-test, Post-test

- Pre-test score
- Post-test score

Student's T-test: compare Test scores between groups

Hedges' g: to measure **effect size** of learning.

Hedges' g used due to small sample size.

Medium effect size: 0.5 to 0.8

Large effect size: greater than 0.8

C. Survey:

- Likert scale
- Free-text comments

Descriptive statistics

Learning gain following an intervention

Group	Gross Anatomy of Pelvis & Perineum				Hedges' g
	Pre Test		Post Test (10 same Qn)		
	M	*SD*	*M*	*SD*	
Anatomage	77.0%	± 16.8%	83.0%	± 14.5%	0.538
Prosected Specimen	74.1%	± 14.7%	86.4%	± 10.9%	1.340

Group	Gross Anatomy of the Brain				Hedges' g
	Pre Test		Post Test (10 same Qn)		
	M	*SD*	*M*	*SD*	
Anatomage	75.9%	± 13.0%	81.4%	± 9.9%	0.669
Cadaveric Dissection	75.2%	± 16.3%	84.3%	± 11.6%	0.903

Comparisons of test scores within groups

Mean scores: Students performed better in Post-Test than in Pre-Test.

Hedge's G: larger effect size for Prosected Group and Cadaveric Group compared to Anatomage Group

Comparisons of test scores between groups

	Gross Anatomy of Pelvis & Perineum					
	Anatomage Group (n=20)		Prosected Specimen Group (n=22)		Hedges' g	p value
	M	*SD*	*M*	*SD*		
Pre Test	77.0%	± 16.8%	74.1%	± 14.7%	1.166	0.554
Post Test: 10 same Qn	83.0%	± 14.5%	86.4%	± 10.9%	1.665	0.399
Post Test: 10 new Qn	58.1%	± 15.3%	54.0%	± 15.2%	1.374	0.486

There is no statistically significant difference in the test scores between Anatomage and Prosected Specimen groups

Even though differences between the **post-test score** was NOT statistically significant, the Prosected group performed better than Anatomage (when same MCQS) while the opposite was observed for 10 brand new MCQs.

Comparisons of test scores between groups

	Gross Anatomy of the Brain					
	Anatomage Group (n=22)		Cadaveric Dissection Group (n=21)		Hedges' g	p value
	M	*SD*	*M*	*SD*		
Pre Test	75.9%	± 13.0%	75.2%	± 16.3%	0.292	0.882
Post Test: 10 same Qn	81.4%	± 9.9%	84.3%	± 11.6%	1.734	0.380
Post Test: 10 new Qn	66.8%	± 21.0%	70.0%	± 13.4%	1.150	0.559

There is no statistically significant difference in the test scores between Anatomage and Cadaveric Dissection groups

Even though differences betwe**post-test score** is NOT statistically significant, Cadaveric Dissection group scored higher than Anatomage Group

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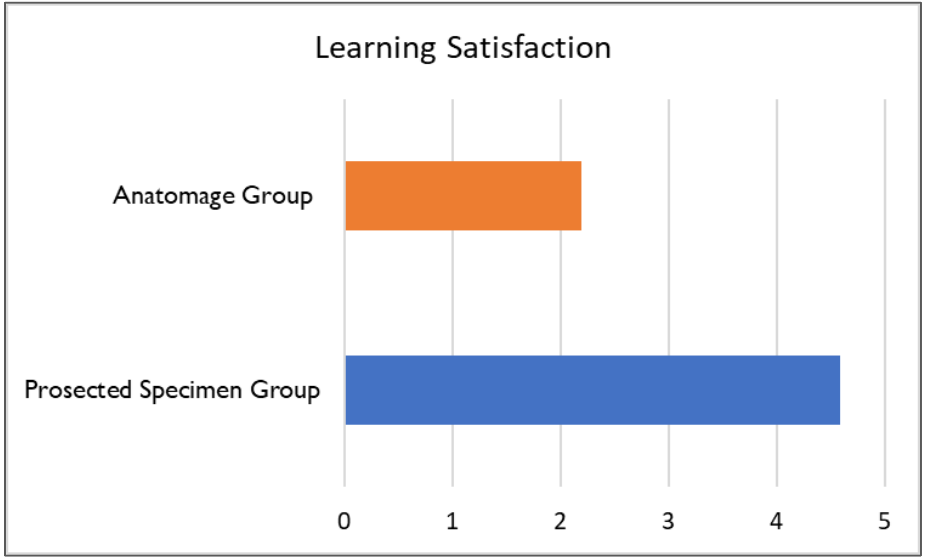
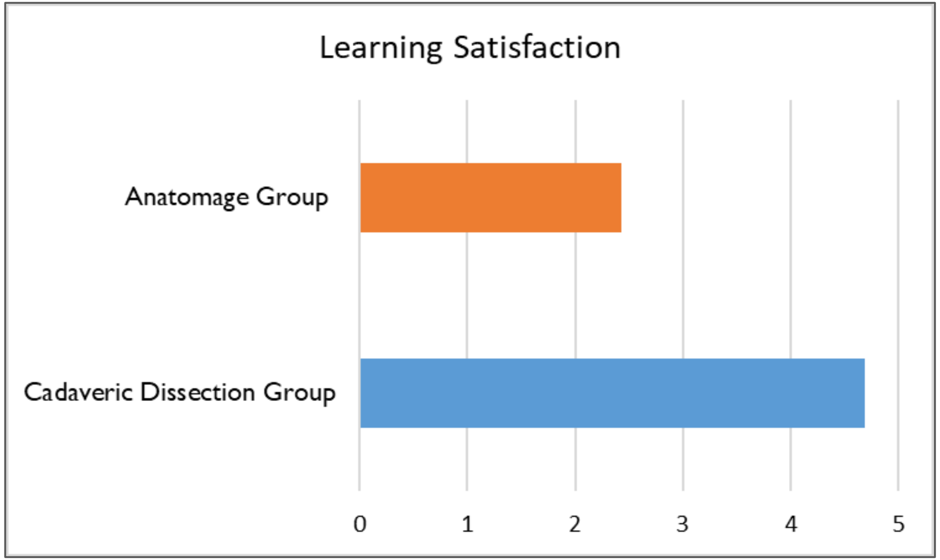
Learning Satisfaction (Summary)



