Student Perceptions and Attitudes Toward Interaction and Collaborative Learning in Human Anatomy; Implications for Interprofessional Curriculum Design and Implementation in Health Professional Education

by

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Dalhousie University is located in Mi'kma'ki, the
ancestral and unceded territory of the Mi'kmaq.
We are all Treaty people.

DEDICATION

To Allah Almighty for the gift of life and health.

To my beloved parents Fatimah and Mohammed for their unconditional love and support.

To my wife, my friend and colleague, Mona, whose support is beyond words.

To my wonderful kids, Mira and Mohammed, for the activities that I missed during my studies.

To those who truly work together for better care and health of others.

To the body donors whose gift enables the education of future health professionals.

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STATEMENT

This thesis is an original work by Ali Alkhawaji under the supervision of Dr. Thejodhar Pulakunta at Dalhousie University. In collaboration with Dr. Gary Allen, Dr. Akram Jaffar and Dr. Irena Rot, the studies in this thesis were conducted with an interest to enhance the quality of teaching and learning in human anatomy. The qualitative data analysis was conducted in partnership with Mona Alhasani (BSc, MACSc), a Ph.D. candidate under the supervision of Dr. Rita Orji at Dalhousie University. As per the University's Research Ethics Board (REB) review, the studies in this thesis fall under the category that includes activities related to Program Evaluation and Quality Improvement (Section 2.5 of the TCPS2 on Research Ethics). Hence, an exemption was received on October 4th, 2016.

ABSTRACT

Interactive and collaborative human anatomy learning provides an infrastructure for health professional education and forms a backbone for healthcare delivery. Yet, there is a growing trend among institutions to modernize student learning environments using innovative teaching alternatives. The adoption of new teaching methods in health professional education has altered the traditional way students learn human anatomy; therefore, it is important to capture student perceptions and attitudes to better appreciate the impact of changes of anatomy education. Since the success of student collaboration depends on the ability to effectively communicate and work as part of a group or team, examining student feedback on interaction with peers is key to explore and promote effective collaborative learning. The work in this thesis sought to understand how different modes of teaching and course design influenced student perceptions and attitudes about interaction and collaboration. The specific objectives were intended to use student feedback on learning in two different environments, namely technology-based (TBAE) and cadaver-based anatomy education (CBAE), to analyze the potential of those environments to foster the shared learning necessary for interprofessional education (IPE). The results of the first study revealed that the flexibility of the TBAE environment promoted personalized and independent learning, impacting student perceived need for social interactions: both interaction with their instructors and peers. Based on student feedback, the study provides recommendations intended to promote peer interaction and collaboration as a basis for shared learning in introductory technology-based anatomy courses. The results of the second study showed that the CBAE environment, using either dissection or prosections, provided a foundation for collaborative and hands-on learning. The difference between students' backgrounds and prior anatomical knowledge influenced the dynamics of their teamwork and collaboration during interprofessional dissections-based activities. Based on the feedback received, the study highlights a set of recommendations that could help optimize the implementation of collaborative cadaver-based pedagogies as a means for shared learning in gross anatomy courses. In conclusion, two issues related to instructional resources and course design appear to limit TBAE and CBAE learning environments as supportive of IPE. These issues are discussed as implications for interprofessional curriculum design and implementation.

LIST OF ABBREVIATIONS USED

-v PI	Negative Professional Identity
+v PI	Positive Professional Identity
ANAT-1010	Basic Human Anatomy course for health professions
ANAT-1010, Section 2	Basic Human Anatomy course for distance education
ANAT-1020	Basic Human Anatomy course for health professions
DEHY-2851	Basic Human Anatomy course for health professions
ANAT-5000, Section 1	Clinical Anatomy course
ANAT-5217	Functional Human Anatomy course
CBAE	Cadaver-based Anatomy Education
CBL	Cadaver-based learning
D-1113	Gross Human Anatomy/Neuroanatomy course
DAL	Digital Anatomy Learning
DDS	Doctor of Dental Surgery
EIL	Emphasized independent learning
F2F	Face-to-Face
FAL	Facilitated active learning
HBDP	Human Body Donation Program
IPAL	Interprofessional anatomy learning
IPC	Interprofessional collaboration
IPE	Interprofessional education
IQR	Interquartile range
KD	Knowledge differential

L&I	Learning and interaction
LMS	Learning management system
MCQs	Multiple-choice questions
Mdn	Median
MOOCs	Massive open online courses
N.B.	New Brunswick
N.S.	Nova Scotia
n.s.	No significance
OBE	Outcome-based education
OT	Occupational Therapy
P.E.I.	Prince Edward Island
PBL	Problem-based learning
PT	Physiotherapy
R&R	Roles and Responsibilities
RIPLS	Readiness for Interprofessional Learning Scale
S-C	Student-content
S-I	Student-instructor
S-S	Student-student
T&C	Teamwork and Collaboration
TBAE	Technology-based Anatomy Education
TBL	Team-based learning
TCPS	Tri-Council Policy Statement
WHO	World Health Organization

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The work in this thesis represents an analysis of students' views on educational issues, combined with my passion to understand and effectively promote interprofessional education among health professional students. Therefore, I wish to acknowledge and sincerely thank my Advisory Committee and other supporting individuals who helped make my Ph.D. journey possible. It was one of the most fulfilling educational experiences of my life that truly inspired me to become an even stronger advocate for interprofessional anatomy education. I would be remiss if I did not acknowledge my previous mentors, Dr. William R. Currie, and Dr. Gita Sinha. Without your wisdom, inspiration and encouragement, my journey in human anatomy teaching and learning would have never been as rich and rewarding.

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CHAPTER 1: INTRODUCTION

Human anatomy is the scientific discipline that seeks to understand the composition and architecture of bodily systems, organs, and tissues. For any healthcare practitioner, a good knowledge and understanding of human anatomy is essential to facilitate clinical investigation and the communication of findings with other health professionals using shared terminology (McCuskey et al., 2005; Turney, 2007). Moreover, since human anatomy is foundational, it is a common ground for different groups of health professional students, presenting a greater opportunity for learning from a set of common objectives (Sytsma et al., 2015). Learning human anatomy collaboratively, therefore, has the potential to provide an infrastructure for interprofessional education, forming a backbone for interprofessional healthcare delivery (Palmer et al., 2020; Herrmann et al., 2015).

In addition to providing a basis for health interprofessional education, there are additional advantages that can be achieved when human anatomy is learned collaboratively. These advantages include (1) promoting active learning that creates a profound educational experience through a sense of ownership and control over the learning process (Vasan et al., 2011), (2) addressing the challenge of low instructor-to-student ratios (Durán et al., 2012), and (3) improving student outcomes (Vasan et al., 2011). Collaborative anatomy learning provides students with opportunities to practice communication, teamwork, and leadership in early stages of their health professional education (Pawlina et al., 2006). Feingold et al. (2008), investigating the impact of collaborative learning between nursing students, further demonstrated that students relate the concept of group work to their future roles as members of healthcare teams. Therefore, early experiences in interprofessional health education are strategic to greater collaboration during later clinical years of education and subsequent professional practice (Harden, 2015).

Anatomy continues to be a component of health professional education, but the nature and extent of anatomy instruction changed substantially in the late 20th and early 21st century. This was driven (especially in the medical school education) by increasing demands on curricular time due to the growth of biomedical knowledge and a greater integration of clinical sciences in areas once the domain solely of basic science (Drake, 2014). A key area of change has been the reduction in cadaveric dissection by students and a greater reliance on pre-dissected specimens (Ashdown et al., 2013; Lackey-Cornelison et al., 2020). Another element of the change has been the adoption of alternative teaching approaches that take advantage of technology permitting teaching of large numbers of students, free of constraints of a classroom or lab, and reaching students at remote locations (Attardi & Rogers, 2015; Kaufman, 1989).

The impact of different modes of content delivery on anatomy education has been the subject of study, notably during the COVID-19 pandemic where online teaching was increased, and the use of cadavers was reduced or eliminated (Attardi & Rogers, 2015; Attardi et al., 2018; Singh et al., 2020; Zarcone & Saverino, 2022). However, further investigation into these modes of teaching is warranted to assess fully their impact. The focus of the work presented in this thesis examines the effect of two modes of anatomy teaching (technology-based and cadaver-based) on student interaction (Moore, 1989) which is an important feature of teaching and learning (Cornelius-White, 2007; Roorda et al., 2011).

The success of collaborative learning depends on the ability of students to effectively communicate and work as part of a group or a team (Evans & Cuffe, 2009). Thus, gathering feedback from students about their experience (interaction) can provide insights into the design of effective collaborative learning. Student feedback provides institutions with information that captures the needs, and monitor the satisfaction, of students, which can aid decision-making in the process of planning and introducing changes, as needed (Murray, 1997). Therefore, the key approach used in this thesis was to assess student perceptions about their learning.

The following literature review will first outline the different types of student interactions and how they support active learning. Then, the role of effective collaboration in health professional practice and education will be explored; this is followed by a brief overview of the *status quo* of human anatomy education as a potential opportunity to promote interprofessional education (IPE). The use of student feedback to enhance teaching and learning will then be discussed in terms of how to optimize the effectiveness of this source of information to cultivate meaningful change.

CHAPTER 2: LITERATURE REVIEW

2.1 Student interaction and learning

The term "interaction" is often used in educational literature to refer to student social communication with the instructor or with other students. However, the term is increasingly employed to describe student engagement with educational content. In 1989, Moore highlighted the importance of characterizing different forms of student interactivity, establishing three distinct types: student-content (S-C) interaction, student-instructor (S-I) interaction, and student-student (S-S) interaction (Figure 1). Although the focus of Moore's arguments was in relation to distance education, such student interaction is considered pivotal to learning in all forms of education (Holmberg, 1983; Simpson & Galbo, 1986; Anderson, 2003; Wei et al.,2019). Recognizing Moore's typology in any given educational setting provides a framework to design interactive processes that help to better suit the different learning needs of students. From these types of interactions emerge two student-centered pedagogical concepts, independent learning and collaborative learning, which enable students to assume ownership and active control of their learning.

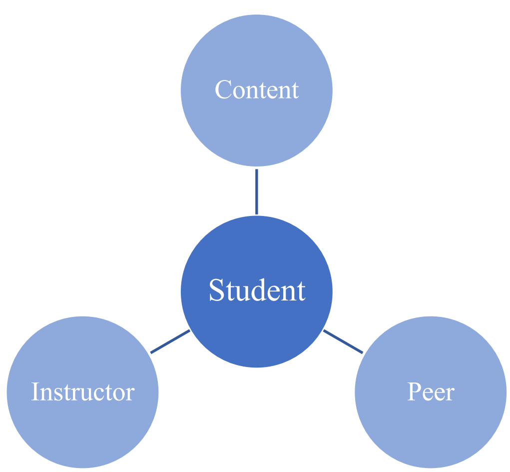

Figure 1: Three types of student interactions (Moore, 1989).

2.1.1 Student interaction with content (S-C)

According to Moore (1989), the first type of student interaction is with the educational content, which occurs when students engage with a course material to construct meaning and establish new knowledge. S-C interaction is typically facilitated by the course instructor directly in a classroom or indirectly via technology when it is used for content delivery. S-C interaction can also be seen in numerous forms of student solo activities. Examples of these activities include basic tasks such as using study guides, reading informative texts, taking formative quizzes, and viewing recorded lectures or other computer-based multimedia resources and interactive modules. S-C interaction may as well be fostered through more complex tasks such as completing an assignment or working on a project, which often require students to search and process information independently.

Moore (1989) regarded S-C interaction as a guided "internal didactic" process, a view introduced by Holmberg (1986) who suggested that learners "talk to themselves" about the information and ideas they encounter in an educational setting. Moreover, Moore (1989) positioned S-C interaction at the heart of the learning experience. Without this fundamental type of interaction, he argued that learning could not take place. This is merely because the learning process entails intellectual interaction with content, which results in changes in the understanding, perspective, or the cognitive structure of the learner's mind (Moore, 1989).

2.1.2 Student interaction with the instructor (S-I)

The second type of student interaction is commonly established when the instructor communicates with students to explain the educational content and stimulate them by providing feedback and guidance (Moore, 1989). Conversely, S-I interaction can be initiated when students communicate with the instructor to ask questions. Research shows that the instructor's verbal and nonverbal immediacy behaviours can minimize the psychological distance between them and their students, leading to greater learning (Gorham, 1988; Velez & Cano, 2012; Al Ghamdi, 2017). Examples of verbal actions include humour, self-disclosure, soliciting opinions, and giving praise. Examples of nonverbal actions include physical proximity, eye contact, facial expressions, touch, and gestures.

2.1.3 Student interaction with peer students (S-S)

The third type of interaction occurs between two or a group of students enrolled in the same course, with or without the presence of an instructor (Moore, 1989). Research suggests that communication between students is supportive to learning (Hurst et al., 2013). The ability to network, whether to ask questions, share ideas or disagree with others, is a basic need in the learning process. According to Picciano (2002), gaps in students' knowledge may be compensated for, or complemented by, their peers' knowledge, representing an advantage of group learning. In addition to the advantage of cultivating collective intelligence, individuals working together tend to provide social and emotional support to each other (Haythornthwaite, 2001).

2.1.4 Independent learning

Driven by S-C interaction is the concept of independent learning, in which students work, individually and at their own level and rate, toward achieving a learning goal (Gokhale, 1995). According to Moore (1984), independent learning occurs when students work with less dependence on traditional instructor support and with less structured educational materials. Independent learners learn through their actions - they direct, regulate, and assess their learning (Pintrich, 2000; Livingston, 2012). Taking responsibility for carrying out their learning, independent learners can set goals and decide how to meet their learning needs, monitor their progress, and self-assess the outcomes (Livingston, 2012). The independent learner is thus perceived as a decision-maker who possess (or will develop) a capacity to choose from the tools and resources available to create learning required to achieve an anticipated outcome (Chan, 2003).

Effective independent learning entails three sets of skills: (1) cognitive skills such as memory, attention and problem-solving, (2) metacognitive skills which include awareness of one's cognitive functioning, understanding how to learn, and how to apply learning in different situations, and (3) affective skills like feelings and emotions, including self-reliance, self-efficacy, and motivation (Meyer et al., 2008, Livingston, 2012). According to Žydžiūnaitė et al. (2014), learners' autonomy and self-identity prevail when they assume a positive attitude toward the purpose and process of learning, exerting greater control over the content and learning methods. As a method for active learning, independent learning is recognized for improving the educational experience and outcomes because it utilizes self-centred learning approaches that enable students to personalize and take ownership of learning (Meyer et al., 2008).

Despite being self-motivated, self-directed and able to interact with the content presented, independent learners may demonstrate vulnerability when it comes to application of knowledge (Moore, 1989). The lack of expertise in the subject matter leaves independent students uncertain whether they are applying the knowledge they developed correctly or not. Most often, the lack of S-I interaction will consequently impede the ability of the instructors and their students to achieve the anticipated level of understanding. Therefore, some degree of S-I interaction is valuable to support learning, in particular through evaluation and feedback (Moore, 1989).

2.1.5 Collaborative learning

Collaborative learning depends on S-S interaction. Collaborative learning requires students with different performance levels to work together in a group to achieve a common learning goal (Gokhale, 1995), which could be completing a task, solving a problem, or creating a product (Laal & Laal, 2012). As an active learning method, collaborative learning entails individuals taking charge of their actions and appreciating the skills and contributions of their peers (Laal & Ghodsi, 2012).

The variety of knowledge and experience within a group of students can benefit the collaborative learning process. Since students in a group may exhibit multiple interpretations of a particular event, individual student learning is enhanced when problem-solving strategies and decision-making skills are integrated in cooperation and harmony with others (Baumberger-Henry, 2005). Cooperation allows students to interact and engage with peers to propose and defend ideas, exchange perspectives, and investigate analytical approaches (Srinivas, 2011). Vygotsky et al. (1978) highlighted that individuals who work in collaborative situations tend to perform at higher intellectual levels than when they work individually. Students in a collaborative environment tend to assume responsibility for their learning and the learning of others in the group because the success of each other contributes to their overall success (Gokhale, 2012). As a result, peer interaction and support enable students to assimilate external knowledge and critical thinking abilities and convert them into intellectual functioning tools (Bold, 2008; Anderson & Soden, 2001). Compared to competitive and individualistic learning, collaborative learning has a greater potential to result in better productivity, higher achievement, enhanced self-stream, and more supportive, caring and committed relationships with peers (Laal & Ghodsi, 2012).

2.2 Conceptualizing effective collaboration in healthcare systems

Fundamental to modern healthcare systems is the *Triple Aim*: ultimate care for individuals, better health for populations, and reduced costs of care (Farmanova et al., 2016). As a result, the complex nature of healthcare delivery necessitates team-based approaches with effective collaboration to deliver comprehensive services (WHO, 2010).

2.2.1 Interprofessional collaboration (IPC)

According to the World Health Organization (WHO, 2010), interprofessional collaboration (IPC) occurs when multiple health professionals from different backgrounds provide comprehensive services by working together with patients, their families, and communities to deliver quality care across settings. When interprofessional team members work together, they integrate their observations, expertise, and decision-making processes to coordinate and collaborate with one another in order to enhance care for a patient or group of patients (Institute of Medicine, 2003). A growing body of literature evaluating the effect of IPC on health services and patient care highlights the potential of IPC in advancing healthcare processes and outcomes (Zwarenstein et al., 2009; Reeves et al., 2017). IPC is recognized for promoting optimal utilization of resources, which improves accessibility and safety of healthcare services (Oandasan et al., 2006; Mickan et al., 2010; Kirch & Ast, 2015). IPC is also recognized for strengthening interpersonal skills and enhancing professional relationships and job satisfaction (Institute of Medicine, 2003; Oandasan et al., 2006; WHO, 2010). Since future health professionals are often expected to work together (WHO, 1988), it is imperative for their education to enable mindsets for such a work configuration (Romanow, 2002; WHO, 2010).

2.2.2 Interprofessional education (IPE)

Due to curricular differences, the education of health professionals has traditionally occurred in separate environments of different schools and areas of clinical practice (Hall & Weaver, 2001; Institute of Medicine, 2003; Baldwin, 2007). As a result, students have been educated and socialized in separation, which could lead to limited knowledge of other health professions (Curran, 2008). This issue is considered one of the main obstacles to effective collaborative practice in healthcare (Mariano, 1989; Fagin, 1992). When members of a healthcare team have limited knowledge of other professionals and/or disciplines, they know very little about their theoretical perspectives, expertise, practices, responsibilities, skills, and values (Institute of Medicine, 2003; San Martin-Rodriguez et al., 2005). Such settings are likely to foster hierarchies leading to exclusive reliance on individual responsibility and decision-making, and a lack of appreciation for the contributions of the other health professions (Curran, 2008). A promising means to achieving the *Triple Aim* of healthcare systems lies in preparing future professionals to readily engage in the collaborative dynamics of responsive healthcare teams (Institute of Medicine, 2003; Kirch & Ast, 2015).

Interprofessional education (IPE) provides a foundation for IPC. IPE occurs when students from two or more health professions learn with, from and about each other to cultivate effective collaboration for improving health outcomes (WHO, 2010). According to the WHO (2010), when students learn how to work interprofessionally, they are prepared to enter the workplace as members of a collaborative team. Such a collaborative mindset is key in moving healthcare systems from fragmentation to a position of strength (WHO, 2010). Research shows that IPE can result in positive perceptions and increased insights into the work of other professionals in the team (Parsell et al., 1998; Parsell & Bligh, 1998; Reeves & Freeth, 2002). Moreover, IPE has the potential to enhance student perceptions and attitudes about IPC (Lapkin et al., 2013). A review of the effects of IPE demonstrated that students respond favorably to IPE interventions, reporting improvement of their attitudes and perceptions of each other and increases in knowledge and skills pertaining to collaboration (Reeves et al., 2016).

IPE and IPC are interconnected concepts with interdependent collaborative perceptions and attitudes (WHO, 2010; Reeves et al., 2011). The WHO's milestone report (2010), *The Framework for Action on Interprofessional Education and Collaborative Practic*e, highlighted the importance of contributing stakeholders from all levels to strengthen healthcare system performance and improve health outcomes, utilizing IPE and IPC as two vehicles (Figures 2 & 3). Harden (2015) describes immersion into IPE as a ladder that starts with basic collaborative skills and leads to full immersion into simulations of IPC (Harden, 2015). Although the biases and attitudes of students are contingent on their early experiences in the educational process (WHO, 1988), IPE initiatives have generally focused on clinical topics rather than basic science activities (Thistlethwaite, 2015). According to Kirch and Ast, (2015), brief interprofessional team-based activities in basic sciences can be beneficial to fostering an understanding and collaboration across professions.

In developing interprofessional activities at a preclinical level, Thistlethwaite (2015) suggests that it is essential to explicitly outline interprofessional learning outcomes in addition to the content and process of learning. There are competency frameworks that can be used to set learning outcomes and successfully gear student perceptions and attitudes toward collaborative practice (WHO, 2010; Orchard et al., 2010). For example, *The Canadian Interprofessional Health Collaborative National Interprofessional Competency Framework* describes the competencies required for effective collaborative practice (Orchard et al., 2010). Six competency domains (namely, Role Clarification, Team Functioning, Patient/Client/Family/Community-Centered Care, Collaborative Leadership, Interprofessional Communication, and Interprofessional Conflict Resolution) highlight the knowledge, skills, attitudes, and values that together shape the judgments that are essential for collaborative practice (Table 1). Generic interprofessional competencies, especially those related to soft skills such as teamwork and communication, can therefore be targeted in basic science courses offered to two or more different health professional students.

Student interaction for IPE

A distinction must be made between common learning and the shared learning that is the basis for IPE. According to the Center for Advancement of Interprofessional Education (CAIPE, 1997), common learning occurs in multi-professional settings when two or more professions learn together for any reason, whereas shared learning occurs when two or more professions learn together with the purpose of cultivating collaborative practice. Shared learning in IPE requires a greater degree of engagement in interprofessional teamwork and communication to promote the development of competencies necessary for effective collaboration (Reeves, 2016). For example, many health professional schools offer introductory anatomy courses where students from all the professions study their core content. Without a clear picture of collaborative practice, Thistlethwaite (2015) suggest that such interaction becomes merely multi-professional or parallel learning (Thistlethwaite, 2015).

Figure 2: Interprofessional education (IPE) as a vehicle to prepare a collaborative practice-ready health workforce (adopted from WHO, 2010).

Figure 3: Interprofessional collaboration (IPC) as a vehicle to achieve optimal health services (adopted from WHO, 2010).

Table 1: The Canadian Interprofessional Health Collaborative National Competency Framework (adopted from Orchard et al., 2010).

#	Core competencies	Definition
1	Role Clarification	Learners/practitioners understand their own role and the roles of those in other professions and use this knowledge appropriately to establish and achieve patient/client/family and community goals.
2	Team Functioning	Learners/practitioners understand the principles of teamwork dynamics and group/team processes to enable effective interprofessional collaboration.
3	Patient/Client/Family/ Community-Centered Care	Learners/practitioners seek out, integrate and value, as a partner, the input, and the engagement of the patient/client/family/community in designing & implementing care/services
4	Collaborative Leadership	Learners/practitioners understand and can apply leadership principles that support a collaborative practice model. This domain supports shared decision-making as well as leadership, but it also implies continued individual accountability for one's own actions, responsibilities and roles as explicitly defined within one's professional/disciplinary scope of practice.
5	Interprofessional Communication	Learners/practitioners from different professions communicate with each other in a collaborative, responsive and responsible manner.
6	Interprofessional Conflict Resolution	Learners/practitioners actively engage self and others, including the client/patient/family, in positively and constructively addressing disagreements as they arise.

2.3 Human anatomy teaching in health professional education

Long-term retention of anatomical knowledge has become an issue in health professional education during the period of curricular reform that began in the late 20th century (Drake, 2014; Masters, 2013; Masters, 2020). Motives behind this ongoing change include the expansion of knowledge and the rise of topic integration to minimize compartmentalized teaching and testing, the reduction of teaching hours to provide students with more opportunities and time for self-directed (independent) learning, and to eliminate redundancy between courses, moving away from a teacher-centred approach to a more student-centred one (Drake, 2014).

Although didactic lectures are perceived as efficient means to communicate bodies of organized knowledge and explain facts to large groups of students (Kaur, 2011), dedicating class time to the delivery of lectures has frequently been criticized (Prober & Heath, 2012). The extensive reliance on this teacher-centered approach to education focuses on passive transmission of information without optimal cognitive advancement (Afzal & Babar, 2016). Research shows that retention of anatomical knowledge improves with interactive approaches to learning (Sugand et al., 2010; Zumwalt et al., 2010). In response, course directors and curriculum planners have developed guiding principles for effective education, which include teaching with less reliance on long and continuous hours of lecturing and the promotion of active learning to improve student outcomes and retention of knowledge (Korf et al., 2008; Finn & McLachlan, 2010; Lufler et al., 2010).

There is no question about the essentiality of human anatomy in health professional education (Cotter & Cohan, 2010). What is important is to revamp its inclusion through creativity and innovations directed at achieving established competencies and outcomes (Pawlina, 2009; Gregory et al., 2009; Hefler & Ramnanan, 2017).

2.3.1 Modernized human anatomy teaching

Effective integration of educational technology in human anatomy teaching has become an expectation rather than an innovation, largely to accommodate increasing student enrolment (Attardi & Rogers, 2015). Educational technology has enabled instructors to develop and disseminate digital learning resources, providing alternatives to traditional methods for content delivery (like classroom lectures). Furthermore, the use of web-based applications with user-centered design, such as learning management systems (LMSs)[1] and social media platforms, has allowed for further possibilities for interaction and dialogue with and between students in virtual learning environments (Akcaoglu & Lee, 2018; Sarwar et al., 2019; Kaufman, 1989).

Literature in educational psychology highlights the role of technology integration in aiding students to become actively involved in the educational process, which underpins more meaningful learning (Vosniadou et al., 2012). According to Dabbagh et al. (2018), when learning involves active, constructive, intentional, authentic, and cooperative activities, it lends itself to a meaningful experience. Thus, technology becomes supportive of meaningful learning when it fulfills a learning need - when technology facilitates student-initiated and controlled interaction and when such interaction is conceptually and intellectually engaging (Dabbagh et al., 2018). To this end, many health professional schools have adopted innovations such as combining the use of multimedia resources and the flipped classroom method, in which students are provided with online materials/activities in advance so they can prepare for class on their own time and pace (Stirling & Birt, 2014; Green et al., 2014). This method focuses on restructuring the scheduled

[1] According to Turnbull et al. (2020), LMSs are online software platforms that provide an interactive learning environment and automate the administration, organization and delivery of educational content and the reporting of learner outcomes.

lecture time to foster active learning (Day, 2018; Fleagle et al., 2018). Various interactive activities have been designed to foster student interaction and collaboration in the classroom; these include problem-based learning (PBL) and team-based learning (TBL) activities, which can be facilitated with applications of educational technology like the use of audience response systems (Wait et al., 2009; Gregory et al., 2009; Alexander et al., 2009; Fergusson et al., 2018).

Teaching in the laboratory

Given the pace of technological innovation, there is an ongoing debate on the optimal way to teach gross anatomy in the laboratory (Estai & Bunk, 2016). Reduced teaching time, paucity of resources and the growing transition from stand-alone anatomy courses to system-based integrated curricula, have prompted some educational institutions to abandon traditional methods like whole-body dissection and adopt cost-effective, less time-consuming, and up-to-date alternatives (Estai & Bunk, 2016). These alternatives include teaching with more structured dissection activities that focus on achieving specific and attainable objectives, more prosections[2] and plastinated specimens[3], increased attention to living anatomy[4], and relying on medical imaging and virtual representations of human anatomy (Estai & Bunk, 2016). Teaching with such efficient methods have allowed instructors to use the laboratory time to further encourage student interaction and collaboration via different modes of active learning (Drake & Pawlina, 2014).

2.3.2 The perfect opportunity to enhance student interaction and collaboration

Since individuals possess different learning styles (Fleming, 1995), the goal of human anatomy teaching should emphasize enabling a more student-centered multimodal (visual, auditory, and

[2] Prosections are professionally dissected cadaveric specimens for educational purposes.
[3] Plastination, also known as forced polymer impregnation, is a long-term preservation method (described by von Hagens, 1986), commonly used to elongate the usability of prosections.
[4] The anatomy revealed on living individuals by inspection is known as living anatomy.

kinesthetic) learning experience (Drake & Pawlina, 2014). Designing interactive multimodal activities in human anatomy focusing on active rather than passive learning experiences provides opportunities across multiple years in the curriculum to enhance student retention of anatomical knowledge (Drake & Pawlina, 2014). Research shows that revisiting information in brief, appropriately spaced sessions may help improve retention (Custers, 2010). In addition to the advantage of enhancing knowledge retention, the student-centered multimodal approach to human anatomy education could also provide interprofessional opportunities that stimulate learning for all types of students.

Given the growing paradigm shift in health professional education from discipline-based courses to more integrated curricula with competency-based outcomes, it has become insufficient for human anatomy to only identify the learning outcomes in terms of mastery and knowledge of the subject or how it contributes to clinical practice (Harden, 2015). Since students' biases and attitudes are influenced by their early experiences (WHO, 1988), it is important that, at this basic level, courses go beyond with contributions to generate interprofessional competencies such as communication, teamwork skills and the recognition of the roles of other health professions (Harden, 2015). The introduction of outcome-based education (OBE), which focuses on specific competencies to be achieved by students, provides continuity across the continuum of the educational process (Harden & Laidlaw, 2016). Using defined learning objectives, OBE provides the means to ensure proper consideration is given to topics that might otherwise be neglected and that the tools used to assess student learning are valid (Harden & Laidlaw, 2016). As a result, interprofessional competencies focusing on respect and communication between team members (the promotion of active listening and discussion skills like the ability to give feedback freely) can be promoted in human anatomy through PBL, TBL and e-learning (online discussion) or blended learning, in which e-learning and other face-to-face (F2F) methods are combined (Reeves, 2016). The proclivity of laboratory-based activities toward interactive and collaborative learning makes it more amenable to implement IPE (Kirch & Ast, 2015).

