NUS National University of Singapore | Department of Anatomy
Yong Loo Lin School of Medicine

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Enhancing Medical Education:
Virtual Dissection vs Cadaveric Dissection
An Evaluation of Student Performance and Perception

Dr. Satish R.L., Department of Anatomy, Yong Loo Lin School of Medicine, National University of Singapore

Lin Mingwan, Ang Eng Tat, Ti Lian Kah, Arthur CH Lau, Deepika K, Jayabharathi K, Chandrika M, Sara KR, Sreenivasulu RM, Sujashree YV, Sim Li Ean, Liu Pai, ST Dheen, George WC Yip.

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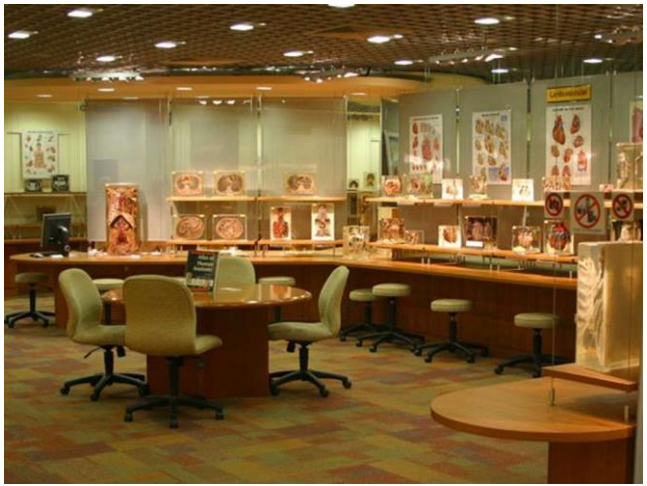
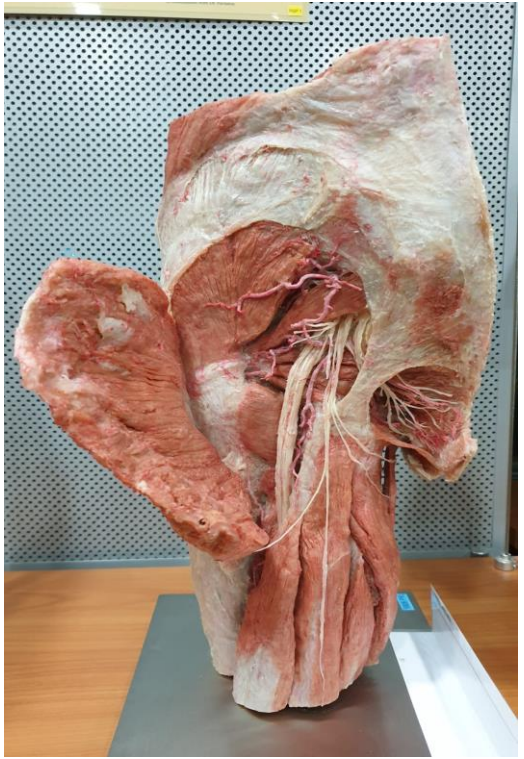
Traditional Methods of Teaching & Learning Anatomy

Cadaveric Dissection



Anatomy Museum



Plastinated Specimen

Newer Methods of Teaching & Learning Anatomy

It is a life-size virtual human body based on the cross-sectional images of human cadavers. A touch screen interactive device with accurate real anatomy.

The most technologically advanced anatomy visualization and virtual dissection equipment.

It has a virtual library of 3D human organs & anatomical regions constructed from CT & MRI scans of real patient data.

Anatomage Table

Studies involving Anatomage

A study conducted in University of Padova (2020) found that the **combination of virtual to traditional gross dissection** resulted in a **significant improvement of second-year medical students' learning outcomes**, and that it could be of help in overcoming the contraction of economic resources, and the shortage of available bodies. However, it had small sample size (n=30) and possible selection bias.

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 did not evaluate and compare the performance of students performing a virtual dissection vs a cadaveric dissection.

A study conducted in University of Michigan (2017) found that **students enjoyed using the anatomage table**, and the active engagement with digital human anatomy may **enhance students' learning**, particularly with regards to **visualizing anatomical relationships**. However, their study *did not evaluate and compare the performance of students*, and did not evaluate the use of Anatomage Table for learning other regions of the body.

Gap in Knowledge

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

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

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

Purpose

To compare **students' objective outcomes** of Pelvic & Neuro anatomy between cadaveric dissection, prosected specimens, and anatomage table.

To evaluate **students' perceptions** of learning human anatomy with these two teaching and learning tools in terms of perceived learning satisfaction, self-efficacy, humanistic values, and limitations of the study

Hypothesis

The students of virtual dissection (Anatomage) will perform better both in objective and subjective outcomes as compared to the cadaveric dissection

Improvement from other studies

Sample size: The total sample size is 63 students
This increase in sample size aims to enhance the reliability and statistical power of the study.

Conducting the study in 2 separate sessions: To alleviate overcrowding and ensure optimal learning conditions. Each session had 32 students, allowing for more focused interactions and engagement during the study.

Linking pre-test and post-test results: To establish clear connections between the intervention and learning outcomes, all pre-test and post-test results was linked using non-identifiable code. This enables a comprehensive analysis of individual students' progress, facilitating a deeper understanding of the impact of the intervention on their learning experience. This provided valuable insights into the students' perceptions and experiences.

Anatomical Region of Study

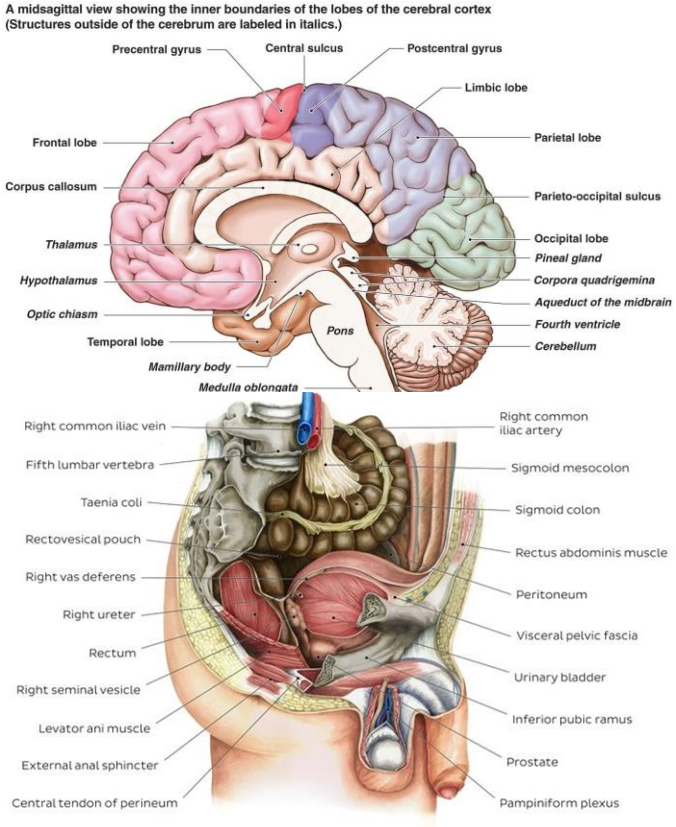
2 Deliberately Chosen Regions

- Gross Anatomy of the Pelvis & Perineum
- Gross Anatomy of the Brain

Why were these regions chosen?

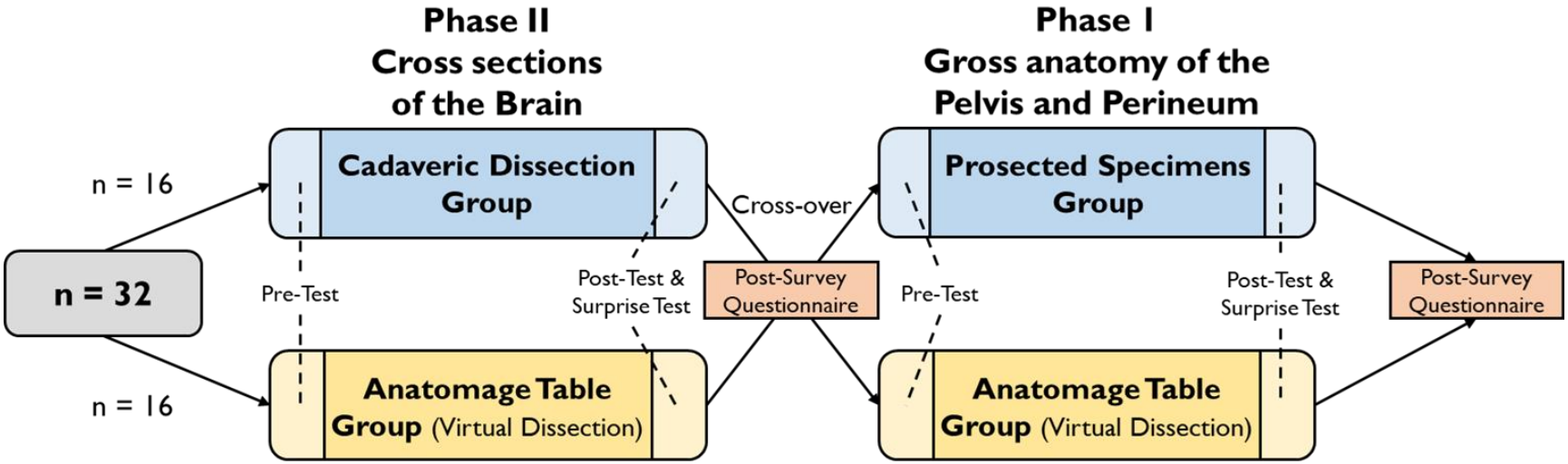
- **Challenging** and **Complicated**
- Requires **visuospatial understanding** for recognition and appreciation of anatomical relationships from a 3D perspective.

Study was separated and conducted in **2 phases** based on anatomical region



Methodology

***Study was conducted in 2 separate session**



Flow Diagram of the Overall Methodology on Actual Day

Timeline of the Study

A total of **63** Year-1 Medical Students

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	Phase I - Pelvis & Perineum Survey Questionaire
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	Phase II - Brain Anatomy Survey Questionaire

Pre-Test MCQ Questionnaire

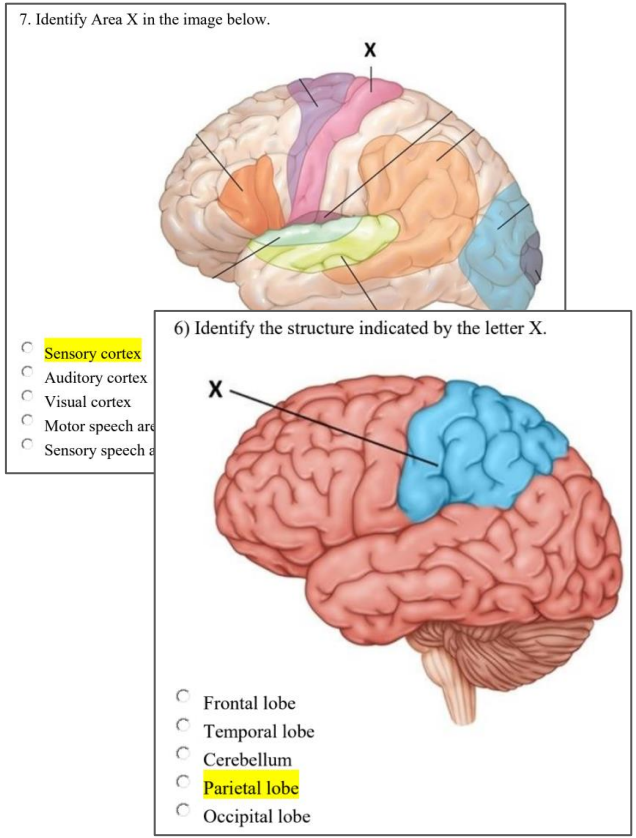
Pre-Test

- Conducted **before** the commencement of Practical Session
- 10 MCQs, 5 Options each, 10 Minutes
- Direct-recall Questions (Level 1 Bloom's Taxonomy)

Purpose

- Estimate the student's baseline knowledge of the anatomy of the pelvis and perineum and the anatomy of the brain (Neuroanatomy).