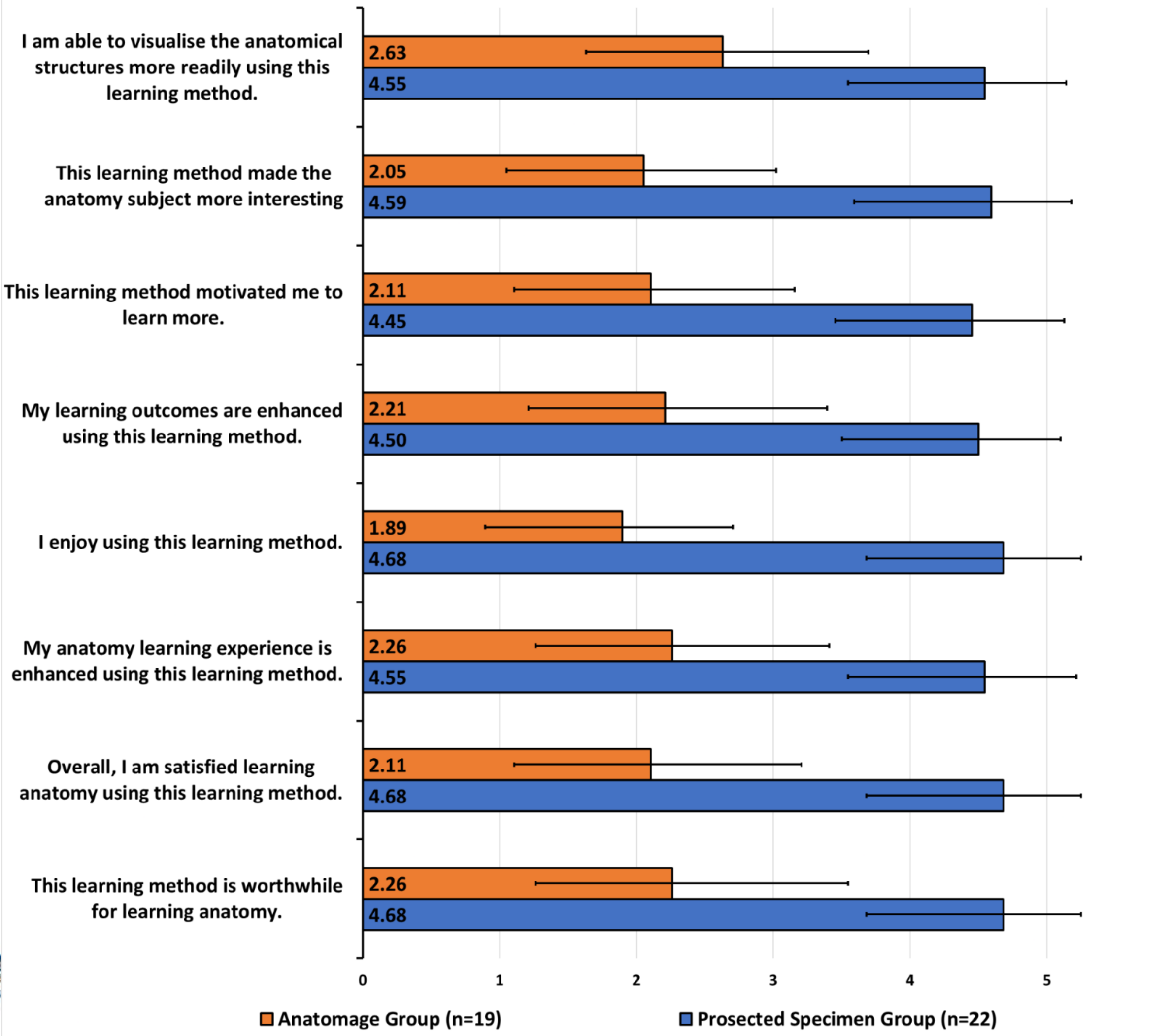
Anatomy of Pelvis & Perineum



Anatomy of the Brain

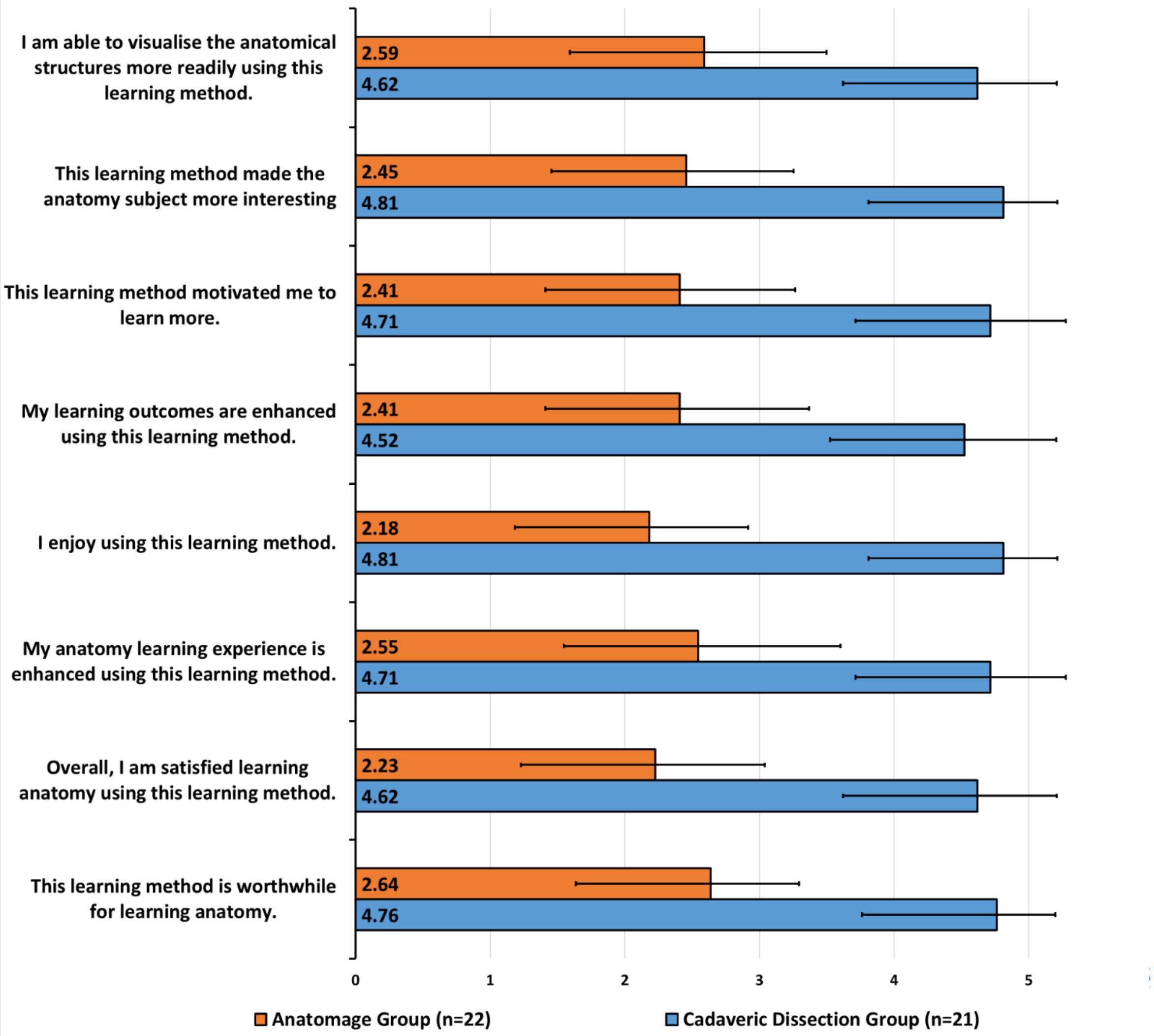
Learning Satisfaction

(Anatomy of Pelvis & Perineum)

