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Keywords

Gross anatomy education, computer-assisted program, occupational therapy education

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ABSTRACT

There is a need to develop an anatomy course with contemporary pedagogy that is consistent with the core of the occupational therapy profession. The purpose of this study was to examine students' perception of a blended learning pedagogy applied to an occupation-based anatomy course compared to a traditionally delivered anatomy course using cadaver lab for entry-level doctoral occupational therapy students at a private university in the Pacific Northwest region. A retrospective, nonrandomized, two-group, post-test only design with data gathered at the completion of each course was used. One student cohort received the occupation-based anatomy course with a traditional in-person learning format and the other received the course guided by the universal design, blended learning format. The primary outcomes were students' course performance and perception of the course. At the completion of the course, both student cohorts had equivalent course performance. Compared to those who received the traditional format, the blended learning format cohort yielded significantly higher scores in 3 out of 5 categories of the course evaluation, including syllabus design, contribution of course content to their needs as a professional, and assessment methods that reflected their learning. The study results suggest that the occupation-based anatomy course guided by a contemporary pedagogical approach is equal to traditional methods in anatomical knowledge acquisition but statistically superior in meeting students' perceived needs as professionals and reflecting their learning.

Introduction

Occupation, everyday activities a person does to occupy time and bring meaning and purpose to their life (American Occupational Therapy Association [AOTA], 2020), is core to the occupational therapy (OT) profession. A person's occupational performance is closely associated with the environment and their personal capacities (AOTA, 2020). OT practitioners use occupations as a tool to facilitate a person's participation in everyday life activities or occupational performance. Therefore, it is critical for OT students and practitioners to learn about occupation through exploring the complexity and dynamic relationship between the person's capacities and environment.

As a foundational course, anatomy education in OT should prepare students with relevant anatomical competency in responding to the complex nature of a person's occupational functioning (Schofield, 2018). The accreditation body mandates the minimal standards of OT curricula to include knowledge of body structure and function (Accreditation Council for Occupational Therapy Education [ACOTE], 2018). However, Bagatell and Womack (2016) advocated that anatomy education in OT should be occupation-based to address the relationship between occupation and human movement to prepare students for future practice. This accentuates the theoretical belief in OT that human movement cannot be fully understood without considering the affordances from the environment in which the occupation is being performed.

Anatomy education in OT should incorporate vertical (i.e., clinical competencies) and horizontal (i.e., learning within clinical context) integration of course content in curricular design (Schofield, 2018; Stabile, 2015). Current trends in healthcare education emphasize competencies for clinical practice (Schofield, 2018; Stabile, 2015). Connecting anatomical education with relevant clinical assessment techniques enhances students' understanding of both clinical scenarios and anatomy related skills (Johnson et al., 2012; Krause et al., 2011). Schofield (2018) reported that United States-based OT practitioners appreciated anatomy education emphasizing musculoskeletal and nervous systems in regions of upper and lower extremities, head and neck, and torso. Moreover, they advocated the integration of anatomically relevant clinical competencies into anatomy education, including assessment of joint movement, muscle strength, pain, and functional mobility.

Instructional approaches should maximize student learning and promote better understanding of course content (Rogers-Shaw et al., 2018). Gross cadaver dissection and/or prosection laboratory remains the most utilized pedagogical method for anatomy education in OT (Carrol & Lawson, 2014; Thomas et al., 2011; Veazy & Robertson, 2023). It affords students with visual and tactile feedback (Granger, 2004; Schofield, 2014); however, the high cost of cadavers (Gasco et al., 2013) and restricted laboratory time contribute to potential learning barriers (Veazy & Robertson, 2023). Additional teaching and learning tools are needed, for example: the use of active learning strategies, such as team-based learning, peer-learning, and case-based learning, and have been found to enhance anatomical knowledge acquisition and retention (Shead et al., 2020). These factors point to the usefulness of employing an alternative learning tool for anatomy education in OT curricula.

Healthcare profession students that typically represent a continuum of traditional to non-traditional students, benefit from pedagogical approaches aligned with Universal Design for Learning (UDL; Center of Applied Special Technology [CAST], 2022) principles in anatomical knowledge acquisition (Dempsey et al., 2023; Shead et al., 2020). Universal Design for Learning principles offer educators an opportunity to design an inclusive anatomy curriculum for all learners, with various learning needs, in facilitating knowledge acquisition and application (Rogers-Shaw et al., 2018). The three UDL principles, (1) multiple means of engagement to sustain learners' attention for learning, (2) multiple means of representation to offer a variety of learning options, and (3) action and expression to demonstrate learning in various ways, provide guidelines for an ideal learning environment (CAST, 2022). Use of a computer-assisted program can be well aligned with UDL principles of multiple means of engagement and representation. There is emerging evidence suggesting that computer-assisted instructional programs, such as three-dimensional (3D) anatomy software, are comparable in effectiveness for learning anatomy to the traditional cadaver laboratory approach (Foreman et al., 2005; Mathiowetz et al., 2016; Thomas et al., 2011; Toth-Cohen, 1994). Shead and colleagues (2020) recommended that a computer-assisted program can be used as a standalone or adjunct pedagogical approach for anatomical knowledge acquisition and retention. For example, a computer-assisted instructional program can be incorporated in a flipped classroom pedagogical approach in anatomy education to facilitate an interactive and active engagement environment (Day, 2018; Mathiowetz et al., 2016).