The definition of IPE indicates that, to be effective, learning must proceed collaboratively through a shared process (Thistlethwaite, 2015). However, human anatomy is a content-rich subject with a high burden of learning, and the depth of knowledge required for anatomy may vary across different health professions. According to Thistlethwaite (2015), when meaning is created through context and experience, the learning process becomes similar for all students. Contextualization of anatomical knowledge can be done through different approaches. The regional approach emphasizes spatial relationships between structures, whereas the transdisciplinary approach focuses on relationships between structure and function in individual organs or the body as a whole. In the clinical approach to contextualization, anatomical knowledge is linked to pathological or traumatic patient scenarios. Contextualized human anatomy learning can therefore be designed for different types of students via a collaborative multimodal approach, utilizing technology, dissection, prosections and many other laboratory-based models and specimens, and living anatomy (Thistlethwaite, 2015). Consequently, opportunities exist more than ever before to create new models of teaching and learning that encourage IPE, thereby, promoting IPC that ultimately could reinforce the healthcare system.

As Thistlethwaite (2015) suggests, anatomists can play a leading role initiating profound student experiences in health professional education through the learning they design. Therefore, gathering and analyzing feedback from students on their interaction with peers in human anatomy can provide insights into the design of effective collaborative learning, which can help facilitate the implementation of IPE. The following section examines the literature related to how to optimize the effectiveness of student feedback to enhance the quality of their education, including the recommended methods by which student feedback is collected and analyzed.

2.4 Student feedback to enhance teaching and learning

Feedback from students is considered an important source of information for quality assurance and enhancement of teaching in higher education (Murray, 1997; Ballantyne et al., 2000; Brookes, 2003; Kelly, 2012; Dalhousie University-1, n.d.). There are other feedback sources that are used with an aim to enhance teaching and learning, notably feedback from instructors, with suitable expertise and working in a similar environment (Archer, 2010). Indeed, it may be argued that peer feedback is of utmost importance because teaching colleagues can provide expert critiques of each other's practices. However, students, as consumers of the product of higher education (knowledge), are well-positioned to provide critical feedback based on their learning experience. Drawing on evidence from different research settings, including field experiments, faculty opinion surveys, and longitudinal comparison of trends, Murray (1997) concluded that student feedback is a significant contributor to enhancing the quality of university teaching and, hence, student learning. Safavi et al. (2013), exploring the impact of student feedback, highlighted that instructors commonly implement changes to enhance their teaching practices based on this source of information.

2.4.1 Optimizing the utilization of student feedback

To facilitate optimal utilization of student feedback for enhancing the quality of teaching and learning, it is imperative to understand the purpose, benefits as well as drawbacks associated with this source of information. Elaborating on the purpose of student feedback, Darwin (2016) indicated that institutions of higher education use it as means to examine student perceptions to assure, or improve, the quality of teaching and student learning. Regarding the benefits, gathering feedback from students demonstrates to them that their voice is heard and that their opinions and concerns regarding the educational process do matter (Josefson et al., 2011), which help promote the perception that their institutions prioritize the quality of their educational offerings.

It is important to note that giving students the power to provide feedback on teaching can prompt different responses from instructors (Arthur, 2009). Therefore, a major drawback to using student feedback is the potential negative perception and reaction to student feedback held by instructors (Anderson, 2006). For example, negative feedback from students can affect instructors emotionally, possibly imposing a negative influence on their subsequent teaching performance. According to Arthur (2009), whether or not instructors make any changes in response to student feedback depends on a number of factors. These include instructors' perceived importance of teaching, how many students reported the same experience, and the teaching culture of the university (Arthur, 2009). Nonetheless, some instructors might show resistance to student feedback (Arthur, 2009), especially if used for administrative decisions that impact their job satisfaction and morale (Wachtel, 1998; Stowell et al., 2012). Interestingly, students were more motivated to provide feedback to improve teaching in terms of format and content, but less motivated to provide feedback that would affect administrative decisions related to promotion, tenure, or salaries (Chen & Hoshower, 2003).

In order for student feedback to be an effective means for meaningful change, Seldin (1989) illustrated that there must be a culture within universities in which academic leadership, faculty, and administrators consider the importance of this source of information. Such a feedbackaccepting culture tends to use both positive and negative feedback to initiate changes so that student expectations and needs for a better learning environment can be achieved. Blair (2017) noted that the gap between student expectations and the realities of what is possible might negatively impact their satisfaction, but that student feedback can nonetheless be used to help fill this gap.

2.4.2 Factors to improve the effectiveness of student feedback

There are several issues that can impact the validly and reliability of student feedback such as bias and lack of specificity (Stein et al., 2012; Surgenor, 2013). Therefore, the following sections discuss various factors that can be considered to improve the effectiveness of student feedback, including the clarity and objectivity of feedback content, the way it is collected, and how it is analyzed and delivered.

Clarity and objectivity of feedback content

The use of generic surveys to collect feedback from students regarding the teaching and design of various courses is a common practice in higher education institutions. However, the use of such surveys may not produce meaningful findings that could facilitate quality enhancement of teaching. For example, teaching methods used in basic science courses are different from those used in social or behavioural sciences, suggesting that only general or vague feedback may be collected by a generic survey. Compared to general and vague feedback, specific and clear feedback can be more informative (Liden & Mitchell, 1985), which signals the need for tailored surveys relevant to the learning environment (validity). Students should also be urged to provide constructive feedback. In order to be constructive, student feedback must be objective, focusing on observable teaching behaviours or certain aspects of the course design; specific, with examples based on student personal experience; and respectful, avoiding derogatory comments and criticism based on race, religion or gender (Svinicki, 2001; Dalhousie university-1, n.d.).

Clarity of the process

The clarity of the feedback process to all stakeholders (why and how feedback will be used) is vital to improving the effectiveness of student feedback (Cornell, 2014). Both students and instructors must be aware of the feedback process (Cornell, 2014), which is geared to meet the needs of students, instructors, and the institution (Watson, 2003). This implies that students must be informed about why their feedback is being collected, the type of feedback sought, and how feedback will be used (Shah et al., 2017). Likewise, instructors must be informed about the purpose and importance of student feedback and what exactly it is going serve. When the feedback process is clear, the data collected has greater potential to enhance the student learning environment (Beran et al., 2007).

Collection of feedback

Surveys are popular tools in health professions education to gather a wealth of data about abstract concepts and ideas, including opinions, beliefs, and attitudes, which help collect information about unobservable behaviours (Rickards et al., 2012). Using surveys can bring about meaningful insights into the understanding and approach to various issues (Allery, 2016). Similarly, surveys are widely used to gather feedback because they are easy to administer to a large number of students (Kember et al., 2002; Richardson, 2005). Online survey platforms have made surveys even more popular and convenient as students have become more comfortable using such technology (Zou & Lambert, 2017). Research shows that students are more motivated and engaged when responding to online surveys, providing more thoughtful comments (Stowell et al., 2012), compared to traditional written or verbal feedback methods (Bennett & De Bellis, 2010; Baleni, 2015). Online surveys facilitate the dissemination of feedback questionnaires and the collection of responses from geographically widespread participants (Tavakol & Sandars, 2014). Also, the use of the online approach permits the extraction and handling of a large amount of data, minimizing errors in data entry (Allery, 2016).

Despite the ability of both formats (online and paper-based) of feedback delivery to produce comparable data (Stowell et al., 2012), instructors may report less interest in using online platforms to receive feedback (Rienties, 2014). This disinterest was attributed to instructors' concern that the online method may lead to lower student response rates, resulting in a less representative reflection of their teaching and student learning experience (Stowell et al., 2012). Therefore, given the concerns, real or perceived, about online survey participation, students should be encouraged and reminded to participate when online surveys are used to collect feedback.

Feedback analysis and delivery

Since students usually lack expertise in specific areas of curriculum development, instructors are likely to accept critique from more qualified individuals. For example, a mediator who can examine student feedback and address it with the instructor can have greater impact on course content and delivery than direct feedback from students to instructors (Brinko, 1993). To maximize the effectiveness of student feedback, the mediator role, that can be assumed by a colleague or a committee, can assist the instructor to interpret the results of student feedback and can provide recommendations (Knapper & Piccinin, 1999). Through this approach the examination and delivery of student feedback can be more of a collaborative learning process, rather than a challenge to the competency of the instructor (Penny & Coe, 2004; Arthur, 2009). Student feedback should be considered one of many sources of information to enhance teaching and learning. Student feedback should be part of an overall strategic plan that seeks triangulated evidence from different perspectives for the development and improvement of teaching and learning (Chan et al., 2014; Collett et al., 2017).

Combined qualitative and quantitative research methodology

Research methodologies are often classified as being either quantitative or qualitative, with researchers using each methods arguing the superiority of one over the other (Johnson & Onwuegbuzie, 2004). Quantitative purists (positivist theorists) insist that research should be objective, privileging timeless, contextless generalizations (Johnson & Onwuegbuzie, 2004). The philosophical stand of their research paradigm is rooted in natural sciences, which perceives reality as based on unchanging, universal laws that explain the natural world (Johnson & Onwuegbuzie, 2004). According to Žukauskas et al. (2018), positivist research philosophy posits that, like the natural world, the social world can be understood objectively. To understand the nature of society, positivist researchers pursue scientific evidence and generalizations that are based on the collection, statistical analysis, and interpretation of quantifiable numerical data. This position considers positivist researchers in the social context as social scientists and objective analysts who can dissociate personal values and work independently. On the other hand, qualitative purists (constructivist theorists) argue that reality is a construct of the human mind, and as such, posit that truth is subjective (Johnson & Onwuegbuzie, 2004). They contend that multiple constructed realities exist, and that research is value bound; therefore, time and context-free generalizations are not desirable or possible (Johnson & Onwuegbuzie, 2004). Social constructivist researchers argue for the use of qualitative methods as essential because knowledge and understanding draw on the observation and judgment of people who are different in the way they construct meanings

(Crotty, 1998). Examples of qualitative methods include semi-structured interviews and open-ended surveys, which are often used to understand people's beliefs, attitudes, experience, and interaction (Pathak et al., 2013). Thus, generalizations that do not consider the context of people’s perspectives would not provide a view of the causes and effects of what is being investigated (Johnson & Onwuegbuzie, 2004).

Even though the use of quantitative and qualitative research methods in a single line of inquiry originated in social science research, it has expanded into the health and medical sciences (Wisdom & Creswell, 2013). Based on constructivism and positivism as philosophical underpinnings, pragmatism is an emerging research paradigm that is not committed to a single system of reality. Pragmatist research tends to focus on answering the 'what' and 'how' of the research problem using quantitative and qualitative methods for data collection and analysis (Tashakkori & Teddlie, 2008). Combining quantitative and qualitative techniques within the same framework enables pragmatist research (Table 2) to incorporate the strengths of both methodologies (Johnson & Onwuegbuzie, 2004). Therefore, utilizing quantitative and qualitative methods to collect and analyze student feedback enables a more thorough examination and understanding (Kruidering-Hall et al., 2009; Ludvigsen et al., 2015).

Table 2: Some general characteristics and weaknesses of pragmatism (Adopted from Johnson & Onwuegbuzie, 2004).

General characteristics
Rejects traditional dualisms (e.g., rationalism vs. empiricism, values vs. facts, subjectivism vs. objectivism) and generally prefers more moderate and common-sense versions of philosophical dualism based on how well they work in solving problems.
Recognizes the existence and importance of the natural or physical world as well as the emergent social and psychological world that includes language, culture, human institutions, and subjective thoughts.
Knowledge is viewed as being both constructed and based on the reality of the world we experience and live in.
Offers the "pragmatic method" for solving traditional philosophical dualisms as well as for making methodological choices.
Places high regard for the reality of and influence of the inner world of human experience in action. Takes an explicitly value-oriented approach to research derived from cultural values (shared values). Endorses practical theory that informs effective practice as the path to determine what works.
Endorses pluralism (different, even conflicting, theories and perspectives can be used; observation, experience, and experiments are all useful ways to gain an understanding of people and the world.
Human inquiry is viewed as being analogous to experimental and scientific inquiry. We try out things to see what works, what solves problems, and what helps us to survive. We obtain warranted evidence that provides us with answers that are ultimately tentative, but, in the long run, use of this "scientific" or revolutionary or practical epistemology moves us toward larger Truth.
Views current truth, meaning, and knowledge as tentative and as changing over time. What we obtain on daily basis in research should be viewed as provisional truths.
Theories are viewed instrumentally (they are true to different degrees based on how well they currently work; workability is judged especially on the criteria of predictability and applicability).
Capital "T" Truth (i.e., absolute Truth) is what will be the "final opinion" perhaps at the end of history. Lowercase "t" truths (i.e., the instrumental and provisional truths that we obtain and live by in the meantime) are given through experience and experimenting.
Weaknesses
Pragmatism may promote incremental change rather than more fundamental, structural, or revolutionary change in society.
What is meant by usefulness of workability can be vague unless explicitly addressed by a researcher.

The term "mixed methods" could be used to describe the utilization of the two types of data in a single research framework. However, the term is widely acquainted with approaches employing more than one mode of data collection, for example, the use of surveys and interviews. Hence, here the term "combined methods" will be used to describe the use of two types of data obtained from a single mode of data collection. The following are examples of survey research studies using a combined methods approach, and which demonstrated how the use of two types of data resulted in greater clarity of the findings and a better understanding of the outcomes.

Inuwa (2012) evaluated the perceptions of first-year medical students toward TBL in Oman. The author used TBL sessions with two student cohorts. For every TBL session, students had to do pre-class readings and then in-class readiness assurance tests before solving clinical cases as teams. Students were surveyed at the end of each course to assess their perceptions using quantitative and qualitative questions. The quantitative results showed that students responded positively because the TBL sessions encouraged problem-solving and in-class discussion. The qualitative analysis revealed that most students agreed that the TBL strategy positively impacted their learning attitudes because it encouraged consistency in their study and increased awareness of self-directed learning. The qualitative analysis also identified a Middle eastern bias - students disliked the idea of the mixed-gender configuration of TBL teams, which was attributed to the fact that many of the students were nourished in a traditional society where the segregation of genders in secondary education is common. The qualitative findings in this example enhanced the quantitative results.

Another study compared student perceptions of two formats of laboratory-based small group learning activities in an integrated medical program at the University of Ottawa (Whelan et al., 2016). The authors used quantitative and qualitative questions to survey participants, who had completed the curriculum. The first format, called Emphasized Independent Learning (EIL) approach, emphasized elements from the flipped classroom strategy, including pre-laboratory preparation and independent learning in the laboratory with limited tutor involvement. In contrast, tutors in the second format, the Facilitated Active Learning (FAL) approach, engage students and were expected to enable and balance their active learning and progression through learning objectives. The quantitative results showed that students perceived that EIL and FAL formats promoted professionalism and enhanced active learning. Also, students in EIL and FAL agreed that high achievers facilitated learning for weaker students during laboratory group demonstrations. Both types of students reported lower levels of agreement regarding the ability of weak students to contribute to collaborative group learning. The qualitative results showed that students associated the inability of weaker students to contribute to collaborative learning primarily with variability among tutors, especially in the FAL cohort. The quantitative results of students in the FAL revealed that they were more likely to report their completion of laboratory learning objectives as learning that was facilitated through collaborative efforts. The qualitative analysis revealed that FAL students associated these outcomes with instructional support and guidance. EIL students characterized their laboratories as inefficient, referencing the lack of instructional direction and feedback. The quantitative results indicated that EIL students were more likely to report that competencies related to collaboration and communication were enhanced through laboratory-based activities. The qualitative results suggested that EIL students also enjoyed the opportunity to learn independently. In this example, the qualitative findings explained the quantitative results.

2.5 Chapter conclusions

The complex nature of healthcare delivery necessitates team-based approaches with effective collaboration, and future health professionals are increasingly expected to work together to deliver comprehensive services. Therefore, it has become imperative for health professional education to enable mindsets for such a work configuration. IPE occurs when students from two or more health professions learn with, from and about each other to cultivate effective collaborative practice.

Although the biases and attitudes of students are contingent on their early experiences in the educational process, current IPE initiatives in health professional education focus on clinical topics rather than basic science activities. Generic interprofessional competencies, especially those related to soft skills (teamwork and communication), can however be targeted in basic science courses offered to two or more different health professional students. Given the essentiality of human anatomy in health professional education, there is a need to revamp its inclusion to achieve competencies and outcomes related interprofessional collaborative practice.

The definition of IPE indicates that effective learning must proceed collaboratively through a shared process. Based on S-S interaction is the concept of collaborative learning, in which students with different performance levels work together in a group to achieve a common learning goal. Thus, gathering feedback from students on their interaction with peers in human anatomy can provide insights into the design of effective collaborative learning as a basis for IPE. Institutions in higher education utilize student feedback to examine student perceptions to assure, or improve, the quality of teaching. Evidence suggests that student feedback significantly contributes to enhancing the quality of university teaching. The use of online surveys facilitates the collection and analysis of feedback from a large number of students. Moreover, combining quantitative and qualitative methods for data collection and analysis incorporates the strengths of both methodologies, allowing for a more thorough examination and understanding of student feedback.

CHAPTER 3: THESIS RATIONALE, OBJECTIVES, AND HYPOTHESES

3.1 Rationale

The work in this thesis sought to understand how different modes of anatomy teaching and course design influenced student perceptions and attitudes toward interaction and collaboration. The specific objectives used student feedback about their learning in two different environments, namely technology-based (TBAE) and cadaver-based anatomy education (CBAE), to analyze the potential of those environments to foster the shared learning necessary for IPE (see Section 2.2.2). The underlying goal of this work was to identify features of course design and delivery that enhance interactions and collaboration between students.

To better understand student feedback, Schifferdecker and Reed (2009) indicated that collecting and analyzing both qualitative and quantitative data can help draw more useful conclusions than if only quantitative or qualitative methods are utilized. Thus, the thesis's pragmatic approach, utilizing combined methods, sought to provide diverse feedback with deeper insights, which could assist instructors in the process of enhancing collaborative learning to facilitate the implementation of IPE. The findings could fit into a larger systematic planning process to develop outcome-based interprofessional curricula framed around collaborative multimodal learning in human anatomy.

3.2 Objectives and hypotheses

The study targeted three human anatomy courses with the broad objective:

> ***To understand how different modes of human anatomy teaching and course design influence student perceptions and attitudes toward interaction and collaboration***

3.2.1 Study I: Technology-based human anatomy education (TBAE)

Study I involved an entry-level undergraduate course that is highly sought after by students because it serves as an integral/prerequisite curricular component for several health professional programs. The course is offered in both a traditional face-to-face (F2F) format and a distance education format, the latter being completely reliant on information technology. The course delivery is facilitated using an integrated LMS shared by F2F and distance education students.

To understand the impact of the technology-based course design on student interaction, students were surveyed for perceptions and attitudes about their learning in relation to three types of interactions: with content (S-C), with instructors (S-I) and with other students (S-S) (see Section 2.1). The Digital Anatomy Learning (DAL) project was an initiative that sought to foster S-S interaction in the course through the design and implementation of an optional online group activity. Possibilities for S-S interaction were framed around the task of creating and sharing educational videos that students find helpful in learning the course content. Peer voting and comments on participant videos were expected to initiate and fuel student-led discussions. Suggestions from students to improve lecture attendance and participation in the DAL project were also explored to gain insights into enhancing the learning experience with S-S interaction in the F2F and online learning environments of the course.

Study I objectives

1. To examine how the technology-based teaching and design of the course provides a foundation for independent and personalized anatomy learning.
2. To explore and explain student perceptions towards three types of interactions (S-C, S-I & S-S).

3. To explore possible correlations between student perceived ability for independent learning and their perceptions towards the three types of interaction.
4. To identify and discuss factors influencing student participation in the optional group project.

The data obtained from the objectives was used to consider three key proposed hypotheses.

Study I hypotheses

1. Depending on delivery modality, students are different in the way they learn the course content. There is a difference between F2F and distance education students in terms of their perceived ability to learn independently.
2. S-S interaction is necessary in the course. There is a difference between F2F and distance education students in terms of their perceived need for S-S interaction.
3. There is a relationship between students' need for S-S interaction and their ability to learn independently.

3.2.2 Study II: Cadaver-based human anatomy education (CBAE)

Study II involved traditional and modernized designs of graduate-level gross anatomy courses. These courses were designed to provide a foundation for three health professional programs: Master of Physiotherapy (PT), Master of Occupational Therapy (OT) and Doctor of Dental Surgery (DDS). Learning in the laboratory was framed around student-led dissection activities in the traditionally designed courses, whereas learning in the modernized courses was framed around student-led discussions involving the use of prosections. The traditional course design was used to foster interprofessional laboratory activities between OT and PT students.

Students were surveyed for perceptions and attitudes toward gross anatomy learning in the traditional and modernized course designs. The goal was to understand the impact of different course designs on student preference and interaction. The study also sought to gain insights into how to optimize the use of cadavers to design effective collaborative activities for one or more types of health professional students.

Study II objectives

1. To examine if traditional dissection-based anatomy teaching and course design provides a foundation for interprofessional learning and interaction.
2. To identify factors influencing interprofessional student collaboration in the traditional dissection-based anatomy laboratory.
3. To explore and explain student perceptions of the usefulness of dissection and prosections in the traditional and modernized course design.
4. To explore and explain student perceptions of the usefulness of dissection and prosections in modernized course design.
5. To compare student performance in traditional and modernized course designs.
6. To examine how the use of donated cadavers in the traditional and modernized course designs provides a foundation for professional learning and interaction.

The data obtained from the objectives was used to consider two key proposed hypotheses.

Study II hypotheses

1. As a result of the different admission prerequisites of their programs, there are differences between OT and PT students in terms of their perceived readiness for interprofessional learning.
2. Students perceive prosections as more useful than dissection in learning the course content because prosections enable straightforward learning facilitated via direct visualization of structures.

CHAPTER 4: STUDY I - TECHNOLOGY-BASED ANATOMY EDUCATION (TBAE)

4.1 Introduction

Increasing student enrolment is one of the challenges facing introductory anatomy education. The limited capacity of a campus-based lecture theatre, classroom or laboratory, curtails the ability to accommodate students in large numbers. Thus, establishing distance education has become a logical response that provides an effective solution (Allen, 2017). With less time and cost involved, distance education offers more accessibility, allowing for virtually unlimited enrolment capacity (Attardi & Rogers, 2015).

Early forms of distance introductory anatomy education relied on correspondence, in which printed course materials were mailed out to students. Before the advent of the internet, interaction with and between distant learners was minimal as students were often only expected to be present in person for a final proctored exam (Allen, 2016). It was not until advances in information technology permitted alternative means for delivery that interaction with distant learners became possible. As distance education evolved, learning has been enhanced through a more dialogical process that emphasize the engagement between the learner and the teacher (Kaufman, 1989; Huett et al., 2004).

4.2 The Basic Human Anatomy course at Dalhousie University

Introductory anatomy courses are a common feature of university course offerings.[5] At Dalhousie University, Basic Human Anatomy is an entry-level undergraduate course that is highly sought

[5] At Dalhousie University, the Department of Medical Neuroscience and its Division of Anatomy operate to deliver core anatomical knowledge to students in various health professions.

after by students. This three-credit-hour course serves as an integral/prerequisite curricular component for several health professional programs. Upon successful completion of this introductory course, students are expected to explain and describe, at a basic level, the micro and macro anatomical levels of the human body.

Course delivery and student interaction

The course delivery had evolved from a traditional lecture-based to an online format. Historically, teaching was carried out exclusively using F2F didactic lectures. Several instructors collaborated with teaching assistants to deliver the course content and interact with manageable class sizes to facilitate learning. However, in response to increasing student enrolment, a distance education section employing self-learning pedagogies was established parallel to the existing F2F sections. To best use available resources, technology has been adopted by all course sections, facilitating the introduction of such pedagogies to all students in the course.

Although the course is currently offered through different F2F and distance education sections, the delivery of all sections is reliant on technology. The course uses an integrated LMS shared by F2F and distance education students. The LMS is used as a hub for asynchronous communication to facilitate teaching, learning and assessment. It contains a vast collection of multimedia learning resources including recorded lectures. All course materials are available online 24/7 on the course's LMS. An online interactive study tool is also used to supplement student interaction. Students registered in F2F sections have the opportunity to attend the course lectures. Since lectures are no longer the primary means for content delivery, student attendance is optional. In addition to this relaxed design, assessment in the course is done online and follows an open-book exam policy.

The origin of this study came from an observation realized from previous offerings of the course, that lecture attendance dwindled as the course progressed. In 2016, the instructor (Dr. A.) made an attempt to motivate students to attend the course lectures by incorporating occasional in-class activities derived from exam questions. The activities were periodically implemented during lectures following a peer-based teaching methodology, an adaptation of the think–pair–share technique and which has been shown to decrease student attrition (Crouch & Mazur, 2001). The idea was to foster learning by helping students recognize gaps in their knowledge and gain familiarity with the exam's tactics. The activities were not graded nor made available as part of the recorded lectures. The intervention did not address attendance deterioration, and student interaction in such course design became in question.

Previous research suggests that learner isolation in online courses can be addressed through promoting interaction between learners to support their learning (Sharp & Huett, 2006; Banna et al., 2015). Therefore, the Digital Anatomy Learning (DAL) project was another initiative that specifically sought to foster S-S interaction through the design and implementation of an optional online group activity. Possibilities for S-S interaction were framed around the task of creating and sharing educational videos that students find helpful in learning the course content. The project's first iteration involved a strict grading scheme based on peer voting and led to three potential bonus points. The DAL project was anticipated to create a source of learner-generated content, which could provide students with renewed learning opportunities (Doubleday and Wille, 2014). Peer voting and comments on participants' videos were expected to initiate and fuel student-led discussions. Unfortunately, student participation in the project was subpar.

Study objectives and hypotheses

To understand the impact of the technology-based course design on student interaction, students were surveyed for perceptions and attitudes toward learning through various types of interactions. Suggestions from students to improve lecture attendance and participation in the DAL project were also explored to gain insights into enhancing the learning experience with S-S interaction in the F2F and online learning environments of the course.

Study objectives

Objective 1:	To examine how the technology-based teaching and design of the course provides a foundation for independent and personalized anatomy learning.
Objective 2:	To explore and explain student perceptions towards three types of interactions (S-C, S-I & S-S).
Objective 3:	To explore possible correlations between student perceived ability for independent learning and their perceptions towards the three types of interaction.
Objective 4	To identify and discuss factors influencing student participation in the optional group project.

The data obtained from the objectives was used to consider three key proposed hypotheses.

Study hypotheses

Hypothesis 1:	Depending on delivery modality, students are different in the way they learn the course content. There is a difference between F2F and distance education students in terms of their perceived ability to learn independently.
Hypothesis 2:	S-S interaction is necessary in the course. There is a difference between F2F and distance education students in terms of their perceived need for S-S interaction.
Hypothesis 3:	There is a relationship between students' need for S-S interaction and their ability to learn independently.

4.3 Methods

In this section, the design of the Basic Human Anatomy course is delineated; this is followed by a detailed description of the study design with highlights on the survey instrument and the established procedures used in data collection and analysis.

4.3.1 Course materials and design

The course core curriculum is comprised of three blocks designed to help students develop anatomical knowledge incrementally. The curriculum introduced students to human anatomy based on an ascending order of the levels of structural organization: atomic, molecular, cellular, tissue and systemic. The objectives of the course were confined to the first three levels of Bloom's Taxonomy (Bloom, 1956): Remember, Understand, and Apply (Figure 4). The course required Principles of Human Anatomy (Tortora, 2002) as a textbook. With newer editions of the book, the publisher provided an online interactive study tool (WileyPLUS), a mandatory component of the course (all students were required to purchase an activation code).

F2F sections of the course (ANAT-1010 Section 1, ANAT-1020 and DEHY-2851) were offered exclusively in the Fall term and included a lecture component. Registration in F2F sections was restricted to students in the Schools of Nursing, Recreation, Physical and Health Education and Kinesiology. Limited seats were also available for students in other health professions, arts and science, or non-degree students. The distance education section (ANAT-1010 Section 2) was offered twice a year, in the Fall and Winter terms. Registration in this section was unrestricted and open to all students.