***No feedback and answers were provided to the students on their pretest performance.**



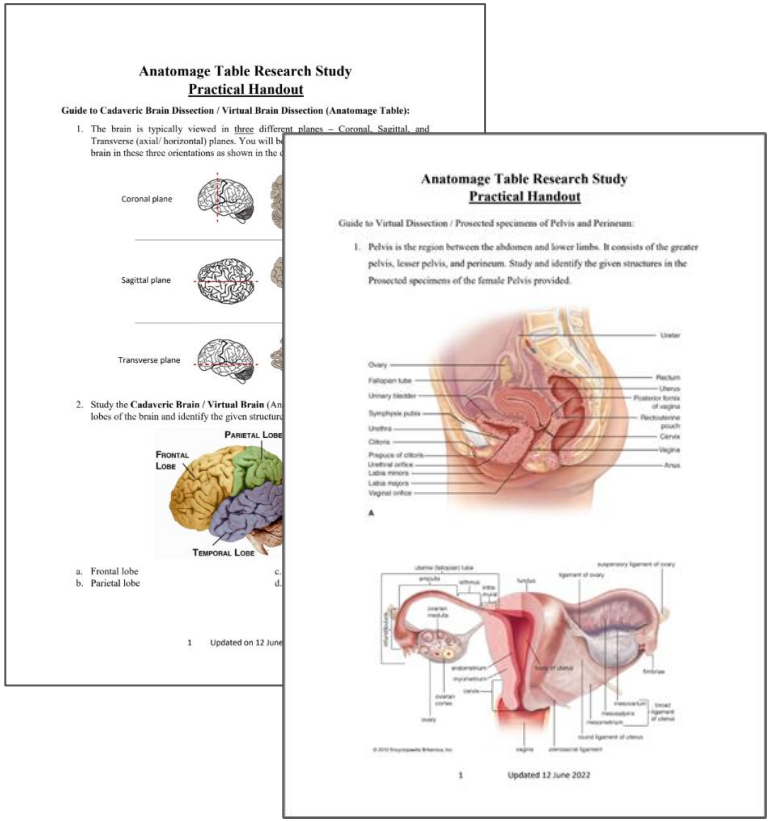
Practical Session + Self Learning

Practical Handouts

- Students were given practical handouts to guide their respective dissections
- Included details on what structures they could identify in the **Pelvis and Perineum** and **Brain**, with the related clinical relevance

Details:

- Total Duration of 1 hour



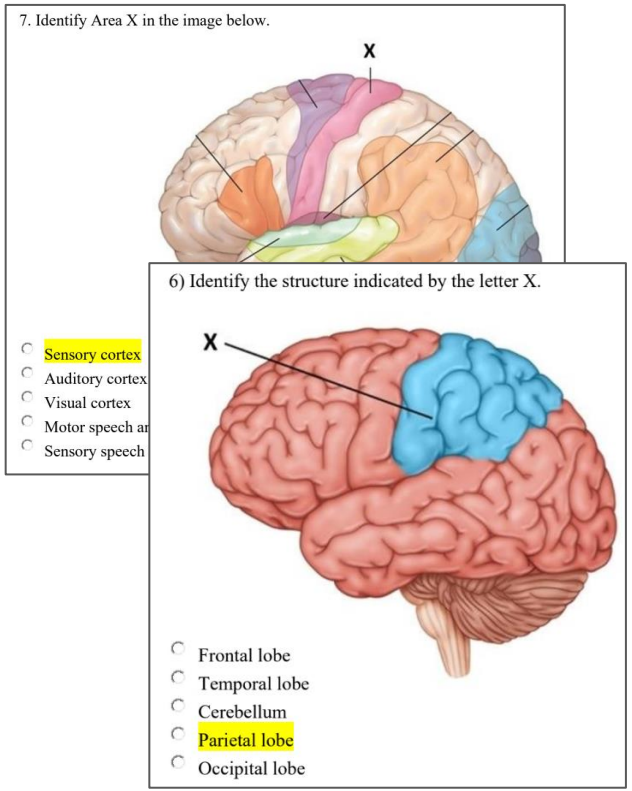
Post-Test MCQ Questionnaire

Post-Test
- Conducted **<u>after</u>** the self-learning practical session
- Total of 20 MCQ Questions, 5 Options each, 20 Minutes
- 20 MCQ Questions split into **2 Key Components**
  1) **10 Same Pre-Test MCQs**
     (Question & Options order reshuffled)
  2) **10 New Post-Test MCQs**

Purpose of "10 Same Questions"

- Evaluate if the students gained new anatomical knowledge following the practical session.

Purpose of Reshuffling Question Number & Options
To minimize rote memorization and recall bias

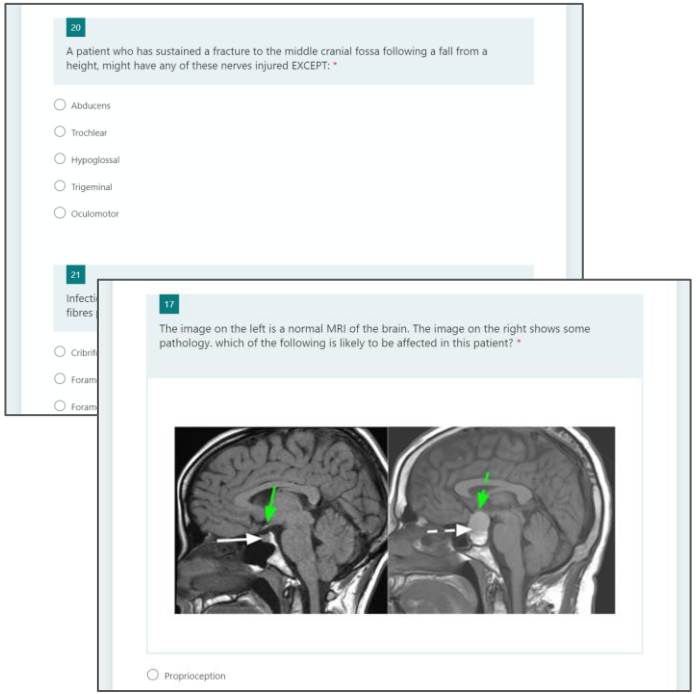


Post-Test MCQ Questionnaire (10 New Questions)

10 New Post-Test MCQs
- Application-based Questions (Level 3 Bloom's Taxonomy)
- Surprise Element as Student were not told about it

Purpose

To investigate if the **Anatomage Table** or **Traditional Methods** facilitated the application of anatomical knowledge beyond mere identification of structures.



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

Post-Study Survey Questionnaire

Online Form consisting of **2 Components**

A. 5-Point Likert Scale
(1=strongly disagree, 5=strongly agree)
- Total of 20 Questions, Comprising of 4 Sections
1. Learning Satisfaction
2. Humanistic Values
3. Self-efficacy
4. Limitations of Study

B. Free-Text Comments
- Total of 2 Questions
1. Strength & Weakness of Learning Approach
2. Area of Improvements/ Suggestions

The survey instrument was adapted from Chandrasekaran, R., Radzi, S., Kai, P. Z., Rajalingam, P., Rotgans, J., & Mogali, S. R. (2021). A validated survey instrument measuring students' perceptions on plastinated and three-dimensional printed anatomy tools. ASE Reference.

Data Collection → Data Analysis

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

Univariate Analysis

B. Pre-Test, Post-Test

- Pre-test score
- Post-test score (10 Same Questions)
- Post-test score (10 New Questions)

Bivariate Analysis

1. Test results by dissection groups
2. Test results by anatomical region

C. Survey:

- Likert scale
- Free-text comments

1. **Univariate Analysis -** Likert Scale
2. **Thematic Analysis** - Comments

Demographics

2023 Study (Overall)

Total Participants: 63 Students
Group A: 34 Students
Group B: 29 Students

Session 1 (22 May 2023)

Participant Information:
Total Participants: 32
Group A: 18 Students
Group B: 14 Students

Gender Distribution:
Female: 12 participants
Male: 20 participants

Session 2 (12 June 2023)

Participant Information:
Total Participants: 31
Group A: 16 Students
Group B: 15 Students

Gender Distribution:
Female: 15 participants
Male: 16 participants

RESULTS

(PRE-TEST & POST-TEST PERFORMANCE)

Comparison of Pre-Test and Post-Test (First 10 Questions) between Groups

Phase I - Anatomy of Pelvis & Perineum

Phase I - Anatomy of the Pelvis & Perineum						
	Pre Test		Post Test (10 Same Question)		Student's t test	Cohen's d
Group	*M*	*SD*	*M*	*SD*	p value	
Anatomage Table (n=28)	75.4%	±18.5%	82.2%	±18.2%	0.152	0.374
Prosected Specimen (n=33)	78.5%	±13.6%	82.2%	±11.4%	0.235	0.297

Phase II - Anatomy of the Brain

Phase II - Anatomy of the Brain						
	Pre Test		Post Test (10 Same Question)		Student's t test	Cohen's d
Group	*M*	*SD*	*M*	*SD*	p value	
Anatomage Table (n=32)	76.3%	±12.9%	82.8%	±11.4%	0.035	0.537
Cadaveric Dissection (n=29)	79.3%	±13.3%	82.1%	±10.5%	0.385	0.229

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Mean score & SD: There is an improvement, and students performed better in Post-Test than in Pre-Test in both Groups. However, SD in ***Prosected Specimen Group*** is smaller as compared to SD in ***Anatomage Table Group***

Student's t test: When 2-sample t-test with 5% level of significance was conducted, p-value suggests that the improvement in score in both groups are not statistically significant.

Cohen's d: Larger effect size for ***Anatomage Group*** as compared to ***Prosected Specimen Group.***

Comparison of Pre-Test and Post-Test (First 10 Questions) between Groups

Phase II - Anatomy of the Brain

Phase II - Anatomy of the Brain						
	Pre Test		Post Test (10 Same Question)		Student's t test	Cohen's d
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Mean score & SD: There is also an improvement, and students performed better in Post-Test than in Pre-Test in both Groups. SD in ***Cadaveric Dissection Group*** and ***Anatomage Table Group*** is very similar

Student's t test: When 2-sample t-test with 5% level of significance was conducted, p-value suggests that only the improvement in score in ***Anatomage Table Group*** was statistically significant.

Cohen's d: Larger effect size for ***Anatomage Group*** as compared to ***Cadaveric Dissection Group.***

Comparison of Test Performance between Groups

Phase I - Anatomy of Pelvis & Perineum

Phase I - Anatomy of the Pelvis & Perineum

	Anatomage Table Group (n=28)		Prosected Specimen Group (n=33)		Student's t test p value	Cohen's d
	M	*SD*	*M*	*SD*		
Pre-Test	75.4%	±18.5%	78.5%	±13.6%	0.801	0.192
Post-Test (10 Same Question)	82.2%	±18.2%	82.2%	±11.4%	0.555	0.005
Post-Test (10 New Question)	56.2%	±17.0%	55.2%	±17.7%	0.656	0.062

Phase II - Anatomy of the Brain

Phase II - Anatomy of the Brain

	Anatomage Table Group (n=32)		Cadaveric Dissection Group (n=29)		Student's t test p value	Cohen's d
	M	*SD*	*M*	*SD*		
Pre-Test	76.3%	±12.9%	79.3%	±13.3%	0.367	0.233
Post-Test (10 Same Question)	82.8%	±11.4%	82.1%	±10.5%	0.792	0.068
Post-Test (10 New Question)	70.3%	±13.1%	76.2%	±13.2%	0.085	0.449

Comparison of Test Performance between Groups

Phase I - Anatomy of Pelvis & Perineum

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2-sample t-test with 5% Level of significance was conducted between the two groups for all 3 test → There is no significant differences in all the test scores between Anatomage and Prosected Specimen groups

Cohen's d was conducted on the 2 group scores, and all value were smaller than 0.2, suggesting a small effect size → Even though differences in scores between the 2 groups is not statistically significant, Prosected Specimen group scored higher in **Pre-Test**, but Lower in **Post-Test (10 New Questions)** Both group have the same mean for the **Post-Test (10 Same Questions)**

Comparison of Test Performance between Groups

Phase II - Anatomy of the Brain

Phase II - Anatomy of the Brain	Anatomage Table Group (n=32)		Cadaveric Dissection Group (n=29)		Student's t test p value	Cohen's d
	M	*SD*	*M*	*SD*		
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2-sample t-test with 5% Level of significance was conducted between the two groups for all 3 test → There is no significant differences in all the test scores between Anatomage and Cadaveric Dissection groups

Cohen's d was conducted on the 2 group scores.

The effect size for the **Pre-Test** and **Post-Test (10 Same Questions)** is small, and the effect size for the **Post Test (10 New Questions**) is Medium →

Even though differences in scores between the 2 groups is not statistically significant, Cadaveric Dissection group scored higher in **Pre-Test** and **Post-Test (10 New Questions).**

Anatomage Group score slightly higher, with a higher mean in the **Post-Test (10 Same Questions)**

Additional Finding: Comparison of Post-Test (New) between Phases

Phase I - Anatomy of Pelvis & Perineum

Phase I - Anatomy of the Pelvis & Perineum

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Phase II - Anatomy of the Brain

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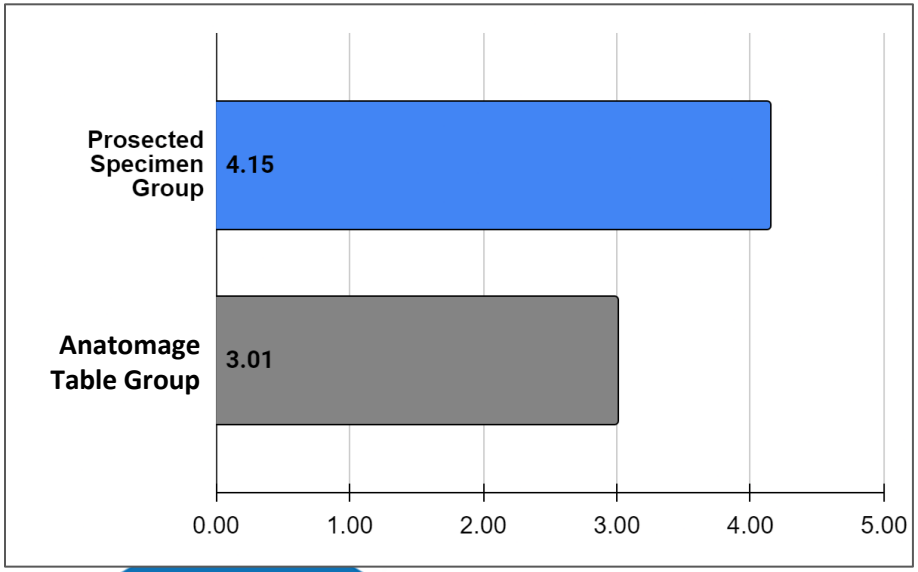
RESULTS

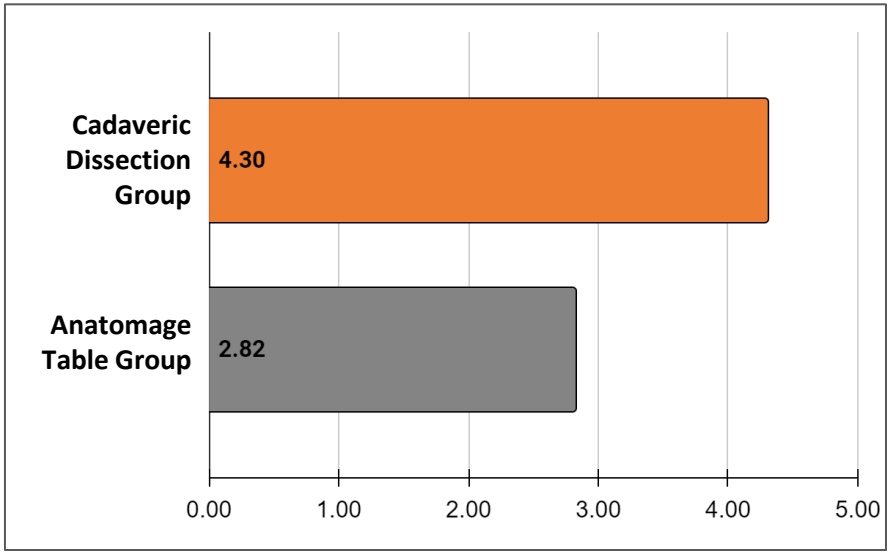
(SURVEY QUESTIONNAIRE) LIKERT SCALE ANALYSIS