Dempsey and colleagues (2023) found that, although not explicitly stated, all three UDL principles were well aligned with contemporary pedagogical methods in anatomy education among healthcare professions, including technology-enhanced teaching, contextualization, and collaborative learning. Moreover, application of elements of UDL in OT curriculum have shown positive effects for not only allowing adult learners to explore various learning methods, but also enhancing engagement in learning and improving personal learning experiences (Murphy et al., 2020; Shiely & McCarthy, 2019). However, due to insufficient research the role and efficacy of UDL in anatomy education in OT remains unclear (Dempsey et al., 2023).

Purpose

Based on the premise that occupation is a core concept and practice tool in OT (Whiteford & Wilcock, 2001), and that learning how to practice occupation-based OT is fostered by teaching methods that used occupation-based strategies (Hooper et al., 2018), it is imperative to develop an occupation-based curricula in OT education. Anatomy education in OT education should not only explore the dynamic relationship between human body function and occupation, but also prepare students' competencies for clinical practice related to anatomical knowledge. In addition, OT educators should employ an innovative pedagogy to cultivate students in becoming active and independent learners. The purpose of this study was to investigate the effectiveness of a blended learning pedagogy, guided by UDL principles and applied to an occupation-based anatomy course, on course performance and students' perception of the course.

Material and Methods

Research Design

A retrospective, non-randomized, two-group, posttest only design was employed to examine students' perception of an occupation-based, computer-assisted instruction (Visible Body Courseware and OTu) anatomical course compared to a traditionally delivered cadaver laboratory anatomical course at the completion of the semester in each cohort. The Visible Body Courseware integrates physiology, atlas, and muscle premium with features of augmented reality. OTu is a learning platform providing high quality educational videos, such as surface anatomy, assessment of range of motion (ROM), manual muscle test (MMT), and therapeutic transfers. The university's institutional review board (IRB) approved this study.

Participants

Participants were first-year, first semester, entry-level doctoral degree students in OT from two cohorts at a private university in the Pacific Northwest region. All students enrolled in the OT program were required to complete an Anatomy & Physiology (A&P) course as one of the prerequisites before taking the Human Movement for Occupation Course which is the focus of this study. The first student cohort was enrolled in an in-person only delivered course with cadaver laboratory in the fall semester of 2019 and the second cohort was enrolled in the course delivered through a UDL inspired, blended learning, computer-assisted course design offered in the fall of 2021. The cohort who took the course in the fall of 2020 was not selected due to the effects of the COVID-19 pandemic on the delivery method. Random assignment was not considered possible due to the format of the course.

Human Movement for Occupation Course

The Human Movement for Occupation course aims to not only build the foundational knowledge of body structures and function, but also enhance OT students' understanding of the relationship between human movement and occupations. The course covers musculoskeletal system, nervous system, and circulation system of the human body throughout the semester. Specifically, 14 modules were developed to establish anatomical knowledge integration including: (1) basic concepts of kinematics, kinetics, and biomechanics; (2) anatomy and kinesiology of the human body; and (3) anatomically relevant clinical competencies, including assessments of range of motion (ROM) and manual muscle testing (MMT), therapeutic transfers, body mechanics, and orthosis fabrication. These types of competencies are essential for OT practice and mandated by the accreditation body to be included in the curriculum (AOTA, 2018). Students need to integrate anatomical knowledge to develop clinical competency. For example, one practice scenario requires students to identify the potential ROM/strength problem in elbow flexion within the elbow complex. Students needed to explore different positions of the forearm with/without resistance to determine if the individual had problems with ligaments stabilizing the complex (lateral collateral ligaments, medial collateral ligaments, or annular ligament) or muscle weakness (biceps brachii, brachioradialis, or brachialis) that could impact occupational performance.