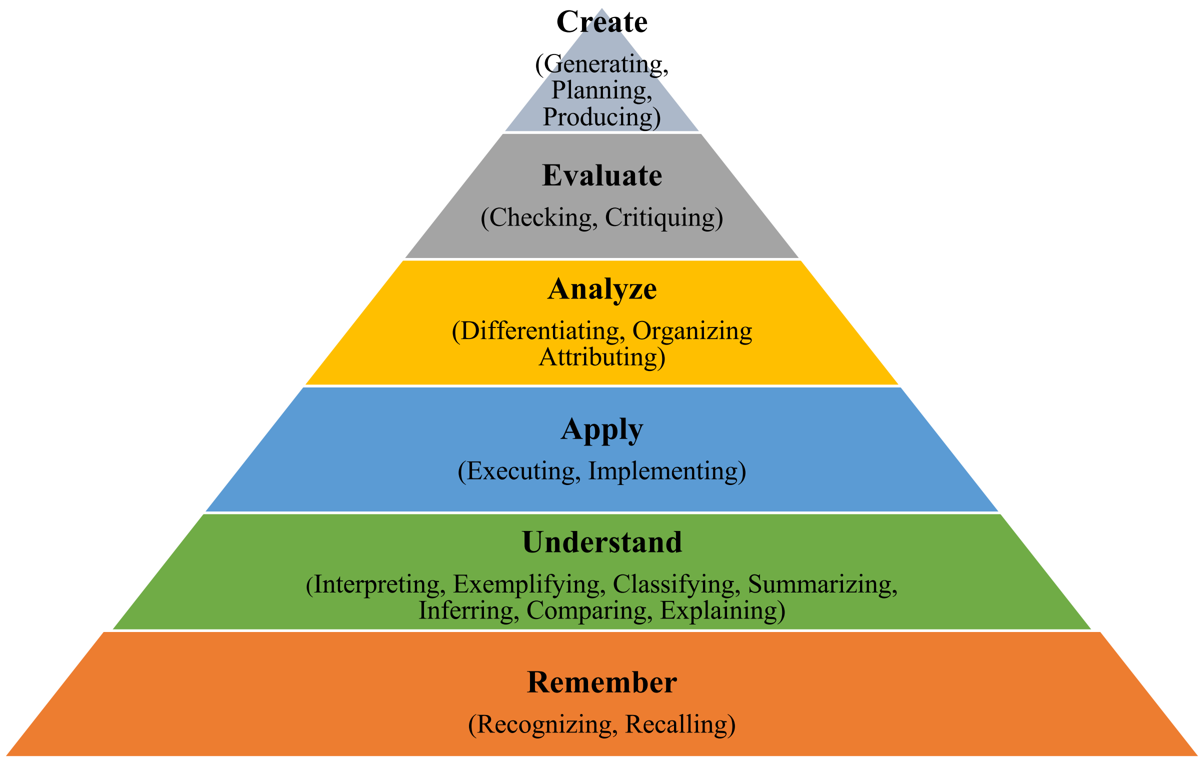

Figure 4: Bloom's Taxonomy (Adopted from Krathwohl, 2002). Created by Bloom (1956) as a way to categorize the levels of reasoning skills expected or intended for students to master as a result of teaching.

Teaching, learning and assessment in the course

F2F interaction in the course occurred during lecture time in a large theatre accommodating up to 185 students. The course's one-hour didactic lectures were scheduled thrice weekly in the Fall term, totalling 34 hours. Every lecture was delivered two times as there were two different F2F sections. Students registered in the course's F2F sections were expected to attend the lectures, while distance education students were welcomed. The first day of the course was used to welcome the students and to provide an overview of the course – information about the design, content, objectives, and assessment. Students were encouraged to communicate questions, problems, and any concerns with the course instructors by telephone, email or in person. Students were also encouraged to visit a museum located on the 13th floor of the Tupper Medical Building, Carleton campus, at Dalhousie. Throughout the course, the instructors strived to convey enthusiasm, fostering a respectful learning environment by demonstrating the appeal of the anatomical facts, addressing their clinical relevance, and emphasizing the importance of all health professions.

Mediated interaction in the course relied on information technology. The course LMS (Brightspace; Desire2Learn, Ontario, Canada) provided students with tools for learner-centred learning. With course materials available from day one, the design of Brightspace allowed the instructors to act as facilitators. In addition to a detailed syllabus – study objectives and assessment, the course materials included 34 recorded lectures (Camtasia software; TechSmith, Okemos, MI), lecture slides and a virtual anatomy laboratory. The virtual laboratory contained 15-20 minute videos made by the instructors using prosections with a voice-over to explain the visuals. All materials available on Brightspace were made downloadable to enable offline accessibility.

WileyPLUS, which complements the course's textbook, was used to promote student engagement with content throughout the term. WileyPLUS provided a combination of a wide range of multimedia learning resources; it also contained weekly formative homework assignments that provided immediate feedback, serving as self-assessment modules throughout the course. WileyPLUS assignments, weighing 20% toward the final grade, were due weekly with penalties for late completion. These assignments comprised sets of multiple-choice questions (MCQs). The instructors enabled the Question Assistance function, which allowed students up to two attempts to answer each question before it locked. When students struggled to answer a question, the feature provided links that opened to the chapter and section of the online textbook, describing the content tested in the question. This strategy is to provide customized content reinforcement for each student through immediate feedback (WileyPLUS, n.d.).

Learning in the course was assessed through three summative midterms (at the end of each block) and a final examination, totalling 80% of the final grade. The exams, consisting of MCQs and True-or-False questions, were administrated online with an open-book policy, which sought to facilitate learning during exams in a private and comfortable environment. Given the breadth of the course content, this approach was believed to enable students to learn how to resource and retrieve information rather than relying on mere memorization. Exam questions included, but were not limited to, structure identification questions using cadaveric images, textbook figures, and screenshots of three-dimensional (3D) computer models.

The Digital Anatomy Learning (DAL) project

While participation in the DAL project (Appendix A) was optional, bonus points were offered to motivate students to form groups and collaborate to create and share short educational videos. To enable students to reflect on their learning and interests, they could choose their topic of interest from the course content to make these videos. Students who wished to participate were required to submit their videos on the project's designated thread on Brightspace to allow other students to watch, vote and comment. Students had deadlines to vote for their favorite videos, which could be done by simply clicking the 'Like' or 'Dislike' buttons.

The DAL project was implemented in eight consecutive terms, from Fall 2016 to Winter 2020. In the first iteration of the project (Fall 2016, Winter 2017, Fall 2017 and Winter 2018), peer voting determined which videos advanced to the finals, where they were critically evaluated by the course instructors using a rubric (Appendix B). A maximum of three group winners (first, second and third) were awarded the bonus points, with group members receiving five, four, or three points, respectively. This grading scheme was based on the concept of gamification and aimed to promote competition and creativity (Urh et al., 2015).

To encourage more students to participate in the activity, the project was refined and implemented in a second iteration (Fall 2018, Winter 2019, Fall 2019 Winter 2020). Starting from Fall 2018, all videos were awarded bonus points. Wining bonus points was no longer governed by peer voting nor limited to three winners. Beginning in Fall 2019, the DAL project was advertised more often, and the criteria of the quality evaluation rubric (Appendix B) were included as part of the project's description (Appendix C). Although the quality of videos was not used as a sole basis for awarding bonus points, sharing the quality evaluation criteria allowed students to know what makes a good video. Further restrictions were waived to encourage more participation in the DAL project – submissions in another electronic format were accepted (Microsoft PowerPoint). Although students were encouraged to work in groups, individual participants were awarded bonus points.

It is worth mentioning that another optional activity (Appendix D) was introduced in Fall 2018 to compliment the DAL project along with the previous refinements. The activity was implemented by presenting two to four questions during lectures and allowing students to submit their answers via personal laptops or other handheld smart devices using an audience response system (Top Hat). The activity aimed to augment student engagement by providing students with real-time feedback and answers. The activity was also available to online students to help them keep proper pace with the course. The questions from this activity were available as homework in an assigned folder within students' Top Hat accounts on the day of the scheduled lecture. Students were given one minute to respond to each question. Students received 0.5 for participation and 0.5 for correctness. Total scores were calculated out of 5% and added on top of the course grade as bonus points.

However, the maximum bonus points students could get for Top Hat and the DAL project were set not to exceed 5 points.

Videos submitted by students before and after the refinement of the DAL project were analyzed by the instructors to improve the design of the activity. Further, the relationship between the number of students involved in making a video and the quality of the video was investigated.

4.3.2 Study design

The study sought to better understand how students interact and engage in the course by examining their approaches to learning. In consultation with the course instructors and other experienced educators, a questionnaire-based survey was developed to collect measurable data from students. The survey was administered online.

In order to be able to survey students, an application to the University's Research Ethics Board (REB) was submitted to obtain research ethics approval. The application received an exemption status as per TCPS2, Article 2.5 (Tri-Council Policy Statement, n.d.; Dalhousie University-2, n.d.). TCPS2, Article 2.5 states that,

> "Quality assurance and quality improvement studies, program evaluation activities, and performance reviews, or testing within normal educational requirements when used exclusively for assessment, management or improvement purposes, do not constitute research for the purposes of this Policy, and do not fall within the scope of REB review."

Measurement instrument

The survey questionnaire (Appendices E-G) consisted of two components: learning and interaction (L&I) and participation in the DAL project (DAL). Each component had quantitative and qualitative questions. The quantitative questions of the survey components comprised of sets of structured statements, which asked students to express their level of agreement or disagreement using 5-point Likert items, ranging from 1 (Strongly disagree) to 5 (Strongly agree). The quantitative questions of the first component (L&I) were intended to measure student perceived ability to learn independently and their perceptions regarding the need and usefulness of the three types of interaction, as defined by Moore (1989): S-S, S-I and S-C interactions. The quantitative questions of the second component were geared towards exploring possible reasons for poor participation in the DAL project.

In each component, the quantitative questions were followed by an open-ended question that offered an unlimited comment field to allow students to express their beliefs and elaborate on their responses. Additionally, component 1 (L&I) included an open-ended question asking students to describe their learning approaches. The purpose of collecting qualitative data was to gain deeper insights into student Likert-item responses by capturing possible perceptions and attitudes about learning and interaction in the course.

Data collection and filtering

At the end of three academic terms: Fall 2016, Winter 2017, and Fall 2017, an invitation to participate in the survey (Appendix H) was sent as an announcement on the course's Brightspace. The recruitment message of the invitation introduced the purpose of the study, encouraging students to provide feedback on their experiences in the course. The message included a note that student responses would be collected anonymously and emphasizing that the results could ultimately improve the experience in the course for future learners. An electronic link to the survey was provided for students who decided to participate. The link directed students to the survey's online page. Participants were informed that participation in the survey was entirely optional, and that they were welcome to stop the survey at any time if they no longer wished to participate. Responding to quantitative questions was required, while responding to qualitative questions was left optional. Partial responses to quantitative questions were considered incomplete and therefore deleted. Reminder emails were sent to students to improve the response rate. A total of 402 responses were received, of which 381 were analyzed. The process of data collection is summarized in Table 3.

Participants' groups

Participants in the study were students registered in different sections of the course in different academic terms (Table 3). Response rates were between 11.7% - 24.3%. Based on their enrolment term and section of registration, student responses were grouped into three main groups and two subgroups:

Group 1**:** with 191 responses from students enrolled in Fall 2016 (total enrolment = 786), Group 1 was a mix of students registered in F2F and distance education sections.

Group 2: with 78 responses from students enrolled in Winter 2017 (total enrolment = 485), all students were registered in the distance education section. Same survey questions were used with Group 1 and 2 except for a statement regarding the ability to attend the course lecture.

Group 3: with 112 responses from students enrolled in Fall 2017, Group 3 was a mix of students registered in the F2F and distance education sections. However, it was possible to distinguish between them by adding a question to the original survey, which allowed students to indicate their section of registration (F2F or distance education). Based on the qualitative analysis of Group 1 responses, Group 3 students were asked to rate six additional statements related to learning and participation in the DAL project (statements 2, 4, 8 and 9 in question 5 in component 1 and statements 1 and 2 in question 9 in component 2; Appendix G). Group 3 was divided into two subgroups, A and B. Group 3A (n=51) students were registered in F2F sections (total enrolment was 312) while Group 3B (n=61) students were registered in the distance education section (total enrolment was 520).

Table 3: Data collection (Study I groups).

Group 1: (Mixed types of students)	Fall 2016 (Appendix E)		**Preliminary**
	Responses: 191 from students registered in F2F sections: ANAT-1010 (Section 1) and ANAT-1020 & Distance education section: ANAT-1010 (Section 2)	Survey components: • Learning and interaction (L&I) • Participation in DAL project (DAL)	
Group 2: (One type of students)	Winter 2017 (Appendix F)		**Follow-up 1**
	Responses: 78 from students registered in Distance education section : ANAT-1010 (Section 2)	Survey components: • Learning and interaction (L&I) • Participation in DAL project (DAL)	
Group 3: (Two separable types of students)	Fall 2017 (Appendix G)		**Follow-up 1**
	Responses: 112 from students registered in F2F sections (n=51) : ANAT-1010 (Section 1), ANAT-1020 & Distance education section (n=61) : ANAT-1010 (Section 2)	Survey components: • Learning and interaction (L&I) • Participation in DAL project (DAL)	

Data Analysis

To address the study objectives and test its hypotheses, quantitative and qualitative analyses were performed using well-known analytical tools and procedures summarized in this section.

Quantitative data

Data were exported from the online survey platform to Microsoft Excel. The variables were then organized for analysis using Statistical Package for the Social Sciences (SPSS) software. SPSS was used to calculate the following:

- The normality of the data was assessed using both graphical (Histograms) and numerical (Shapiro-Wilk) tests. Based on the data distribution, the following statistics and tests were calculated for each of the datasets (groups):
    - Descriptive statistics of quantitative variables: the median (*Mdn*) for central tendency and the interquartile range (*IQR*) for dispersion. Boxplots were used as a graphical technique to summarize the distribution of datasets, providing a more convenient way to compare the study groups (Williamson, 1989). The construction of a boxplot divides the distribution of a dataset into quartiles (Potter, 2006). The box indicates the location of the upper and lower quartiles. The interior of this box (the area between the two quartiles) indicates the IQR, consisting of 50% of the distribution. The box is intersected by a crossbar, showing the Mdn of the dataset. The other ~50% of the distribution is represented by one or two lines (also known as whiskers) extending from the box to the extrema of the distribution (minimum, maximum values in the dataset or both). Outliers, which are numerically distant from the rest of the data, are symbolized as individual data points located beyond the whiskers of a boxplot.
    - Wilcoxon signed rank (non-parametric) test was used for comparisons with the neutral midpoint of 3 on 5-point Likert items.
    - Kruskal-Wallis one-way analysis of variance (non-parametric) test was used to compare the results of the three groups.
    - Bonferroni test was used to perform post hoc analysis.
    - Mann-Whitney U test (non-parametric) was used compare between F2F and distance education students and to test the study hypotheses.
- Spearman's rank correlation coefficient (Spearman's rho) test (non-parametric) was used to measure the strength and direction of associations between two ranked variables.

- In all cases, the null hypothesis was rejected if $p < \alpha = 0.05$.

Qualitative data

Qualitative data (from Group 1) were exported in PDF format, and then to Microsoft Word. Thematic analysis was carried out to identify and analyze recurring themes, which were patterns of meaning that showed up repeatedly (Braun & Clarke, 2006; Joffe, 2011). The steps of the thematic analysis followed a specific protocol, which was inspired by Kawulich and Holland (2012):

1. To organize the data, each student response was labelled (coded) with a color that represented a specific category of meaning. New responses were constantly compared with the color-coded ones, and new colors were used to code responses with new meaning that did not fit into none of the already identified categories.
2. To ensure the validity and reliability of the analysis, the previous step was performed by two researchers independently (the author of this thesis and an external investigator). The researchers compared and subsequently integrated the categories they created after reaching consensus.
3. The researchers then grouped the categories into themes and sub-themes according to their properties and dimensions. Disagreements between the researchers were addressed through conversation.
4. The researchers systematically refined the themes by revisiting student responses.

Using a publicly available online tool, word clouds were generated to visually illustrate frequently mentioned words (WordClouds, 2021). More frequently mentioned words were larger than less frequently mentioned ones. Since word clouds do not provide context, and the meaning of individual words may be lost, this visual technique was only used to provide an overview of the data by identifying trending words (italicized and bolded).

4.4 Results

In this section, the distribution of the study's data is discussed; this is followed by an examination of student responses to the survey's two components: L&I and DAL. Quantitative results are presented in descriptive statistics and boxplot graphs, and comparisons were made against a neutral midpoint of 3 (5-point Likert items) and between different groups of students, using appropriate statistics with statistical significance set at $\alpha = 0.05$. Qualitative results are presented in themes and sample quotes from student responses to open-ended questions.

4.4.1 Normality of quantitative data

Histograms were used to graph the distribution of quantitative data (not shown). These graphs suggested that all the data distributions collected did not display a bell-curvature. The Shapiro-Wilk test was then used to assess normality; the result for all items was $p < 0.05$. Thus, data was considered skewed and treated as not normally distributed. Therefore, statistical comparisons that follow employed non-parametric tests. For comparisons of data to the neutral midpoint, the Wilcoxon signed rank test was used. To compare two groups, the Mann-Whitney U test was employed. For comparisons between three groups, the Kruskal-Wallis test was used and, if applicable, Bonferroni post hoc comparisons were performed.

4.4.2 Component 1: learning and interaction (L&I)

The analysis of L&I component addresses student perceived ability for independent learning, their perceptions towards the need and usefulness of three types of interactions, and the impact of independent learning on lecture attendance.

The perceived ability for independent learning

This segment addresses the study's first objective, *to examine how the technology-based design of the course provides a foundation for independent and personalized anatomy learning.* The statement "I was able to develop my own learning style through independent study of the course materials available on Brightspace" was intended to measure student perceived ability to learn independently. When students were asked to indicate their level of agreement or disagreement with the statement, the results from Group 1, 2 and 3 were the same (*Mdn*=4; see Table 4 & Figure 5). For each group the median value was significantly different (p<0.001) from the neutral midpoint (Wilcoxon test, Table 4), but the data from the three student groups were not significantly different (p=0.133, Kruskal-Wallis test). This suggests that each group of students agreed that the course promoted independent learning through Brightspace and developed personalized approaches to learning the course content. No difference was detected between distance education students (Group 2) and the groups of mixed (F2F & distance) students (Group 1 & 3) suggesting that both types of students agreed that the course promoted independent learning.

Table 4: The perceived ability for independent learning (Group 1, 2 & 3).

Statement	**Group 1:** Mixed (n=191)			**Group 2:** Distance (n=78)			**Group 3:** Mixed (n=112)		
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
I was able to develop my own learning style through independent study of the course materials available on Brightspace.	4	1	**< 0.001**	4	1	**< 0.001**	4	1	**< 0.001**
Kruskal-Wallis *p*-value	0.133								

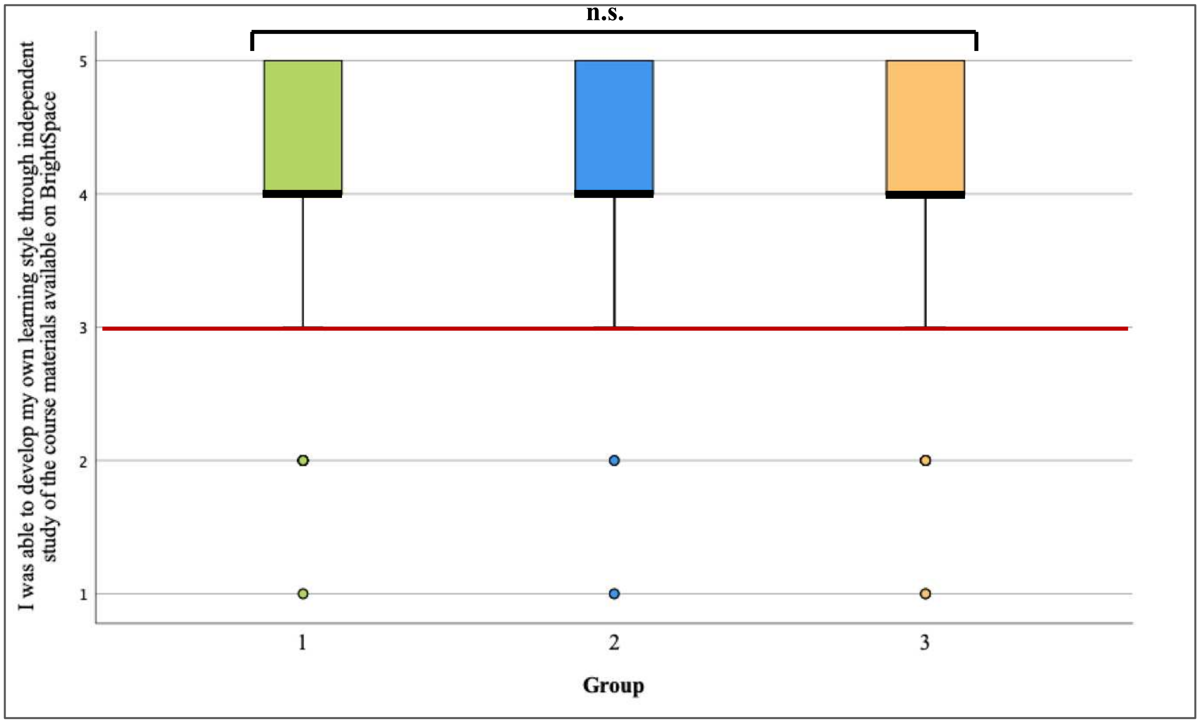

Figure 5: Boxplots of student levels of agreement (on a scale from 1 to 5) with a statement on independent learning (y-axis) for Group 1, 2 & 3 (x-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians *(Mdn),* and colored boxes span interquartile range (*IRQ*). n.s.= not significant.

Student perceptions towards three types of interactions

This segment addresses the study's second objective, *to explore and explain student perceptions towards three types of interactions.* Students were asked to indicate their agreement or disagreement with three statements intended to measure student perceived need for S-S, S-I and S-C interactions. The Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint of 3 (Table 5 & Figure 6). The results from the three groups reveal that students did not perceive (disagreed) that there was a need for S-S interaction to understand the course content (*Mdn*=2, $p<0.001$) and that they perceived (agreed or strongly agreed) WileyPLUS (S-C) as useful for engagement with the course content and progression (Group 1: *Mdn*=5, $p<0.001$; Group 2: *Mdn*=4, $p<0.001$; Group 3: *Mdn*=4, $p<0.001$). While Group1 students were neutral (*Mdn*=3*,* *p*=0.143), Group 2 and Group 3 students did not perceive (disagreed) the need for S-I interaction (*Mdn*=2, *p*<0.001).

The Kruskal-Wallis test was also used to compare the three groups of students. The results show that no significant differences between the groups in terms of S-S interaction. Regarding S-I interaction, the post hoc analysis (Bonferroni test) revealed significant differences, with the Group 1 results (*Mdn*=3) significantly different than Group 2 and 3 (*Mdn*=2). Regarding S-C interaction, the results of Bonferroni test comparison revealed a significant difference between Group 1 (*Mdn*=5) and 3 (*Mdn*=4). Table 5 and Figure 6 summarize the results from the three groups.

Table 5: Student perceptions towards three types of interactions (Group 1, 2 & 3).

	Group 1: Mixed (n=191)			**Group 2:** Distance (n=78)			**Group 3:** Mixed (n=112)			
Statements	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	Kruskal-Wallis *p*-value
Interactions with classmates were necessary to understand the course content (S-S interaction)	2	2	**< 0.001**	2	2	**< 0.001**	2	2	**< 0.001**	0.053
Interaction with the course instructor was necessary to understand the course content (S-I interaction)	3	2	0.143	2	2	**< 0.001**	2	1	**< 0.001**	**<0.001**
WileyPLUS was helpful to stay engaged with course content and progression (S-C interaction)	5	1	**< 0.001**	4	1	**< 0.001**	4	1	\ **< 0.001**	**<0.001**

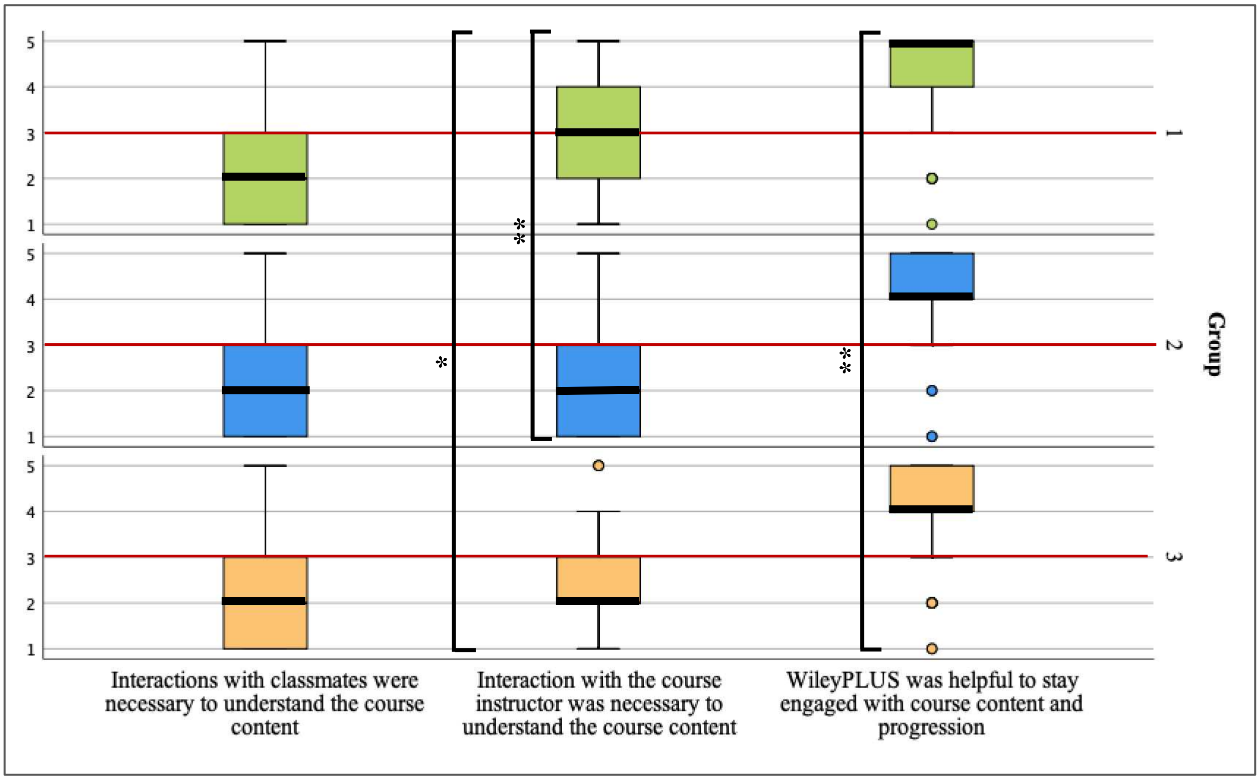

Figure 6: Boxplots of student levels of agreement (on a scale from 1 to 5) with three statements on three types of student interaction (x-axis) for Group 1, 2 & 3 (y-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IQR*). Stars represent significant differences between the groups (* $p<0.05$, ** $p<0.001$).

Although statistically significant differences between the different student groups were detected, the meaning of these findings are not clear. While it might have been expected that the groups containing F2F students (Group 1&3) would show a greater dependence on S-I interaction (e.g., Group 1 vs. Group 2), this was not the case for Group 3. Group 1 and 3 were also different in the case of S-C interaction, even though these groups were both mixes of distance and F2F students.

Insights from qualitative analysis

Students were asked to describe their learning approaches in the course. Thematic analysis of their responses (Group 1, n=145) revealed six themes (Table 6). Students reported different styles, highlighting the various learning opportunities provided by the course.

Table 6: Themes and subthemes revealed from student responses to describe their learning approaches (Group 1).

Themes	Subthemes
Favorable perceptions about teaching and course design	The course blended approach (combining F2F lectures and online learning resources)
	The instructor's teaching style
	The flexibility of the course design
The use of study notes to customize learning	Helped organizing information and handling the breadth of the course content
	Facilitated information resourcing
The learner-centred design of the course	Enabled independent learning styles
Advantages of attending F2F lectures	Understanding the course content
	Enjoyable and easier way to stay engaged
	Interaction with classmates
Advantages of using Brightspace	Provided accessibility to the course materials
	Included recorded lectures, which were helpful to stay engaged and understand the course content
Advantages of WileyPLUS weekly assignments	Reenforcing key topics and concepts
	Improving cognitive engagement

As shown in the word cloud below (Figure 7), ***lecture(s)*** was the most frequently mentioned word.

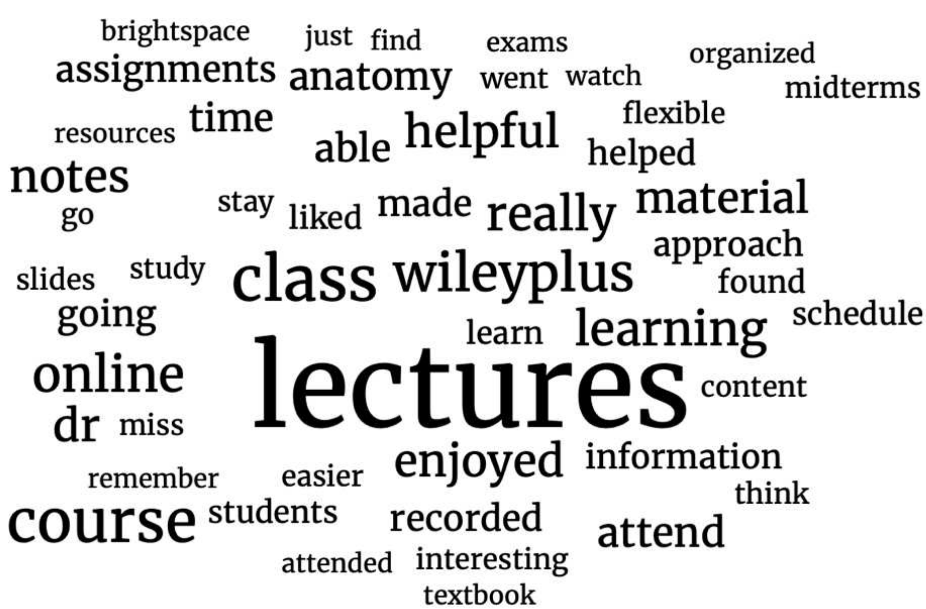

Figure 7: A word cloud of student responses to describe their learning approaches (Group 1). Larger font size represents more frequent mentioning.

The following analysis addresses the first and second objective of the course, respectively:

<u>How the course provides a foundation for independent and personalized learning (Objective 1)</u>

Students generally demonstrated favorable perceptions toward the teaching and design of the course. They admired the course's blended approach combining F2F lectures and online learning resources, the instructor's teaching style and the overall flexibility the course offered. Regarding the course teaching and design, students reported:

> "I actually have no real interest in learning anatomy but the way that this course was set up and the combination of online aids, as well as informative ***lectures*** made it a fairly straight forward learning process."