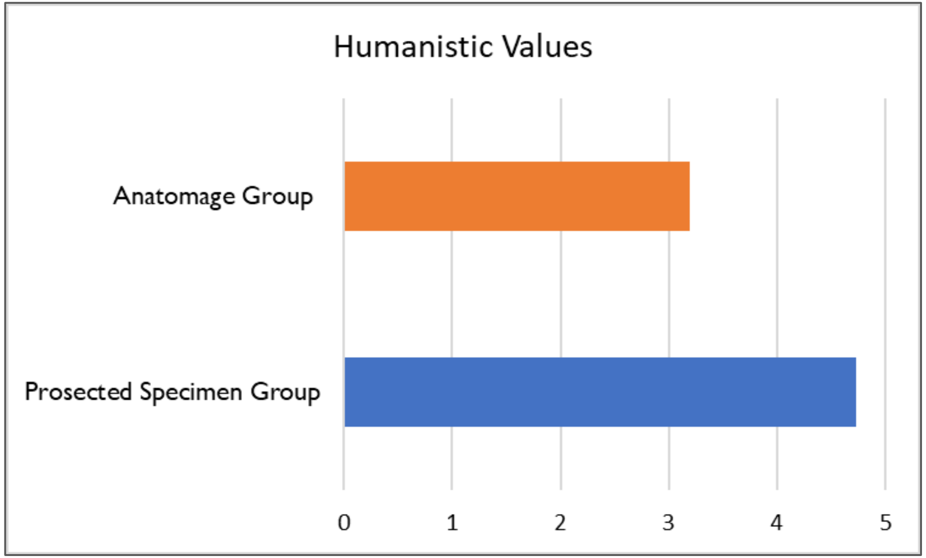


Learning Satisfaction

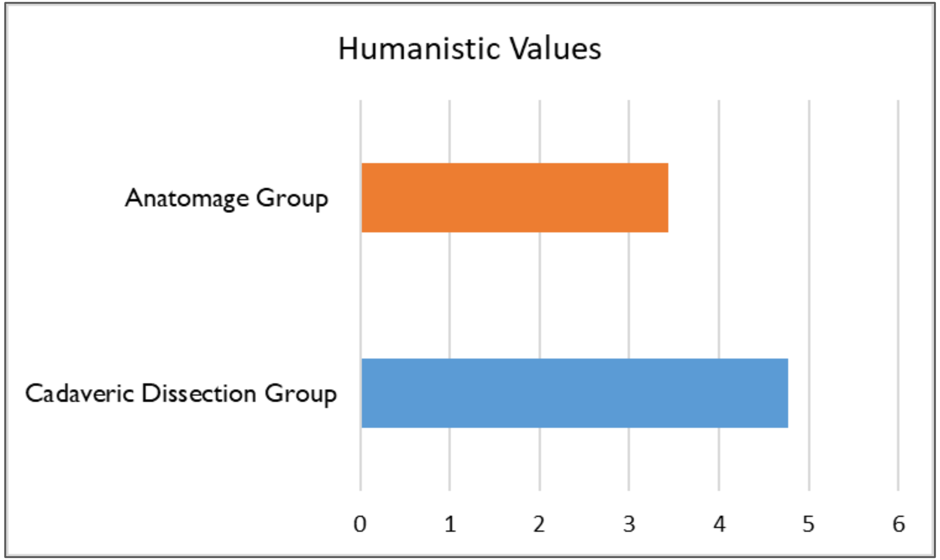
(Anatomy of Brain)



Humanistic Value (Summary)



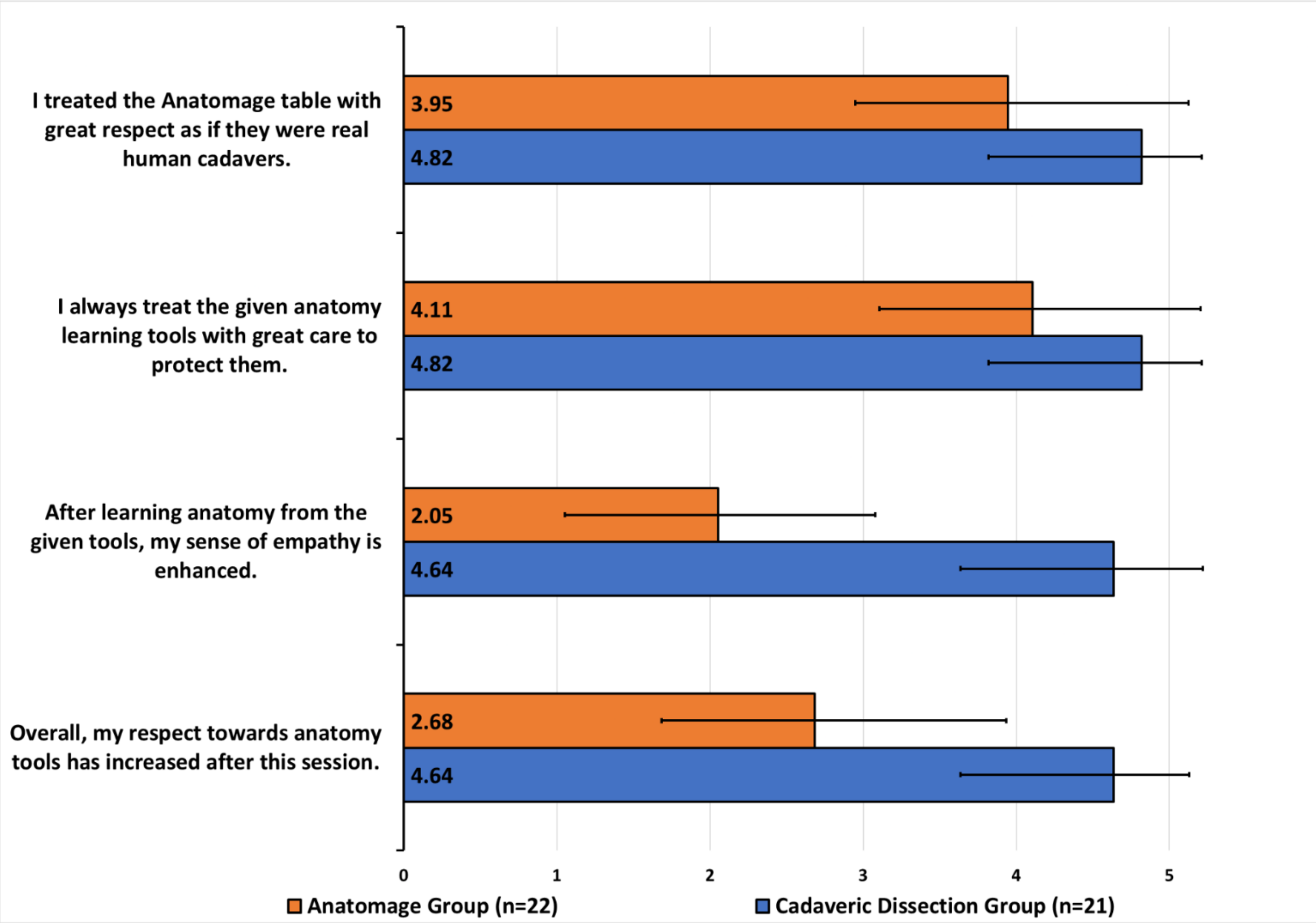
Anatomy of Pelvis & Perineum



Anatomy of the Brain

Humanistic Value

(Anatomy of Pelvis & Perineum)