Students explored the dynamic relationship between human movement and occupation through table conference and movement analysis assignments. Table conference, a group assignment, required each group member to select an occupation requiring movements of the whole body and present an impromptu analysis of kinesiological, anatomical, and potentially clinical issues throughout the semester. Students demonstrated their understanding of covered course content through identifying corresponding anatomical structures and relevant kinesiology for the occupation, as well as indicating potential pathology and adaptation pertinent to their occupation. Students performed the movement analysis assignment individually to explore how the study of movement and anatomy fit into an individual's occupational performance. In addition to describing the occupation and contextual factors unique to the individual, students conducted a thorough analysis of required movements for the occupation, including involved joints, agonists and antagonists muscle groups, nerve innervation, type of contraction, and minimum strength and ROM needed. These two integrative occupational analysis assignments were designed to enhance horizontal anatomical knowledge integration. The same instructor led the course with different pedagogical approaches for the two student cohorts, as described in Table 1.

In-Person Only Format

The in-person format organized the course content via weekly lecture and laboratory in a sequence of three sections: (1) basic concepts of kinematics, kinetics, and biomechanics; (2) anatomy and kinesiology of human body; and (3) 'Putting it all together' (see Table 1). Students received lectures of anatomical knowledge of musculoskeletal, nervous, and circulation systems of the human body. Cadaver laboratory and activity analysis, with emphasis on human movements, were used as laboratory activities to enhance students' understanding of content. Students learned anatomically relevant clinical techniques at the 'Putting it all together' section, including ROM and MMT assessment for upper extremity, therapeutic transfers, and orthotic fabrication, toward the end of the course. More weight was put on the application of learned anatomical knowledge, such as teaching and learning of therapeutic transfers, proper body mechanics, and orthotic fabrication. In addition, Moodle learning management system was used to integrate course information. A basic virtual anatomy program that only provided the atlas function was available for students through the library as a means of supplemental learning.

Blended Learning Format

The blended learning format rearranged the course content to align with related clinical competencies (see Table 1) to facilitate vertical integration of anatomical knowledge. Specifically, students applied basic biomechanical concepts, such as Newton's law, moment arm, and lever systems, to therapeutic transfers techniques; conducted wheelchair prescription and ergonomic evaluation when learning the region of lower extremity and region of head and torso; and surface anatomy, ROM, and MMT while learning regions of upper and lower extremities.

Table 1

Overview of Course Design in "Human Movement for Occupation" Course

Content	In-Person Format	Blended Learning Format
Basic kinematics, kinetics, and biomechanics	Week 1-3 **In-Class Activity** • In-person lectures **Lab** • Concept application through Activity Analysis	Week 1-4 **Out-of-Class Activity** • Pre-recorded videos of covered content **In-Class Activity** • Clarification of key concepts • Concept application through Activity Analysis **Lab** • Clinical application: o Video demonstration through OTu for Therapeutic transfers
Anatomy of Body Systems • Skeletal system • Muscular system • Circulation system • Nervous system	Week 4-11 **In-Class Activity** • In-Person lectures o LE: Hip, Knee, Ankle, Foot, & Gait o Head, Neck, & Torso o UE: Shoulder, Elbow, Forearm, Wrist, & Hand **Lab** • Wet Lab o Cadaver laboratory on covered body systems • Dry Lab o Concepts application through Activity Analysis o Surface anatomy	Week 5-15 **Out-of-Class Activity** • Pre-recorded videos of covered content • Visible Body Courseware on anatomy & physiology for kinesiology o LE: Hip, Knee, Ankle, Foot, & Gait o Central and peripheral nervous system o Head, Neck, & Torso o UE: Shoulder, Elbow, Forearm, Wrist, & Hand **In-Class Activity** • Clarification of key concepts • Concept application through Activity Analysis • Anatomy o Visible Body Courseware- Atlas app for anatomy with augmented reality feature; muscle premium app for animated muscle movement/function o Video demonstration through OTu for surface anatomy **Lab** • Clinical application

		o Video demonstration through OTu for goniometry & MMT on LE & UE joints **Special topics of clinical application** • Wheelchair & Ergonomics following module of Head, Neck, & Torso • Orthosis fabrication following module of Wrist & Hand
Clinical Application (Putting it all together)	Week 12-14 • **In-Class and Lab Activities** o In-Person lectures ▪ Goniometry & MMT for UE joints ▪ Therapeutic transfers ▪ Ergonomics ▪ Orthosis fabrication	Integrated in anatomy of body systems
Assessment Methods	**Written Exams** • Scheduled time & dates • Quizzes and cadaveric pin tests • Midterm, Cumulative final cadaveric pin test & final exam **Presentation** • Table conference **Practicum** • Goniometry & MMT of UE and therapeutic transfers **Written Report** • Movement Analysis Midterm and final exam more heavily weighted in grading	**Written Exams** • Open from Monday through Friday o Quizzes and computer-based pin tests o Midterm exam & cumulative final computer-based pin test • Final exam at scheduled time & date **Presentations** • Table conference • Brachial Plexus presentation **Practicum** • Goniometry & MMT of UE and LE and therapeutic transfers **Written Report** • Ergonomic Evaluation- computer task • Movement Analysis Weight of grading more evenly distributed across assignments rather than heavily focused on midterm and final exam