> "I believe that I learned the most in this course because it was more hands on for me as a student. I attended class, but I loved being able to not feel like I would be behind if I were to miss a class. I used the textbook and the PowerPoint ***lectures*** as references for my WileyPlus assignments (which I found extremely helpful)"

> "I really enjoyed the class and only ever missed one ***lecture***. I loved that everything was online so that when I did miss the ***lecture***, I could watch it online just as well. WileyPlus kept me engaged with the material and Dr. A. is a great prof- interesting and funny."

> "Really liked the layout of the course. The deadlines allowed for a flexible schedule for myself."

> "I enjoyed the class because of how flexible it was. I liked how attendance wasn't mandatory to succeed in the class."

Students expressed a preference to organize and customize their learning through the use of study notes. Students created and used their notes to organize and retrieve information in preparation for or during the course assignments and exams. The use of study notes supported learning through information resourcing rather than mere memorization; students deemed them powerful and efficient tools to handle the breadth of the course content. Students reported the following on the use of notes:

> "Made my own notes as per the schedule in the syllabus. Then, I did the quizzes usually on the weekend, and only used my notes if needed."

> "I kept my notes organized so it was easy to look up information quickly."

> "I found it beneficial to meet with other students in the course prior to midterms or exams in order to compare notes and quiz each other on our knowledge of anatomy chapters."

Students also used online tools to organize their notes:

> "I copied detailed notes on each ***lecture*** topic and created online flashcards as a way to remember the course material for midterms and examinations. I did not find the textbook useful because it is much more detailed than what we are required to know."
>
> "I use an online site that forms Q-cards for you to study off of. I would go through each ***lecture*** notes Professor A. posted on Brightspace and create qcards for all the content. After I was finished making those cards, I was able to continuously study the notes online through the site."

Students elaborated on the usefulness of the information resourcing:

> "I think that the course is very good for independent learning and for a focus on resourcing over memorization, but I think that this can lead to a dependence on the internet rather than a true understanding of the information."
>
> "I found the approach of learning to use resources instead of just memorizing extremely useful and much more applicable to my profession & real-life situations."

Given the online learner-centred design of the course, students were able to develop independent learning styles:

> "I learn best independently. My approach for this course was to watch the video ***lectures*** of that week on weekends and write notes. Before a major assessment I would review my notes."
>
> "I wasn't really interested in going to ***lectures*** and I found that I was able to retain more information using WileyPlus and independent studying."
>
> "My approach was very independent. I did not seek help from classmates or the professor and largely relied on the internet and wileyplus to facilitate my learning."

<u>Explaining student perceptions towards three types of interactions (Objective 2)</u>

The following qualitative analysis examines student learning, specifically through the three types of student interactions (S-S, S-I and S-C). The analysis focuses on benefits and advantages students gained/achieved from attending F2F lectures and from the use of Brightspace and WileyPLUS.

Students found F2F lectures important to understand the course content and to hear the pronunciation of anatomical terms (S-I):

> "I went to almost all the ***lectures*** as it helped me understand the content more clearly when it would come from Dr. A."

> "I felt that it was important to attend ***lectures*** to hear complex terms at least once from Dr. A. before attempting to study the content."

They said that attending lectures was enjoyable and that it was an easier way to stay engaged:

> "I enjoyed going to the ***lectures*** as I found Dr. A. had a good sense of humour and it made his ***lectures*** enjoyable to attend. I found it helpful when Dr. A. would quiz us a few times a ***lecture*** on material we were trying to learn, and it was fun too!"

> "I really enjoyed the course and I found attending ***lectures*** helpful as Dr. A. would often apply visuals and examples of what was being learned which helped with my comprehension. (example is for joints where he would show things such as pronation and supination) and he would often include ways to remember concepts. I really enjoyed the course and I recommended it to many of my peers!"

> "I took it seriously to attend ***lectures*** in person and found that I did not benefit from watching recorded ***lectures*** online in the cases where I did not attend a ***lecture***. I found that watching online ***lectures*** could not hold my attention well, while attending ***lectures*** could."

> "I found going to the ***lectures*** more helpful because it was easier to stay engaged and pay attention…"

Attending F2F lectures allowed students to interact with other students (S-S):

> "The material on Brightspace and Wileyplus was very much organized. However, in the interest of the time and for the purpose of grasping the main concepts and be successful in the exams, I had to go to class unless it is beyond my ability. Moreover, we discuss with fellow students and share ideas. Some students have fascinating ways of learning and committing the subject matter into memory."

> "It was also really helpful to relate the external anatomy to yourself and have people to discuss the content with."

Using Brightspace, the course provided students with plenty of online learning resources and communication channels that together underpinned S-C interaction. Students had utmost accessibility to interact with course material, which provided for individually customizable and flexible learning experience:

> "Dr. A. went above and beyond in making the course flexible for part-time students by providing a high-quality of online materials (PowerPoint slides, recorded ***lectures***, practice questions). Thus, my approach was to go over the ***lecture*** slides each week and flesh out any material that I didn't understand with the recorded ***lectures*** and the textbook (as well as the Wiley Plus materials)."

> "I found the virtual anatomy labs to be the most helpful part of the course! Answering the review questions and labeling things myself helped me to put all the information we had learned together, and after doing the labs, I found I had an easier time associating a structure with its function."

Students demonstrated positive views about the online learning recourses of the course; they found recorded lectures essential to keep them engaged and to understand the content:

> "I downloaded the audio and listen to it on my car and when I woke up and when I went to bed. I also listened to it one more time during review, I attribute my success to the webcast ***lectures*** so it's like going to class but no car parking, transit and no loss in pay from my job."

> "It is hard for a ***lecture*** to be able to match the 3D organ system animation that a video provides. Also, I can stop, slow, or replay any sections of a video that I may have missed or not fully understood the first time."

Students perceived WileyPLUS weekly assignments as helpful in highlighting, reviewing, re-examining, and understanding tricky topics and concepts, especially after attending or watching lectures on BrightSpace. WileyPLUS assignments were beneficial to consolidate their knowledge before exams and to drive the material into a longer-term memory:

> "I would make my best attempt to have a condensed summary of the ***lectures*** notes before the actual class where I would make supplementary notes following Dr. A's dialogue. Wileyplus was a tremendously useful tool in driving the material into a longer-term memory."

> "I would attend the course ***lectures*** and then re-examine any tricky topics after the ***lecture***. I really enjoyed the quizzes available on wileyPLUS they were super helpful and actually quite fun."

> "Wiley was very useful in keeping me up to date and helped me in understanding the concepts I did and did not understand."

WileyPLUS was a tool to improve cognitive engagement of students throughout the term:

> "I really liked Wileyplus because we had to keep up with what we were learning in class and didn't wait until the midterms or final to start learning the information."

> "I thought the WileyPlus assignments were well done and really helped me stay on top of the material."

> "Wiley Plus was stimulating in order to stay on top of the ***lecture*** slides; particularly, the weekly due dates. I greatly enjoyed this course."

The impact of the perceived ability to resource information and learn independently on lecture attendance (explain Objective 2)

Every year, the course lectures were delivered primarily for students registered in the F2F sections; however, distance education students were also welcome to attend. Based on the assumption that all types of students were able to attend the lectures in the course, Group 1 (mixed; n=191) was asked to indicate whether the ability to resource information and learn anatomy independently allowed them to skip lectures or not. Students who were not able to attend lecture merely due to uncontrollable circumstances (like geographical location) had the choice to respond to the statement by choosing Neutral. The results indicated that Group 1 students agreed with the statement (*Mdn*=4). Group 3A (F2F students) was also asked the same question. The analysis revealed the same result (*Mdn*=4), consistent with perceived ability to resource information and learning independently impacting lecture attendance. The Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint of 3; the analysis showed that the results for the two groups were significantly ($p<0.05$) different from the neutral midpoint (Table 7). The Mann-Whitney U test was used to compare between groups; the results revealed no significant differences ($p=0.796$; Figure 8).

Table 7: The impact of the perceived ability to resource information and learn independently on lecture attendance (Group 1 and 3A).

Statement	**Group 1:** Mixed (n=191)			**Group 3A:** F2F (n=51)		
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
The ability to resource information and learn anatomy independently allowed me to skip lectures with or without excuses	4	1	**< 0.001**	4	1	**0.046**
Mann-Whitney U *p*-value	0.796					

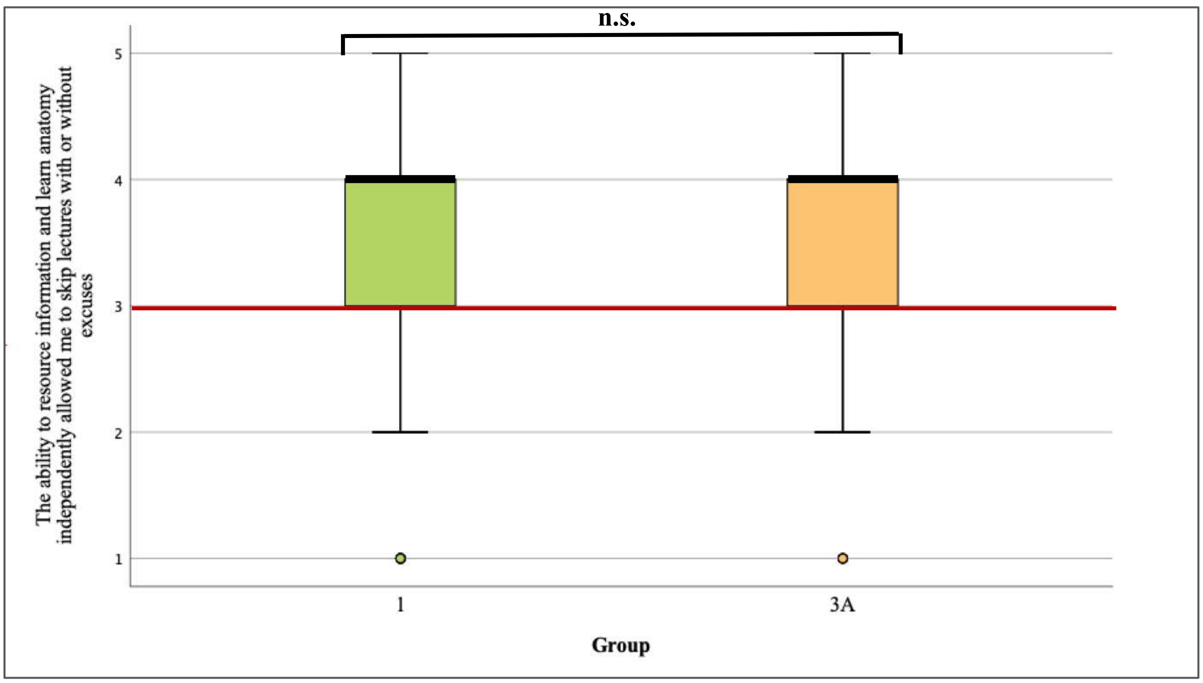

Figure 8: Boxplots of student levels of agreement (on a scale from 1 to 5) with a statement on the impact of the ability to resource information and learn anatomy independently on lecture attendance (y-axis) for Group 1 and 3A (x-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IQR*). n.s.= not significant.

F2F versus distance education students

It was hypothesized that there were differences between F2F and distance education students in terms of the ability to learn independently (Hypothesis 1) and the perceived need for S-S interaction (Hypothesis 2). The *Mdn* of student responses of Group 3A and 3B were the same for the question related to Hypothesis 1 (*Mdn*=4) and Hypothesis 2 (*Mdn*=2). The Wilcoxon signed rank test demonstrated that these *Mdn* values were significantly ($p<0.001$) different from the neutral midpoint of 3 (Table 8). A Mann- Whitney U test was performed to compare Group 3A (F2F) and 3B (distance education) student responses. The analysis showed no significant differences between the two types of students in terms of the ability to learn independently (Hypothesis 1, $p=0.612$) or the need for S-S interaction (Hypothesis 2, $p=0.1558$).

Table 8: Comparing student responses to test the hypothesis related to the perceived ability for independent learning and the perceived need of student-student (S-S) interaction (Group 3A & 3B).

Statement	**Group 3A** F2F (n=51)			**Group 3B** Distance (n=61)			Mann-Whitney *p*-value
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	
I was able to develop my own learning style through independent study of the course materials available on Brightspace.	4	1	**< 0.001**	4	1	**< 0.001**	0.612
Interaction with classmates were necessary to understand the course content	2	1	**0.007**	2	2	**< 0.001**	0.1558

Further possible differences between F2F and distance education were explored. In all cases, a Wilcoxon signed rank test was performed to compare the *Mdn* of student responses of Group 3A and 3B to the neutral midpoint of 3; the analysis showed significant results for the two subgroups except for Group 3A regarding S-I interaction (Table 9). There was a significant difference between the two subgroups (F2F versus distance education) regarding the perceived need for S-I ($p=0.027$). The mean ranks indicated that distance education students perceived less need for this type of interaction (Table 9). Figure 9 shows the boxplots for F2F and distance education student responses. Regarding the perceived helpfulness of WileyPLUS (S-C interaction), there was no significant difference (p=0.229) between the two types of students.

Table 9: Comparing the perceived need for student-instructor (S-I) interaction and helpfulness of WileyPLUS (Group 3A & 3B).

Statement	**Group 3A** F2F (n=51)			**Group 3B** Distance (n=61)			Mann-Whitney *p*-value
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	
Interaction with the course instructor was necessary to understand the course content	3	1	0.084	2	2	**< 0.001**	**0.027**
WileyPLUS was helpful to stay engaged with course content and progression	4	1	**< 0.001**	4	1	**< 0.001**	0.229

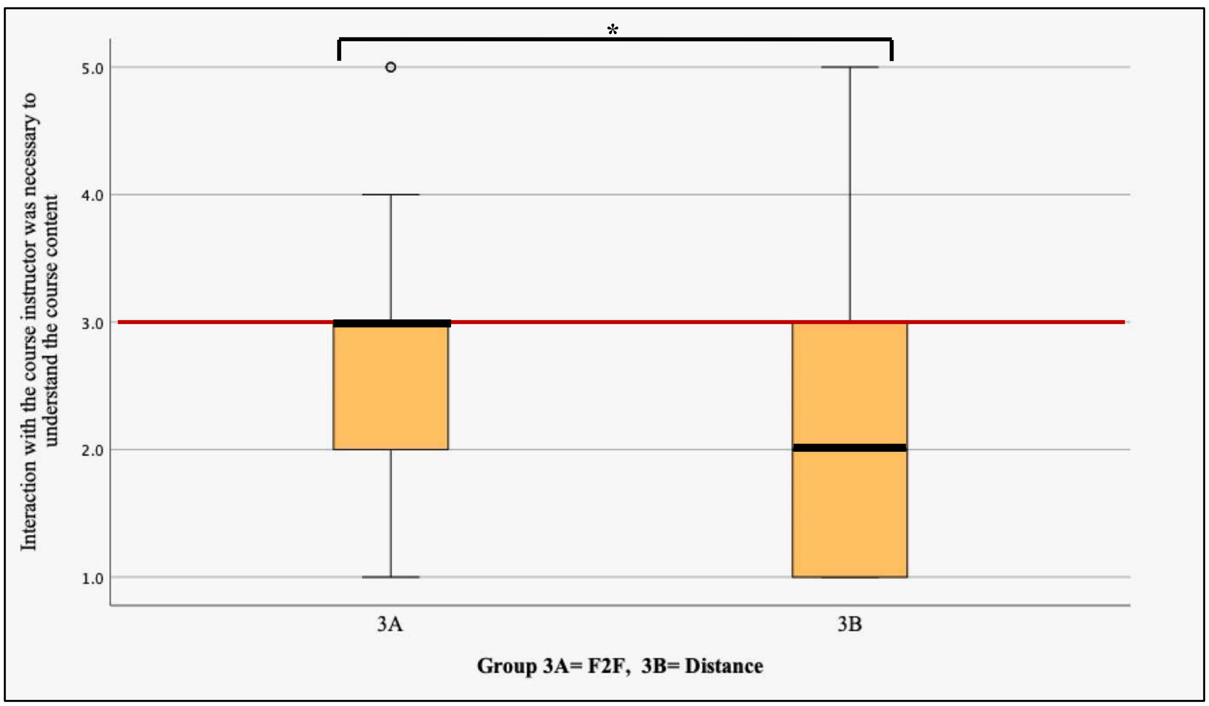

Figure 9: Boxplots of student levels of agreement (on a scale from 1 to 5) with a statement on the perceived need for interaction with the course instructor (y-axis) for Group 3A and 3B (x-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IQR*). The star represents significant difference between the subgroups (*=p < 0.05).

Based on the qualitative analysis of Group 1, Group 3A & 3B were asked to rate four additional statements related to learning and interaction - the purpose was to confirm previous results and to explore possible differences between F2F and distance education students regarding the way they approach learning. A Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint of 3; the analysis showed significant results for the two subgroups except for the statement "I web-searched most of the course content to learn from various learning resources available online (ex: YouTube and Wikipedia)." No significant differences between the two subgroups in terms of all of the four statements were found (Table 10).

Table 10: Comparing student responses to the four additional statements (Group 3A & 3B).

Statement	**Group 3A** F2F (n=51)			**Group 3B** Distance (n=61)			
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	Mann-Whitney *p*-value
WileyPLUS assignments were helpful to prepare for the course exams	4	1	**< 0.001**	4	2	**< 0.001**	0.229
The availability of recorded lectures and videos in the virtual anatomy lab were helpful to understand the course content	4	2	**< 0.001**	4	2	**< 0.001**	0.939
I web-searched most of the course content to learn from various learning resources available online (ex: YouTube and Wikipedia)	3	2	0.163	3	2	0.555	0.171
I web-searched most of the course content just to look up answers and I did not learn much	2	1	**0.005**	2	2	**< 0.001**	0.462

Correlations between the ability to learn independently and three types of interactions

This segment addresses the study's third objective, *to explore possible correlations between student perceived ability for independent learning and their perceptions towards three types of interactions.* The analysis showed that the correlations between the ability for independent learning and the need for S-S interaction were weak. Group 3A's (F2F students) correlation was positive, while the correlation in Group 3B was negative (distance education). Also, the correlations between the ability for independent learning and the need for S-I interaction were weak but positive in both subgroups (Table 11). However, none of these correlations were significant indicating that there isn't sufficient evidence to claim that these correlations exist in the study population.

Significant positive correlations were found in the two subgroups between independent learning and the S-C interaction (the perceived usefulness of WileyPLUS). Group 3A's (F2F students) correlation was moderate, while the correlation in Group 3B (distance education) was strong.

Table 11: Results of Spearman's rank correlation coefficient test between independent learning and three types of interactions (Group 3A & 3B).

Types of student interactions	**Independent learning:** Q: I was able to develop my own learning style through independent study of the course materials available on Brightspace.	
	Group 3A: F2F (n=51)	**Group 3B:** Distance (n=61)
Interactions with classmates were necessary to understand the course content (S-S interaction)	0.150	-0.147
Interaction with the course instructor was necessary to understand the course content (S-I interaction)	0.074	0.178
WileyPLUS was helpful to stay engaged with course content and progression (S-C interaction)	**0.378***	**0.681***

*=Correlation is significant at the 0.01 level

Student suggestions to improve the course

Students were asked to share their opinions about the course and to suggest possible solutions for improvement. Thematic analysis of their responses (Group 1, n=106) revealed five themes (Table 12). Students raised various issues related to the course design, delivery, and assessment (exam questions). Students suggested extending the course to a year-long, incorporating online discussions, having in-class examinations rather than online, allocating grade on attendance, and organizing visits to the laboratory.

Table 12: Themes revealed from student suggestions to improve the course (Group 1).

Themes
Duration and delivery of the course
Pros and cons of the nature of the course assessment
Improving lecture attendance
Technical issues related to Brightspace and WileyPLUS
Organizing visits to the laboratory

As shown in the word cloud below (Figure 10), student suggestions frequently involved ***time***, ***class(es)***, ***question(s)***, and ***attendance***.

Figure 10: A word cloud of student suggestions to improve the course (Group 1). Larger font size represents more frequent mentioning.

Regarding the length and delivery of the course, students said:

> "I found that there was a lot to learn in a very short ***time***. I believe this course should be a year-long course. I couldn't study like I needed to because there was so much to learn and not enough ***time*** to learn it... I'm taking four other courses this semester. I found that I had to reference more than I wanted to. I feel that if it was a yearlong course, I would be able to retain and recall more information from memory…. I do like how the course is online and I do not have to travel to school for a lecture. It is very convenient which is great."

> "I think that the course is very good for independent learning and for a focus on resourcing over memorization, but I think that this can lead to a dependence on the internet rather than a true understanding of the information. Maybe a small mandatory in ***class*** component would be beneficial."

> "I think more ways to make the ***class*** more engaging would be to have more emails and discussions online so students can be part of the ***class*** but can also work at home."

Students held different views regarding the flexibility of the course and the nature of its assessment:

> "More ***time*** on the midterms would've definitely been helpful. For ***questions*** that read "Which of the following are correct..." or "which of the following are false..." I found that it took me close to 5 minutes to find the right answer. I think 90 minutes rather than 60 minutes would be better for the midterms. It would also give students a chance to review their answers one more ***time*** and would make them feel less anxious and stressed and under pressure.

> "I did find the ***questions*** on the exams to be quite hard at times, but I suppose that is to be expected with an open book exam. Perhaps a bit more exam ***question*** prep could be beneficial?"

> "This ***class*** was too easy. The open book format didn't challenge me to study nearly as hard as I would have for other courses. I know that it ultimately falls on the individual, but for my learning style, I knew that I didn't need to study as hard given that I could look up answers, so I used my ***time*** to focus on other ***classes***. The exams should be far more challenging either in terms of ***time*** so that you need to know the answer off hand or complexity, so you're challenged to apply the knowledge in other ways."

> "I think it will be better if the major exams are IN-***CLASS*** so grades will be REALLY based on students learning."

Students provided suggestions regarding the accessibility of the course content and poor lecture attendance. They indicated:

> "Dr. A. is a very good professor, but by providing all of the material online allows students to watch lectures online rather than going to lecture. My biggest suggestion for

having student ***attendance*** increase is to post the online lecture recordings either that day after ***class***, or to post them on the weekend after ***class***. This will likely make students attend ***classes*** more often. Another thing that could be done is to add clicker ***questions***. This will require students to attend the lectures in order to get the grade for their clicker ***questions***."

"Maybe allocating grade on ***attendance*** or making ***attendance*** mandatory. Or else, it will remain a ***class*** taken to boost GPA."

"Maybe slow down when teaching, it is a lot of information being thrown at us and it might be easier if we had a chance to process it. Great Prof! Thanks for the wonderful semester."

"The lectures were very good, just the same info available in the textbook. Maybe throwing in some extra info would encourage students to attend ***class*** more regularly."

"Perhaps to improve the ***class attendance***, you may want to make those in-***class*** exam ***questions*** actually worth a small percentage, however I do know it would increase cost and ***time***. I think ***attendance*** may have been low because the material that you provide online is SO accessible and useful that the material can be to some degree self-taught. This is entirely to your credit!"

Students also commented on technical aspects of WileyPLUS and the virtual laboratory on Brightspace:

"WileyPLUS is a particularly terrible website. The assignments take such a long ***time*** to load, and when they finally load, each ***question*** loads slowly. It also seemed that the longer I spent on the site, the slower it got. So, I once attempted to finish all three assignments when they opened but ended up spending THREE HOURS on the second assignment because each ***question*** took four minutes to load, and four minutes to submit the answer.."

"…WileyPLUS website not working occasionally was kind of annoying and inconvenient but other than that it was really helpful!"

"The only real issue I encountered was during the labs. Sometimes the images were so small that it was very difficult to identify some structures."

Finally, students expressed interest in having organized visits to the laboratory, especially during the scheduled lecture time:

"One regret was not being able to find the ***time*** to go up to the lab to see the anatomy of the body firsthand! Maybe in the future one ***class*** could go up there during lecture ***time***."

"I think this course is great and the online lectures and labs are well done. The only thing I wish was provided was an actual visit to the lab. Thank you!"

4.4.3 Component 2: participation in the Digital Anatomy Learning project (DAL)

The DAL project sought to foster S-S interaction through an optional online group activity; yet student participation was subpar. This segment addresses the fourth objective of the study, *to identify and discuss factors influencing student participation in the optional group project.* When students were asked about their participation in the DAL project, 99% of the responses indicated that they did not participate (Group 3, n=112). Table 13 summarizes the most and least rated reasons that impacted/prevented student participation. The most rated reasons were, by order:

- Participation was optional.
- I did not know what to make the video about.
- The activity seemed cumbersome, and the grade worth was not appealing.
- It was difficult to find or make a group.

Group 3 was asked to rate two additional reasons: (1) the course was easy, and there was no need to participate; and (2) I did not hear or know about the project. These two reasons received the least rating (Table 13).

Table 13: Student reasons behind poor participation in the Digital Anatomy Learning (DAL) project.

statements	**Group 1:** Mixed (n=191)		**Group 2:** Distance (n=78)		**Group 3** **A** F2F (n=51)		**Group 3** **B** Distance (n=61)	
I didn't participate in DAL project because:	*Mdn*	*IQR*	*Mdn*	*IQR*	*Mdn*	*IQR*	*Mdn*	*IQR*
Participation was optional	4	2	4	1	4	2	4	1
I didn't know what to make the video about	4	1	4	1	4	2	3	2
The activity description was complicated	3	1	3	1	3	1	3	2
The activity seemed cumbersome; the grade worth was not appealing	4	2	4	2	3	2	4	2
It was difficult to find or make a group	4	1	3	2	3	1	4	2
I did not hear or know about it	n/a	n/a	n/a	n/a	2	1	2	2
The course was easy, and I did not feel the need to participate	n/a	n/a	n/a	n/a	3	1	2	1

Student suggestions to improve the DAL project

Students were asked to share feedback to improve the implementation of the DAL project. Thematic analysis of their responses (Group 1, n=84) revealed three themes (Table 14). Students highlighted several factors, which students claimed to have inhibited participation in the activity. These factors were intertwined but can be categorized as external and internal factors related to the activity design.

Table 14: Themes and subthemes revealed from student suggestions to improve the Digital Anatomy Learning (DAL) project (Group 1**).**

Themes	Subthemes
External factors impacting student participation in the DAL project	Lack of time
	Lack of technical skills
Internal factors impacting student participation in the DAL project	The requirement of group work
	The nature of the activity grading
Suggestions to improve the design of DAL project	Making the activity mandatory
	Awarding bonus points for all participations:
	Allowing other forms of electronic submissions
	Allowing individual submissions
	Providing samples of successful submissions
	Facilitating communication between students

As shown in the word cloud below (Figure 11), student suggestions frequently referred to ***time***, ***group(s), work,*** and ***video(s)***.

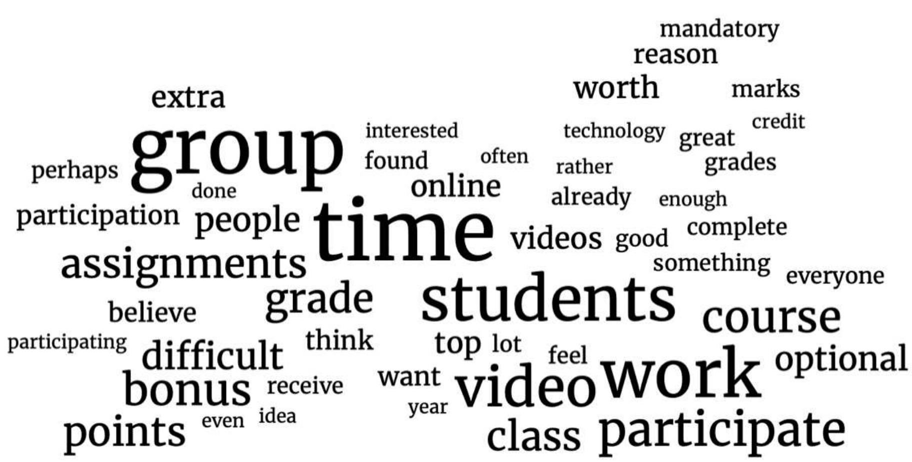

Figure 11: A word cloud of student suggestions to improve the Digital Anatomy Learning (DAL) project (Group 1). Larger font size represents more frequent mentioning.

External factors included heavy course loads and busy schedules, which can create perceptions of lack of time and trigger worry among students. Students said:

> "The only reason I didn't participate was because I was very bogged down with other assignments and I just didn't feel like I had the ***time***.
>
> "I believe that the poor participation in the DAL project may be partially attributed to a lack of ***time***. I had initially intended to participate in the DAL project, but I found that I did not have the extra ***time*** to produce the ***video***. It was not out of lack of interest, but due to ***time*** restraints."
>
> "I did actually intend on attempting the DAL project early in the semester and then a cascade of assignments from other classes bogged me down."

Poor participation was attributed to a lack of technical skills:

> "I am not very good with technology. I don't even have a way to shoot ***videos*** on my phone. This is the only reason I did not participate in the DAL project. I usually will do any extra ***work*** to receive bonus grades, but unfortunately this type of assignment was far above my level of understanding of technology."
>
> "The reason I did not participate in the online DAL project is because I am not technically savvy enough to complete a ***video*** that I believe was up to standards. Regardless I think it is a very good idea for extra credit."