Learning Satisfaction - Survey Analysis (Likert Scale)

Phase I - Anatomy of Pelvis & Perineum

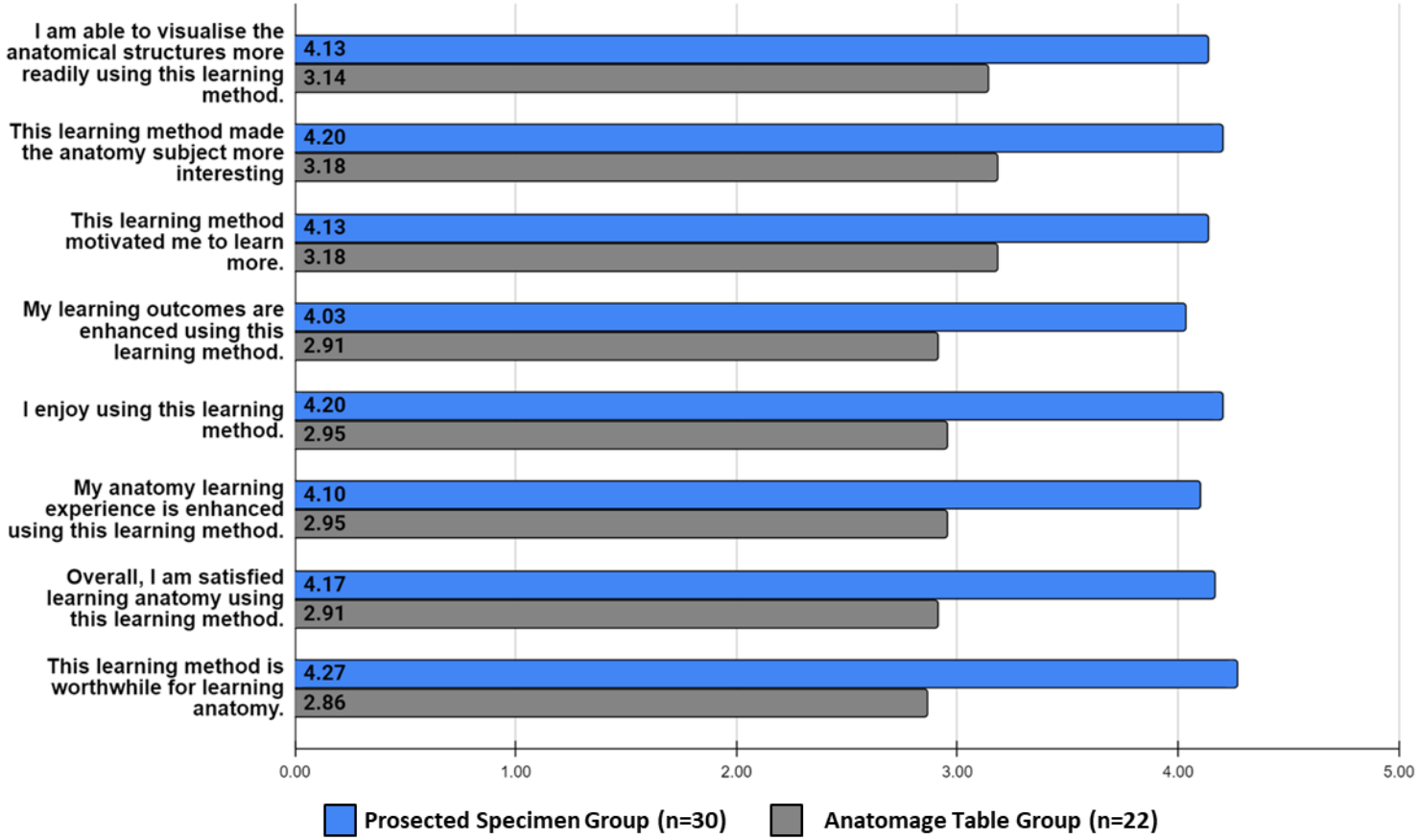


Phase II - Anatomy of the Brain



Learning Satisfaction

Phase I - Anatomy of Pelvis & Perineum



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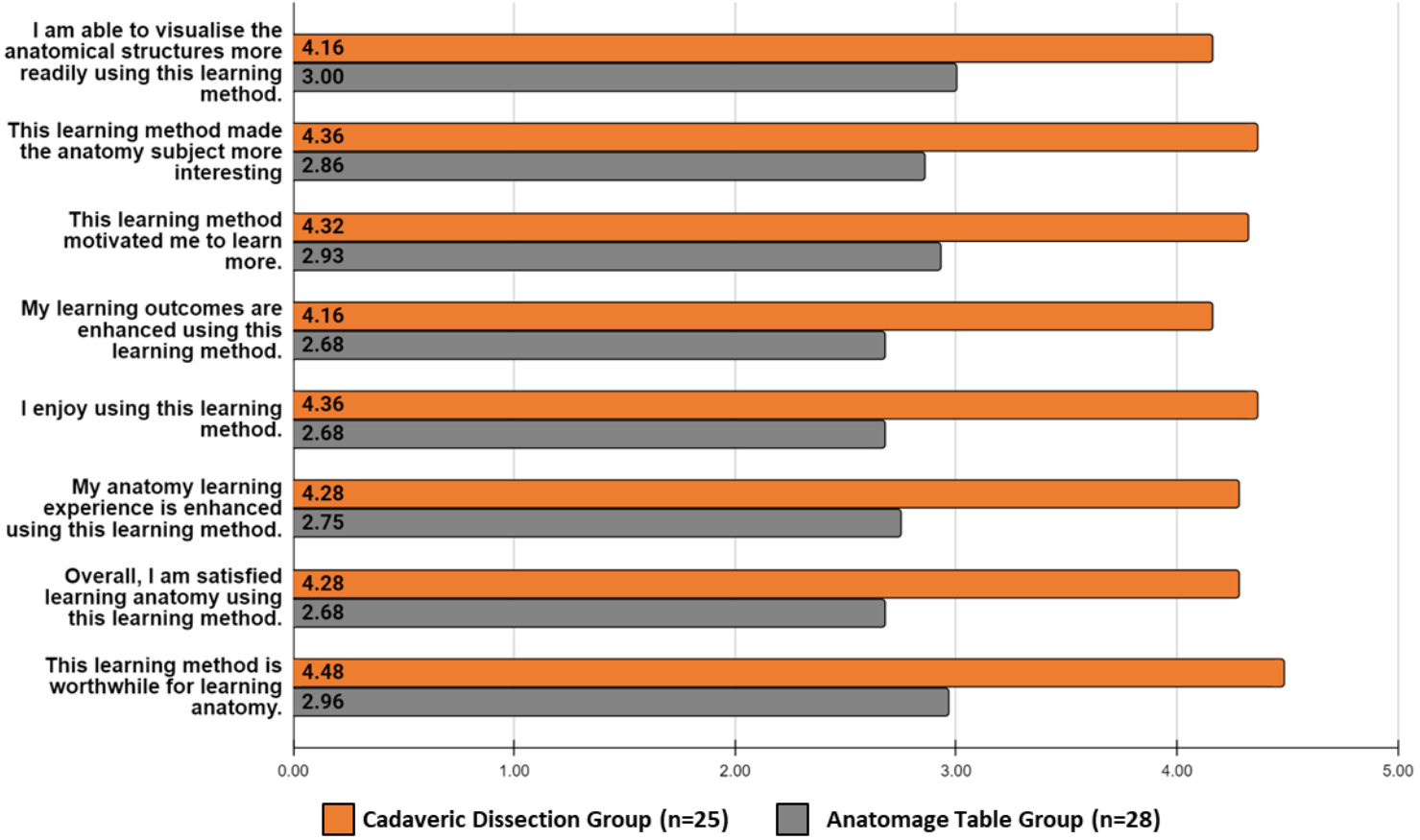
Learning Satisfaction

Phase II - Anatomy of the Brain



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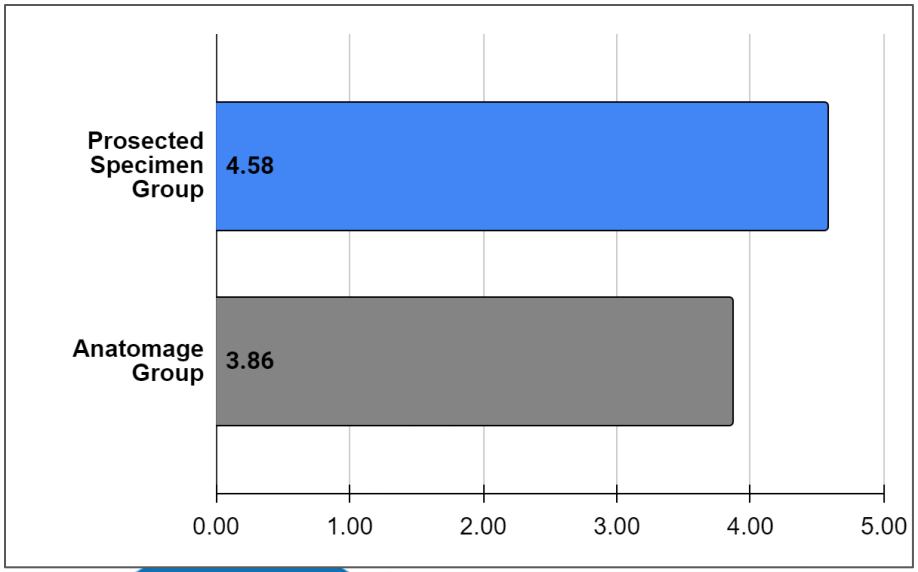
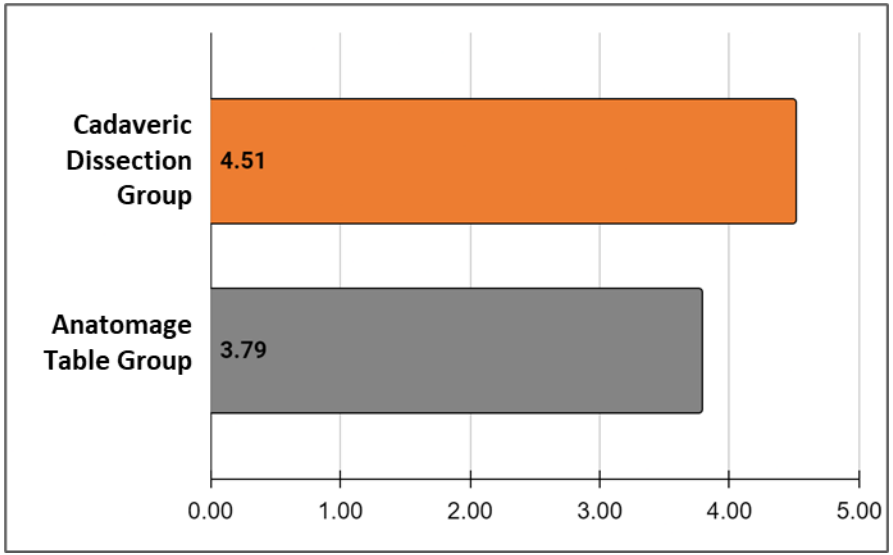
Humanistic Values - Survey Analysis (Likert Scale)