Note. MMT = manual muscle test; ROM = range of motion; OTu is an online learning platform offering videos for ROM, MMT, and therapeutic transfers

Guided by UDL principles of multiple means of representation, the flipped classroom model and three online learning platforms were employed. Basic content knowledge was delivered through online mini-lectures on Moodle, while scheduled classroom sessions focused on application and/or development of problem-solving abilities. In addition to Moodle, two computer-assisted online platforms, Visible Body Courseware and OTu, were used to provide multiple resources for learning. The Visible Body Courseware incorporates atlas, muscle premium, and physiology apps with augmented reality features to enhance learning of anatomical knowledge (see Figure 1 for a snapshot of using the augmented reality feature of the atlas from the Visible Body Courseware). The OTu is a platform containing online rehabilitation educational videos for clinical competencies required for this course, such as therapeutic transfers, ROM, MMT, and orthosis fabrication. Cadaver labs were not provided to this group.

Figure 1

A Snapshot of 3D Atlas Anatomy Software.

Note. The 3D anatomy software is equipped with augmented reality feature. Users can use the software at any location to enhance interactive learning experience.

The UDL principle of multiple means of engagement was applied through weekly teaching assistant (TA) sessions reviewing content for the previous module, weekly work plans summarizing educational activities and assignment due dates, online discussion forums, and weekly instructor feedback. The UDL principle of multiple means

of action/expression was applied through rubric assessment; practicums; and choice of video, audio, or any form of artwork for presentations. Furthermore, weekly TA sessions also served as a form of peer-learning to facilitate not only knowledge acquisition, but also to smooth the transition into graduate study since this course occurs in the first semester.

Measures

The primary outcomes of the study were students' course performance and perception of the course measured by the final percent grades and students' anonymous course evaluation, respectively. The course used multiple means to evaluate students' performance, including five quizzes, five pin tests (anatomical knowledge tests on musculoskeletal, nervous, and circulation systems), midterm exam, brachial plexus presentation, table conference, movement analysis, final exam, and practical exam of transfers, ROM, and MMT. The final percent grade is a cumulation of course performance reflecting students' understanding in musculoskeletal, nervous, and circulation system of human body; relationship between human body and occupation; and anatomically related clinical techniques. The course evaluation is an anonymous survey designed and used by the university and OT program to evaluate students' perceptions regarding the adequacy of the course. For course evaluation, students use a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to rate how effective the content of the course enhances their learning, including (1) "the syllabus included clearly stated expectations of students taking this course"; (2) "the educational resources (e.g., tools, texts, technology) used in this course effectively supported my learning"; (3) "this course challenged and strengthened my critical thinking skills"; (4) "course content contributed to the knowledge, skills, and abilities I will need as a professional"; and (5) "assessments methods effectively allowed me to demonstrate what I learned in this course". The course evaluation also includes students' qualitative feedback regarding the course through two open-ended question (1) "what aspects of the course (e.g., assignments, activities, assessments) most effectively helped you learn" and (2) "please share any constructive feedback (positive or negative, with suggestions for improvement) that you have not had an opportunity to offer above."

Admission variables, including grades of prerequisites in A&P, prior cumulative grade point average (GPA), and last 45 hours GPA, were considered potential confounding factors to course performance. Prior knowledge in anatomy (A&P GPA) may directly affect students' performance in the course. Due to the inconsistency in reported format of grades, students' prerequisites A&P GPA was averaged and converted into ordinal scale. Prior cumulative GPA represents a student's overall academic performance and learning experience. The last 45 hours GPA was considered because many prospective students take required prerequisite courses later in their undergraduate education or are beginning a second career in occupational therapy. Differences in these variables between the two pedagogical formats were sought.

Data Analysis

The R statistical package (version 4.1.2; R Core Team, 2021) was used for data analyses. The normality of variables was examined graphically with variation bands in *sm* package (Bowman & Azzalini, 2014). The Chi-square test was used to examine differences in gender and ethnicity between the in-person format and blended learning format. The Mann-Whitney U test was used for non-parametric data (ordinal scale) to compare whether there were statistically significant differences in median between the in-person and blended learning formats, including course related admission variables and students' perception of the course. Effects of any variables were controlled as a covariate if statistically significant differences were found between the two pedagogical approaches. Since none of the admission variables were found statistically different between the two formats, the Welch two-sample *t*-test, which is appropriate for possible unequal variances (Algina et al., 1994; Welch, 1947), was used to compare whether there were statistically significant differences in means between in-person and blended learning formats. In addition, quantile regression was performed to examine the association between lower (25^{th} quantile), middle (50^{th} quantile), and higher (75^{th} quantile) prerequisite GPA in A&P, pedagogy used, and course performance in the Human Movement for Occupations course. The level of significance was set as .05.