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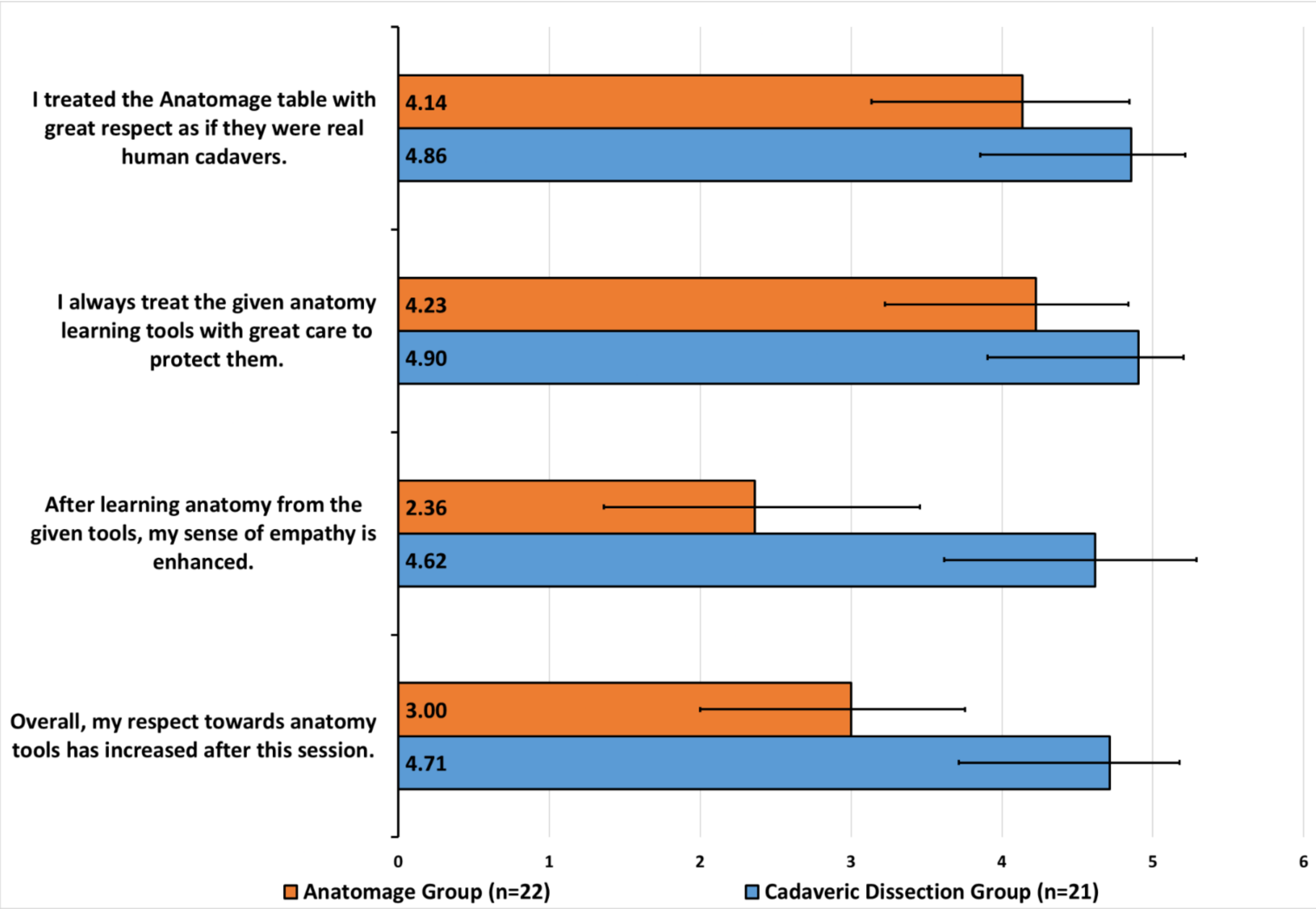
Humanistic Value

(Anatomy of the Brain)



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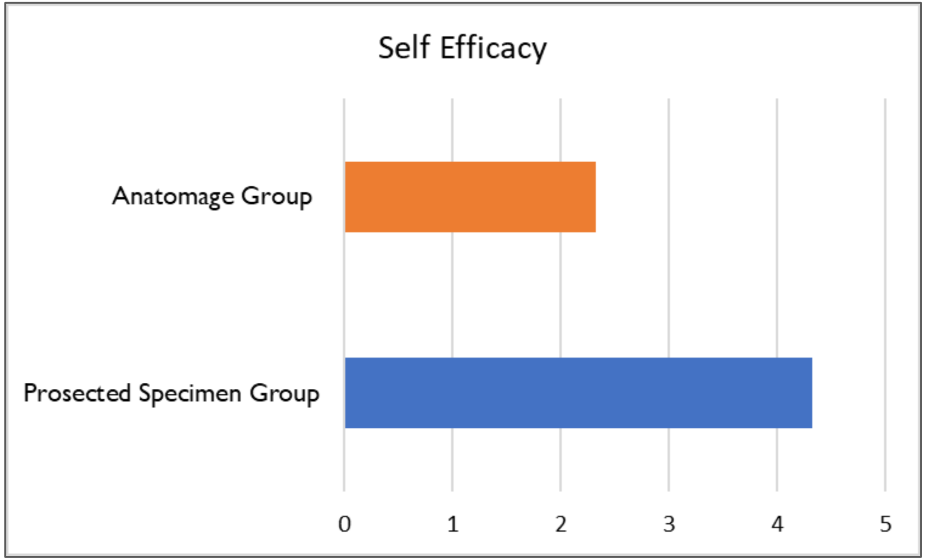
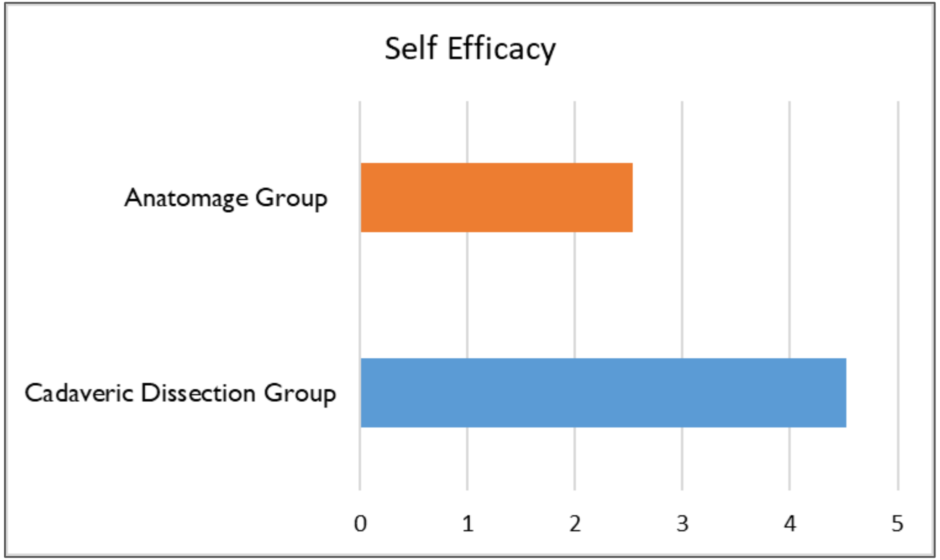
Self-Efficacy (Summary)