Phase I - Anatomy of Pelvis & Perineum

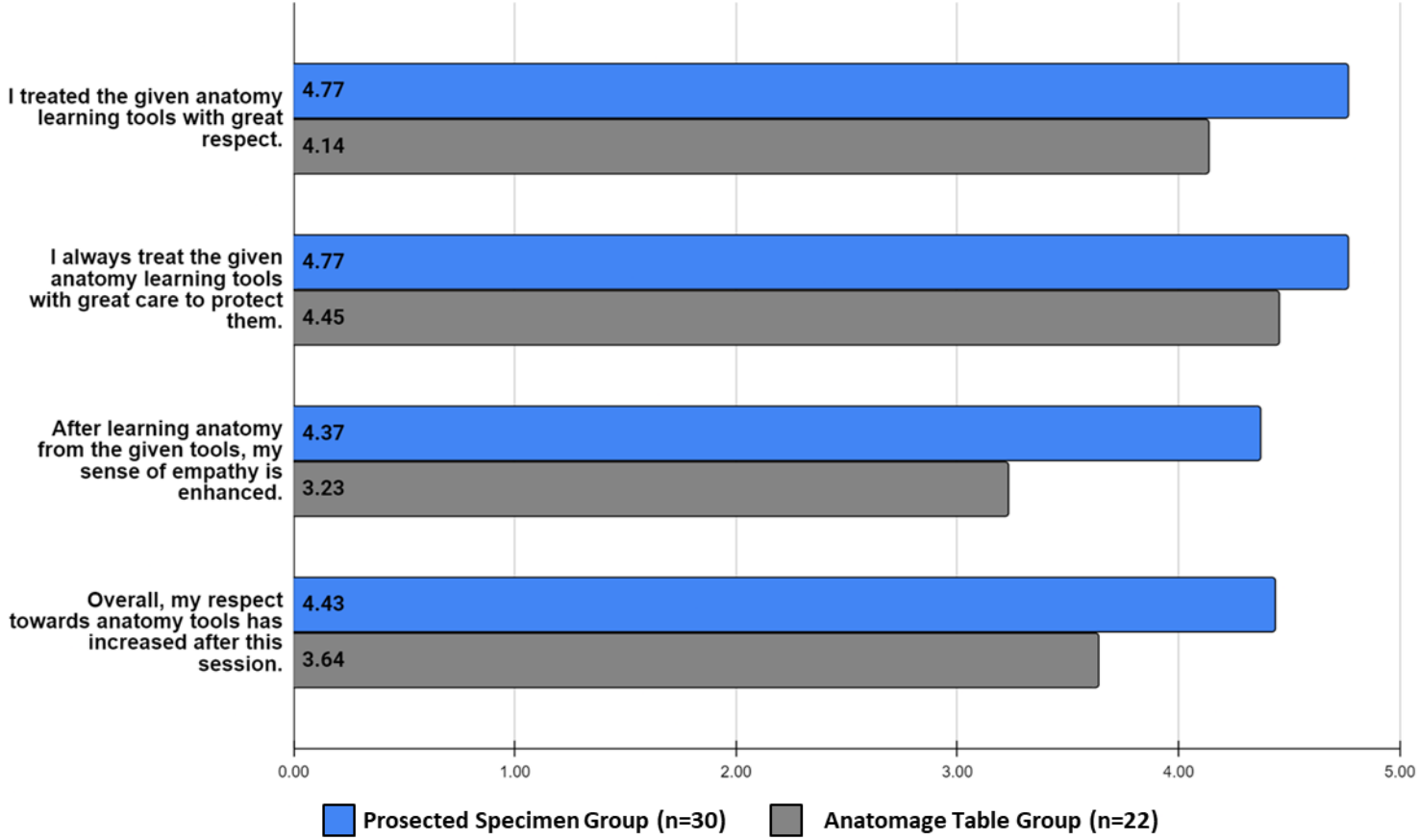


Phase II - Anatomy of the Brain



Humanistic Values

Phase I - Anatomy of Pelvis & Perineum



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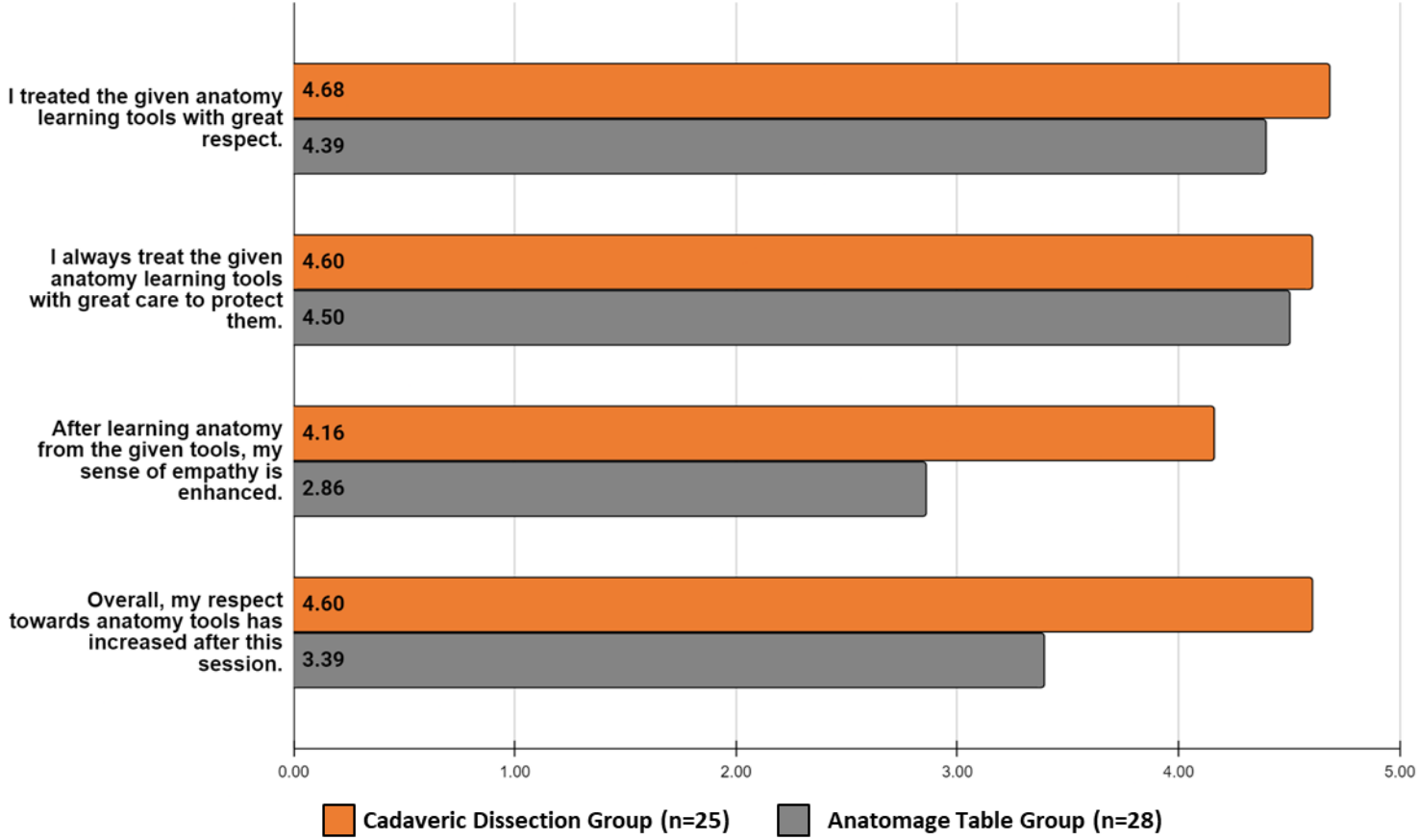
Humanistic Values

Phase II - Anatomy of the Brain



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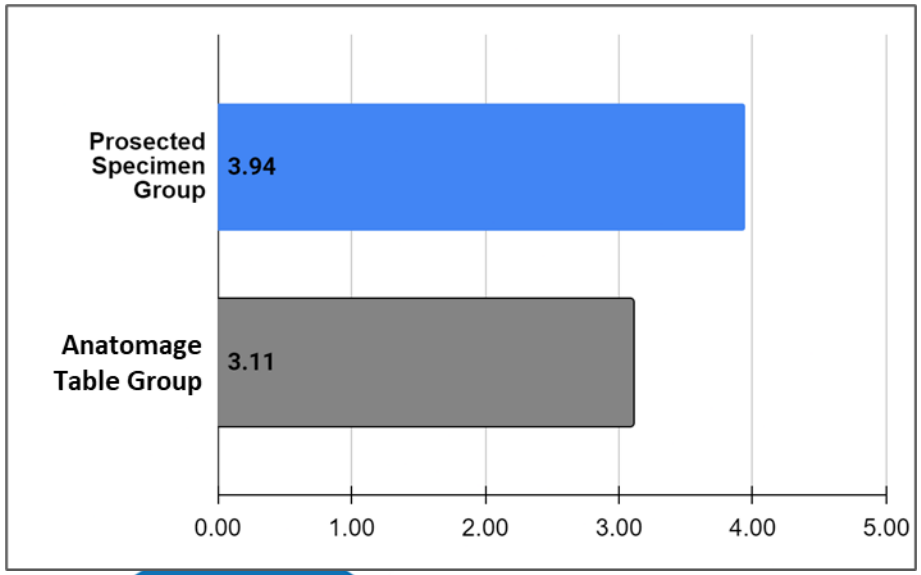
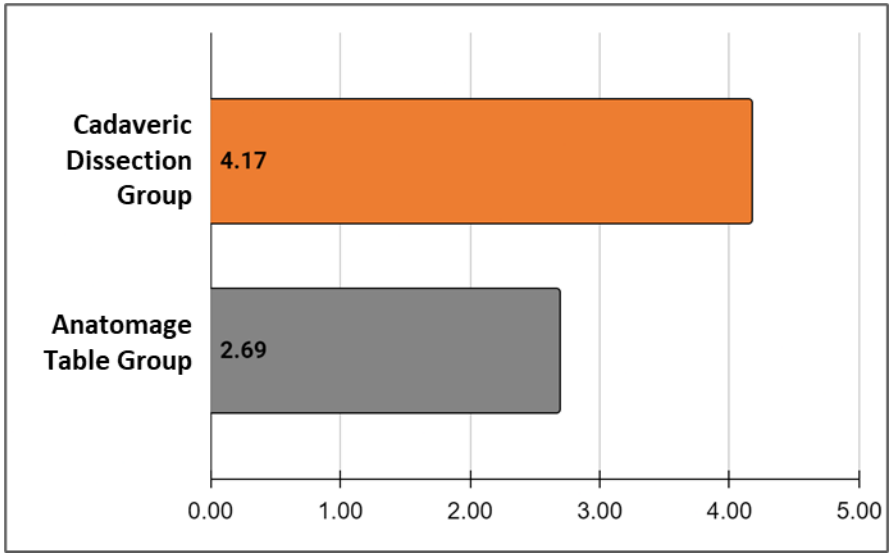
Self Efficacy - Survey Analysis (Likert Scale)

Phase I - Anatomy of Pelvis & Perineum

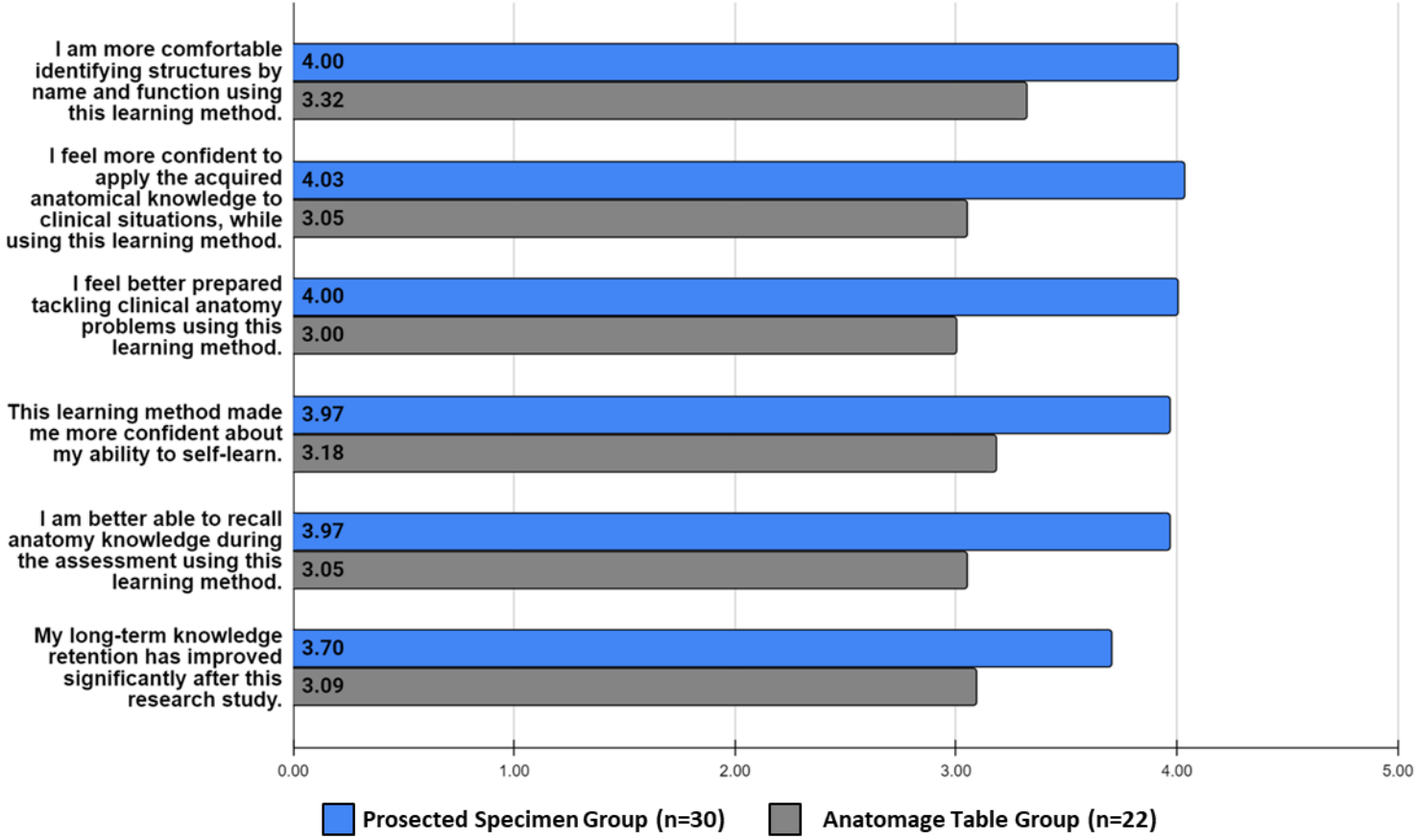


Phase II - Anatomy of the Brain



Self Efficacy

Phase I - Anatomy of Pelvis & Perineum



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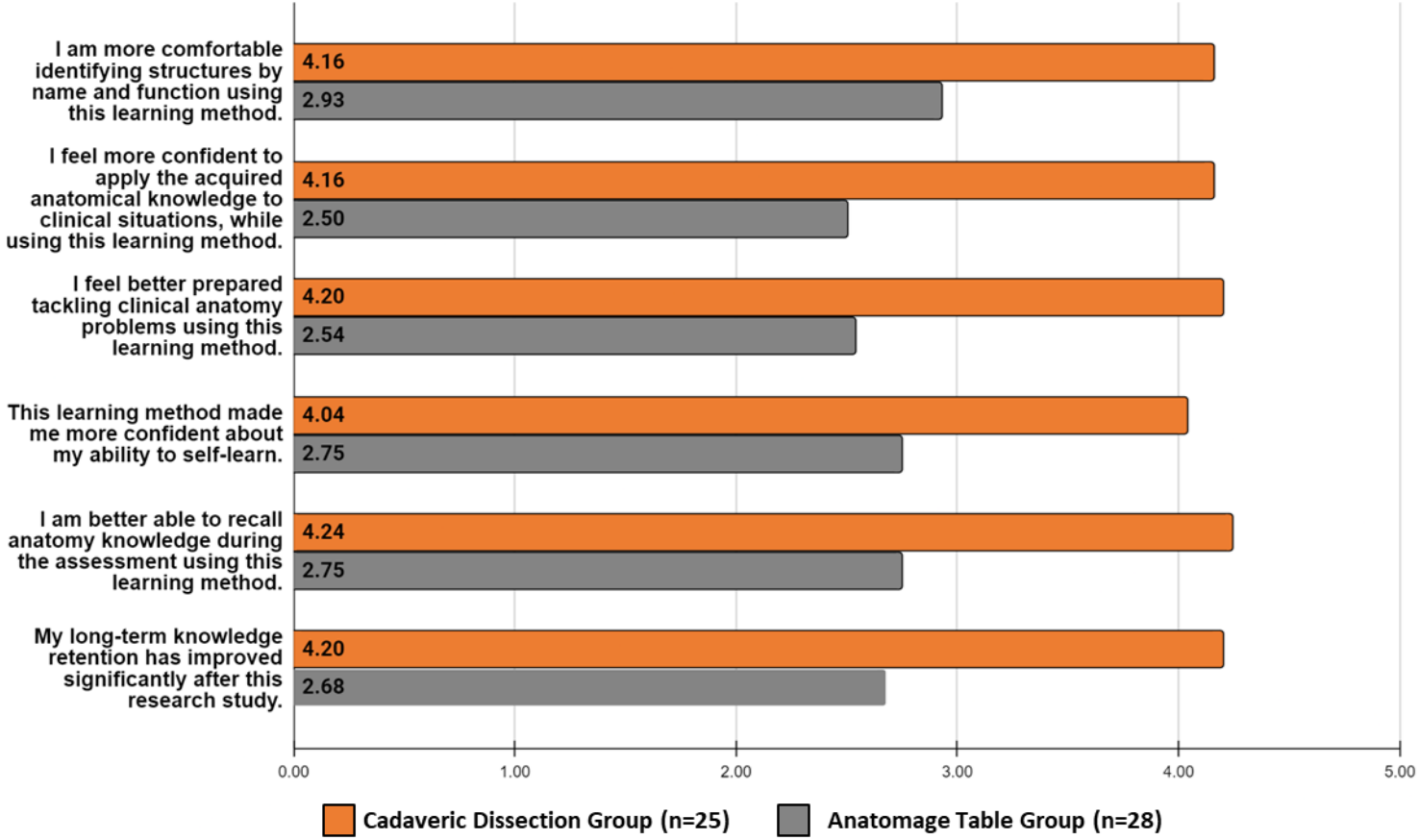
Self-Efficacy