Regarding the internal factors, students heavily criticized the discouraging nature of the activity design and grading - how videos were supposed to be done and voted for in order to win one of three bonus grades:

> "I did not do a DAL project as the benefit was only for the top projects and I assumed that many other ***groups*** would be doing it so it would be a waste of my ***time*** to put together a ***video*** and not receive credit for it."
>
> "I also was a little discouraged at the thought of spending all that ***time*** on a ***video*** and not getting any points for it anyway"
>
> "I couldn't even entertain the idea, especially since it wasn't worth bonus points unless it was voted as such."

Regarding the requirement of group work, student feedback was specific. They said:

> "As someone who doesn't enjoy ***group*** projects and prefers to ***work*** independently, I found the DAL project to be very interesting but was not interested in a ***group*** project. I believed I could do well in the course without the addition of this bonus assignment."

> "***Group work*** is notoriously difficult. The grade worth was not large enough to commit to doing the extra ***work*** and potentially having trouble working with the ***group***."

Regarding the requirement of peer votes as part of the evaluation strategy:

> "I didn't want to participate because if my ***video*** wasn't the highest rated, I wouldn't get any marks for it. I also didn't want to have to deal with the negative comments from other students-just the instructor would have been fine."

> "I did not like the you would have to post your ***video*** online for everyone to see and that other students would be grading it."

Some possible solutions students provided to improve participation in the DAL project revolved around two themes: allocating grades and fostering communication between students. Students suggested making the activity mandatory:

> "This course was too easy, and I didn't feel the need to take on an extra assignment. I think this would have been good as a mandatory element, although there should be an option to do it individually instead of in a ***group*** (this may be the case already, but I wasn't sure)."

> "It was an adjustment. Had it been mandatory everyone would have done the project."

If the activity is to continue as optional, students suggested awarding bonus points for all participations:

> "The biggest downside to doing the Dal Project was the grade distribution, if everyone were to get marks for just participating that would be more appealing, and then top marks awarded to the highest ranked ***videos***. Making ***videos*** are a lot of ***time*** and effort. Also, the confusion of them being uploaded, they were all over the place and I personally had difficulty viewing them all."

> "Make multiple winners for the DAL project! More incentive to participate if greater chance at winning."

> "I was going to participate in the DAL project; however, when I found out that only the best project would receive bonus points. I believe that if everyone who participated in the DAL project received bonus points, more people - including myself - would have participated."

They suggested allowing other forms of electronic submissions:

> "If there was a list of optional ways to complete the project perhaps more students would do it. In general, interactions on brightspace such as discussions are not stimulating to students (in any course) but assignments or quizzes with a deadline are more likely to yield a higher yield of completion by students."

> "If there was another format accepted for this type of bonus assignment (such as a poster or paper), I believe participation would have greatly increased."

And allowing individual submissions:

> "Anatomy online is often taken by students who are not on campus for the semester, thus having a project such as the DAL project, where you are required to ***work*** with a ***group*** because highly difficult, if not impossible, which denies off-campus students the opportunity to earn the extra grade. If there was another form of bonus assignment, which students would be able to complete on their own, it may be more fair for the entire class."

> "I live 6 hours from Halifax, so communicating with students from the course was difficult. I think the Dal project would be used more often if there were an option to do it independently, somehow. It was a great experience for me."

Students also suggested a better introduction of the activity by providing samples of successful submissions, and a better facilitation of communication between students. Suggestions included the implementation of in-class icebreakers and/or assigning groups for students to work within:

> "I think we would benefit from viewing an example in class and hearing your feedback on it."

> "Assigning ***groups***, showing more examples of previous projects and dedicating more class ***time*** to explain how to properly make it."

> "I think that at the beginning of the year there should be a lecture where we all get to meet in person, and someone explains how the course works in person as well. This would give us an opportunity to meet each other, form friends in the class, and also have a chance to ask questions and meet the prof. This would also be a great opportunity to introduce the Dal project, and then students would be able to form ***groups*** there and start brainstorming. It would be a much more convenient approach to the project, rather than posting in the comments section on the wall, and that too gets disorganized."

> "Maybe gather the list of people wanting to do the DAL project using email and having their contact information. Then help them to make ***groups***."

> "Do not make it mandatory. You will not get quality ***videos*** if you do in my opinion. Optional is still better, but perhaps offering some sort of in class ***group work*** outside of the DAL project. That would likely facilitate student-student interaction and hopefully foster friendship/reduced anxiety regarding ***group work***. If that is done, I feel people

> would be more willing to make ***groups*** and participate in the DAL project. I realize that incorporating that sort of thing into the framework of the class would be difficult, but perhaps creating tutorial sessions where people go to the lab and look at the available specimens in ***groups*** and answering outlined questions would help. Make the questions worth 5 - 8 points or so, nothing major but enough that people will want to go. I did one science degree already, and most of the ***time***, I was more willing to ***work*** with people because I had seen them in tutorials or labs."

Analysis of DAL project videos

This segment presents the analysis results of 31 videos submitted by students before and after the refinement of the DAL project. In total, the DAL project received 40 submissions. Nine submissions were excluded from the analysis because they could not be viewed (due to technical issues and improper video formatting) or included substantial portions of popular educational content found online (YouTube and Khan Academy). As part of the analysis, the quality of videos was evaluated using a rubric (Appendix B), which contained 4 criteria: content quality, content impact, audience fit, and technical aspects. Each video examined against these criteria was given scores from 1 to 4. The average of these 4 scores was calculated to reflect the average quality score (AQS) for each video (out of 4).

Analysis of videos before the refinement

Ten videos were submitted before the refinement of the DAL project. Videos varied in duration ranging between 1:27 – 5:53 minutes. In addition to student voting, the quality of submitted videos was used to determine the winners of bonus points. Some videos were disqualified (eliminated) and did not receive bonus points. The disqualification was because videos were made by individual students and/or the AQSs of these videos were ≤ 2. Table 15 details the results of the analysis of the first set of DAL project videos.

Out of three videos submitted in Fall 2016, only one was awarded bonus points, and the other two videos were eliminated. The AQS of the winning video was 4. The AQSs of the eliminated videos were 1 and 1.75. Out of three videos submitted in Winter 2017, only one video was awarded bonus points, and the other two videos were eliminated. The AQS of the winning video was 3.25, and the AQS of both eliminated videos was 1.75. In Fall 2017, two videos were submitted, and both were awarded bonus points. The AQSs of the two videos were 2.25 and 3.5. In Winter 2018, two videos were submitted, one of which was awarded bonus points and the other was eliminated. The AQS of the winning video was 3.75, and the score of the eliminated video was 2.

Analysis of videos submitted after the refinement

Twenty-one videos were submitted after the refinement of the DAL project. Videos varied in duration ranging between 2:23 – 6:53 minutes. Table 16 details the results of the analysis of the second set of DAL project videos. In Fall 2018, two videos were submitted, and the lowest AQS was 1.5. In Winter 2019, two videos were submitted, and the lowest AQS was 2.25. In Fall 2019, seven videos were submitted, and the lowest AQS was 1.25. Two out of the seven videos were individual participations. In Winter 2020, ten videos were submitted; three out of the ten videos had low AQS (1.5), and four of the ten videos were individual participations.

The quality of videos and number of participants

Low-quality videos and videos submitted by individual students seem to have overlooked the purpose of the project - to facilitate learning and interaction between students (S-S). Therefore, the relationship between the quality and the number of participating students per video was investigated. Table 17 summarizes the AQSs for all videos submitted by one, two and three students. The average of the AQSs of each of the three categories was calculated. The quality appears to increase as the number of students per video increases; however, the results of one-way analysis of variance (ANOVA) test show no statistical differences between the three groups.

Table 15: Analysis of student videos before the refinement of the Digital Anatomy Learning (DAL) project.

<table>
<tr><td colspan="7">DAL project videos submitted in Fall 2016</td></tr>
<tr><td></td><td colspan="2">Video 1
(5 bonus points)</td><td colspan="2">Video 2</td><td colspan="2">Video 3</td></tr>
<tr><td>Title</td><td colspan="2">The Integumentary System</td><td colspan="2">The Skeletal system</td><td colspan="2">The Human anatomy</td></tr>
<tr><td>Date of submission</td><td colspan="2">Oct 21st, 2016</td><td colspan="2">Oct 22nd, 2016</td><td colspan="2">Dec 1st, 2016</td></tr>
<tr><td>Duration</td><td colspan="2">5:05 mins</td><td colspan="2">2:28</td><td colspan="2">4:32</td></tr>
<tr><td>Number of participants</td><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">3</td></tr>
<tr><td>Total views</td><td colspan="2">367</td><td colspan="2">351</td><td colspan="2">65</td></tr>
<tr><td>Votes</td><td colspan="2">+43</td><td colspan="2">-3</td><td colspan="2">+3</td></tr>
<tr><td>AQS</td><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">1.75</td></tr>
<tr><td colspan="7">DAL project videos submitted in Winter 2017</td></tr>
<tr><td></td><td colspan="2">Video 1</td><td colspan="2">Video 2
(5 bonus points)</td><td colspan="2">Video 3</td></tr>
<tr><td>Title</td><td colspan="2">Muscle tissue</td><td colspan="2">Digestion rap</td><td colspan="2">Cardiovascular system: Blood</td></tr>
<tr><td>Date of submission</td><td colspan="2">Mar 13th, 2017</td><td colspan="2">Mar 27th, 2017</td><td colspan="2">Mar 27th, 2017</td></tr>
<tr><td>Duration</td><td colspan="2">4:15</td><td colspan="2">1:51</td><td colspan="2">5:53</td></tr>
<tr><td>Number of participants</td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><td>Total views</td><td colspan="2">45</td><td colspan="2">57</td><td colspan="2">46</td></tr>
<tr><td>Votes</td><td colspan="2">+10</td><td colspan="2">+14</td><td colspan="2">+6</td></tr>
<tr><td>AQS</td><td colspan="2">1.75</td><td colspan="2">3.25</td><td colspan="2">1.75</td></tr>
<tr><td colspan="7">DAL project videos submitted in Fall 2017</td></tr>
<tr><td></td><td colspan="3">Video 1
(2 bonus points)</td><td colspan="3">Video 2
(3.5 bonus points)</td></tr>
<tr><td>Title</td><td colspan="3">The skeletal system</td><td colspan="3">The axial skeleton</td></tr>
<tr><td>Date of submission</td><td colspan="3">Nov 19th, 2017</td><td colspan="3">Nov 19th, 2017</td></tr>
<tr><td>Duration</td><td colspan="3">5:01</td><td colspan="3">5:01</td></tr>
<tr><td>Number of participants</td><td colspan="3">3</td><td colspan="3">3</td></tr>
<tr><td>Total views</td><td colspan="3">86</td><td colspan="3">95</td></tr>
<tr><td>Votes</td><td colspan="3">+5</td><td colspan="3">+9</td></tr>
<tr><td>AQS</td><td colspan="3">2.25</td><td colspan="3">3.5</td></tr>
<tr><td colspan="7">Analysis of DAL project videos submitted in Winter 2018</td></tr>
<tr><td></td><td colspan="3">Video 1</td><td colspan="3">Video 2
(5 bonus points)</td></tr>
<tr><td>Title</td><td colspan="3">the anatomy of the heart</td><td colspan="3">Hearing and equilibrium</td></tr>
<tr><td>Date of submission</td><td colspan="3">Apr 6th, 2018</td><td colspan="3">Apr 9th, 2018</td></tr>
<tr><td>Duration</td><td colspan="3">1:27</td><td colspan="3">5:21</td></tr>
<tr><td>Number of participants</td><td colspan="3">3</td><td colspan="3">3</td></tr>
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<tr><td>Votes</td><td colspan="3">+2</td><td colspan="3">+5</td></tr>
<tr><td>AQS</td><td colspan="3">2</td><td colspan="3">3.75</td></tr>
</table>

Table 16: Analysis of student videos after the refinement of the Digital Anatomy Learning (DAL) project.

Analysis of DAL project videos submitted in Fall 2018		
	Video 1	**Video 2**
Title	Bones of the Back and Arm	The Brain
Date of submission	Nov 5th, 2018	Nov 29th, 2018
Duration	5:01	5:00
Number of participants	2	2
Total views	22	13
Votes	+3	0
AQS	1.5	2.5

Analysis of DAL project videos submitted in Winter 2019		
	Video 1	**Video 2**
Title	Gastrointestinal Tract (GIT)	Cell organization
Date of submission	Apr 2nd, 2019	Apr 9th, 2019
Duration	4:18	4:46
Number of participants	2	2
Total views	18	7
Votes	0	0
AQS	2.25	2.75

Analysis of DAL project videos submitted in Fall 2019			
	Video 1	**Video 2**	**Video 3**
Title	The Heart	Skeletal System	Endocrine & Vascular System (x2)
Date of submission	Nov 26th, 2019	Dec 2nd, 2019	Dec 2nd, 2019
Duration	5:04	5:03	5:03 & 5:38
Number of participants	3	3	2
Total views	31	17	26
Votes	+5	0	+2
Average quality score (AQS)	3.75	1.25	2

Analysis of DAL project videos submitted in Fall 2019 (Cont.)			
	Video 4	**Video 5**	**Video 6**
Title	Conduction System of The Heart	Respiratory System: Mechanics & Structure	Male Reproductive System
Date of submission	Dec 2nd, 2019	Dec 2nd, 2019	Dec 2nd, 2019
Duration	4:46	5:09	4:45
Number of participants	1	2	1
Total views	13	12	8
Votes	+4	+3	+3
AQS	2.5	3	2.75

Analysis of DAL project videos submitted in Fall 2019 (Cont.)	
	Video 7
Title	The Digestive System
Date of submission	Dec 3rd, 2019
Duration	5:01
Number of participants	2
Total views	12
Votes	+4
AQS	3.75

Table 16: Analysis of student videos after the refinement of the Digital Anatomy Learning (DAL) project (cont'd).

Analysis of DAL project videos submitted in Winter 2020			
	Video 1	**Video 2**	**Video 3**
Title	Drug Travelling in Human Body Based on the Anatomy	Hair	Cranial Bone Search
Date of submission	Feb 22nd, 2020	Mar 4th, 2020	Mar 13th, 2020
Duration	6:42	6:13	2:23
Number of participants	1	3	2
Total views	52	44	38
Votes	+13	+6	+5
Average quality score (AQS)	1.5	2	1.5
Analysis of DAL project videos submitted in Winter 2020 (cont'd)			
	Video 4	**Video**	**Video 6**
Title	Levels of Organization	Human Bone: Classification, Formation, Functions & Degradation	Cardiovascular System
Date of submission	Mar 31st, 2020	Apr 8th, 2020	Apr 15th, 2020
Duration	4:49	5:02	2:51
Number of participants	3	2	1
Total views	29	11	9
Votes	+4	+1	+1
Average quality score (AQS)	2.25	3.25	2.75
Analysis of DAL project videos submitted in Winter 2020 (cont'd)			
	Video 7	**Video 8**	**Video 9**
Title	Digestive System	Anatomy of Running & Shin Splints	Animal & Plants Cells
Date of submission	Apr 15th, 2020	Apr 15th, 2020	Apr 15th, 2020
Duration	5:24	6:12	6:53
Number of participants	1	1	2
Total views	8	7	17
Votes	0	+1	+1
Average quality score (AQS)	2.5	2.75	1.5
Analysis of DAL project videos submitted in Winter 2020 (cont'd)			
	Video 10		
Title	Muscular system		
Date of submission	Apr 15th, 2020		
Duration	5:12		
Number of participants	3		
Total views	12		
Votes	+3		
Average quality score (AQS)	2.25		

Table 17: Summary of the average quality scores (AQS) of the Digital Anatomy Learning (DAL) project videos based on the number of students per video.

1 Participant	2 Participants	3 Participants
1	3.25	4
1.75	1.75	1.75
2.5	1.5	2.25
2.75	2.5	3.5
1.5	2.25	2
2.75	2.75	3.75
2.5	2	3.75
2.75	3	1.25
-	3.75	2
-	1.5	2.25
-	3.25	2.25
-	1.5	-
Average (Mean)		
2.18	**2.41**	**2.61**

4.5 Discussion

4.5.1 The perceived ability for independent learning (Objective 1)

Recent technological innovations have led to new ways to teaching and learning. For instance, the use of Massive Open Online Courses (MOOCs), which allow educational content to be delivered to a wide range of learners. MOOCs are online courses designed based on traditional learning theories. There are two main types of these online courses: connectivist (cMOOCs) and extended (xMOOCs). The design of cMOOCs is based on connectivism, a learning theory in which learners work together in a network configuration (Siemens, 2005). On the other hand, xMOOCs, a more popular type of MOOCs, follow a behaviourist approach (Brahimi & Sarirete, 2015). xMOOCs are driven by a self-guided design (McAuley et al., 2010) that allows learners to interact primarily with course content in an individual way (Conole, 2014). The adoption of user-centred design in the Basic Human Anatomy course at Dalhousie University suggests it is of the xMOOCs type. Taken as a whole, each group of students surveyed agreed that the course materials available on

Brightspace allowed them to develop their own independent learning style. Qualitative analysis also revealed student perceptions that the course promoted independent learning.

Since students were registered in different sections of the course, it was hypothesized that there was a difference between F2F and distance education students in terms of the perceived ability to learn independently. The findings showed that no significant difference between the two types of students, which rejects the hypothesis. Despite the heterogeneity of the student population in the study (differences in background knowledge), both types of students perceived that the course promoted independent learning and the samples from both types of students were not statistically different. These results suggest that the use of technology in the course facilitated the implementation of self-learning pedagogies, enabling students to customize their learning. Endorsing the accessibility and flexibility of Brightspace, students expressed favorable perceptions towards individualized approaches to learning, in which they created and used study notes to resource information.

Student perception of independent learning in anatomy courses with online content has not been studied extensively. One recent study (Tayem et al., 2022) reported that 75% of students enrolled in a distance education class (instituted due to the COVID-19 pandemic) agreed that the instruction promoted independent learning, a finding consistent with the results reported here.

4.5.2 The impact of course design on student interaction (Objective 2)

The design of the Basic Human Anatomy course fostered a learning environment in which most students did not perceive the need for social interaction (S-I or S-S). Since students in distance education are usually independent, and do not seek nor have the time to socialize with each other (Liu, 2008), they are likely to perceive a low need for S-S. Therefore, it was hypothesized a difference between F2F and distance education students in terms of the perceived need for S-S interaction. The findings showed no significant difference between F2F and distance education students; both types disagreed that there was a need for S-S interaction, which rejects the hypothesis. A significant difference was found between the F2F and distance education students in terms of the perceived need for S-I interaction. Distance education students disagreed that there was a need for S-I interaction, while F2F students were neutral. Although the difference was modest, it is reasonable that F2F students would perceive a greater influence by an instructor compared to distance education students (Liu, 2008).

Students, both collectively and separated into F2F and distance education cohorts, agreed (some of the groups strongly) that the online interactive study tool (WileyPLUS) associated with the mandatory textbook was helpful to maintain engagement in the course. As WileyPLUS was a component of the online content, it represents a form of student-content (S-C) interaction. To determine to what extent the perceptions of need of interaction (S-S, S-I & S-C) might correlate with perceived ability to learn independently (Objective 3), correlation analysis was performed. In the case of S-S and S-I no statistically significant correlation were found. However, significant positive correlations were found between independent learning and the value of WileyPLUS (a form of S-C interaction). This underlines the impact of WileyPLUS as a contributing factor to the favorable perception of the course for independent learning.

In most cases, qualitative analysis provided evidence that agreed with the quantitative results. Students found that the online (S-C) resources (Brightspace, WileyPLUS, recorded lectures and other videos) were useful for learning course content. Endorsing the interactive nature of WileyPLUS, students expressed favorable perceptions towards the course weekly assignments as they were helpful in highlighting, reviewing, re-examining, and understanding tricky topics and concepts. Web searching did not appear to play a prominent role. One area of apparent disagreement were statements indicating the importance of F2F lectures for understanding the course content and for promoting S-S interactions. Given that the quantitative analysis indicated that the perceived value of S-I interaction to learning was, at best, neutral and more typically generated disagreement, these qualitative comments are not congruent with the quantitative findings.

Other studies of anatomy courses (with F2F, online or both components) have evaluated aspects of student perceived interactions but focused mostly on the extent of S-S and S-I interaction and the level of engagement (Alsharif et al., 2022; Attardi et al., 2018; Nausheen et al., 2021; Pollock, 2022). The survey employed here challenged students to evaluate the extent to which S-S and S-I interaction were necessary to understand the course content and if a key component of S-C (WileyPLUS) was helpful to maintain engagement. In summary, the results suggest that the online instructional components (S-C) were considered by the students to be sufficient for their independent learning and understanding of course content without substantial S-S or S-I interaction. It is worth noting that a component of the online content was recorded lecture and lab content. Therefore, students may well have received some of the benefit of S-I but, as it was delivered online, considered it part of S-C (see also Section 4.6).

4.5.3 F2F students lecture attendance and engagement in the course

An ongoing issue in the course was the decline in lecture attendance during the term (see Section 4.2). Student responses to a question in the survey employed here suggests that the ability to resource information (S-C) supported independent learning and allowed students to skip lectures.

This result was the same in both a mixed group (F2F and distance education students) and a group that was solely F2F students. Previous research into the importance of attending lectures underlined several advantages, including providing opportunities for students to make connections and build rapport with peers and transforming the process of learning into a collective experience that can create a shared understanding among students (French & Kennedy, 2017). Although qualitative analysis demonstrated the role of attending lectures in facilitating social interaction (with the course instructor and other students), the ability to resource information and learn independently impacted student motivation to attend lectures.

According to Trowler (2010), attending lectures can be seen as a dimension of student engagement; and skipping lectures can result in more reliance on information technology for learning and interaction. Furthermore, Trowler (2010) proposed a model for student engagement (Table 18), discussing three dimensions of engagement (behavioural, emotional, and cognitive) defined by Fredricks et al. (2004). The model suggests that each dimension can be seen with a negative and a positive pole; each represents a form of engagement, separated by a gap of non-engagement (i.e., withdrawal or apathy). According to Trowler (2010),

> "It would be perfectly conceivable for a student to engage positively along one or more dimensions while engaging negatively along one or more, or to engage positively or negatively along one or more while not engaging along another/others" (p.74).

Drawing on Trowler's model of engagement (2010), skipping lectures means behavioural non-engagement, whereas meeting WileyPLUS weekly assignments can indicate a positive cognitive engagement. Although students were registered in different sections of the course, the tendency to skip lectures suggests that F2F students, like those in distance education, learn and engage in independent cognitive zones.

Table 18: Examples of positive and negative engagement (adopted from Trowler, 2010).

	Negative engagement	Non-engagement	Positive engagement
Behavioral	Boycotts, pickets, or disrupts lectures	Skips lectures without excuse	Attends lectures, participates with enthusiasm
Emotional	Rejection	Boredom	Interest
Cognitive	Redefines parameters for assignments	Assignments late, rushed, or absent	Meets or exceeds assignment requirements

4.5.4 Student participation in the Digital Anatomy Learning (DAL) project

The DAL project was designed to foster S-S interaction in the course. However, the majority of students did not participate in the DAL project, and their reasons in descending order were: participation was optional; I did not know what to make the video about; the activity seemed cumbersome - the grade worth was not appealing; it was difficult to find or make a group. S-S interaction seem to have been diluted in the learning environment of the course. Without attending lectures, F2F and distance students could have interacted with peers in the course through Brightspace's discussion threads and forums. However, such S-S interaction was not facilitated in the course.

4.5.5 High-Tech, Low-Touch

Pike and Kuh (2005) in their study, confirming that institutions differ in the way they engage students, identified seven types of institutions. They characterized high-tech, low-touch institutions as,

> "Information technology rules at these universities to the point of muting other types of interactions. There is a sense of stark individualism as little collaboration

> occurs, academic challenge is low, and the interpersonal environment is not a distinguishing feature of the campus." (p. 202).

Drawing on Pike and Kuh (2005), the impact of the course design on student interaction can be attributed to the flexibility provided using technology. The quantitative and qualitative results of L&I and DAL components revealed that certain aspects of the course (including the accessibility of the course materials, the open-book exam policy, and the optionality of lecture attendance) influenced student learning attitudes, hence, their perceptions toward the need for S-S interaction. Since the time and space separation in online learning allows students to manage their own time and activities, technology provides more control over learning and enables individualism that is driven by the convenience of independent learning (Liu, 2008). Learning independently within cognitive and interpersonal comfort zones, therefore, lacks academic challenge and limits social interaction (Pike & Kuh, 2005).

4.6 Limitations

A specific limitation to this study was that two of the groups (Group 1 and Group 3) consisted of both F2F and distance education students, although in the case of Group 3 it was possible to separate the results from each type of student within the group. The use of data from the mixed groups limits the interpretation of differences between F2F and distance education students. However, the ability to segregate the Group 3 students into F2F and Distance Education cohorts revealed results that were very similar to the results from the mixed groups.

As described in Section 4.5.2, all students had access to online content that included recorded lectures and lab content. Therefore, students from both F2F and Distance education cohorts may have received S-I influence but considered it to be S-C. This would skew the perceived importance of S-I relative to S-C.

4.7 Conclusion

In the age of information, digital literacy has become essential for lifelong learning. But the over-reliance on technology in any given course design engenders seemingly passive isolated learners who do not perceive a need for social interactions. The flexibility of the course design examined in this study enabled students to become independent learners and did not encourage social interaction between them.

S-S interaction and collaboration underpins shared learning, essential for IPE in an introductory anatomy course. Yet, S-S interaction was a major issue in the high-tech low-touch course design, in which teamwork and communication are particularly difficult (Attardi et al., 2022). Minor refinements in the course design, however, could facilitate S-S interaction.

4.8 Design recommendations

Student suggestions to improve lecture attendance and participation in the DAL project were explored to gain insights into enhancing the learning experience with S-S interaction in F2F and online learning environments. Promoting S-S interaction and collaboration can provide a foundation for shared learning in such "high-tech, low-touch" course design.

Lecture attendance and course exams

Student suggestions on improving the course delivery (including lectures and exams) showed some level of frustration resulting from the academic workload, which probably promoted them to take the most individualized routes to learning. Different tactics were proposed to boost F2F lecture attendance and interaction. These include:

- Delaying the posting of online course material like recorded lectures would motivate students to attend class in order to keep proper pace. Previous research shows that students use recorded lectures to substitute lecture attendance (Gupta & Saks, 2013; Bos et al., 2016).
- Incorporating laboratory sessions/visits would persuade kinesthetic learners, who prefer practical application and real-life experience, to attend to get involved in hands-on learning (Fleming, 1995).
- Allocating a small percentage of grade for lecture attendance would encourage students to attend more regularly. Research suggests a relationship between lecture attendance and student performance in exams (Kassarnig et al., 2017; Landin & Pérez, 2015). However, the implementation of mandatory lecture attendance has been under considerable criticism (Verbeeten & Van Hoof, 2007). The use of in-class pop-up graded clicker questions provides a practical solution to encourage students to attend and interact with peers. The use of clicker points has previously been reported to encourage students to attend and remain engaged throughout the lecture (Trees & Jackson, 2007).

Different suggestions were also proposed to improve the course exams; these include:

- Exams should be more challenging in terms of time so students know the answer off-hand, or in terms of the complexity so students are challenged to apply knowledge in other ways.
- Exams should be held in-class so grades can be based on "actual" student learning. The implementation of in-class written examinations may be challenging given student large enrolment in the course. A plausible alternative would be to continue to use the online exam policy with some of the midterms to be proctored in class. Nevertheless, different strategies leveraging inherent features within LMSs (like Brightspace) are used in online education to support student academic integrity and honesty and deter cheating during exams (Varble, 2014; Budhai, 2020).
- Exams should feature fewer True or False questions as they require less effort, especially if multiple attempts are allowed.

- Exams should be appropriately spaced: although the exams are not too difficult but require studying/reviewing, having a third midterm right before the final examination can be stressful, especially when students are preparing for other final exams.

Recommendations to improve DAL project based on analysis of survey responses

Based on the analysis of student responses, the following recommendations are to improve the design and implementation of the DAL project. What was evident from student responses is that understanding technology was essential to participate in the DAL project. To improve student participation in the DAL project, the activity design should consider the following factors (which could also be used to inform other group activities in the course):

- Explain the activity: dedicate more time to introduce and advertise the activity, which can be done by showing examples from previous years and guiding students with feedback.
- Use icebreakers: for F2F students, incorporating graded in-class/online group discussion would facilitate S-S interaction and hopefully foster friendship and reduce anxiety regarding online group work.
- Help students to form groups: creating a list of topics allows students to choose and join the group of their interest.
- At this introductory course level, participation in the DAL project activity should remain optional, and all submissions should continue to be awarded points. Students are transitioning to higher education, and they may still be trying to figure out their learning styles and approaches. The first iteration of the project awarded bonus points for the top three videos, which was a disincentive for other students. A more democratic approach that acknowledges student creativity is awarding all participants, with the top three receiving extra bonus points. If the DAL project is to continue in a third iteration, the evaluation of student videos and the distribution of the bonus points should be designed based on two peer evaluation systems:
    - Class evaluation: peer voting for submitted videos in previous iterations of the project was optional (ungraded), based on preference, and done through the Like or Dislike function of Brightspace's discussion thread. Class evaluation should

continue to be a basis for evaluation, yet the instructor's quality rubric could be used to inspire the process. Creating a concise version of the rubric for students to use would enhance peer voting and feedback. Meaningful feedback from students should therefore be rewarded.

- Intragroup evaluation: in addition to class evaluation, peer evaluation within student groups should be part of the evaluation of the videos. Intragroup evaluation could be carried out by creating and using peer evaluation forms, which contain a simplified rubric that targets competencies related to teamwork and communication. Members in a group should evaluate each other once or twice in the middle and at the end of the activity to ensure balanced group dynamics.