Anatomy of Pelvis & Perineum



Anatomy of the Brain

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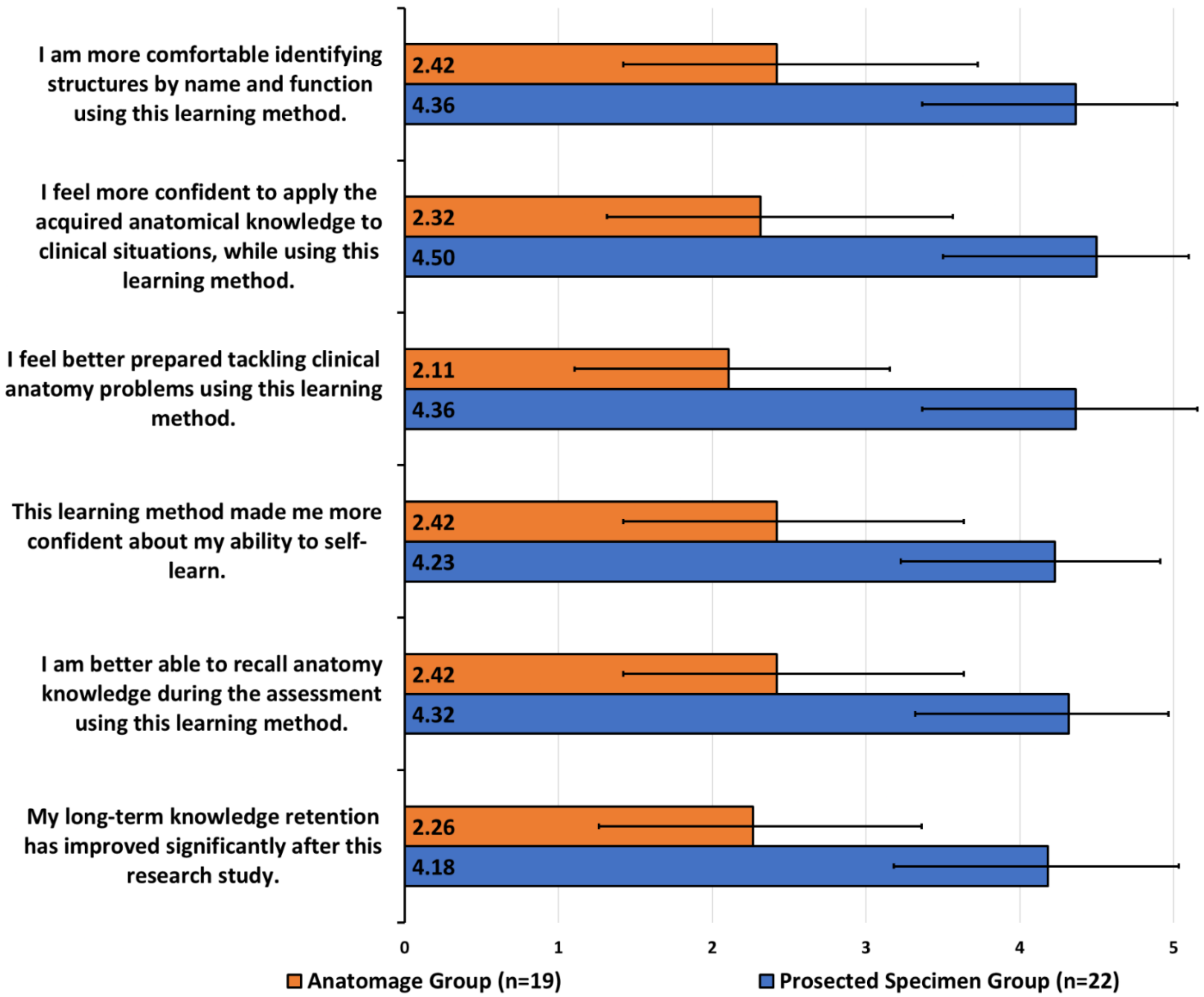
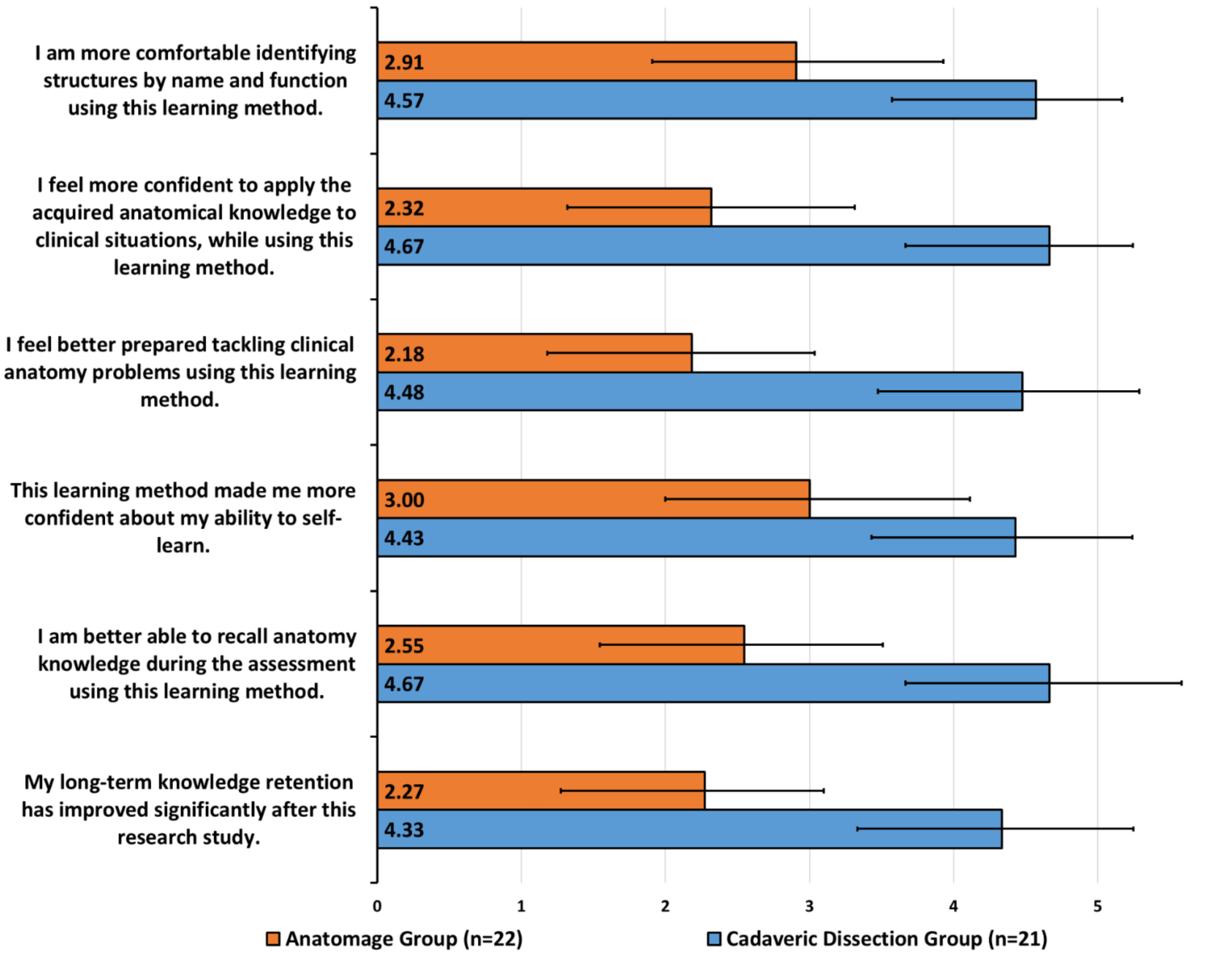
Self-Efficacy