Phase II - Anatomy of the Brain



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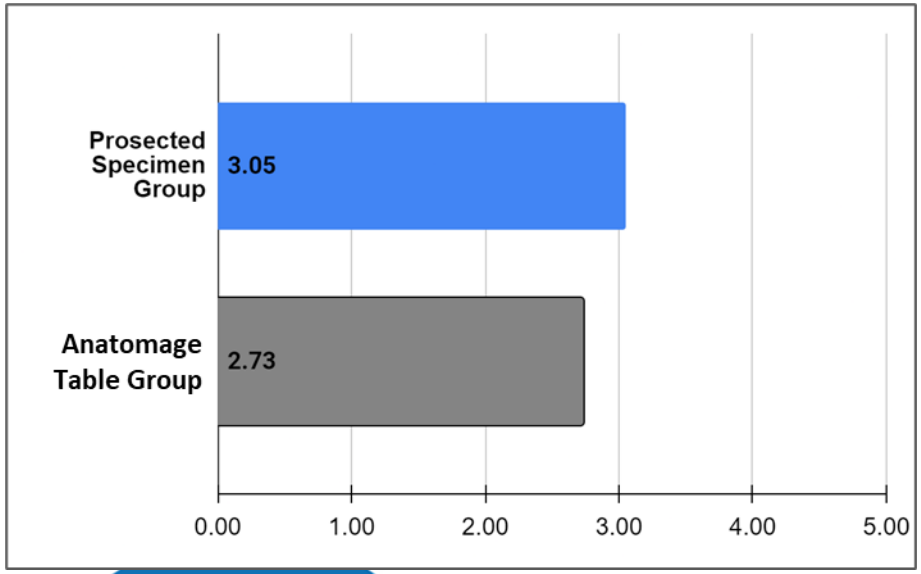
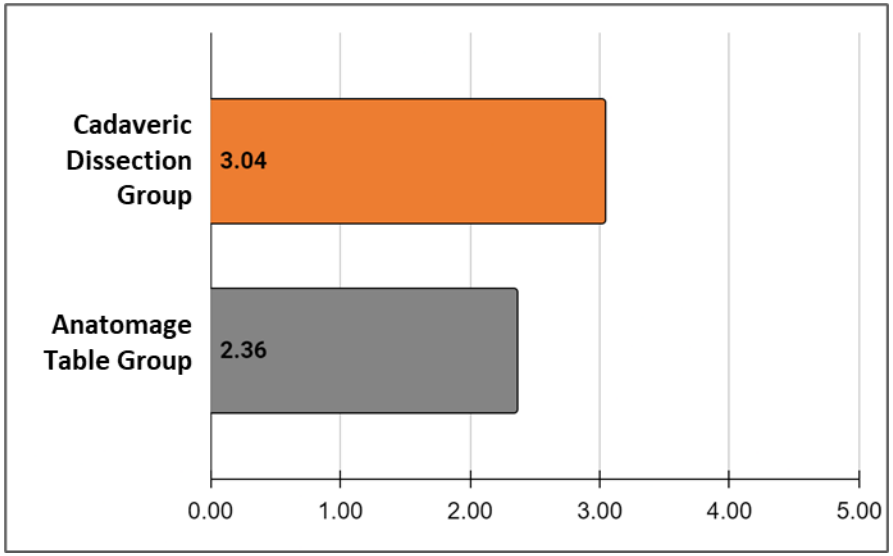
Limitations of Study - Survey Analysis (Likert Scale)

Phase I - Anatomy of Pelvis & Perineum

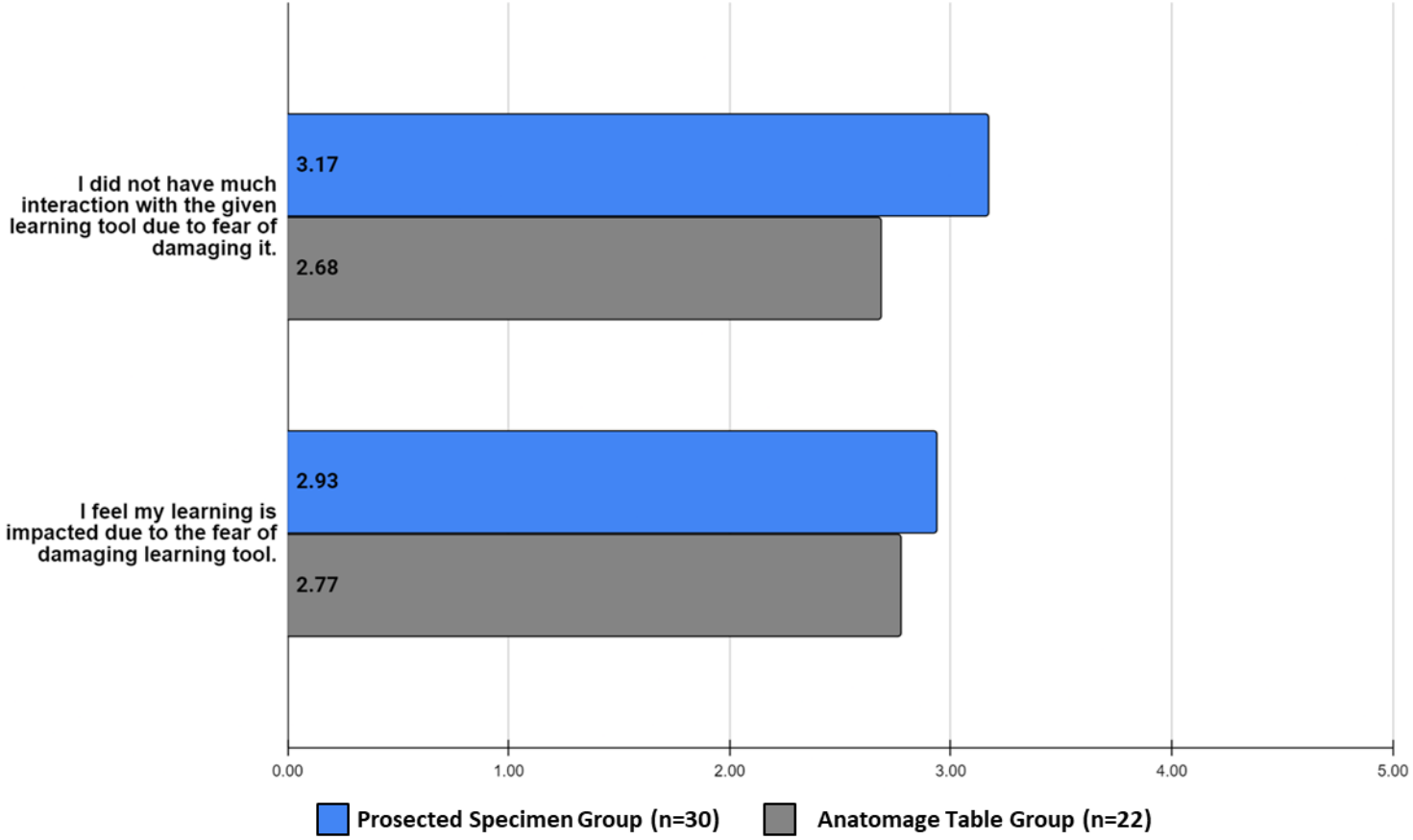


Phase II - Anatomy of the Brain



Limitations of Study

Phase I - Anatomy of Pelvis & Perineum



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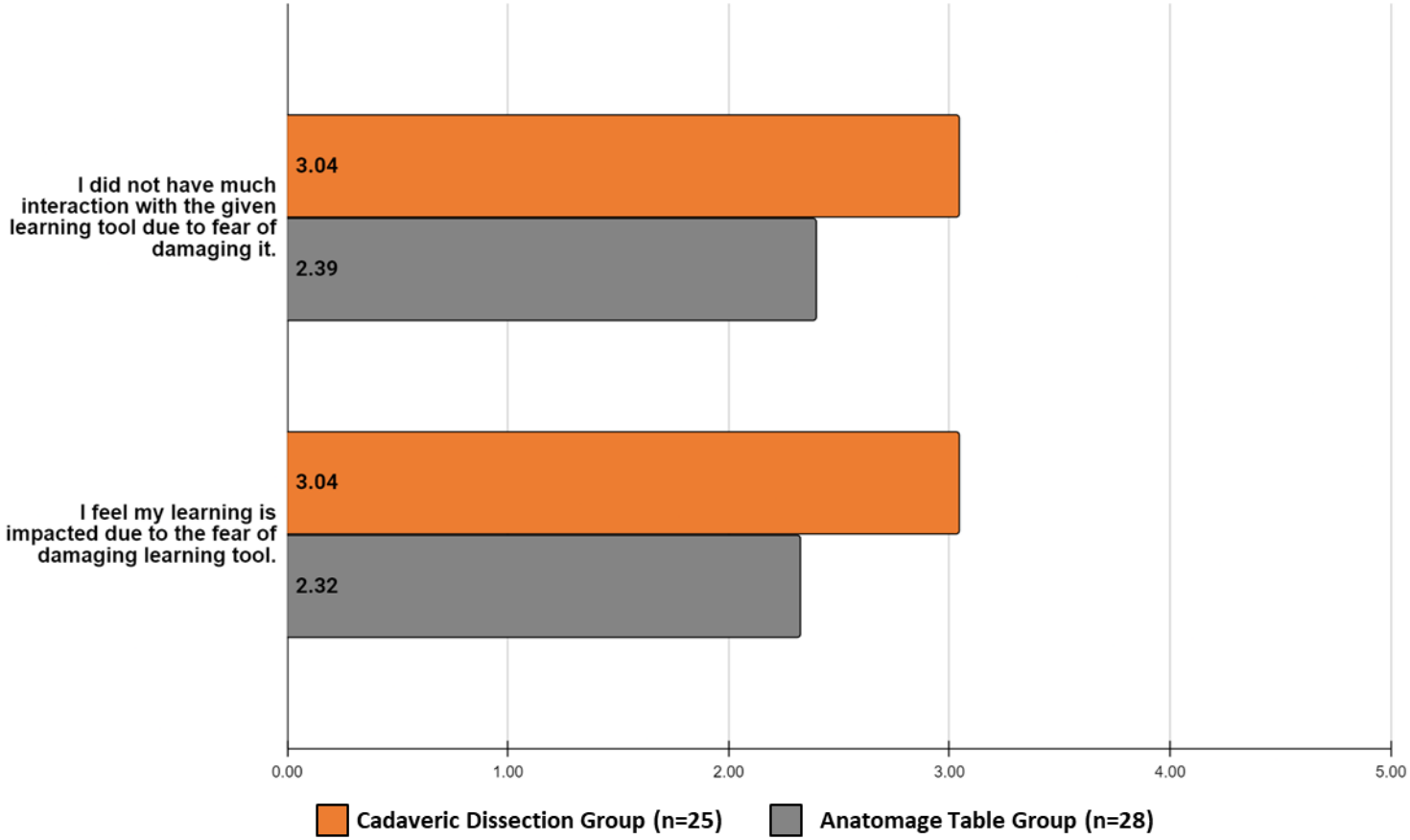
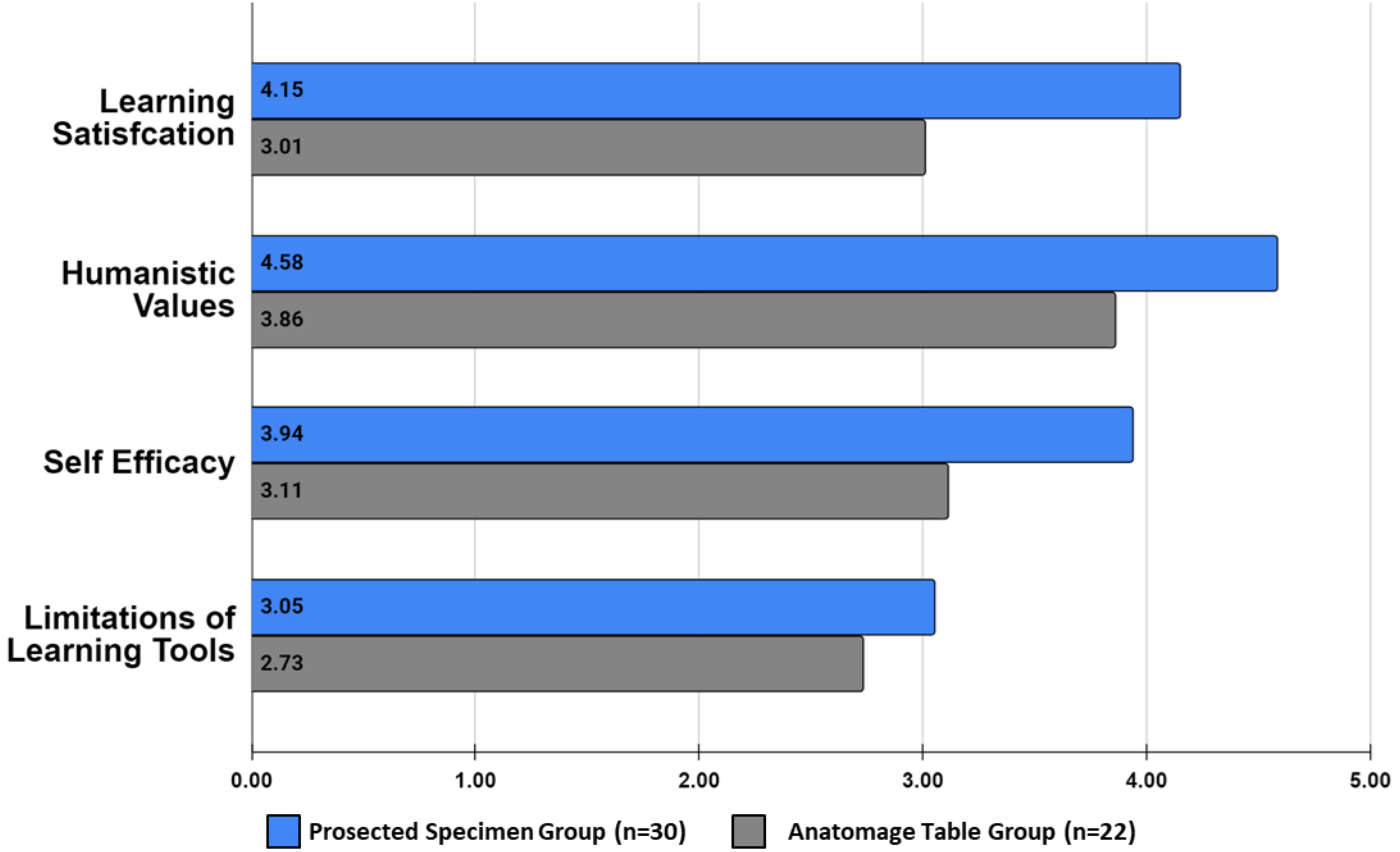
Limitations of Study