Qualitative content analysis was used to analyze text data obtained from students' qualitative feedback of the open-ended questions in the course evaluation. Using content analysis, researchers immerse themselves in the text data to develop inductive categories about the subject of interest (Kondracki et al., 2002). Hsieh and Shannon (2005) described specific analytic approaches commonly categorized as content analysis: conventional (inductive categories are developed during data analysis), directed (codes are guided by existing theory or prior research), and summative (keywords are identified by the frequency of occurrence in text) approaches. Using a conventional approach to content analysis, one researcher independently performed iterative, inductive coding on all feedback. The other two team members reviewed codes for accuracy. Coding discrepancies were resolved through discussion among researchers. Codes were categorized into meaningful clusters of codes or categories.

Results

Demographic Information

Eighty entry-level OT doctoral students (40 in each group) at a private, non-profit university in the Pacific Northwest region were included in this study. Both groups included a high percentage of females and White students. No statistically significant differences in gender and ethnicity between the two groups were found (see Table 2).

Table 2

Demographic Information of the In-Person and Blended Learning Formats

Demographic Information	In Person	Blended learning	*p*-value
Total participants: *n*	40	40	
Gender: *n* (%)			.64
Male	3 (7.5)	2 (5)	
Female	37 (92.5)	38 (95)	
Ethnicity: *n* (%)			.08
Asian	2 (5)	9 (22.5)	
Hispanic	1 (2.5)	1 (2.5)	
White	35 (87.5)	27 (67.5)	
Multiple	2 (5)	3 (7.5)	

Note. In-person learning format (*n* = 40); blended learning format (*n* = 40)
Note. Chi-Square test was used to examine differences in demographic information between the two pedagogical approaches

Comparisons Between Groups on Admissions Variables

All admission variables, including cumulative GPA, last 45 hours GPA, and A&P GPA, were distributed within the variation bands, indicating that these variables were normally distributed. In general, students in both groups had similar scores in all course related admission variables. The results of Mann-Whitney U test and 95% CI of differences between the two groups suggested that there were no statistically significant differences between groups in all admission variables (see Table 3). None of these variables was added as a covariate for subsequent analysis.

Table 3

Comparison of Admission Variables Between Groups

	In Person	Blended learning	*p*-value	95% CI
Cumulative GPA				
Mean (SD)	3.53 (.22)	3.55 (.33)	.42	-.17, .08
Median	3.50	3.57		
Minimum-Maximum	3.08-3.89	2.65-4.00		
Last 45 hours GPA				
Mean (SD)	3.80 (.15)	3.80 (.17)	.96	-.08, .08
Median	3.83	3.82		
Minimum-Maximum	3.40-4.00	3.44-4.00		
A&P GPA				
Mean (SD)	3.44 (.50)	3.48 (.53)	.55	-.25, .13
Median	3.50	3.57		
Minimum-Maximum	2.09-4.00	2.09-4.00		

Note. In Person format (*n* = 40); Blended learning format (*n* = 40); CI, confidence interval; GPA, grade point average; SD, standard deviation; A&P, Anatomy and Physiology.
Note. Mann-Whitney U test was used to examine differences in admission variables between the two pedagogical approaches

Comparisons Between Groups on Course Related Variables

Students in both groups had similar scores in course final percent grade. The result of Welch's *t*-test and 95% CI of difference between the two groups indicated that there was no statistically significant difference between groups in course final grade.

Thirty-five students from the in-person only group and 29 students from the blended learning group completed the anonymous course evaluation. Overall, students in both groups rated the courses positively, ranging from 3.71 to 4.76 out of 5 (see Table 4). Students in the blended learning group rated scores higher in all five categories compared to those from the in-person only group. Results of Mann-Whitney U test indicated statistically significant differences between groups, with medium effect sizes, on 3 of the 5 categories: syllabus design ($r = .3$; $p = .008$), course content contributed to their needs as a professional ($r = .36$; $p = .002$), and assessment methods reflected their learning ($r = .4$, $p = .0008$). In contrast, no statistically significant differences between groups were found in two categories: education resources supporting their learning ($r = .15$, $p = .12$) and the course challenged and strengthened their critical thinking ($r = .11$, $p = .2$) (see Table 4).