(Anatomy of the Pelvis & Perineum)

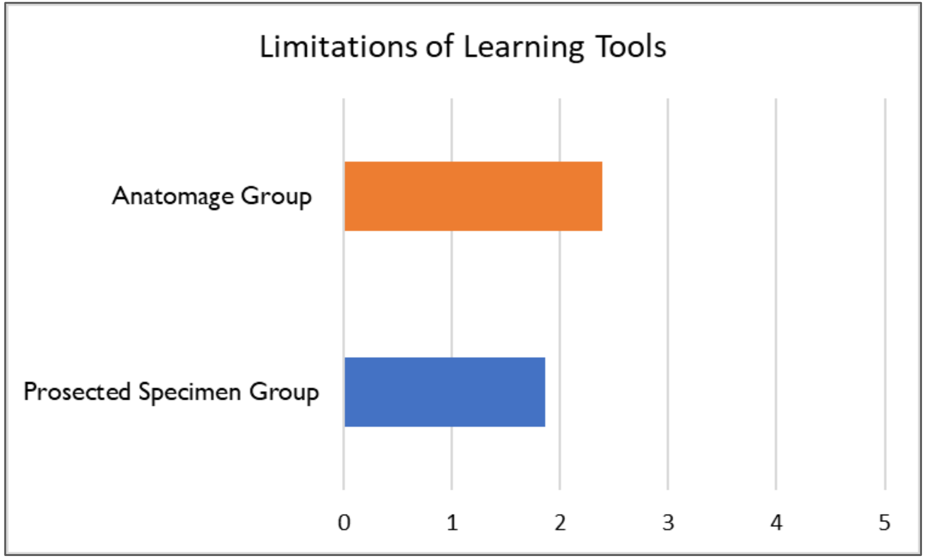


Self-Efficacy

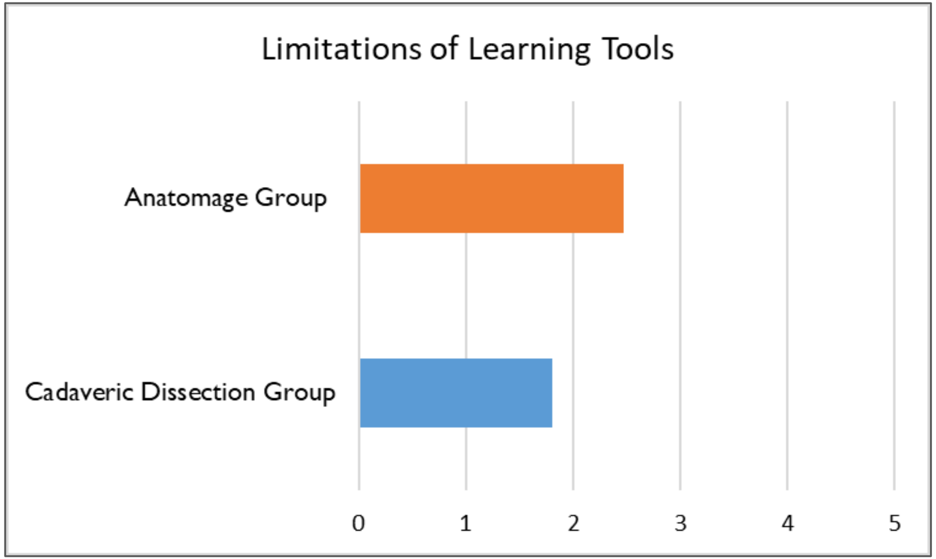
(Anatomy of the Brain)