Phase II - Anatomy of the Brain



Summary of Survey Results (Phase I)



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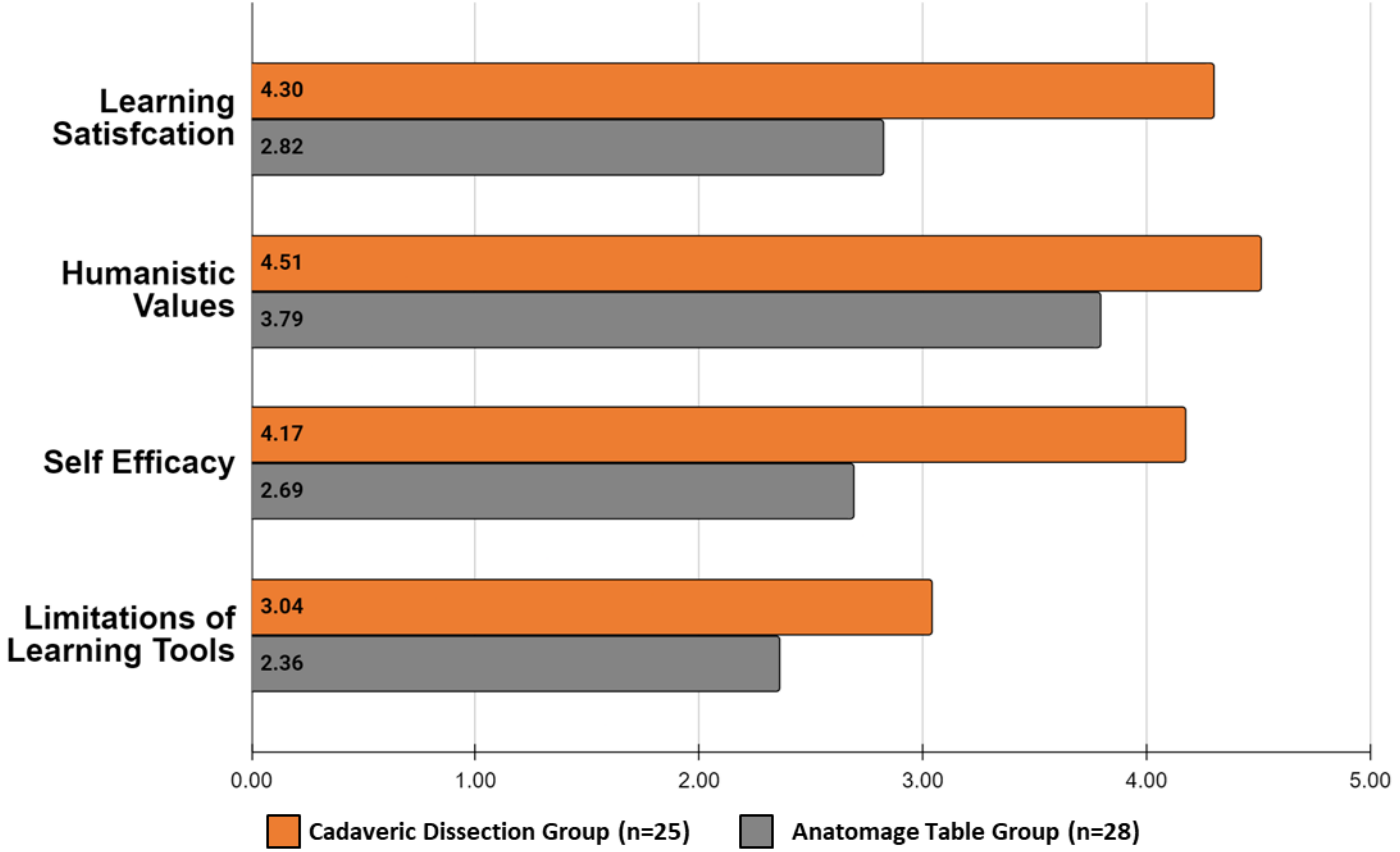
Summary of Survey Results (Phase II)



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RESULTS

(SURVEY QUESTIONNAIRE)

THEMATIC ANALYSIS

Phase I & Phase II

Strengths (Anatomage Table Group)

Visual Learning and Comprehensive Exploration
The Anatomage Table allows for easy visualization of anatomy in 3D, making it convenient and comprehensive.
Students can dissect specific parts and view internal structures clearly, enhancing their understanding of anatomy.
It offers a wide range of topics, including histology and CT scans, all in one platform.
The table provides detailed explanations and clear annotations for better comprehension of structures and functions.

Interactive and User-Friendly Features
The Anatomage Table is convenient to use and offers simple instructions.
It supports self-study, allowing students to explore and learn independently without the need for professors' guidance.
The table offers various functions, such as different sections (cuts), checkbox selection of specific structures, annotations, and multiple views (e.g., MRIs), providing a user-friendly and interactive learning experience.

Detailed and High-Fidelity Images
The Anatomage Table provides high-resolution and detailed visualizations, making it superior to other anatomy learning tools.
It allows students to see structures they may not always be able to observe in real-life dissection.

Enhances Learning Beyond Basic Anatomy
The Anatomage Table offers in-depth explanations, enabling students to delve deeper into specific structures, functions, and blood supplies beyond what is covered in regular anatomy lessons.

(Phase I) - Anatomy of Pelvis & Perineum

Strengths (Prosected Specimen Group)
Enhanced 3D Visualization and Realism The prosected specimens are 3D and provide a more "real" experience, allowing for better visualization of anatomy. Students find it interesting and informative to view different plastinated specimens in the museum. The 3D nature of the specimens helps in visualizing the structures in space, aiding future recall and clinical practice.
Clinical Relevance and Application The method allows easy relation to clinical practice, helping students understand how anatomy applies to real-world situations. Observing pathologies of different structures provides insights into clinical problems and applications. Various specimens with clinical relevance offer opportunities to learn about anatomy's links to clinical scenarios.
Interactive Learning and Clear Labels The method allows interaction with specimens, which enhances learning and understanding. Clear labels on the specimens aid recognition and identification of anatomical structures. Students appreciate the ability to learn through observation and interaction.
Curiosity and Engagement Students find the method interesting and enjoyable, piquing their curiosity for learning. Learning and interacting with the specimens are eye-opening and engaging.

(Phase II) - Anatomy of the Brain

Strengths (Cadaveric Dissection Group)

Enhanced Visualization and Real-life Experience
Better visualization of anatomical structures.
Experiencing real specimens from silent mentors helps appreciate complexities and variations in real patients that simulations cannot provide.
Visualizing the labeled specimens in the anatomy hall has improved learning.
Being able to see and visualize the actual specimens in real life enhances understanding.

Hands-On Learning and Interactivity
The real-life specimens provide a more hands-on learning experience.
Students can interact with the specimens and answer questions, enabling a deeper understanding beyond the curriculum.

Greater Appreciation and Respect for the Human Body
Using actual specimens leads to more respect for the human body.
Students feel more encouraged to learn due to the use of real specimens.

Accuracy and Real-world Perspective
Cadaver specimens reflect real-world anatomy, providing a more accurate representation.
The use of real specimens allows for understanding anatomical structures in their proper scale.

(Phase I & Phase II)

Weaknesses (Anatomage Table Group)
Laggy and Unresponsive System The Anatomage Table is often described as laggy and slow, which affects the learning experience. It can be unresponsive and may take a while to load, making it challenging to navigate effectively. Lag and unresponsiveness can hinder efficient learning and cause frustration.
Limited Accessibility and Usability Only one person can use the Anatomage Table at a time, which can be inconvenient and time-consuming in group learning settings. Some students find the system difficult to use and not very intuitive, requiring guidance and coordination during its use. Lack of a user-friendly interface and tactile feedback can make it challenging for some students to fully benefit from the system.
Overlap with Existing Resources Some students feel that the Anatomage Table does not offer significant additional benefits compared to other existing resources, such as Complete Anatomy or textbooks. The availability of alternative tools and software can make the Anatomage Table seem less necessary for learning.
Lack of Detailed Labels and Variations The system may not label everything clearly, such as sinuses, hindering understanding in certain areas. The anatomical structures on the Anatomage Table may appear too distinct compared to real human bodies, lacking variations that are present in living individuals.

(Phase I) - Anatomy of Pelvis & Perineum

Weaknesses (Prosected Specimen Group)
Lack of Guidance and Explanation The method requires guidance from a teacher or instructor to identify the structures properly. There is no explanation of the function of structures or how they relate to other anatomical components. Some specimens lack labels, making it difficult to identify certain structures, especially without prior knowledge.
Limited View and Difficulty in Identification It can be challenging to get a good view of certain structures due to the position of the specimen. Some students find it difficult to identify anatomical structures on the specimens. There is no "model answer" provided, leading to uncertainty about the correctness of identifications.
Fear of Damaging Specimens There is a fear among students of damaging the plastinated specimens since they are considered expensive and delicate. Students are instructed not to touch the specimens, which can limit the level of interaction.
Label Fading and Absence of some Labels Some labels on the specimens may have faded off over time, affecting their usability. In comparison to the anatomage method, there is a noted absence of labels on certain specimens.

(Phase II) - Anatomy of the Brain

Weaknesses (Cadaveric Dissection Group)
Limited Participation and Passivity Not everyone is able to actively participate in the cadaveric dissection, leading to some students being passive observers. The method may not be inclusive for all students, as some may not have the opportunity to engage in the dissection process fully.
Lack of Labels and Descriptions The absence of labels and descriptions on the specimens makes it harder to learn while examining them. Without proper labeling, students may find it challenging to identify and understand the anatomical structures they are observing.
Challenges in Visualization Some structures may not be clear to visualize in real life, which can hinder the learning process. Certain positions and angles may be difficult to access, limiting the students' ability to view the specimens comprehensively.
Limited Manipulation and Observation The specimens being fixed in a block restrict the ability to manipulate and observe them fully. The inability to slice or spread apart the specimens for better visualization can be a limitation.

(Phase I & Phase II)

Areas of Improvements (Anatomage Table Group)
Guided Learning and Smaller Groups Incorporate tutorials or written instructions on how to use the Anatomage Table effectively. Have a staff or professor to guide students while using the Anatomage Table to ensure more effective learning. Stagger the number of students using the table by splitting the big group into smaller groups, allowing each group a set time to use the table. Implement a turn-based system where all students are given time to use the Anatomage Table.
Improved User Interface and Response Times: Improve the quality and speed of the Anatomage Table software to make it smoother and more user-friendly. Upgrade to a better table with faster response times and reduced lag.
Complementary Use and Faculty-Led Sessions Use the Anatomage Table as a complement to dissection/prosection and not as a replacement. Incorporate faculty-led sessions where professors guide students on what to search for and explain the significance and information of the structures seen on the table.
Enhanced Integration with Complete Anatomy Invest more in the Complete Anatomy software, which students find more preferable and useful compared to the Anatomage Table. Use an iPad with Complete Anatomy and project it on a board for a more practical and cost-effective solution.

(Phase I) - Anatomy of Pelvis & Perineum

Areas of Improvements (Prosected Specimen Group)
Increased Interactivity and Freedom to Explore The department could allow students more freedom to touch and manipulate the specimens under supervision. This hands-on approach would enhance the learning experience. Allowing students to interact with the specimens more actively can aid in understanding anatomy better.
Improved Labeling and Annotations Adding more labels to the specimens would be beneficial, as it helps students identify structures and enhances their learning process. Providing annotations and labels for all the specimens can improve the clarity and usefulness of the learning materials.
Accessibility and Availability of Specimens Making more specimens available for perusal, both online and in person, would provide students with more opportunities to learn from different examples. Ensuring specimens are readily available to students would enable more frequent and convenient access to study materials.
Online Resources and Annotated Versions Providing an online or soft copy annotated version of the specimens, perhaps with annotated QR codes, would allow students to refer back to the material at their convenience. Online resources can supplement in-person learning and facilitate review and self-paced study.