Table 4

Comparisons of Course Related Variables Between Groups

	Mean (SD)	Median	Range	Effect size	*p* value	95% CI
Course Final Percent Grade						
In-Person (*n* = 40)	91.60 (3.97)	92.44	81.38-98.91	*d* =.08	.72	-1.95, 1.35
Blended learning (*n* = 40)	91.90 (3.41)	91.93	81.64-97.89			
Students' Perception of the Course						
Syllabus Design						
In-Person (*n* = 35)	4.11 (.90)	4	1-5	*r* =.3	<.01*	-.1, <-.01
Blended learning (*n* = 29)	4.62 (.62)	5	3-5			
Educational Resources						
In-Person (*n* = 35)	3.97 (.95)	4	2-5	*r* =.15	.12	-.1, <.01
Blended learning (*n* = 29)	4.31 (.85)	4	1-5			
Critical Thinking						
In-Person (*n* = 35)	4.57 (.50)	5	4-5	*r* =.11	.20	-.5, <.01
Blended learning (*n* = 29)	4.66 (.67)	5	2-5			
Needs as a professional						
In-Person (*n* = 35)	4.37 (.60)	4	3-5	*r* =.36	<.01*	-.1, <-.01
Blended learning (*n* = 29)	4.76 (.64)	5	2-5			
Assessment Methods						
In-Person (*n* = 35)	3.71 (1.23)	4	3-5	*r* =.4	<.01*	-1, <-.01
Blended learning (*n* =29)	4.59 (.87)	5	1-5			

Note. In-person, In-person learning format; blended learning, blended learning format; CI, confidence interval; *d*, effect size for *t* test; *r*, effect size for Mann-Whitney U test; *Students'* perception of the course was measured on the five-point Likert scale (1=strongly disagree to 5=strongly agree); syllabus design, the syllabus included clearly stated expectations of students taking this course; educational resources, the educational resources used in this course effectively supported my learning; critical thinking, the course challenged and strengthened my critical thinking skills; prepare for practice, course content contributed to the knowledge, skills, and abilities I will need as a professional; and assessment methods, assessments methods effectively allowed me to demonstrate what I learned in this course.

*p< 0.01

Note. Welch two-sample *t* test was used to examine differences in final percent grade between the two pedagogical approaches. Mann-Whitney U test was used to examine differences in students' course evaluation between the two pedagogical approaches.

Association Between Prior Anatomical Knowledge and Course Performance

Table 5 shows the results of lower (25th), middle (50th), and higher (75th) quantile regression models examining the effects of prior knowledge of anatomy (A&P GPA) and pedagogy on students' course performance in final percent grade. There was no statistically significant main effect of pedagogy on student's course performance when controlling for the main effects of A&P GPA and the interaction effect. Controlling for effects of pedagogy and the interaction effects, there was statistically significant main effect of A&P GPA on students' course performance in the lower (25th) and middle (50th) quantile regression models. The results suggest that the 25th and 50th percentile of students' performance in the Human Movement for Occupations course increases by about 4 percent for every one-point increase in their A&P GPA.

Table 5

Association Between A&P GPA and Pedagogy on Course Performance

	Intercept	Coefficients	95% CI
Prerequisites-A&P			
25th percentile	75.73		
A&P GPA		3.98	2.39 - 5.90*
Pedagogy		-1.04	-11.84 - 11.05
Interaction		.28	-2.87 - 3.22
50th percentile	78.43		
A&P GPA		3.92	.86 - 4.36*
Pedagogy		2.78	-12.06 – 6.77
Interaction		-.81	-1.61 – 3.47
75th percentile	90.57		
A&P GPA		1.0	-1.66 - 4.32
Pedagogy		-8.23	-20.11 – 7.45
Interaction		2.45	-2.17 – 4.99

Note. Examination of association between prior knowledge in anatomy and 25th, 50th, and 75th percentile course performance in Human Movement for Occupational course. A&P, Anatomy & Physiology; CI, confidence interval; GPA, grade point average.
*$p < 0.05$
Note. Quantile regression was used to examine the association between A&P GPA, pedagogical approaches, and final percent grade.

Summary of Students' Qualitative Feedback

Table 6 summarizes code clusters/categories that derived from students' qualitative feedback regarding the course. Generally, students in both groups valued the course design that emphasized occupation and clinical competencies through hands-on learning activities, the occupation-based integrative assignments, and emphasis of learning rather than grades. For example, one student responded that "The assignments required the students to think critically about their environments and how they affect the individual. Learning about how different social and physical environment affect the person and their resources is very important to them." Another student shared that "I feel like I am leaving the class with a great understanding of this course material, regardless of my grade!" Students receiving the blended learning appreciated the pedagogical approach that facilitated their learning, including use of the flipped classroom model, computer-assisted learning platforms, and application-based assignments. For instance, "I liked how many resources we were given to learn the material. I felt as though there were multiple ways I could learn the information. I also enjoyed the in class worksheets, I feel as though they were very applicable to what we were learning and helped me better understand the material." While the use of cadaver laboratory was perceived to enhance students' learning for anatomy education, number of students to each cadaver and limited access were considered challenges to their learning (see Table 6).