Limitations of Learning Tools

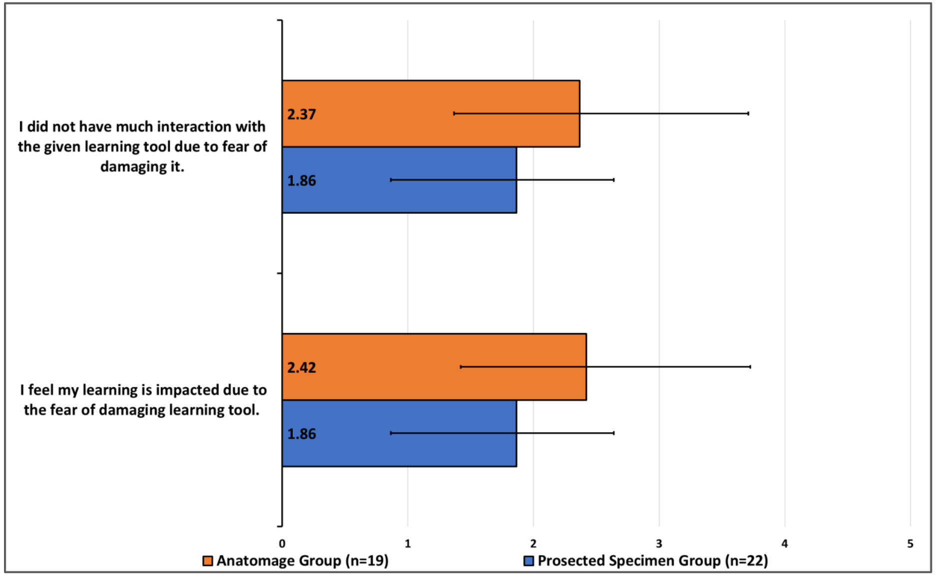


Anatomy of Pelvis & Perineum

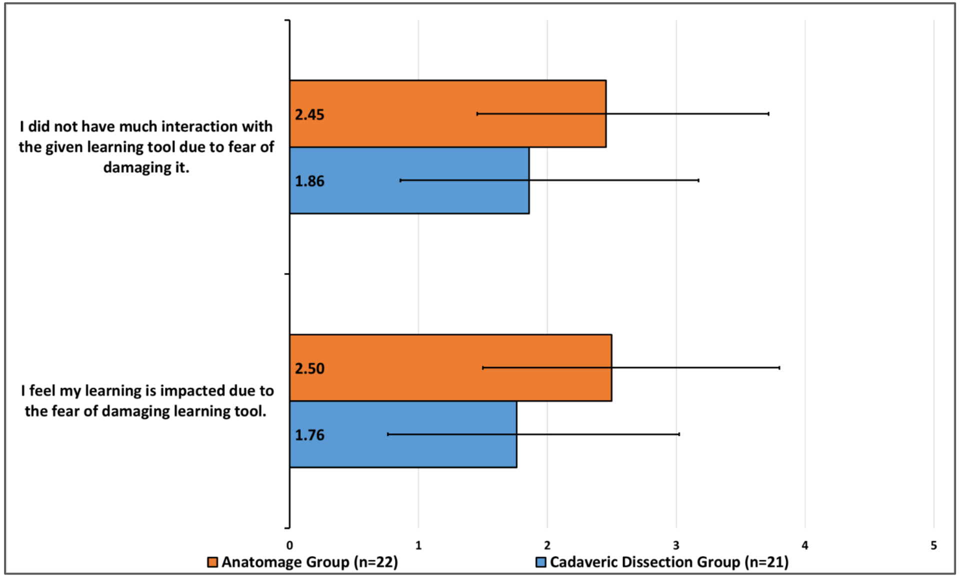


Anatomy of the Brain

Limitations of Learning Tools

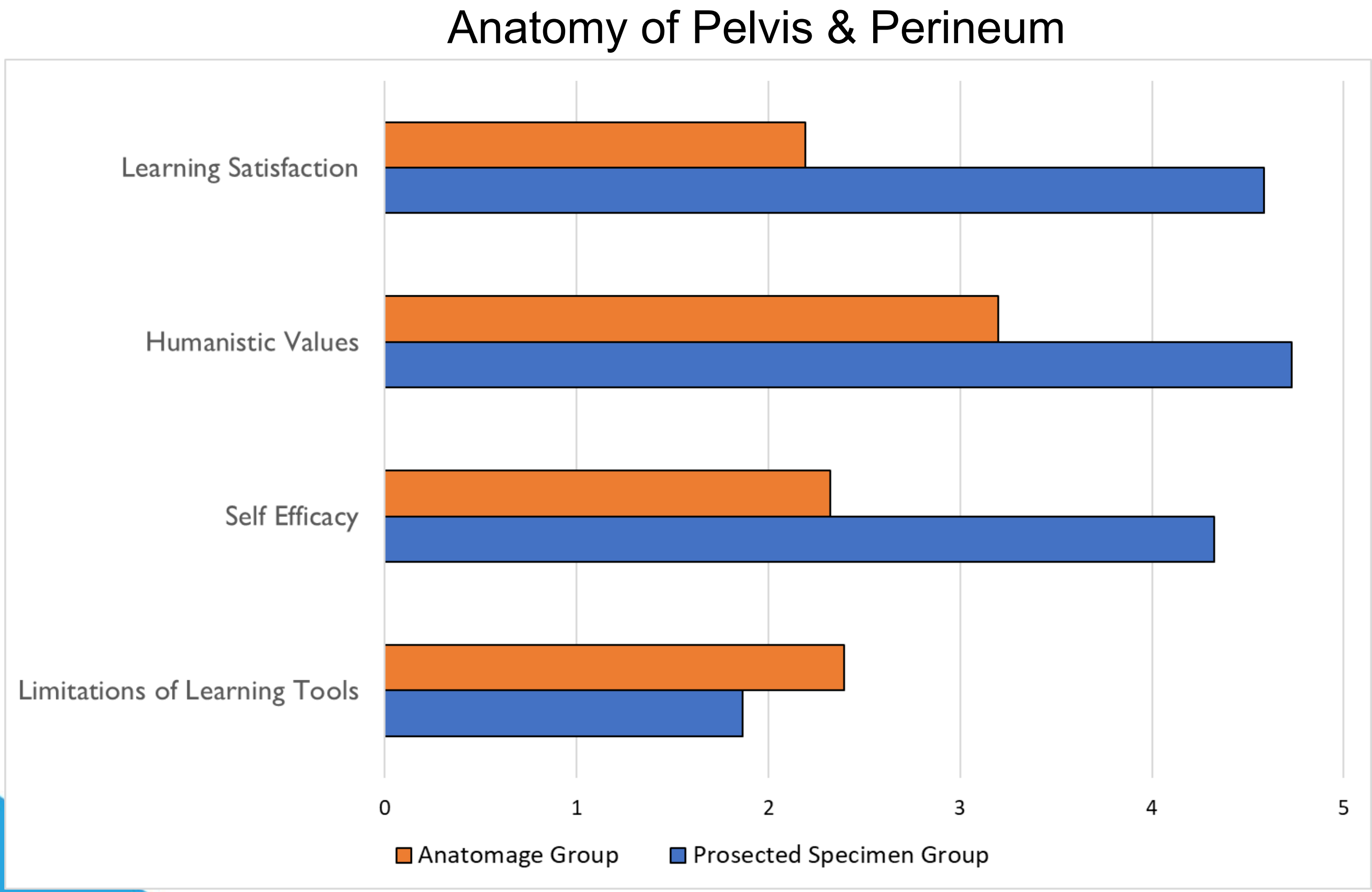


Anatomy of Pelvis & Perineum

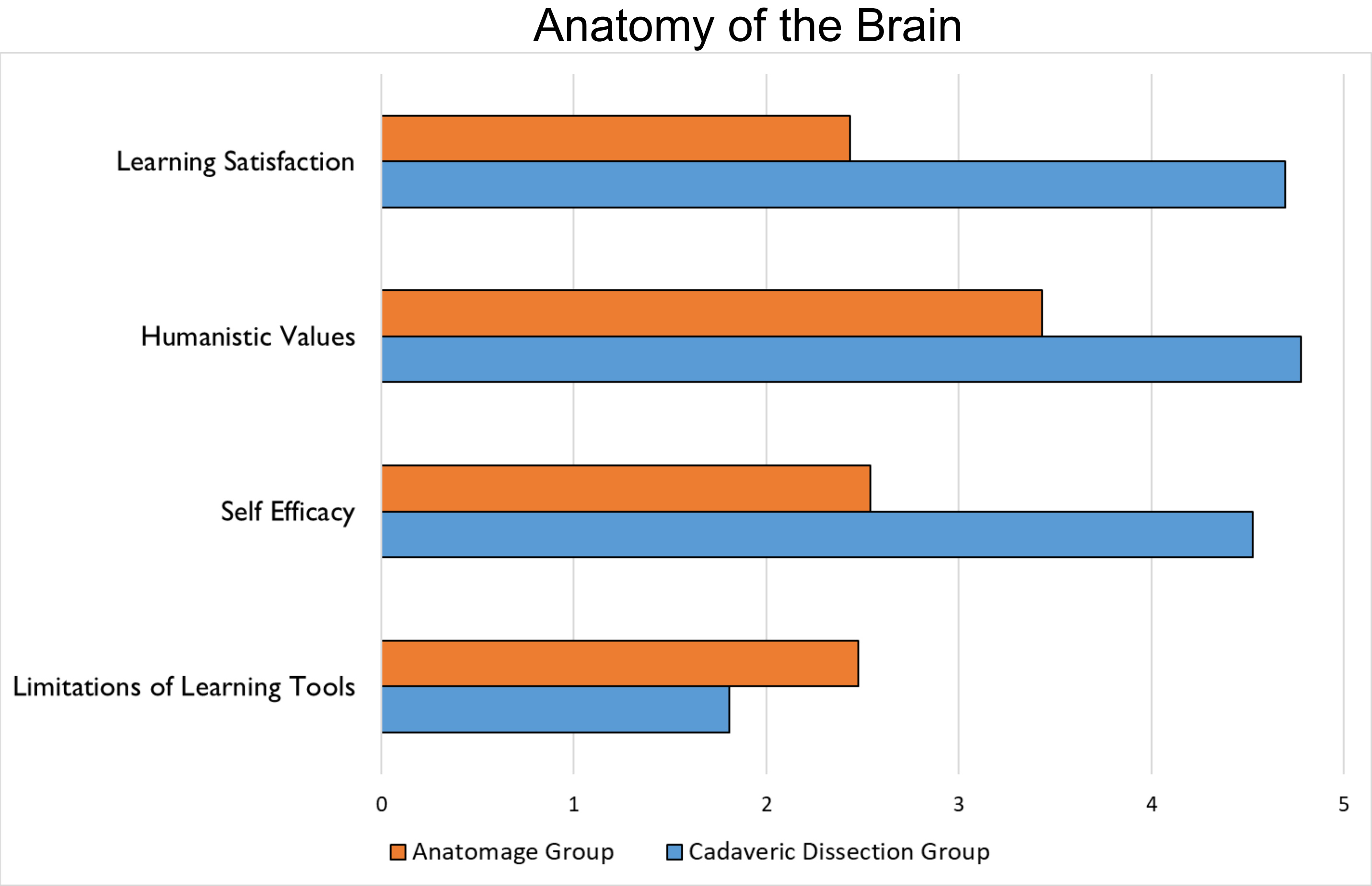


Anatomy of the Brain

Summary of Survey Results



Summary of Survey Results



Qualitative comments

Benefits of Anatomage Table	
	Number of supporting comments (%)
Encouraged individual autonomy	3 (7%)
Allowed for good visualization and identification of anatomical structures	16 (39%)
Beneficial for knowledge retention and enforcing previously acquired knowledge (supplementary tool for learning anatomy)	6 (15%)
Has multiple functions and pathologies in one system, promoting convenience	8 (20%)
Enables a more efficient use of available resources	1 (2%)
Interesting tool to learn anatomy	1 (2%)

Qualitative comments

Weaknesses of Anatomage Table	
	Number of supporting comments (%)
Limited number of students can use the Anatomage Table at any one time. Hinders teamwork between students	19 (46%)
It does not sufficiently and accurately portray real-life Anatomy	6 (15%)
The images on the Anatomage Table are of poor quality	14 (34%)
There were many technical difficulties while using the Anatomage Table	10 (24%)
Not user-friendly, more time was spent on learning how to operate the Anatomage Table than learning anatomy	18 (44%)
Not interesting to learn anatomy	4 (10%)
Students should have mastered basic anatomy knowledge in order to benefit from the use of the Anatomage Table	1 (2%)

Qualitative comments

Areas of Improvement	
	Number of supporting comments (%)
An improved interface with lesser technical glitches – less lagging and images of better quality	7 (17%)
More guidance on how to navigate the Anatomage Table	10 (24%)
Form smaller groups	10 (24%)
Anatomage Table as a supplementary and complementary resource for learning anatomy	13 (32%)

Qualitative comments

Cadaveric Dissection:

1. **Strength**

Allowed for good visualisation of anatomical structures- **12 (57%)**

2. **Weakness**

Challenging to identify certain anatomical structures that maybe less defined in appearanc
- **4 (19%)**

Prosected Specimens:

1. **Strength**

Allowed for good visualisation of anatomical structures- **15 (68%)**

2. **Weakness**

Challenging to identify certain anatomical structures that maybe less defined in appearance **5 (23%)**