Class and intragroup evaluation and feedback can be facilitated using Kritik's online platform. Using customizable rubrics and text feedback features, Kritik allows students to anonymously evaluate each other's performance or as a group evaluating another group(s). Student grades from Kritik are calculated based on their evaluation from peers and on how much their evaluation of peers is close to the class evaluation mean, which ensures that students remain honest and objective when evaluating and providing feedback (Kritik, n.d.). The use of Kritik for class evaluation requires students who want to vote to go through a learning curve (sign up and use), which might result in a small number of votes, especially if this type of evaluation remains optional. Thus, it is more practical to either make class evaluation mandatory or require participating students only to evaluate each other's submissions.

- Support some level of anonymity in the DAL project. Aiding students to submit their videos anonymously could help minimize subjectivity in the evaluation process, making students feel more comfortable when participating. Although it may be difficult to completely anonymize videos, allowing students to submit their videos indirectly through the instructor, who could post them anonymously for the class evaluation, would introduce some level of anonymity, excitement, and interaction between students.

Recommendation to improve DAL project based on analysis of the DAL project videos

Based on the analysis of DAL project videos, the following suggestions are to improve the design and implementation of the DAL project:

- The evaluation criteria should continue to be included in the DAL project description (Appendix C).
- To improve the diversity of topics, the course instructor could provide the students with a list of topics to choose from.
- The requirement of five-minute videos should be modified to allow for more flexibility. Students should be given a time range; for example, videos should not be less than three minutes or more than five minutes.
- Having two seasons of the DAL project with different windows of submissions and deadlines was somewhat confusing. Multiple windows for submission could be replaced with one main window that starts at the beginning of the term and closes two to three weeks before the final examination. Students should be encouraged to submit their videos as early as possible to get more views hence votes.
- Students should be encouraged to work in pairs or groups of 3. To improve the quality of videos, the optimal number of participants per video is three. The number of group members should not exceed three to minimize the chances of having "hitchhiking" students, also known as free-riders. Those are students in a group that do not contribute or make an effort to participate.

CHAPTER 5: STUDY II - CADAVER-BASED ANATOMY EDUCATION (CBAE)

5.1 Introduction

The study of human anatomy using cadavers has a history, dating back to the Renaissance (Persuad, 1984). For many years anatomy was a dominant, perhaps the dominant, component of medical education (Eldred & Eldred, 1961). The strength of anatomy was enhanced by the Flexner Report of 1910 that led to the creation of national standards (in the United States and Canada) and positioned scientific disciplines, but especially anatomy, as all important during initial training, only later followed by clinical training (Flexner, 1910; Cooke et al., 2006). However, starting in the 20th century, the broad expansion of biomedical knowledge, plus a greater recognition of the psychosocial aspects of medicine, resulted in reduced time for anatomy (Drake, 2014).

For decades, gross anatomy education relied on a traditional F2F approach, utilizing a combination of didactic lectures and cadaver-based laboratories (Pawlina & Drake, 2014). Learning in these laboratories was primarily framed around student-led dissection activities. The dissection activities were based on team-based tasks that sought to expose students to target anatomical structures. Prosections was often incorporated in the process to guide the dissection by demonstrating the relevant structures they needed to look for, preserve or sacrifice.

The traditional approach to gross anatomy education is recognized to allow students to explore the human body in multidimensions (Aziz et al., 2002). Dissection involves an active learning process, which enables students to indulge a sensory experience that is essential for the development of various learning competencies (Aziz et al., 2002; Papa & Vaccarezza, 2013; Estai & Bunt, 2016).

Prosections, on the other hand, are professionally pre-dissected cadaveric specimens, widely considered and used as models that provide various perspectives into deep and intricate bodily layers and structures (Fruhstorfer et al., 2011; Estai & Bunt, 2016). The use of prosections allows anatomical knowledge to be conveyed efficiently via structure visualization (Pawlina & Drake, 2014). Such multimodal experience has provided firm underpinnings for professional learning and interaction (Netterstrøm & Kayser, 2008).

Students' ability to use human cadavers in their education has been a privilege made possible with generous donations from thoughtful individuals. It is, therefore, only with active participation in the laboratory to achieve maximum learning, that they can express their appreciation of these precious gifts. Although students still participate in dissection activities, they often favor learning from prosections (Wisco et al., 2015; Schurr et al., 2022). The move to prosections has been made necessary by decreased teaching time available and increased operating cost (Drake & Pawlina, 2014). In pursuit of excellence, gross anatomy education has been modernized with practices keen on optimizing the use of available resources to achieve the anticipated outcomes. This has led to a decline in traditional dissection models in favor of more modern approaches that utilize prosections.

Study objectives and hypotheses

Students were surveyed for perceptions and attitudes about gross anatomy learning in courses with traditional (dissection-based) and modernized (prosection-based) designs. The goal was to understand the impact of the different course designs on student preference and interaction. The study also sought to gain insights into how to optimize the use of cadavers to design effective collaborative activities for health professional students.

Study objectives

Objective 1:	To examine if the traditional dissection-based anatomy teaching and course design provides a foundation for interprofessional learning and interaction.
Objective 2:	To identify factors influencing interprofessional student collaboration in the traditional dissection-based anatomy laboratory.
Objective 3:	To explore and explain student perceptions of the usefulness of dissection and prosections in traditional course design.
Objective 4:	To explore and explain student perceptions of the usefulness of dissection and prosections in modernized course design.
Objective 5:	To compare student performance in traditional and modernized course designs.
Objective 6:	To examine how the use of donated cadavers in traditional and modernized course designs provides a foundation for professional learning and interaction.

The data obtained from the objectives was used to consider two key proposed hypotheses.

Study hypotheses

Hypothesis 1:	As a result of the different admission prerequisites of their programs, there are differences between OT and PT students in terms of their perceived readiness for interprofessional learning.
Hypothesis 2:	Students perceive prosections as more useful than dissection in learning the course content because prosections enable straightforward learning facilitated via direct visualization of structures.

5.2 Methods

In Atlantic Canada, the Department of Medical Neuroscience and its Division of Anatomy at Dalhousie University is home to the Human Body Donation Program (HBDP). The HBDP is the University's source of donated human remains, which are greatly celebrated in the education of future health professionals (Dalhousie University-3, n.d.). The HBDP has been in existence for over 150 years, with approximately 3,000 registered living donors (Kovac et al., 2018). Though located in Halifax, donations are accepted from across three Maritime provinces: Nova Scotia (N.S.), New Brunswick (N.B.) and Prince Edward Island (P.E.I.).

The dedicated individuals in the Department support the University's health professional programs that make hands-on gross anatomy learning possible through thoughtful design and implementation of cadaver-based curricula (Dalhousie University-4, n.d.). The goal is to enable students to cultivate the knowledge and skills they need in their subsequent professional education and practice (Dalhousie University-5, n.d.). The students surveyed in this study were from one of three health professional programs: Master of Physiotherapy (PT), Master of Occupational Therapy (OT) and Doctor of Dental Surgery (DDS).

5.2.1 Course materials and design

Functional Human Anatomy (ANAT-5217) was a full credit (six credit hours) course. The course was designed initially to bring together first-year OT and PT students to learn with, from and about each other. The philosophy of the course was to teach functional morphology - how the body works in terms of how the structure supports the function and not just what the component parts are named. The primary learning objective of the course was for students to understand detailed functional gross anatomy and peripheral neuroanatomy of the upper and lower limbs and the back. The course included a survey of the major structures of the head, neck, and trunk from a functional point of view. The course also included insights from histology, osteology, arthrology, myology, peripheral neurology and living anatomy. Consideration was given to several aspects of human existence such as evolution, death, bipedalism, beauty, and sex. *Clinically Oriented Anatomy* (7^{th} Ed.) (Moore et al., 2014) was used as the course textbook.

Gross Human Anatomy/Neuroanatomy (D-1113) was a full credit (six credit hours) course. The course, designed exclusively for first-year DDS students, was divided into two components (gross anatomy followed by neuroanatomy). The study was concerned only with the first component. The learning objectives of this component were for students to be able to identify and describe the normal gross morphology of bodily organs in a regional approach with a particular emphasis on structures involved in dentistry, to use appropriate anatomical terminology in communication with medical and non-medical personnel, and to apply anatomical knowledge in reasoning and solving clinical cases. *The Anatomical Basis of Dentistry* (3rd Ed.) (Liebgott, 2011) was used as the course textbook. The course code (D-1113) will be used here to refer to the first component of the course.

Traditional gross anatomy course design

Prior to the Fall term of 2019, both the ANAT-5217 and D-1113 course were designed and implemented following a traditional dissection-based approach. Both courses utilized laboratory-based resources such as embalmed cadavers, prosections, plastinated specimens, bones, x-rays, and plastic models. In addition, the courses used a LMS (BrightSpace; Desire2Learn, Ontario, Canada) to mediate instructional communication and provide students access to course materials. The course materials included syllabi (detailed descriptions of study objectives and assessment) and a series of faculty-made multimedia resources. The materials were downloadable to enable offline accessibility. Study guides and laboratory manuals were prepared, printed, and distributed to students enrolled in the courses at the beginning of the academic term. The courses offered 60-90 minutes of F2F didactic lectures, which were scheduled twice weekly, and the PowerPoints slides used by the instructors were made available before every lecture. Students were also advised to watch the appropriate instructional video before attending the respective lecture and the subsequent laboratory session.

Laboratory teaching in the two courses commenced with a live demonstration projected by video against a large screen in the lab. Using prosections, the instructors showcased target structures and taught students how to approach dissection. Every 6-7 students were assigned as a group around a dissection table with a designated embalmed cadaver. Following the directives of their laboratory manuals, groups of students then set off to undertake extensive dissection tasks and worked as a team. Dissection tasks for OT and PT students were designed to expose them to the topographic composition of the human body and grasp the range of motion of joints. Dissection tasks for DDS students were more intricate, including some simulated surgical procedures (for example, parotidectomy). In both courses, students were expected to take turns as lab manual reader, dissector, atlas demonstrator within their groups. Students were therefore encouraged to take the time to discuss the content of laboratory manuals and guide each other to perform the assigned dissection activity.

Opportunities for collaborative learning in the laboratory were framed around team-based activities, which required students to socialize and actively participate (engage) in small and large group discussions. Students were also encouraged to become independent, self-directed learners so that they could continue to expand their understanding of the human body throughout their professional careers. Therefore, they were supplied with anatomical (Grant's) atlases and electronic tablets to look up information on their own. Ad hoc assistance was provided by laboratory instructors and, as they moved between groups of students, they often utilized prosections to aid students with their dissection or to illustrate key concepts. Before the end of the laboratory time, students were able to view the prosections individually or in groups. These quality prosections were products of the Summer Prosections Program (SPP), which offered summer employment positions to students of Medicine, Medical Science, and Dentistry. The Department of Medical Neuroscience hired students as prosectors (dissectors) to prepare prosections under the supervision and guidance of skillful anatomists (Dalhousie University-6, n.d.).

Learning in these courses was assessed through summative midterms and final examinations, which included laboratory-based bell-ringer exam components. Theoretical exam components consisted of MCQs, True-or-False, short answer, and essay questions. Practical exam components included, but were not limited to, structure identification questions on dissected cadavers, prosections or other laboratory-based resources (such as plastinated specimens, bones, x-rays, and plastic models). The D-1113 course allocated 9% of the total grade to group case presentations and pop-up quizzes. Each student group was given a clinical case related to the practice of dentistry; toward the end of the term, student groups presented their cases and were evaluated by the course instructors (5%). The pop-up quizzes took place in the laboratory, in which students were given answer sheets and asked to identify anatomical structures (video projected on the lab screen) that were dealt with in the prior lab sessions (4%).

Modernized gross anatomy course design

The dissection-based interprofessional design of the ANAT-5217 course was last offered in the Fall term of 2018. Starting from Fall 2019, OT and PT students were no longer learning gross anatomy together, and dissection was no longer used as pedagogical means in their laboratories. To accommodate these changes while maintaining the same lecture and laboratory time slots, a new course was created for OT students (Clinical Anatomy course, Section 1; ANAT-5000), in which the laboratory sessions were scheduled before the course lectures. When PT students in the ANAT-5217 course were in the lecture theatre, OT students in the ANAT-5000 course were in the laboratory and vice versa. In the two courses, dissection was replaced completely with structured activities that involved the use of prosections. The course materials and learning objectives were mostly the same as in the previous ANAT-5217 course. In the modernized design of the ANAT-5217, assessment of student learning remained the same. In the new ANAT-5000 course, 90% of the exam questions were new.

Laboratory teaching in the D-1113 course was also modernized, but dissection was still maintained. Major dissection activities were reduced to more structured activities. Since dissection remained used in the modernized design of the D-1113 course, the study did not follow up with DDS students. The intent was to explore possible differences between the use of dissection and prosections versus the use of prosections only in providing foundation for professional learning and interaction, and whether the elimination of dissection and interprofessional learning impacted student performance or not.

5.2.2 Study design

The study sought to better understand student preference and interaction by examining how they perceive and approach learning in the laboratory. In consultation with the instructors of the courses and other experienced educators, a questionnaire-based survey was developed to capture and measure student perceptions. The survey was administrated online. Modified versions of the survey questionnaire were used to follow up on the preliminary findings by comparing the results of student responses.

Measurement instruments

The survey questionnaire (Appendix I-a) consisted of two components: interprofessional anatomy learning (IPAL) and cadaver-based learning (CBL). Each component contained quantitative and qualitative questions. The quantitative questions of the first component (IPAL) involved the Readiness for Interprofessional Learning Scale (RIPLS). The RIPLS, originally developed by Parsell and Bligh (1999), was later refined by McFadyen et al. (2005). The scale is widely used to assess students' perceptions and attitudes toward IPE to determine their readiness for interprofessional learning (Fernandes et al., 2015; Herrmann et al., 2015). The refined RIPLS comprised nineteen structured statements that make up four subscales related to various interprofessional competencies (Canadian Interprofessional Health Collaborative, 2010). These subscales, and associated defining characteristics (Parsell & Bligh, 1999), are:

(1) **Teamwork and Collaboration** (T&C) – nine statements that assess the link between the positive outcomes of teamwork and the adoption of team-based approaches to learning prior to qualification.

(2) **Negative Professional Identity** (-ve PI), and (3) **Positive Professional Identity** (+ve PI) – three and four statements, respectively, that either negatively or positively assess the importance of professional identity with both potential negative and positive influence on IPE.

(4) **Roles and Responsibilities** (R&R) – three statements that assess perceptions about roles in professional practice settings. Pre-existing ideas about ranks within healthcare teams may limit IPE.

Students were asked to express their level of agreement or disagreement with the scale's statements using 5-point Likert items, ranging from 1 (Strongly disagree) to 5 (Strongly agree). The statements that compose the T&C and +ve PI subscales were positive with respect to IPE. That is, student agreement with these statements is an indication of readiness for interprofessional learning. In contrast, the statements that make up the -ve PI and R&R subscales are negative; student disagreement with these statements is an indication of readiness for interprofessional learning. The quantitative questions of the second component (CBL) comprised two 11-point Likert type sliding items ranging from 0 (strongly not useful) to 10 (strongly useful) with a step size of 0.5. Students were asked to rate the usefulness of the two cadaver-based modalities, dissection and prosections, in learning the course content. Average student grades were made available by the course instructors for a subset of the students surveyed, allowing for comparison of academic performance between traditional and modernized gross anatomy course design.

Optional qualitative questions were used in the survey to offer the students opportunity to express their opinions and elaborate on their responses. The first component (IPAL) included two open-ended questions, which asked students to reflect on their interprofessional experience and identify possible factors that influenced teamwork dynamics in their laboratory groups. The CBL component included two open-ended questions geared to exploring students' perceptions about death and cadavers as well as their approaches toward learning in the laboratory. The purpose of collecting qualitative data was to gain deeper insights into student responses by capturing any possible perceptions and attitudes toward cadaver-based learning.

Data collection and filtering

Data were collected from three academic terms: Fall 2017, Fall 2018, and Fall 2019:

- In Fall 2017, students enrolled in ANAT-5217 were invited to respond to the survey questionnaire. Data were collected at the beginning of the term, before the midterm examination (Part 1: Entry/Primary Survey; Appendix I-a), and once again at the end of the term, after the final examination (Part 2: Exit/Secondary Survey; Appendix I-b). Students enrolled D-1113 were invited to respond to the survey questionnaire (CBL component only); data were collected using the same approach by which data were collected from students enrolled in ANAT-5217 (Appendix J-a &J-b).

- In Fall 2018, students enrolled in ANAT-5217 were invited at the end of the academic term to respond to the survey questionnaire addressing the CBL component (Appendix K).
- In Fall 2019, students enrolled in ANAT-5217 and ANAT-5000 were also invited at the end the academic term to respond to a concise questionnaire addressing the CBL component (Appendix L).

The survey invitations (Appendices M to O) were sent as announcements on Brightspace of the courses. The recruitment message in all invitations introduced the purpose of the study. The message included a note on how students' responses would be collected anonymously. To encourage students to participate, the message emphasized the importance of optimizing the use of cadavers to improve their learning experience. Participants were informed that participation in the survey was entirely optional, and they were welcome to stop the survey at any time if they no longer wished to participate. An electronic link to the survey was provided for students who decided to participate. The link directed students to the online survey page. Responding to quantitative questions was required, while responding to qualitative questions was optional. Partial responses to quantitative questions were considered incomplete and therefore not included in the data. Reminder emails were sent to students to improve the response rate. A total of 245 responses were received, of which 223 were analyzed.

Participant groups

Participants in the study were students enrolled in different gross anatomy courses for different health professional programs (Table 19). Admission into these programs involved systematic evaluation processes, which adhere to profession-specific competencies. Thus, students in a program cohort should have shared common backgrounds of knowledge and skills. Response rates were between 18% - 56%. Based on their enrolment term and program of study, students' responses were grouped into four main groups and two subgroups:

Group 1**:** included 82 responses (Part 1: 40; Part 2: 42) from interprofessional OT and PT students enrolled in Fall 2017. To establish a quasi-experimental design (pre- and post-test), students in this group were allowed to generate unique identity codes; the self-generated codes were intended to match students' responses to the RIPLS at Entry with their responses at Exit. Few students created a unique identity code making it possible to match the responses of 11 individuals only (7 OT and 4 PT). This sample size was considered insufficient to compare between OT and PT students. Instead, the study focused on examining if the traditional course design provided a foundation for interprofessional learning and interaction, utilizing a combination of quantitative and qualitative data from the mixed student responses.

Group 2: included 49 responses (Part 1: 30; Part 2: 19) from DDS students enrolled in Fall 2017.

Group 3: included 44 responses from interprofessional OT and PT students enrolled in Fall 2018. Based on the qualitative analysis of Group 1 responses in CBL component (Primary), 3 questions comprising a total of 11 statements were developed and added to the same component to collect explanatory responses from Group 1 (Secondary), Group 2 (Secondary), and Group 3. The statements were intended to explore possible reasons influencing student perceptions and preference toward dissection and prosections. Additionally, the statements were followed by three open-ended questions to allow students to explain their responses, share suggestions, and elaborate on potential roles for instructors in the laboratory.

Group 4: included 48 responses from students enrolled in ANAT-5000 or ANAT-5217 (Fall 2019). Group 4 was divided into two subgroups: Group 4A, OT students (n=36); Group 4B, PT students (n=12).

Table 19: Data collection (Study II groups).

Group 1: (IPE: OT/PT students)	Fall 2017 (Appendix I-a & I-b)			Preliminary
	Part 1: Responses: 42 from students enrolled in ANAT-5217	Survey components: • Interprofessional anatomy learning (IPAL-Entry) (OT: n=27; PT: n=15) • Cadaver-based learning (CBL-Primary) (OT: n=24; PT: n=14)		
	Part 2: Responses: 40 from students enrolled in ANAT-5217	Survey components: • Interprofessional anatomy learning (IPAL-Exit) (OT: n=12; PT: n=9) • Cadaver-based learning (CBL-Secondary) (OT: n=22; PT: n=18)		
Group 2: (DDS students)	Fall 2017 (Appendix J-a & J-b)			Follow- up 1
	Part 1: Responses: 30 from students enrolled in D-1113	Survey component: • Cadaver-based learning (CBL-Primary) *		
	Part 2: Responses: 19 from students enrolled in D-1113	Survey component: • Cadaver-based learning (CBL-Secondary) *		
Group 3: (IPE: OT/PT students)	Fall 2018 (Appendix K)			
	Responses: 44 from students enrolled in ANAT-5217	Survey components: • Cadaver-based learning (CBL)*		
Group 4: (Separate OT & PT students)	Fall 2019 (Appendix L)			Follow-up 2
	Responses: 48 from students enrolled in ANAT-5000 (OT: n=36) & ANAT-5217 (PT: n=12)	Survey components: • Cadaver-based learning (CBL)		
Student grades (traditional vs. modernized course designs)	OT	Fall 2017	66	Follow-up 3
		Fall 2019	66	
	PT	Fall 2017	61	
		Fall 2019	62	

*Quantitative data only

Data analysis

To address the study's objectives and test the stated hypotheses, quantitative and qualitative analyses were undertaken utilizing analytical tools and procedures summarized in this section.

Quantitative data

Data were exported from the online survey platform to Microsoft Excel. Four composite scores were created by calculating the mean of each student response within each subscale (Lestari et al., 2016; Mèche et al., 2016). The variables were then organized on the Excel sheet to be used by Statistical Package for the Social Sciences (SPSS) software. Using SPSS, the normality of the data was assessed using both graphical (Histograms) and numerical (Shapiro-Wilk) tests. Based on the data distribution, the following statistics and tests were performed for each of the datasets (groups):

- Descriptive statistics: *Mdn* for central tendency and *IQR* for dispersion. Boxplots were used as a graphical technique to summarize the distribution of datasets, providing a more convenient way to compare the study groups (see quantitative data analysis in section 4.3.2)
- Wilcoxon signed rank test: for comparisons with the neutral midpoints of 3 (on 5-point Likert items) and 5 on (11-point Likert sliding type sliding items).
- Mann-Whitney U test: for comparisons between OT and PT students across the RIPLS's subscales and to explore differences between the perceptions of dissection vs prosections.
- Independent sample t-test: to compare the grades of OT and PT students (2017 vs 2019).
- In all cases, the null hypothesis was rejected if $p < \alpha = 0.05$.

Qualitative data

Qualitative data (from Group 1 and 4) were exported in PDF format, and then to Microsoft Word. Thematic analysis was carried out to identify and analyze recurring themes. Word clouds were generated to visually illustrate frequently mentioned words (italicized and bolded). See qualitative data analysis in section 4.3.2 for more details.

5.3 Results

In this section, the distribution of the data is first considered; this is followed by an examination of student responses to the survey's IPAL and CBL components. Quantitative results are presented in descriptive statistics and boxplot graphs, and comparisons were made against a neutral midpoint of 3 (5-point Likert items) and 5 (11-point Likert type sliding items) and between different groups of students, using appropriate statistics with significance set at $\alpha=0.05$. Qualitative results are presented in themes and sample quotes from student responses to open-ended questions.

5.3.1 Normality of quantitative data

Histograms were used to graph the distribution of quantitative data (not shown); all graphs suggested that data distributions in the study were skewed. The Shapiro-Wilk test was used to assess the normality of data; the result for all items was $p<0.05$. Thus, data were treated as not normally distributed. Therefore, statistical comparisons that follow employed non-parametric tests. For comparisons of data to the neutral midpoint, the Wilcoxon signed rank test was used. To compare two groups, the Mann-Whitney U test was employed. For comparisons between three groups, the Kruskal-Wallis test was used and, if applicable, Bonferroni post hoc comparisons were performed.

5.3.2 Component 1: interprofessional anatomy learning (IPAL)

In this section, the results of the perceived readiness for interprofessional learning among OT and PT students are presented across the four subscales of the RIPLS: Teamwork and Collaboration (T&C), Positive Professional Identity (+ve PI), Negative Professional Identity (-ve PI), and Roles and Responsibilities (R&R). Factors influencing teamwork dynamics were then identified along with suggestions from students to improve group collaboration in the laboratory.

The perceived readiness for interprofessional learning

This segment targets the study's first objective, *to examine if the traditional dissection-based teaching and course design provides a foundation for interprofessional learning and interaction.* Students in Group 1 were asked to respond to the RIPLS; Table 20 summarizes the results of their responses at the beginning and at the end of ANAT-5217 course.

The Wilcoxon signed rank test was performed to compare student responses to the neutral midpoint of 3. In each case, the subscale data were significantly different (p<0.001) from the midpoint (Table 20). The results from the T&C and +ve PI subscales (*Mdn* > 4) showed that students agreed with the statements of these subscales (Figure 12). Students disagreed with the statements in the -ve PI and R&R subscales (*Mdn*<2). Data collected at Entry were not significantly different (p> 0.05) from data collected at Exit (Table 20, Figure 12).

The design of the RIPLS is such that agreement with questions from two of the subscales (T&C and +ve PI) is consistent with readiness for interprofessional learning (RIPL), whereas agreement with the questions constituting the other two subscales (-ve PI and R&R) would indicate reduced RIPL (Parsell & Bligh, 1999; McFadyen et al., 2005). This means that agreement with the T&C and +ve PI subscale questions combined with disagreement with the -ve PI and R&R subscale questions indicates an overall RIPL. This pattern is revealed in the data here with *Mdn* Likert scores > 4 for T&C and +ve PI and <2 for -ve PI and R&R.

Another approach (Lestari et al., 2016; Visser et al., 2018) is to reverse the subscale score for the -ve PI and R&R so that the scores can be combined to produce a single measure of RIPL with values > 3 indicating increased RIPL and values < 3 indicating decreased RIPL. For the data here, this means the value of -v PI and R&R would be reversed to 4.33 and 4.00, respectively, for the data collected at Entry, and to 5.00 and 4.00, respectively, for the data collected at Exit.

Table 20: Overall results of the Readiness for Interprofessional Learning Scale (RIPLS; Group 1).

RIPLS Subscales	**Group 1**						
	Entry survey OT/PT (n=42)			**Exit survey** OT/PT (n=21)			Wilcoxon test *p*-value
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	
Teamwork and Collaboration (T&C)	4.38	1.00	**< 0.001**	4.66	0.83	**< 0.001**	0.458
Negative Professional Identity (-ve PI)	1.66	1.00	**< 0.001**	1.00	0.83	**< 0.001**	0.124
Positive Professional Identity (+ve PI)	4.16	1.00	**< 0.001**	4.25	1.00	**< 0.001**	0.932
Roles and Responsibilities (R&R)	2.00	0.33	**< 0.001**	2.00	0.83	**< 0.001**	0.441

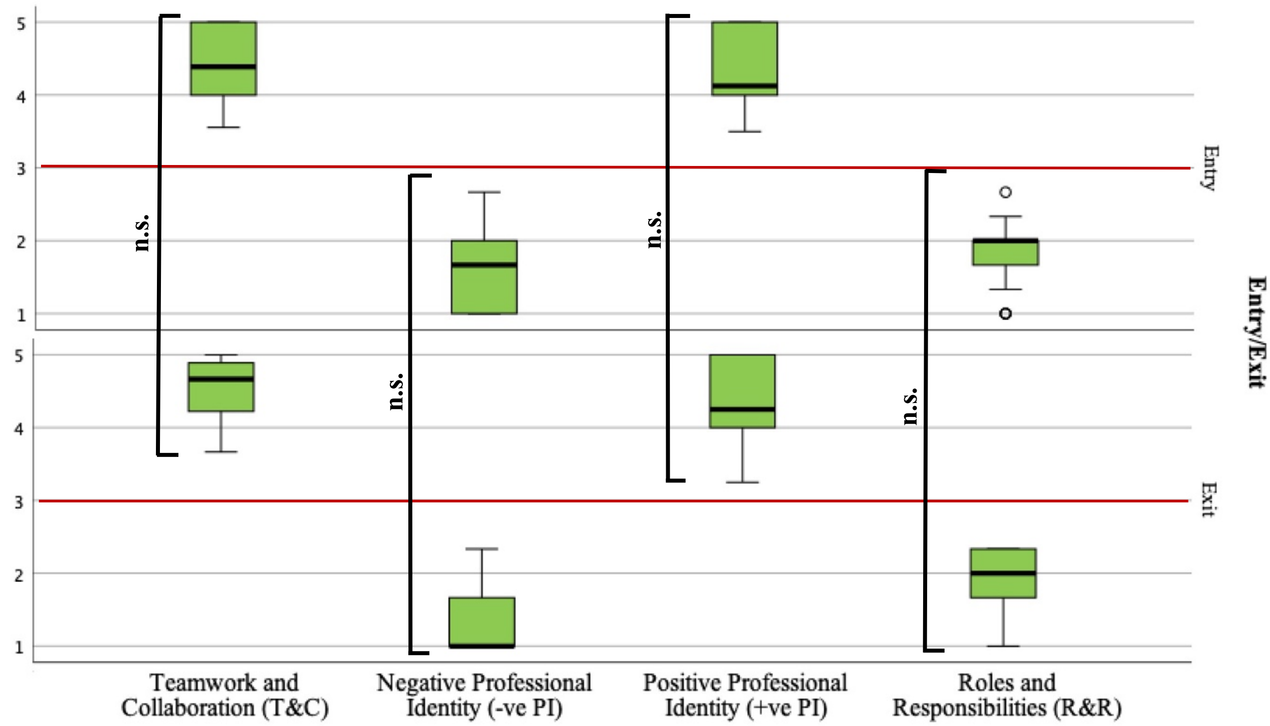

Figure 12: Boxplots of the overall results of the Readiness for Interprofessional Learning Scale (RIPLS; Group 1). The figure shows boxplots of student levels of agreement with (on a scale from 1 to 5) RIPLS's four subscales on the perceived readiness for interprofessional learning (x-axis) for Entry and Exit surveys (y-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IQR*). n.s.= not significant.