Table 6

Categories Derived from Students' Feedback

Code Clusters	Sample Feedback
Sample size	• In-person format (*n* = 35) • Blended learning format (*n* = 29)
Common in both pedagogies	
• Learning from hands on labs and assignments	• Lectures with strongly related visuals, succinct explanations regarding the subject matter and an abundance of application activities were all extremely helpful. • I enjoyed having the lab time to practice and understand the material in a deeper way. I also enjoyed the opportunity to do practicals and see how a real life situation would work. • All of the assignments and in class activities most effectively helped my learning because I was able to apply the knowledge that I was learning through the lecture to real life
• Integrative assignments enhance learning: Movement analysis & Table conferences	• The movement analysis allowed us to integrate subjects of interest with the knowledge we have obtained in class. It was tedious but overall enjoyable assignment • While the assignments were challenging, I learned most from the movement analysis and table conferences because they required the application of what we were being taught into real life scenarios. Rather than being assigned specific occupations or activities, I appreciated the ability to choose our table conference and movement analysis topics which gave me more motivation to complete them.
• Emphasis of learning rather than grades	• I appreciate that quizzes and exam scores were not a reflection of who we are as students and that there were other opportunities to outshine and represent our understanding of the materials through assignments and activities. • The way in which assignments, exams, and activities are distributed and graded is very impressive. For example, the short quizzes and major exams were very very challenging, however there were plenty of other assignments and opportunities to apply good work for high scores. Thank you for giving us many chances to show up and do our best! The expectations were clear and empowering.
In-Person format	
• Cadaver labs enhance/restrict learning anatomy	• I enjoyed cadaver lab and being able to visually learn the structure of the body. I also found the pin tests helpful to encourage my learning process.

	• Though I appreciated the opportunity to learn in a cadaver lab, it was often challenging to retain all of the information I needed in a small amount of time that we got with the professor in the lab. It was sometimes difficult to see the structures and then difficult to remember when I went in later with my classmates. • Cadaver lab was especially hard when there are so many people involved.
• Instructors are approachable and have worked well together	• Having three different professors who were able to help us build on the information was really helpful and helped me to fully engage in the class. They all did a great job of teaching the material as well. I really liked the set-up of the class. • I valued the flexibility of instructors and their willingness to answer questions and clarify material.
Blended Learning format	
• Flipped classroom model to allow preparation and review	• In terms of learning content, I relied on using the video lectures, printing out the slides, and drawing the anatomy or writing out the material to summarize. In class activities were super helpful to work through the content in application. I appreciate how class was structured this way, online videos and then lecture and in class exercises to ground our understanding.
• Computer-assisted learning platform facilitate learning	• Visible body was a great addition to the course! I utilized it to the fullest to be able to learn the anatomy portions. • The visible body app was amazing and I will continue to use this even after I graduate.
• Application assignments benefit learning and strengthen critical thinking	• With how complex the brachial plexus is to understand I also appreciated the freedom that that assignment brought in that we can represent it however we wanted and made sense to us that always helps me truly understand and remember what I am learning. • I think the projects, especially movement analysis and ergonomic evaluation all really helped me think critically and apply concepts which was very impactful for learning.

Note. In-person, in-person learning format (*n* = 35); blended learning, blended learning format; movement analysis (*n* = 29), individualized occupational analysis assignment; table conference, group format occupational analysis assignment.
Note. Qualitative content analysis was used to obtain themes from student's feedback in the course evaluation.

Discussion

We examined the effectiveness of a contemporary (UDL informed, blended learning format) pedagogy applied to a reformed anatomy course in OT that based around the concept of occupation, incorporated with anatomically relevant clinical competencies and exploration of human movement within context, compared to that delivered through traditional (in-person format) pedagogy. The study results indicate that students receiving the in-person learning and those receiving blended learning had equivalent outcomes in relation to overall course performance. Students in both groups appreciated the occupation-based approach to the anatomy courses. Students receiving the blended learning format rated three of the five categories in the course evaluation significantly higher than those receiving the in-person format, including the course syllabus design, contribution of course content to their needs as a professional, and assessment methods reflected their learning. These results support the concept of using occupation-based approaches in anatomy education in OT, connecting anatomical knowledge with relevant clinical competencies, and delivering content through a contemporary pedagogical approach.