Strengths of our Study

Brain dissection was not part of the formal year 1 medical school curriculum.

Study Design (Methodology) allows for **students to experience both virtual and traditional learning approaches**.

The **regions** selected were **challenging and complicated.**

Study **evaluated both Anatomage and traditional learning approaches**, allowing for direct comparison and analysis of student outcomes.

Limitations of our Study + Potential Future Work

A small sample size could have contributed to insignificant P values. Hence, a **larger number of students** with **no formal training in Anatomy** could be recruited

Other anatomical regions could be explored

Students could be **trained on how to operate the Anatomage Table** prior to its use

Specific questions to be asked to **explore how and when to better incorporate Anatomage** into the medical curriculum

Minimise possible **self selection bias**

Conclusion

With regard to objective outcomes, **students' performance** were **similar irrespective** of the **learning methods** and **study topics.**

Students had **higher positive opinions** for **traditional methods** compared to Anatomage Table.

Given these findings, **Anatomage** might **NOT** replace the traditional cadaveric dissection or prosection but it can be a **valuable supplement** to the existing methods to maximize teaching and learning of anatomy.

Acknowledgment

We would like to thank
the silent mentors (cadavers) and their families

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and the **students who participated and helped with designing and conducting the study**

Acknowledgement

Lin Mingwan

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THANK YOU

Learning satisfaction: How satisfied students are with this learning method: in terms of how interesting it is, whether it is useful?

Humanistic Value: These statements are assessing the values - in terms of empathy and respect evoked from the learning method.

Self Efficacy: These statements are assessing how effective the learning method is for the learning of anatomy - in terms of long-term knowledge retention, preparing them for future anatomy problems.

Limitations of Learning Tools: These statements are assessing the disadvantages of the learning methods - in terms of fear of damaging tools which hinders their learning.