OT versus PT students

It was hypothesized that there were differences between OT and PT students in terms of the readiness for interprofessional learning. To test the hypothesis, responses were compared against each other using Mann-Whitney U test. Table 21 summarises the detailed results of RIPLS at the beginning and at end of the course. Although there were some differences between OT and PT students, none of these differences were statistically significant.

Taken as a whole, these results suggest that the surveyed students (Group 1) were prepared for IPE. Such preparedness was evident at the start (Entry) of the course and was not altered by the course (Exit). The group of students surveyed was a mix of OT and PT students. Both types of students demonstrated indistinguishable perceived preparedness for IPE.

Table 21: Detailed results of the Readiness for Interprofessional Learning Scale (RIPLS; Group 1).

RIPLS Subscales	Group 1									
	Entry survey					Exit survey				
	OT (n=27)		PT (n=15)		Mann-Whitney U p-value	OT (n=12)		PT (n=9)		Mann-Whitney U p-value
	Mdn	*IQR*	*Mdn*	*IQR*		*Mdn*	*IQR*	*Mdn*	*IQR*	
Teamwork and Collaboration (T&C)	4.44	0.88	4.33	1.00	0.651	4.88	0.75	4.33	0.72	0.069
Negative Professional Identity (-ve PI)	1.66	1.00	1.33	1.00	0.422	1.00	0.66	1.00	1.00	0.702
Positive Professional Identity (+ve PI)	4.00	1.00	4.33	1.00	0.837	5	0.94	4.00	0.8	0.082
Roles and Responsibilities (R&R)	2.00	0.66	2.00	0.33	0.522	2.00	0.83	1.66	0.83	0.917

Insights from qualitative analysis (Objective 1)

Students were asked to reflect on their overall interprofessional experience. Thematic analysis of their responses (Group 1 Entry and Exit, 86 comments from 63 responses) revealed two themes (Table 22).

Table 22: Themes and subthemes revealed from student reflections on their interprofessional experience (Group 1).

Themes	Sub-themes
Fostering social aspects of learning	-
Difference in background knowledge	Positive impact
	Negative impact

As shown in the word cloud below (Figure 13), student responses frequently mentioned ***learn(ed & ing)***, ***students***, ***PT(s)***, ***OT(s)***, ***background(s)*** and ***experience***.

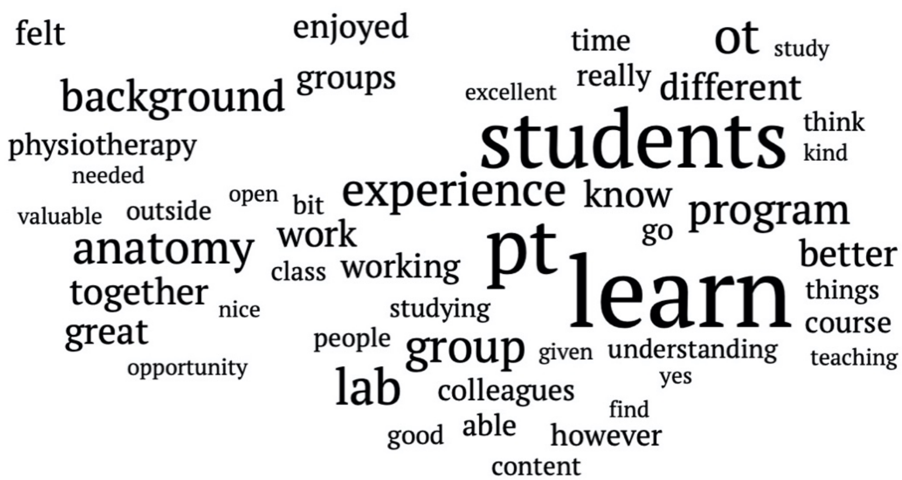

Figure 13: A word cloud of student reflections on their interprofessional experience (Group 1). Larger font size represents more frequent mentioning.

The following qualitative analysis examines interprofessional learning and interaction facilitated through the dissection-based design of the ANAT-5217 course. Student comments highlighted the potential of the traditional dissection-based course design in fostering social aspects of learning:

> "I really enjoyed my lab group. I wouldn't necessarily say I ***learned*** from them (***PTs*** teaching ***Ots*** or vice versa) but it was fun ***learning*** with them and getting to know them. It's nice to see familiar faces outside of your immediate program."

> "My ***experience*** was good having **Ots** and ***PTs*** working together. I felt it was a good way to meet people in the ***PT*** program and ***learn*** about what kind of work they do. This is important since in the real-world ***Ots*** and ***PT***s do interact."

> "I loved having class with the ***PTs***, I think it really helped solidify a sense of commonality among students."

> "It was great to have the ***PT*** students in anatomy with us. More as another group of friends/colleagues to ***learn*** with. Especially as the semester progressed and we were ***learning*** more in our respective fields, it was nice to compare our programs and outcomes and work together in ***learning*** the material."

> "The dissecting labs gave us an opportunity to get to know our colleagues in the ***PT*** program better, as well as provided me with a better understanding of their scope of practice. This will benefit me in the long run when I graduate and have a better understanding of what my coworkers do and how they fulfill their roles as we work

> together as part of the inter professional team. No other aspect of the program so far, including the IPE events, have given this kind of contact and I find it to be incredibly valuable."

OT and PT programs adhere to different profession-oriented admission standards and program outcomes, which resulted in a difference between students' background knowledge. Responses from OT students highlighted how this knowledge differential (KD) promoted positive interprofessional perceptions and attitudes among OT students:

> In this course I've found that ***PT*** student tend to have a bit more ***background*** knowledge, so the approaches are a bit different to the information. However, it's been an overall positive ***experience***."
>
> "I liked having ***PT*** students as that was refreshing. However, I do find them to be more advanced and so keeping up was a challenge. I enjoy working with the physiotherapy students because they have different educational ***backgrounds***, and it has been helpful to ***learn*** from and with them."
>
> "It was great to work with physiotherapy students in the lab. They had more of an anatomy ***background*** and could explain new things to the entire group."
>
> "I feel like the specific program they were (***OT*** or ***PT***) in did not affect how we ***learned*** with each other. It depended on our ***backgrounds*** in anatomy from our undergrad. Some people had ***experience*** with functional in-depth anatomy, where other had a single course which was all they needed to apply."

Positive interprofessional perceptions and attitudes were also highlighted by PT students:

> "I have had no problems with it. I enjoy working with the ***Ots***. Some of them have very little anatomy knowledge but I enjoy teaching what I already know."
>
> "Coming from our different ***backgrounds*** it was great to ***learn*** from each other. We all knew lots of different things outside of our course and were able to ***learn*** from each other. We were able to quiz each other and go through questions and help each other ***learn*** via different ***learning*** approaches."
>
> "I felt that it was a great ***experience*** to discuss with students from other programs the content in that day's lab. Although with our program's different schedules the students in the ***OT*** program had more studying opportunities which I felt they were ahead of myself in ***learning*** the content and tried to make me feel bad for not being as prepared for the lab as they were themselves."

While KD is almost inherent in many interprofessional settings, students demonstrated negative perceptions:

> "I have found that ***PT*** students seem to have a better understanding (maybe more ***background*** in anatomy) and don't want to spend as much time. I would rather ***learn*** with colleagues of a similar ***background***. ***PT*** students always want to rush through because they know everything rather than helping their colleagues."

> "The physiotherapy students in my lab group seemed to take over and didn't really let everyone have a chance to dissect/go through the lab manual. Also, during the laminectomy, the ***Ots*** on my side of the lab room were disappointed because the ***PTs*** didn't wait to continuing to dissect through the spinal cord before letting everyone see it."

> "I didn't like working with other students, regardless of which program they were from. They were overwhelming and dominating and trying to collaborate with them was time-consuming and took away from my ***learning*** about anatomy."

> "I think level of past ***experience*** impacted how the groups got along. Those who were more ***experienced*** within groups didn't go at the same speed as some of those who had less ***experience*** with the content. If it would be possible in the future to somehow take that into account so people felt more comfortable ***learning*** in their groups, it might go better initially."

Such negative outlooks resulted in homogeneous learning for some students:

> "I had a positive ***experience***. I did ***learn*** a little bit from the ***PT*** students; however, most ***learning*** was done within our group of ***OT*** students."

> "While I believe it is crucial to develop inter-professional relationships, I did most of my studying and ***learning*** with individuals from my own program."

> "Well, it was hard to see things on my cadaver, so I mainly used prosections. I did so not with my lab group but with my friends as I was comfortable with them, and they weren't known it alls trying to rub it in my face. I felt many of the physiotherapy students had that persona."

Factors influencing group collaboration in the laboratory

This segment addresses the second objective of the study, *to identify factors influencing interprofessional student collaboration in the traditional dissection-based anatomy laboratory.* Group 1 students were asked to elaborate on what would make their laboratory group more effective. Thematic analysis of their responses (Group 1 Exit, 40 comments from 21 responses) revealed three themes (Table 23). Various factors were underlined such as the need for more structured laboratory activities along with greater instructional guidance, especially for dissection.

These factors were deemed important to enhance collaborative learning between interprofessional students.

Table 23: Themes and subthemes revealed from student responses to what would make their laboratory group more effective (Group 1).

Themes	Sub-themes
The need for more instructional guidance	-
Factors related to the course design	The number of students assigned per a laboratory group
	The nature of student attendance and participation in laboratory
Student suggestions to enhance teamwork dynamics	Using icebreakers
	Enforcing grades on student participation
	Having tutors from OT and PT professions
	Implementing aspects of gamification and flipped classrooms

As shown in the word cloud below (Figure 14), student responses frequently mentioned ***lab***, ***group(s)***, ***dissection,*** and ***time***.

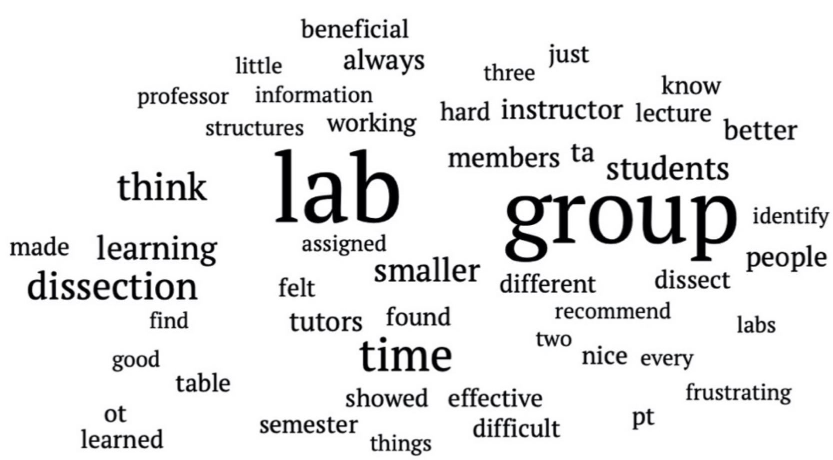

Figure 14: A word cloud of student responses to what would make their laboratory group more effective (Group 1). Larger font size represents more frequent mentioning.

The importance and the need for more instructional guidance in the laboratory was apparent in student responses:

> "I think it would be more effective if we had our own TA or if the TA was assigned two or three ***lab groups***."

> "I think if pictures of the cadavers could be used more in lectures, it would have helped to prepare us better for the ***lab***. I also think that if there were more instructors in the ***lab*** that they could spend more ***time*** at each table."

> "I can't really think of anything that I would change, except that a more structured flow to the ***lab*** would have been nice. At the beginning of the semester, we were told that each ***lab group*** would have a ***lab*** instructor at their table every 5 minutes. We were lucky if we got the attention of one of two by the end of the ***lab*** session. Other than that, I have no complaints."

> "If there were Tas assigned to just a few tables for the semester to ensure that there was always someone available to better explain things. Many times, our ***group*** would be waiting for a TA & they would always be with certain ***groups***, or all be on one side of the ***lab*** at one ***time***."

Examples of structural factors related to the course design included the number of students assigned per a laboratory group:

> "I felt that my ***group*** (3 Ots and 2 PTs) worked and learned well together. I'm not sure that I would have enjoyed having any more in our ***group***, 5 seemed to be a good number, 6 may have become too crowded."

> "I liked how the ***lab*** was conducted however, smaller ***groups*** may make it easier for people to be engaged in the ***dissection***. Having a ***group*** of 3 or 4 would allow more members to be involved in the ***dissection*** and make it easier to work through the ***lab***. I often found that my ***lab*** rushed through the information and often missed details because some didn't care, and no one wanted to spend the ***time*** to read it. Smaller ***groups*** may help people be more willing to take the ***time*** to go over the material in ***lab***."

> "For most of the sessions, only 3-4 out of the 6 of our ***lab group*** showed up. I found I learned much more when we were in smaller ***groups*** because you could see more and have more opportunities to dissect."

> "Less student per cadaver would have been helpful; six students to one body always left a couple of students passively back and watch, even if we tried frequently taking turns with ***dissection***."

The "expected but ungraded" nature of student attendance and participation in laboratory was highlighted as another structural factor influencing teamwork dynamics:

> "I think our ***group*** was so effective because there were really only three of us there most days. It was somewhat frustrating when one of our ***group*** members showed up after not being there for several weeks and wanted us to teach them what they'd missed or try to

dissect and make a mess of it. We were also told that we had one of the "nicer" cadavers, which may have made a difference in our success and interest too."

"... I would also have the students earn a mark for attendance and for completing aspects of their ***dissection*** to ensure they are utilizing their ***lab time*** properly."

"My ***group*** members didn't always show up, so at times it was hard to complete the ***lab***."

<u>Student suggestions to enhance teamwork dynamics</u>

The following qualitative analysis focuses on enhancing teamwork dynamics in the laboratory. To improve interprofessional group learning and interaction, students suggested using icebreakers, enforcing grades on student participation, having tutors from both OT and PT professions, and implementing aspects of gamification and flipped classrooms:

"Taking a short ***time*** to get to know each other before ***dissection*** (it seemed to take a while and it felt unclear where everyone's comfort was especially given how little we knew about our respective classmates much less the other disciplines)"

"I would recommend ***groups*** of PT versus ***groups*** of OT. Different aspects were important to the different professions and working in a ***group*** of strictly PT or OT may be beneficial."

"Emphasis that everyone needs to participation in the ***dissection lab***, as everyone tries to contribute somehow."

"Studying the ***lab*** sessions before going to the ***lab***."

"The interprofessional learning was great. I was able to get to know the 3 Ots at my table. However, I think it would have been nice to be able to work with more students, perhaps by changing the ***groups*** at the midway point of the semester."

"Learned a lot of how the ***lab*** can be applied to each profession in different ways. Would be nice to have OT tutors as well as PT tutors to show an even greater picture."

5.3.3 Component 2: cadaver-based learning (CBL)

The analysis of the CBL component begins by examining student perceived usefulness of dissection and prosections. Then, comparisons were made between OT and PT student performance in traditional versus modernized course designs. Lastly, student learning is captured around two themes, death, and the use of donated cadavers.

The perceived usefulness of dissection versus prosections in traditional course design

This segment addresses the study's third objective, *to explore and explain student perceptions of the usefulness of dissection and prosections in traditional course design*. The perceived usefulness of dissection and prosections in learning the course content was measured (quantified) among OT, PT and DDS students (Group 1, 2 Primary Survey & Group 3) in courses that required dissection but that also employed prosections as teaching aids. 11-point Likert type sliding items were used to evaluate questions about the usefulness of dissection and prosections. The Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint of 5. The results indicated that students in each group perceived both dissection and prosections as useful (*Mdn* >5, $p<0.05$ different from the neutral midpoint, Table 24 & Figure 15) but prosections were considered strongly useful (*Mdn* values 9.5-10), significantly ($p<0.001$, Mann-Whitney U) different than the perceived usefulness of dissection (*Mdn* 6-9, Table 24).

Table 24: Student perceived usefulness of dissection versus prosections (Group 1, 2 & 3).

Statements	**Group 1** Fall 2017 OT/PT-Primary (n=38)						**Group 2** Fall 2017 DDS-Primary (n=30)			**Group 3** Fall 2018 (n=44)					
	OT (n=24)			PT (n=14)			DDS			OT (n=24)			PT (n=20)		
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
How useful was cadaver dissection in learning the course content?	7.5	5	**0.004**	9	2	**0.006**	6	3	**0.034**	6.5	4	**0.047**	7	6	**0.023**
How useful was the use of prosections in learning the course content?	10	1	**<0.001**	10	0	**<0.001**	9	2	**<0.001**	10	2	**<0.001**	9.5	2	**<0.001**
Dissection vs. prosections Mann-Whitney U (*p*-value)	**< 0.001**			**< 0.001**			**< 0.001**			**< 0.001**			**< 0.001**		

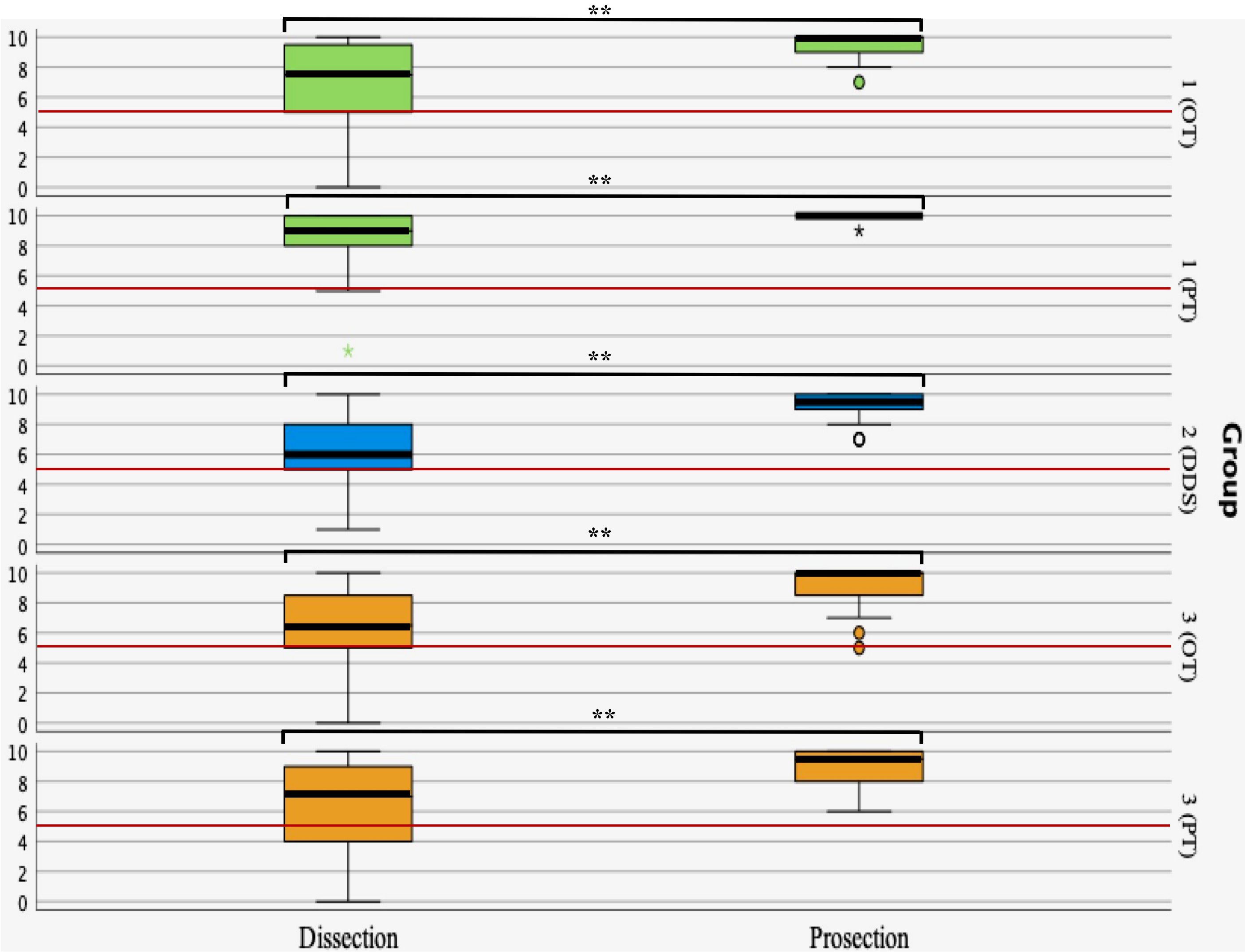

Figure 15: Boxplots of student levels of agreement (on a scale from 0 to 10) with statements on the perceived usefulness of dissection versus prosections (x-axis) for Group 1, 2 & 3 (y-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IRQ*). Stars represent significant differences between the groups (** $p < 0.001$).

Group 1 students were also invited (Secondary Survey) to describe how they utilized dissection and prosections in the laboratory. Thematic analysis of their responses (Group 1 Secondary, n=40) revealed two themes (Table 25). Students elaborated on the powerful combination to learn multimodally, exhibiting different approaches and preferences.

Table 25: Themes revealed from student responses to describe how they utilized dissection and prosections to learn in the laboratory (Group 1).

Themes
Usefulness of both cadaver-based modalities
Preference to use prosections for learning

As shown in the word cloud below (Figure 16), students frequently mentioned ***dissect(ion & ing)***, ***prosection(s)*** and ***structures***.

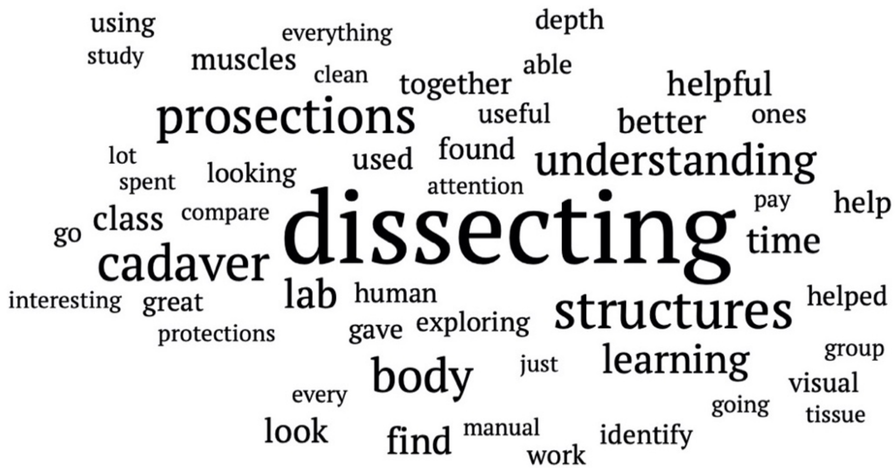

Figure 16: A word cloud of student responses to describe how they utilized dissection and prosections to learn in the laboratory (Group 1). Larger font size represents more frequent mentioning.

The following is a sample of student responses, in which they describe their learning approaches expressing the usefulness of dissection and prosections:

> "***Dissection***, comparing to slides and manual description/photos, compare to my own body, compare amongst other ones in the lab, gives a better understand to how the human body varies with every person."
>
> "Quizzing, exploring orientations and attachments to determine function at a more tactile environment than just visual or classroom learning."
>
> "I found the ***dissections*** gave a very good understanding about the depth which ***structures*** lay. The prosecutions were very helpful to show clear details which would not otherwise be seen. A key to my learning was the access to the lab after hours to go back and review ***prosections***."
>
> "I would ensure I was actively involved in the ***dissection*** so I could understand how muscles, ligaments, nerves, bones, etc all work together. I made sure to look at as many ***prosections*** as possible and analyze different angles. It helps me to have a better

understanding of how different aspects of the human body are connected and work together."

"Studying from the ***prosections*** after class was most useful, while the ***dissections*** were useful in class time to discover ***structures*** with other classmates in a less rigid manner."

The preference to using prosections was apparent in student responses:

"It is great to see how ***structures*** look and work on a real human body, but I find the pro sections much more useful to my learning than the actual cadaver ***dissection***."

"I don't find it very helpful ***dissecting*** the cadaver myself. I would rather look at a ***prosection*** to find what I am looking for. I feel as though ***dissecting*** the cadaver doesn't give me a very good visual as it seems to be a lot of fat cutting and not something that I am going to be doing in the future anyway. Seems like there could be a better use of the time."

"***Dissection*** was great to see the depth of tissue, but I found ***prosections*** best to study from since they were clean and easy to see."

Factors influencing the perceived usefulness of dissection versus prosections in traditional course design

It was hypothesized that students perceive prosections as more useful than dissection in learning the course content because they facilitate straightforward learning facilitated via direct structure visualization. Based on the previous qualitative analysis, students (Group 1 & 2 Secondary Survey, Group 3) were asked about possible factors that could have had an impact on their perceived usefulness of dissection (Table 26, Figure 17). These surveys employed 5-point Likert items. A Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint of 3. Most students in all groups agreed (*Mdn*=4, $p<0.001$ different from the neutral midpoint) that dissection required more time, patience (F1), and instructional guidance (F2); and that they were worried about cutting through structures that needed to be preserved (F3). While Group 2 and 3 were neutral ($p=0.74$ & $p=0.10$, respectively), Group 1 (OT & PT) agreed (*Mdn*=3.5, $p=0.04$) that interaction with cadavers (F4) impacted on their perceptions about the usefulness of dissection. While Group 1 and 2 were neutral (*p*=0.216 & *p*=0.42, respectively), Group 3 (OT & PT) disagreed (*Mdn*=2, p<0.008) that interaction with other students during the dissection (F5) was an impacting factor.

Table 26: Factors impacting student perceptions toward the usefulness of dissection (Group 1, 2 & 3).

Statements		**Group 1** Fall 2017 OT/PT- Secondary (n=40)			**Group 2** Fall 2017 DDS - Secondary (n=19)			**Group 3** Fall 2018 OT/PT (n=44)		
		Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
F1	Dissection requires more time and patience to learn from	4	0	**<0.001**	4	1	**<0.001**	4	1	**<0.001**
F2	Dissection requires more instructional guidance	4	1	**<0.001**	4	1	**<0.001**	4	1	**<0.001**
F3	Students worry that they might cut through structures that need to be preserved	4	1	**<0.001**	4	1	**<0.001**	4	1	**<0.001**
F4	Dissection requires interaction with cadavers	3.5	1	**0.04**	3	2	0.74	3	2	0.10
F5	Dissection requires interaction with other students	3	2	0.216	3	3	0.42	2	1	**0.008**

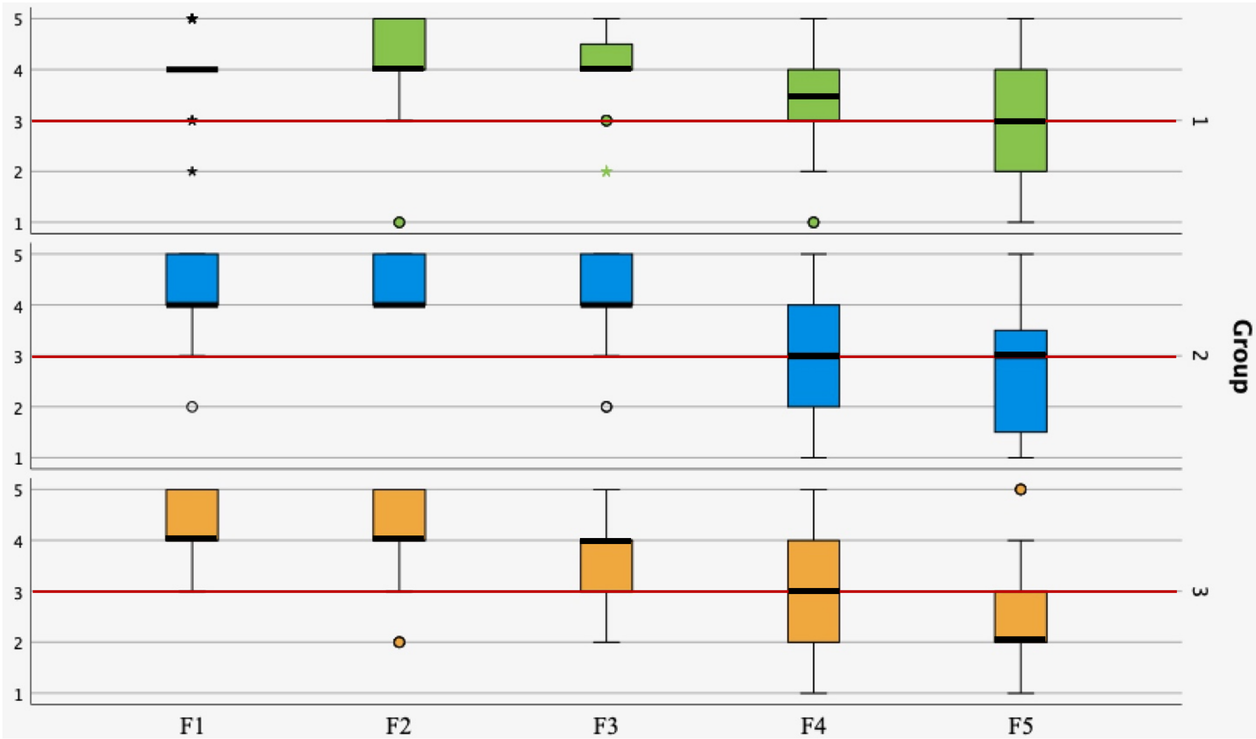

Figure 17: Boxplots of student levels of agreement (on a scale from 1 to 5) with factors impacting perceptions toward the usefulness of dissection (x-axis) for Group 1, 2 & 3 (y-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IRQ*).

Likewise, students were asked about possible factors that could have promoted their perceived usefulness of prosections (Table 27, Figure 18). Most students in all groups agreed (Mdn 4-5, p <0.001 different from the neural midpoint of 3, Wilcoxon test) that prosections were simple and easy to understand and learn from (F1), and that prosections enabled focused visualization of structures and application of lecture knowledge (F2), which enabled efficient and confident learning (F3). All groups were neutral (*Mdn*=3) about the last two factors (F4 & F5), which were targeting two types of student interactions: interaction with cadavers and interaction with other students.