Occupation was at the center of the curricular design for this anatomical education course in both cohorts. Through the integrative assignments, students used the lens of occupation to not only acquire anatomical knowledge of the human body, but also explore the dynamic relationship between human movements and the surrounding context within which the occupation is performed. Incorporating anatomically relevant clinical competencies, including therapeutic transfer, ROM, MMT, and orthosis fabrication, into anatomy education in OT enhances acquisition and application of anatomical knowledge and strengthens critical thinking since these competencies required knowledge of musculoskeletal, nervous, and circulation systems of human body. This was recognized in students' reflections that the course related activities enhance their critical thinking and better prepare them for future practice. The reflections echoed Stabile's (2015) statement that learning in clinical context enhances anatomical knowledge acquisition in adult learners.

Difference in pedagogy was one major difference in the curricular design between the two groups. The in-person format used traditional in-person lectures as well as skill practice and cadaver laboratory. In contrast, the blended learning format employed the flipped classroom model, two additional computer-assisted instructional programs, and multiple assessment formats. Students showed significantly greater appreciation toward the blended learning format to not only consolidate learned anatomical knowledge and strengthen their critical thinking, but also build up confidence for future practice. Our findings are well aligned with Dempsey and colleague's (2023) findings that students benefit from anatomy courses using principles of UDL to improve performance and understanding of anatomical knowledge, as well as to enhance course participation and confidence in future practice.

Another major difference in the curricular design between the two groups was the allocation of anatomically relevant clinical competencies in relation to course content. The clinical competencies were spread out throughout the entire course in the blended learning format to better align with the corresponding course content. For example, therapeutic transfers were aligned with concepts of Newton's laws and lever systems and ROM and MMT were aligned with anatomy of body regions. Students appreciated the connection and direct application of learned anatomical knowledge to relevant clinical practice. This was further reflected on the category of assessment method and preparation as a professional in course evaluation. In contrast, all clinical competencies were allocated in the third section of the course in the in-person format, namely 'Putting it all together'. This section was intended to build up anatomically relevant clinical competencies for future practice and was different from the previous sections that focused on anatomical knowledge. Although students highly valued the hands-on learning activities, completing all of these in the final section of the course, thus having limited time to prepare for the practical exams, incurred anxiety among students.

Our findings suggested that use of computer-assisted program can be an effective pedagogy for anatomy education in OT. While students in both groups had equivalent course performance, those receiving the blended learning format appreciated the flexibility, convenience, and thoroughness of the anatomy software's ability to enhance their learning experience. However, those receiving the in-person format had conflicting feedback towards pedagogy using cadaver laboratory. Although visual and tactile feedback are a strength in cadaver pedagogy (Stabile, 2015), limited access and available times to access the cadaver laboratory were the primary concerns of students. Our findings supported that, as the technology continues to advance, anatomy software can be better aligned with the contemporary pedagogy with striking visual feedback and enhanced interactive learning, such as augmented reality and animation.

Implications for Anatomy Education in OT

The results of this study have the following implications for anatomy education in OT:

- Occupation-based anatomy education enhances students learning within context.
- OT students benefited from the anatomy courses that incorporate anatomically relevant clinical competencies throughout the course, matched with appropriate content.
- Principles of UDL, including multiple means of representation, engagement, and action/expression, enhance OT students' learning experience.

Study Limitations and Future Research

There was no random assignment applied to the two groups. The course content and pedagogy were designed for a cohort as a whole. Randomization is not appropriate because potential contamination effect among students with different assignment may occur. The second cohort occurred as we were emerging from the COVID-19 pandemic. There were still precautions in place during administration of the course that did not exist during the first cohort. It would be ideal to investigate the effectiveness of the course by adding a cohort receiving traditional pedagogy with related clinical competencies spread out throughout the entire course. This study only examined

knowledge acquisition rather than knowledge retention. With the post-test only design in the study, interpretation of knowledge acquisition is limited and should be done with caution. Future study should explore whether students carry learned anatomical knowledge and relevant clinical competencies over to related clinical courses.

Conclusion

This study examined the effectiveness of an occupation-based anatomy course incorporated with competencies related to anatomical knowledge and contemporary pedagogy for 80 entry-level doctoral OT students. Our results suggest that the occupation-based anatomy course incorporated with competencies related to anatomical knowledge and guided with a contemporary pedagogical approach is equal to traditional methods in anatomical knowledge acquisition but superior in meeting students' perceived needs as professionals and reflecting their learning, thus strengthening students' confidence as a professional. OT students benefitted from the course that is occupation-based and uses blended learning, computer-assisted instructional format in anatomy education.

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