(Phase II) - Anatomy of the Brain

Areas of Improvements (Cadaveric Dissection Group)
Enhanced Access and Time for Exploration Providing more time for students to independently look at the specimens in the anatomy hall and explore them. Allowing each student to have hands-on experience by holding and examining the brains during the anatomy session.
Learning Support and Structured Approach Offering a learning guide or suggested reading materials before the anatomy session to prepare students for the dissection. Developing an Anatomy Museum guide, starting from basic brain anatomy and progressing to more advanced features. This would enable students to follow a structured approach while examining specimens.
Increased Dissection Time and Integration with Technology Allocating more time for the actual dissection process to ensure thorough exploration and learning. Integrating the cadaveric dissection with the anatomage table or other technology to enhance the learning experience.
Student Interaction and Teaching Quality Providing opportunities for students to dissect the equipment themselves, promoting active learning and understanding. Ensuring the availability of knowledgeable and skilled professors, who can effectively guide and facilitate the learning process.
Improved Labeling Adding labels to the specimens to aid students in identifying structures even when the tutor is not present.

Study Conclusion

With regard to **objective outcomes** in the Pre-Test and Post-Test, **students' performance** were still **very similar irrespective of the learning methods.** When students perform better in one anatomical region, the trend is seen in both learning methods.

Based on **Survey Responses,** the study indicates that students perceive different strengths and weaknesses in each learning method, namely the **Cadaveric Dissection Group**, the **Prosected Specimen Group**, and the **Anatomage Table Group.**

Students had **higher positive opinions** about **traditional methods**, appreciating the real-life experience and hands-on learning. However, the Anatomage Table received mixed feedback due to its technical issues, limited accessibility, and perceived overlap with other digital resources.

Considering the diverse opinions from the students, it is evident that **no single learning method can fully replace the others**. Instead, a **combination of approaches** may be the **most effective way to enhance teaching and learning of anatomy.**

The traditional cadaveric dissection and prosection remain crucial for providing real-life experiences and improving understanding. However, the Anatomage Table can be a valuable supplementary tool to aid visualization, provide additional information, and complement the existing methods in anatomy education.

Given these findings,

The **Anatomage Table might not replace the traditional cadaveric dissection or prosection** but it can be a **valuable supplement to the existing methods** to enhance teaching and learning of anatomy.

Acknowledgment

Dr. Arthur Lau

Dr. George Yip

Dr. Deepika K

NUS National University of Singapore | Department of Anatomy Yong Loo Lin School of Medicine

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Madam Pan Feng

Lin Mingwan

NUS National University of Singapore | Department of Anatomy Yong Loo Lin School of Medicine
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Year-1 Medical Students
Yong Loo Lin School of Medicine
National University of Singapore
Singapore


My Students

Acknowledgment

We would like to thank
the silent mentors and their families

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Yong Loo Lin School of Medicine

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

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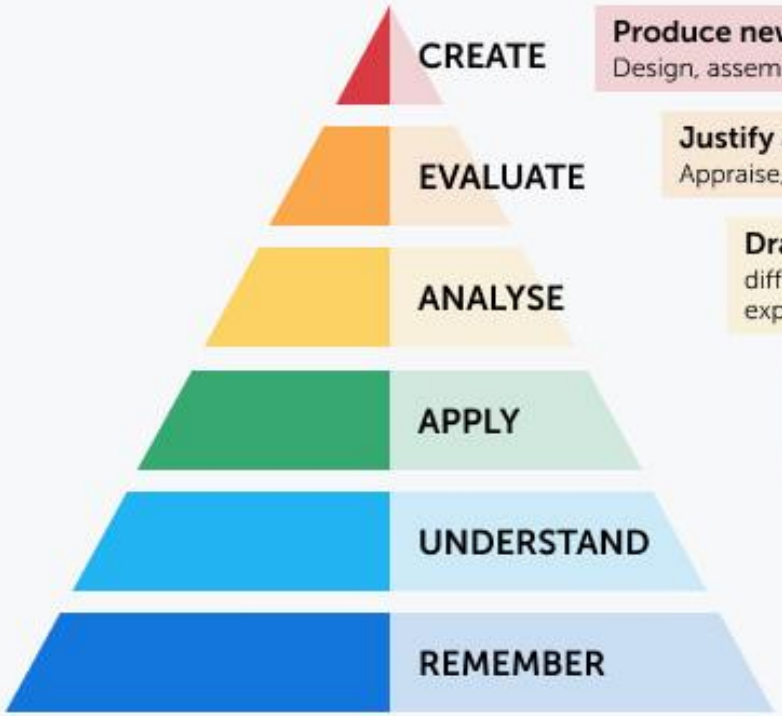
THANK YOU

Spare slides
“Not” for presentation
To be used “Only’ for Discussion

Bloom's Taxonomy



Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate

Justify a stand or decision
Appraise, argue, defend, judge, select, support, value, critique, weigh

Draw connections among ideas
differentiate, organise, relate, compare, contrast, distinguish, examine, expertiment, question, test

Use information in new situation
Execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch

Explain ideas or concepts
Classify, discribe, discuss, explain, identify, locate, recognize, report, select, translate

Recall facts and basic concepts
define duplicate, list, memorise, repeat, state

Purpose of 2022's Study

To compare **students' objective outcomes** of Pelvic & Neuro anatomy between cadaveric dissection, prosected specimens, and Anatomage.

To evaluate **students' perceptions** of learning human anatomy with these two teaching and learning tools in terms of perceived learning satisfaction, self-efficacy, humanistic values, and limitations of the study

Hypothesis

The students of virtual dissection (Anatomage) will perform better both in objective and subjective outcomes as compared to the cadaveric dissection

2022's Study 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 Table might not replace the traditional cadaveric dissection or prosection** but it can be a **valuable supplement to the existing methods** to enhance teaching and learning of anatomy.

Main Shortcomings of 2022's Study

The sample size was relatively larger compared to other similar studies; however, it was limited to **only 44** participants.

22 students had to share the Anatomage table, which may have impacted their learning experience.

Students **did not have sufficient training** to use the Anatomage Table prior to study

The pre-test and post-test **results of the students were not linked**, and individual performance could not be analysed and compared. This hindered the ability to establish connections between the intervention and learning outcomes.

The **presence of 2 duplicate questions** in one post-test introduced potential bias and may have affected the reliability of the results.

2022 Study

Group	Gross Anatomy of Pelvis & Perineum: Pre Test *M*	Pre Test *SD*	Post Test: 10 same Qn *M*	Post Test: 10 same Qn *SD*	Hedges' g
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: Pre Test *M*	Pre Test *SD*	Post Test: 10 same Qn *M*	Post Test: 10 same Qn *SD*	Hedges' g
Anatomage	75.9%	± 13.0%	81.4%	± 9.9%	0.669
Cadaveric Dissection	75.2%	± 16.3%	84.3%	± 11.6%	0.903

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

Comparison between 2022 and 2023 Extended Study

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	Phase I - Anatomy of the Pelvis & Perineum				Student's t test p value	Cohen's d
	Pre Test		Post Test (10 Same Question)			
	M	*SD*	*M*	*SD*		
Anatomage Table (n=28)	75.4%	±18.5%	82.2%	±18.2%	0.152	0.374
Prosected Specimen (n=33)	78.5%	±13.6%	82.2%	±11.4%	0.235	0.297

Comparison between 2022 and 2023 Extended Study

	Gross Anatomy of the Brain				
	Pre Test		Post Test: 10 same Qn		Hedges' g
Group	*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

	Phase II - Anatomy of the Brain					
	Pre Test		Post Test (10 Same Question)		Student's t test	Cohen's d
Group	*M*	*SD*	*M*	*SD*	p value	
Anatomage Table (n=32)	76.3%	±12.9%	82.8%	±11.4%	0.035	0.537
Cadaveric Dissection (n=29)	79.3%	±13.3%	82.1%	±10.5%	0.385	0.229

2022 Study

	Gross Anatomy of Pelvis & Perineum				Hedges' g	p value
	Anatomage Group		Prosected Specimen Group			
	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

2-sample t-test with 5% Level of significance was conducted between the two groups → There is no significant differences in the test scores between Anatomage and Prosected Specimen groups

Hedges' g was conducted on the 2 group scores, and results were more than 0.8, suggesting a large effect size → Even though differences between the **post-test score** is not statistically significant, Prosected Specimen group scored higher than Anatomage for 10 same Qn but Anatomage scored higher for 10 new Qn

2022 Study

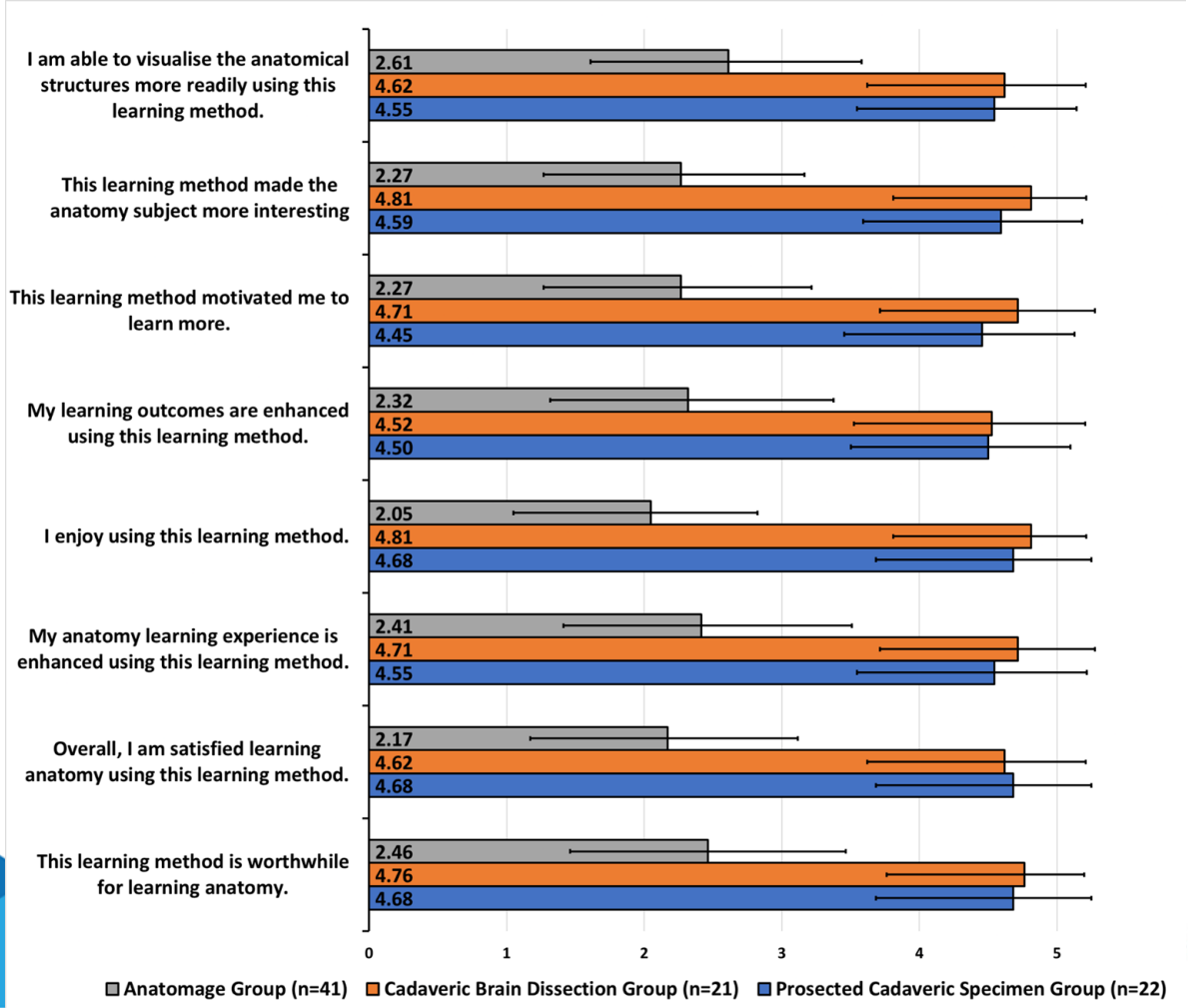
	Gross Anatomy of the Brain					
	Anatomage Group		Cadaveric Dissection Group		Hedges' g	p value
	M	*SD*	*M*	*SD*		
Pre Test	75.9%	± 13.0%	75.2%	± 16.3%	0.292	0.882
Post Test: 10 same Qn	81.4%	± 9.9%	84.3%	± 11.6%	1.734	0.380
Post Test: 10 new Qn	66.8%	± 21.0%	70.0%	± 13.4%	1.150	0.559

2-sample t-test with 5% Level of significance was conducted between the two groups → There is no significant differences in the test scores between Anatomage and Cadaveric Dissection groups

Hedges' g was conducted on the 2 group scores, and results were more than 0.8 for post-test, suggesting a large effect size → Even though differences between **post-test** score is not statistically significant, Cadaveric Dissection group scored higher than Anatomage Group

Learning Satisfaction

2022 Study



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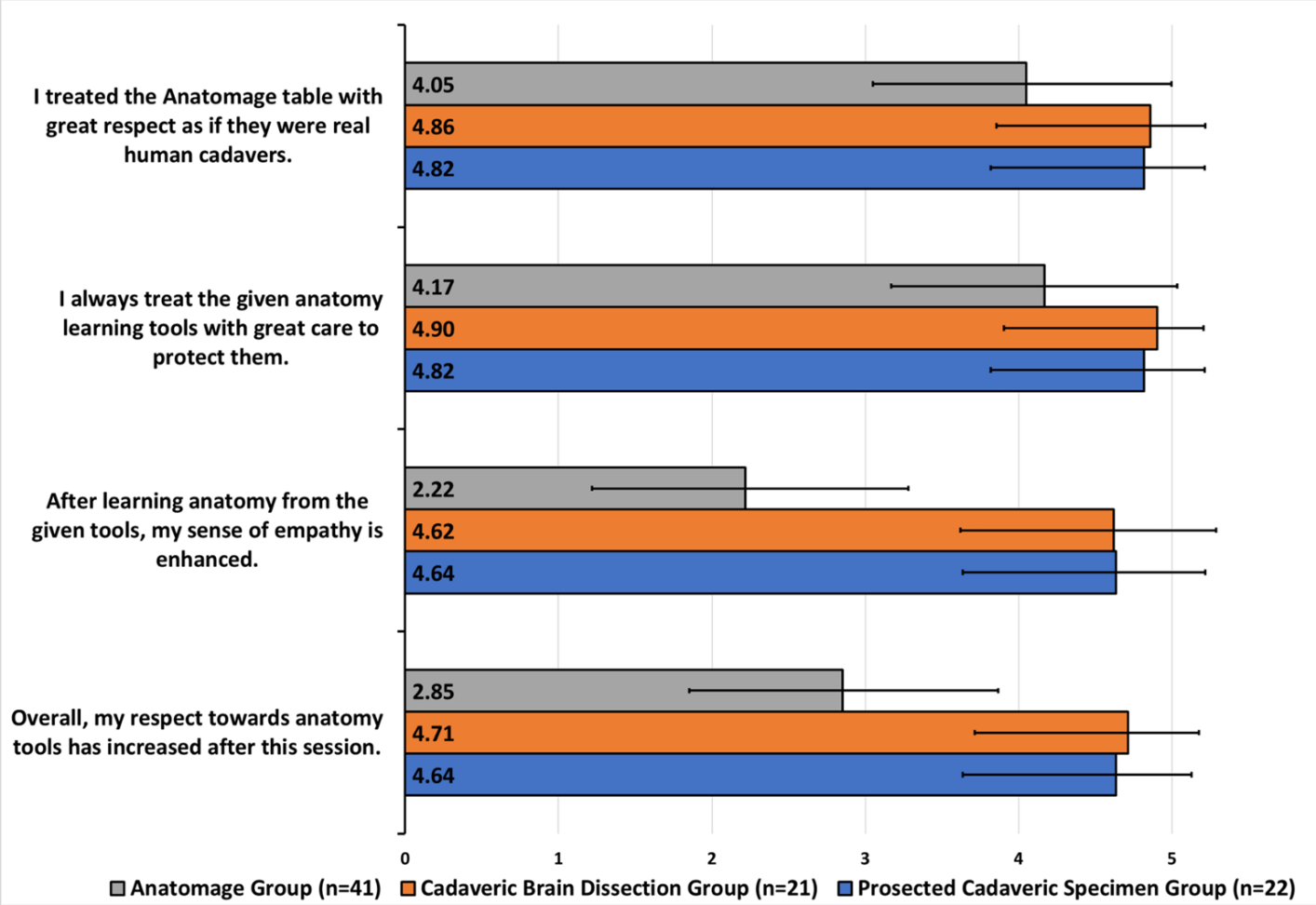
Humanistic Values

2022 Study



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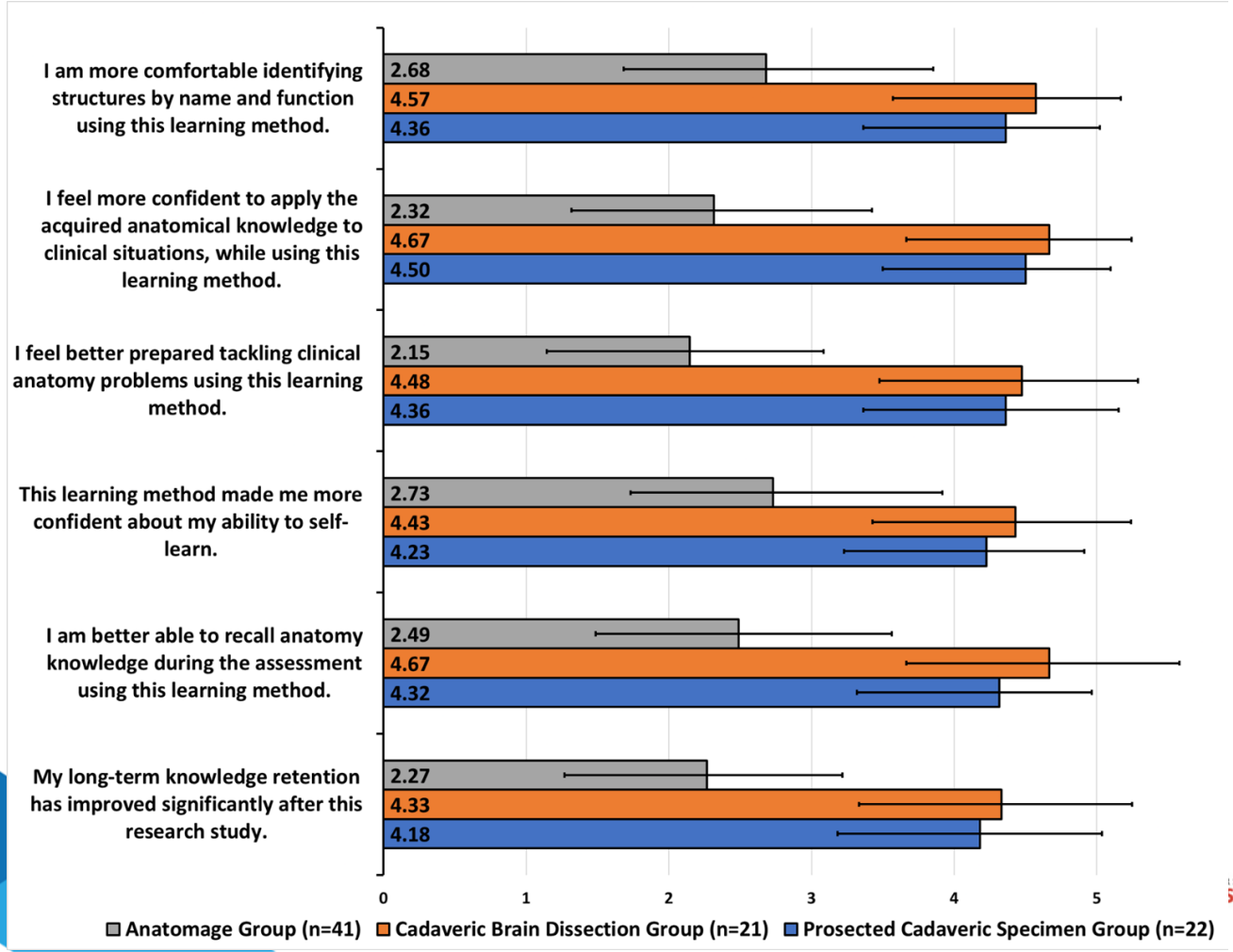
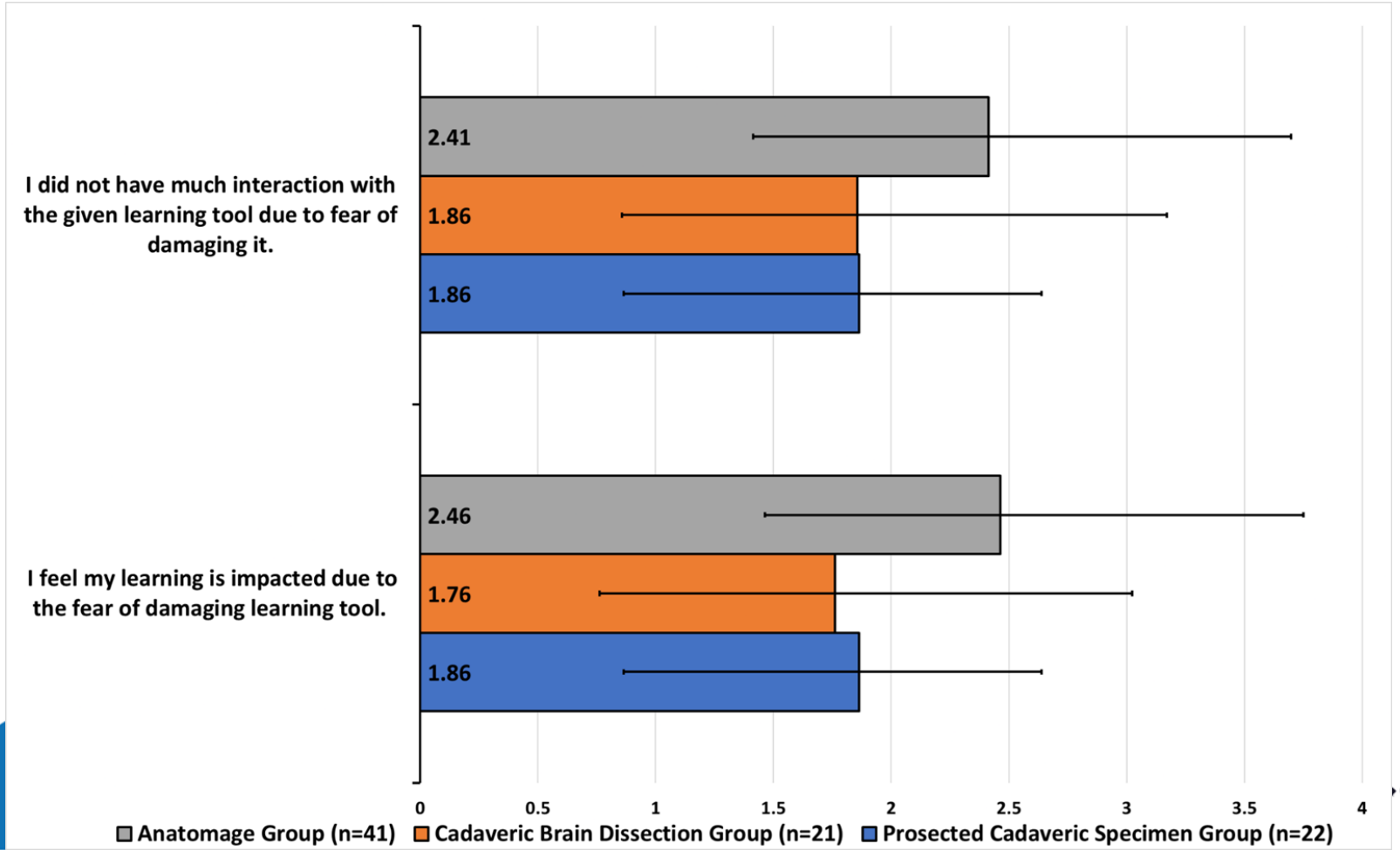
Self Efficacy

2022 Study

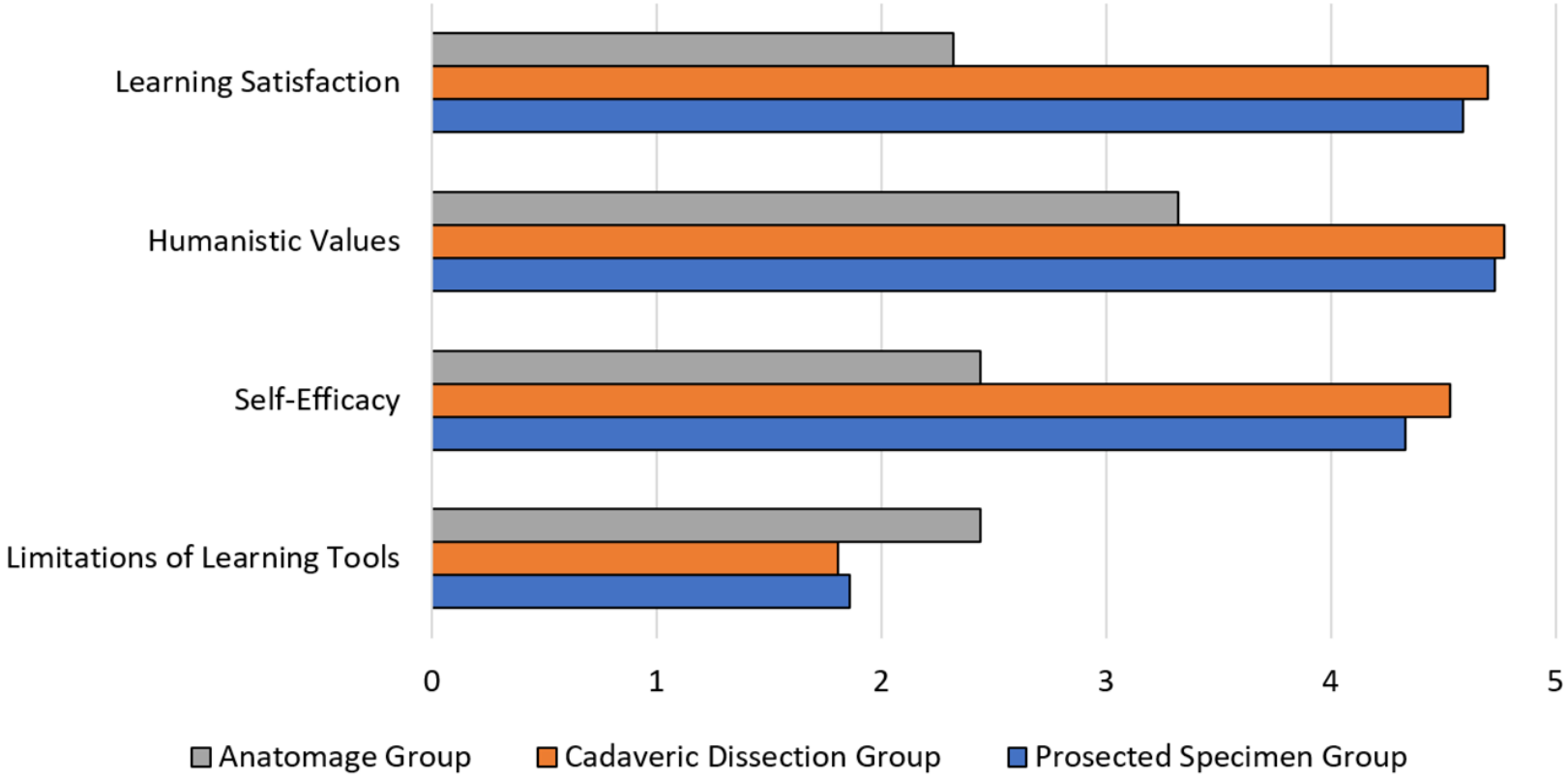


Limitations of Study

2022 Study



Summary of 2022 Survey Results



2022 Studies - 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%)

2022 Studies - 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%)

2022 Studies - 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%)

2022 Studies - Qualitative comments

Cadaveric Dissection:

1. **Strength**

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

1. **Weakness**

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

Prosected Specimens:

1. **Strength**

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

1. **Weakness**

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

Strengths of our Study

Students were in Year 1 with **prior Anatomy knowledge** so that they could compare and contrast the two modes of learning.

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**

2022 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 Table might not replace the traditional cadaveric dissection or prosection** but it can be a **valuable supplement to the existing methods** to enhance teaching and learning of anatomy.