Table 27: Factors promoting student perceptions toward the usefulness of prosections (Group 1, 2 & 3).

Statements		**Group 1** Fall 2017 OT/PT-Secondary (n=40)			**Group 2** Fall 2017 DDS – Secondary (n=19)			**Group 3** Fall 2018 OT/PT (n=44)		
		Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
F1	Prosections are simple and easy to understand and learn from	5	1	**<0.001**	4	1	**<0.001**	5	3	**<0.001**
F2	Prosections enable focused structure visualization and application of lecture knowledge	4	1	**<0.001**	4	1	**<0.001**	5	2	**<0.001**
F3	Prosections enable efficient & confident learning	4	1	**<0.001**	5	1	**<0.001**	5	1	**<0.001**
F4	Prosections require interaction with cadavers	3	2	0.38	3	2	0.78	3	2	0.35
F5	Prosections require interaction with other students	3	1	0.17	3	2	0.50	3	2	0.96

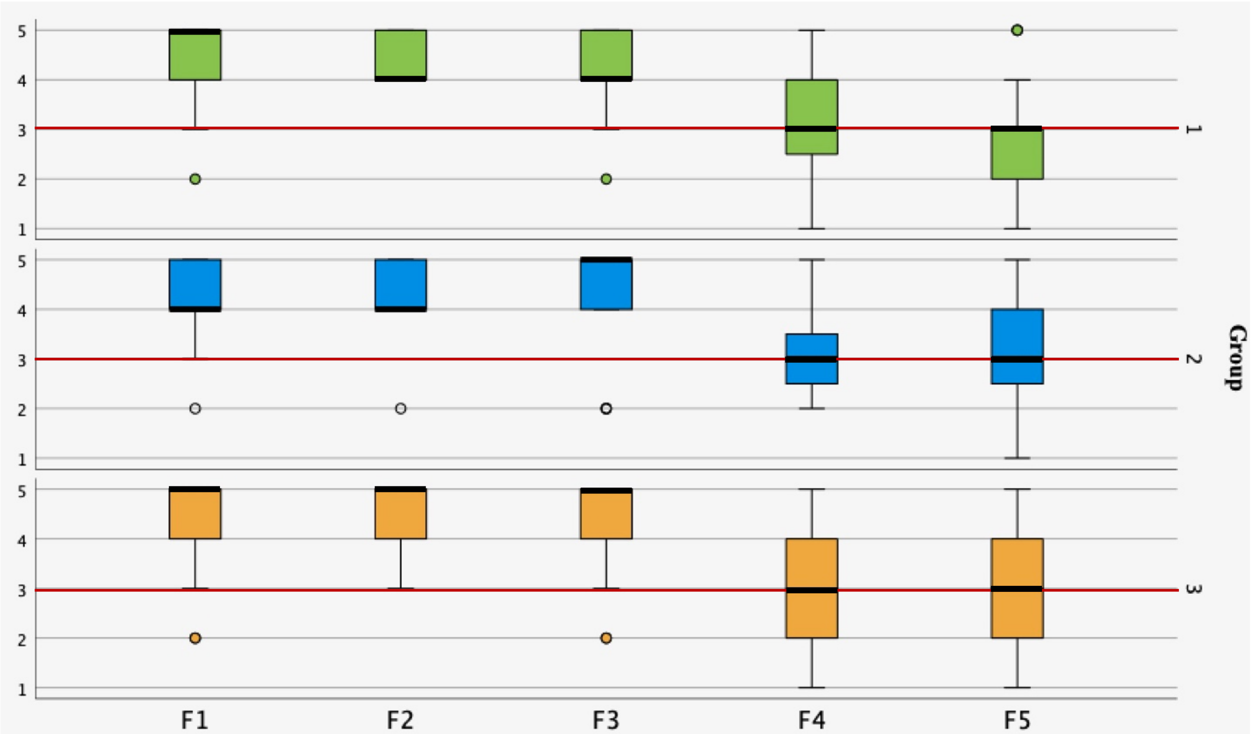

Figure 18: Boxplots of student levels of agreement (on a scale from 1 to 5) with factors promoting perceptions toward the usefulness of prosections (x-axis) for Group 1, 2 & 3 (y-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IRQ*).

To understand better the discrepancy between the perceived usefulness of dissection and prosections, students were invited to elaborate on their preferences for the two cadaver-based modalities.

Dissection

Thematic analysis of student responses (Group 1 Primary and Secondary Surveys, n=64) revealed two themes (Table 28). Students acknowledged and appreciated the ability to dissect in the course, which allowed them to achieve various advantages. Despite concerns expressed by students (such as the limited laboratory time and students' lack of dissection skills), dissection provided a tactile experience. Students highlighted that such experience facilitated a multidimensional understanding into the human body – the feel, the look and the spatial location and orientation of bodily structures, and their regional relationships from a functional point of view.

Table 28: Themes and subthemes revealed from student elaborations on their ratings of the usefulness of dissection to learn in the laboratory (Group 1).

Themes	Subthemes
Benefits of dissection	Provided tactile learning and
	Enabled spatial understanding
Drawbacks of dissection	A slow learning approach
	Lack of dissection knowledge and skills

As shown in the word cloud below (Figure 19), students' trending words included ***dissect(ion & ing), learn(er, ed & ing)***, ***cadaver(s)***, ***time***, ***looking*** and ***helpful***.

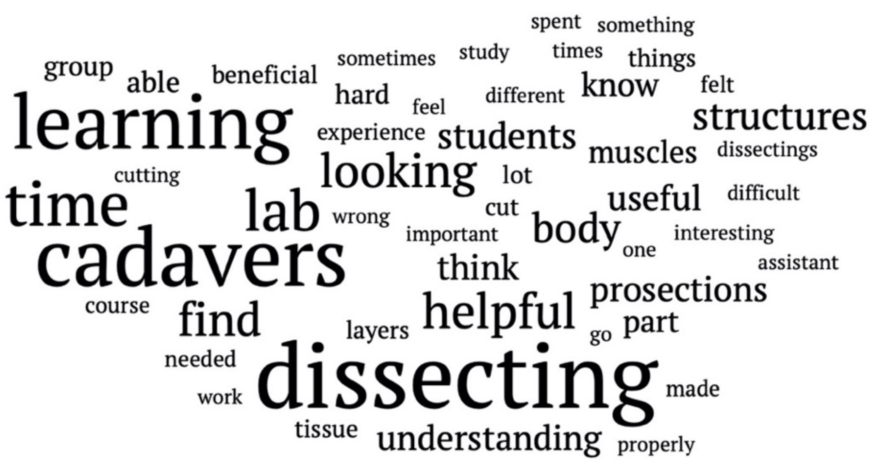

Figure 19: A word cloud of student elaborations on their ratings of the usefulness of dissection to learn in the laboratory (Group 1). Larger font size represents more frequent mentioning.

The following is a sample of student comments on the value of dissection:

> "I really enjoyed ***dissecting*** the ***cadaver***. It gave me a greater understanding of the strength of the muscles and tendons, how they slide and move. And being able to go from one layer to the next so see how they all interact."

> "It has been very beneficial to really see how the muscle fibres run, where they attach and being able to actually follow the path of the nerves is great."

> "***Dissection*** taught me the most because I gained a very visceral sense of the body. Cutting through layers and feeling the tension and pull of various and differing tissue provided

> detail that reading or observing could not. ***Dissection*** provided a real idea of depth and scale."

> "***Dissection*** was useful because I am a hands-on ***learner***, and therefore by being able to see and touch the structures while also going through the lab manual, I was able to retain a lot more information. I missed one lab throughout the entire semester, and I noticed a huge difference in my ability to ***learn*** the material without ***dissection***."

> "Once you see it on the ***cadaver***, it is hard to forget. While in class some concepts are hard to imagine, but once you see it physically in front of you in your own hands it really sticks with you. You can see muscle on your body and feel them with palpation, but ***cadavers*** allow you to see other structures that surface palpation does not allow. It was an amazing experience and it allowed ne to ***learn*** a lot more then I think I ever could have from a book."

Yet, dissection was criticized for some reasons. First, it was time consuming and a slow learning approach:

> "Very beneficial to understanding layers and depth of tissue but challenging at times to find appropriate structures due to ***time*** constraints."

> "My group lucked out and had a ***cadaver*** that was very lean, so we benefited quite a bit from ***dissecting*** on our own. It was however more ***time*** consuming when we had to remove a lot of excess fat/skin to actually see what we needed to. In that sense the prosections were more beneficial. That being said I felt I could manipulate our own ***cadaver*** much more and not worry about wrecking the specimen."

> "The ***cadaver*** itself was really difficult to work with because of all the fatty tissue., so we spent most of our ***time*** digging out the muscle and trying to decide what was fatty tissue and what was muscle."

> "Sometimes we would spend too much ***time*** cleaning the ***cadaver*** or be unsure if we were ***looking*** that the right part thing."

Second, the lack of knowledge and skills in dissection created a sense of frustration:

> "Depending on the ***cadaver***, it is difficult to ***learn*** from ***dissection***. We have no ***dissecting*** skills, and due to personal characteristics, much of the testable material is not visible on ***cadavers***. Pro sections are very helpful."

> "I personally ***learn*** a lot more from the prosections. I appreciate having the ***cadavers*** to ***learn*** from, but I find I end up wasting a lot of ***time dissecting*** the wrong part or ***looking*** at things I don't understand – it can become very overwhelming. The ***cadavers*** are beneficial when you have a TA to go over it with you and help you find what you're ***looking*** for."

"It was cool to try and find the parts we were ***looking*** for, but we often cut something we were supposed to. We felt like the prosections were more useful for the ***cadaver*** since we did not know exactly how to ***dissect*** properly."

"I found performing the ***dissections*** to be interesting however we often were not sure of what we were ***looking*** at/for as we had just ***learned*** it in lecture beforehand."

<u>Prosections</u>

While dissection was criticized for various reasons, prosections hardly received any. Thematic analysis of student responses (Group 1 Primary and Secondary Surveys, n=65) revealed one theme (Table 29). Students considered and praised prosections as the most useful way to learn as they provided clean and clear visuals which made them easy to learn from.

Table 29: Theme revealed from student elaborations on their ratings of the usefulness of prosections to learn in the laboratory (Group 1).

Theme	Sub-themes
Advantages of prosections	Provided clear details
	Efficient means to prepare for exams

As shown in the word cloud below (Figure 20), students' trending words included ***prosections*** and ***structure(s)***.

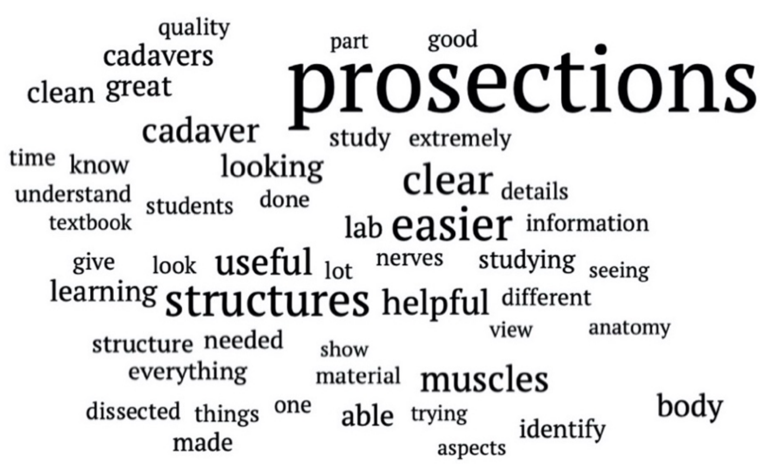

Figure 20: A word cloud of student elaborations on their ratings of the usefulness of prosections to learn in the laboratory (Group 1). Larger font size represents more frequent mentioning.

Prosections provided more focus and clarity than dissection, which allowed straightforward learning. A sample of student comments on learning from prosections:

> "The ***prosections*** are the most useful part of the lab, in my opinion. The give context to what we should be seeing, while in the cadaver we are trying to discover more whole-body connections."

> "The ***prosections*** are extremely useful because not only can I touch and move things I can clearly see the ***structure*** and not have to spend time cleaning out a cadaver with the risk of cutting or ruining a ***structure***."

> "With everything cleaned, we know we're looking at good examples. I know what I'm looking at and am more confident when identifying ***structures***."

> "With the ***prosections*** you know what's you're looking at and there's not a ton of guesswork involved. It was fun using cadavers, but we were so unsure of ourselves that we felt like we needed s tutor to confirm everything we were looking at."

> "***Prosections*** were less process oriented and while very tactile and useful in providing high quality dissections, the experience lacked the process of dissection that really helps to integrate the information."

Students found prosections as efficient means to cover the course content in preparation for exams:

> "***Prosections*** have been done by somebody who is experienced and knows how to clear the areas and ***structures*** for the best visibility. It is still possible to assess ***structure*** and function on the ***prosections***. It closely reflects the testable material."

> "***Prosections*** are great for those who don't want to put in any extra work into their learning, who don't want to be uncomfortable, and who are unwilling to do something that might constitute a mistake. Students expect to be handed notes or slides to study from and know exactly what and how things will be presented on an exam. The ***prosections*** provide that."

> "The ***prosections*** were useful in studying for the finals in that we could quiz each other and use them to identify the ***structures*** from different angles and viewpoints. They were a bit frustrating to find the ones that were dissected to the level that I needed depending on what I was looking for. Sometimes images in the textbook were just as useful."

The potential of using prosections before dissection in the traditional course design

Students were asked if previewing target structures thoroughly using prosections before undertaking dissection could prepare their laboratory groups for a more student-led collaborative learning and how lab instructors could facilitate deeper and collaborative learning. Thematic analysis of their responses (Group 1 Secondary Survey, n=31) revealed several roles (Table 30), which revolved around backing and enriching dissection and discussion activities.

Table 30: Potential roles revealed from student responses to elaborate on how instructors could facilitate learning in the laboratory (Group 1)**.**

Potential roles for the lab instructors if prosections were used to guide dissection
Aiding with dissection
Quizzing and validating student knowledge
Providing clinical context and applications

According to the word cloud below (Figure 21), the frequently mentioned roles involved ***dissect(ion & ing)***, ***instructor(s)***, ***lab(s)***, ***group(s),*** and ***structures***.

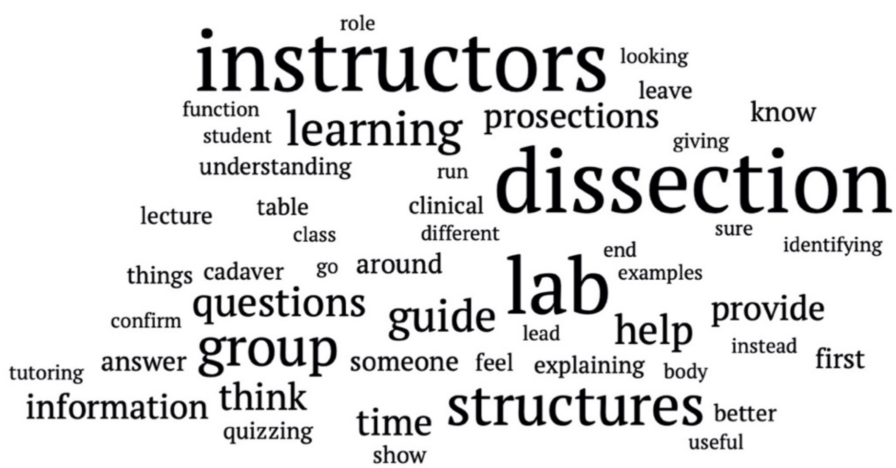

Figure 21:A word cloud of student responses to elaborate on how instructors could facilitate learning in the laboratory (Group 1). Larger font size represents more frequent mentioning.

Examples of roles for the lab instructors included aiding with dissection, quizzing and validating student knowledge, and providing clinical context and applications related to their health professions:

> "The most effective ***labs*** were when there was an ***instructor*** at our table to confirm our dissecting actions and clarify/provide further details regarding the sections we were working on. I know it's unrealistic to have an ***instructor*** at each table but having someone around instilled confidence in our learning."

> "The role of the ***lab instructor*** wouldn't change. They would be around to help identify ***structures*** and show ***dissection*** techniques. Especially in the first few weeks when

> students are especially nervous with ***dissection*** and are too gentle, thus taking forever, the ***instructors*** were good to show that some force can be applied."

> "Although prosections help guide learning, if what you are looking at isn't clear or understood by the student then the ***instructors*** can assist in creating a better understanding. They also can provide explanations and examples about the application of what is being taught in our health professions."

> "If prosections were to guide ***dissection***, you would still need ***lab instructors*** to help you understand the ***structures*** and their functions. Otherwise, it's just memorization, and that isn't useful for anyone. ***Lab instructors*** would provide more in-depth information about how the ***structures*** function and what they act on."

> "The ***lab instructors*** are important to guide the learning for the students and provide information, especially clinical examples, of importance and relevance of topics being learned."

> "Quizzing students on the ***structures*** before they are allowed to leave the ***lab***."

Some students indicated the use of prosections before dissection could be discouraging:

> "I think having prosections before ***dissection*** would cause some students to just leave and not engage in ***dissections***… I think it would be beneficial to have the first class be a crash course in ***dissection*** because for the first couple weeks, I found my ***group*** and I to do very hesitant during ***dissections*** and worried about damaging the specimen until we learned better techniques. Also, in relation to this question, I think ***lab instructors*** would be stuck teaching/explaining information to students and students would not lead their own learning (people may take advantage of having someone spew out information to them instead of first trying to figure out things on their own)."

> "I feel as if students would use only the prosections in this case and would be unmotivated to search for the ***structures*** through ***dissection***. I feel as if the ***lab instructors*** should spread their time more evenly with different ***groups***. Spending 30 minutes with one ***group*** while another ***group*** isn't getting any direction and is waiting for an answer to a question is unfair."

The perceived usefulness of dissection versus prosections in modernized course design

This segment addresses the fourth objective of the study which sought to explore and explain the perceived usefulness of dissection and prosections in modernized course design. For this analysis OT and PT students (Group 4A and 4B), in the modified (starting in 2019) anatomy courses that featured only prosections, were surveyed using 11-point Likert type sliding items. The Wilcoxon signed rank test was performed to compare the *Mdn* of student responses to the neutral midpoint.

As shown in Table 31 and Figure 22, students agreed strongly about the usefulness of prosections, in terms of learning the course content (*Mdn*=10, *p*<0.001 different from the neutral midpoint of 5), and in in terms of fostering collaborative and hands-on learning activities (*Mdn*=10, Group 4A: *p*<0.001 & Group 4B: *p*=0.002 different from the neutral midpoint of 5).

Table 31: Student perceived usefulness of prosections in the modernized course design (Group 4A & 4B).

Statements	**Group 4A** Fall 2019 OT (n=36)			**Group 4B** Fall 2019 PT (n=12)		
	Mdn	*IQR*	Wilcoxon test *p*-value	*Mdn*	*IQR*	Wilcoxon test *p*-value
How useful is the use of prosections in learning the course content?	10	1	**<0.001**	10	0	**<0.001**
How useful is the use of prosections in fostering collaborative and hands-on learning activities?	10	1	**<0.001**	10	1	**0.002**

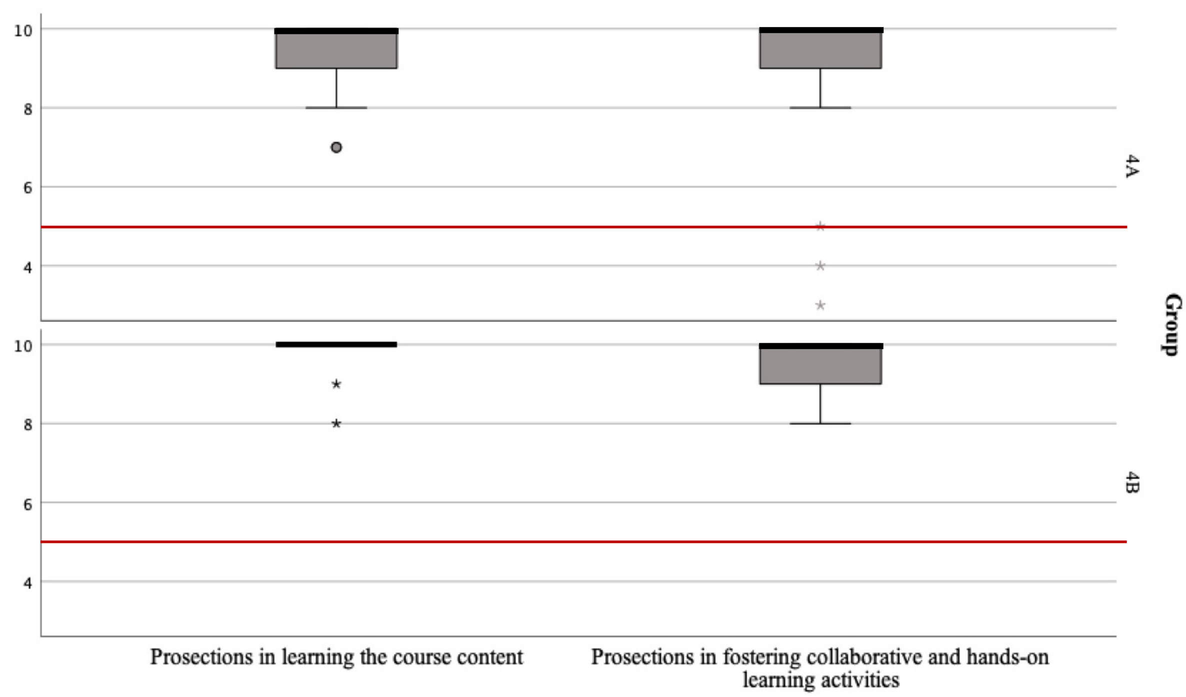

Figure 22: Boxplots of student levels of agreement (on a scale from 1 to 5) with statements on the perceived of the usefulness of prosections in the modernized course design (y-axis) for Group 4A & 4B (x-axis). Higher rating indicates stronger agreement. Neutral rating is represented by the red horizontal line. Bolded lines represent medians (*Mdn*), and colored boxes span interquartile range (*IRQ*).

Students were also asked to describe how they learned in the laboratory. Analysis of their responses (Group 4A & 4B combined, n=35) revealed three themes (Table 32).

Table 32: Themes and subthemes revealed from student responses to describe how they learned in the laboratory (Group 4A & 4B).

Themes
Provide tactile experience
Enable peer instruction
Allow learning out of class time

The following word cloud demonstrates the trending words in student responses, which included ***learn(ed & ing)***, ***lab*** and ***structures*** (Figure 23).

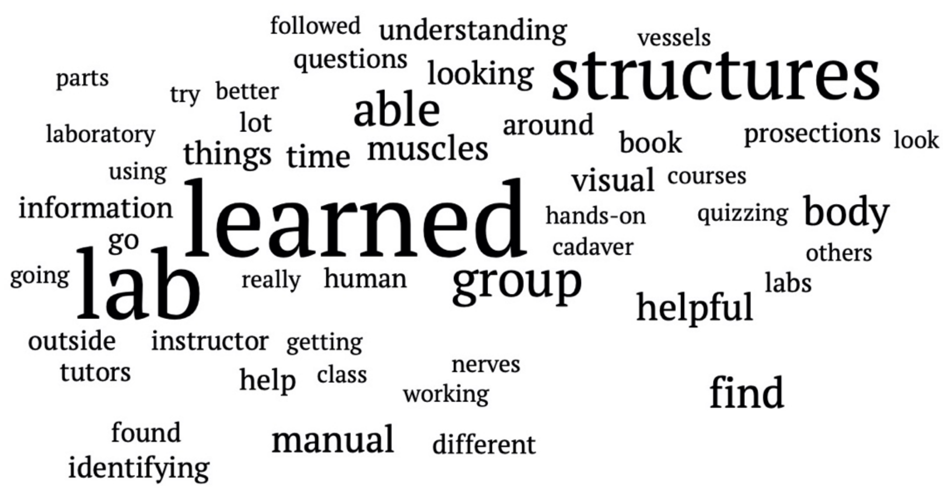

Figure 23: A word cloud of student responses to describe how they learned in the laboratory (Group 4A & 4B). Larger font size represents more frequent mentioning.

Students repeatedly highlighted the utility of prosections as they allowed focused structure visualizing with reasonable hands-on interaction. A sample of student responses included:

> "I am more of a hands-on ***learner***, so being able to pull on a tendon to see how it moves a body part was helpful. I also found being able to see how all the muscles, nerves, and blood vessels were oriented on an actual body was far better than ***learning*** about a muscle from a picture that isolates it."

> "I ***learn*** through being able to touch the muscles. I am also ***learning*** through being able to see the whole picture. I can see where things attach and how it all connects. The human body has never made more sense until now. For years I have looked at pictures and gotten to see animal organs, but after being in lab with the cadavers it has all come together."

> "I ***learned*** by getting my hands in and around the cadavers 'digging' for ***structures***, relating nerves and vessels to function as would be applied in our profession."

OT students explained how peer instruction was taking place. Students were quizzing each other's knowledge:

> "I ***learn*** by having parts explained to me by others and then being quizzed. I need to repeat information again and again for it to stick, so the more opportunities to practice recall the better."

> "I ***learn*** by actually identifying things on the cadaver by myself but also quizzing each other in a larger group to check our understanding."

> "We studied in a group; we would read the ***lab*** instruction first and find ***structures***/tissues. We would go over each one and then later quiz each other and try to label the ***structures***. We would also ask questions to instructor/tutors if anything is unclear. Mostly we tried to self-direct ***learn*** by looking at the textbook and comparing the textbook images with the cadaver."

The accessibility of prosections outside of the class time also allowed students for additional learning opportunities. A sample from OT and PT student responses included:

> "Within the laboratory we are first exposed to the human body in labs, and outside of that we can examine and study it further on our own time. Attending ***lab*** on my own time has been really helpful."

> "… Additionally, I appreciate the 24-hour access we have in the ***lab***, as I come in after class time to go over ***structures*** of the body for further ***learning*** and understanding."

> "Looking over the body initially, then reviewing material outside of the ***lab*** followed by a return to the ***lab*** to look at the specific areas of interest."

Group 4 students were asked to specify regions of the body where dissection could be more useful to understand the anatomy. Students (n=43) listed several organs and regions that dissection would have been useful to learn from (Table 33); these include the brain, hand, foot, forearm, arm, and brachial plexus.

Table 33: Student list of regions of the body where dissection could be more useful to learn from (Group 4A & 4B).

List of regions
Brain
Hand
Foot
Forearm
Arm
Brachial plexus

According to the word cloud below, the frequently mentioned words were ***dissection*** and ***layers*** (Figure 24).

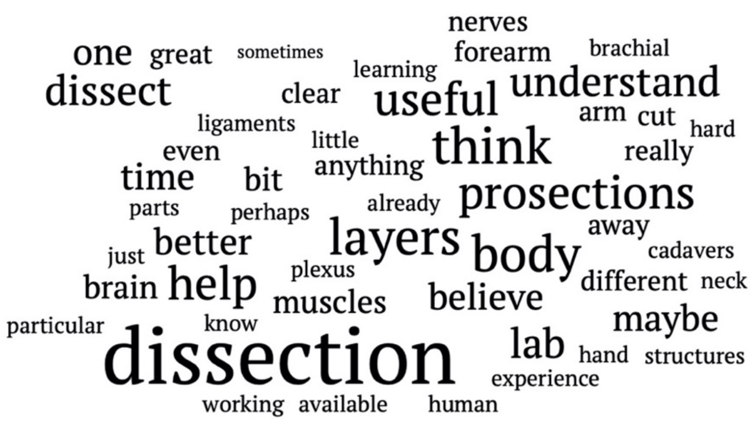

Figure 24:A word cloud of student responses to specify regions of the body where dissection could be more useful to learn from (Group 4A & 4B). Larger font size represents more frequent mentioning.

A sample of student responses included:

"Maybe arm. Some of the brachial plexus on some cadavers were severed and not very clear as those on other cadavers."

"Hands and feet, a lot of very small structures that were damaged in the prosections."

"In the arm, forearm, and hand - if we did a ***dissection*** where we could cut away the various ***layers***, it might help to understand its structure somewhat better, but also would allow us to cut away additional ***layers*** to see what is often obscured by ***layers*** of muscle that have not always been cut away in the prosections."

"Having done ***dissection*** before, I think within the allotted time it would have been impossible to complete each lab (even without ***dissection*** getting through each lab on

> time was occasionally challenging). ***Dissection*** was mostly previously more useful in gaining and understanding of fascia and its relationship to different structures in the body, so perhaps showing one video on that could have been of use? (if those videos even exist)."
>
> "The brain maybe. We saw it all deconstructed, and as a whole but being a part of the process might help people to understand it a bit better."

Student performance in traditional versus modernized course designs (Objective 5)

OT and PT student performance was compared in traditional versus modernized gross anatomy course designs (i.e., before and after the dissection-based interprofessional design of ANAT-5217 was phased out). Since they were enrolled in different cohorts, an independent sample t-test was used to compare the grades of students enrolled in Fall 2019 with the grades of the same type of students enrolled Fall 2017 (Table 34, Figure 25). The analysis revealed that there was no difference (p=0.954) in the mean grade of PT students in the traditional versus modernized course but there was a decrease (4.89%, p<0.001) in the mean grade of OT students in the modernized course.

Table 34: Student grades in traditional versus modernized gross anatomy course design.

Program	Academic term	n	Mean	Std. Deviation	Independent sample t-test *p*-value
OT	Fall 2017	66	86.64	6.93	**< 0.001**
	Fall 2019	66	81.75	5.69	
PT	Fall 2017	61	85.64	5.68	0.954
	Fall 2019	62	85.71	6.56	

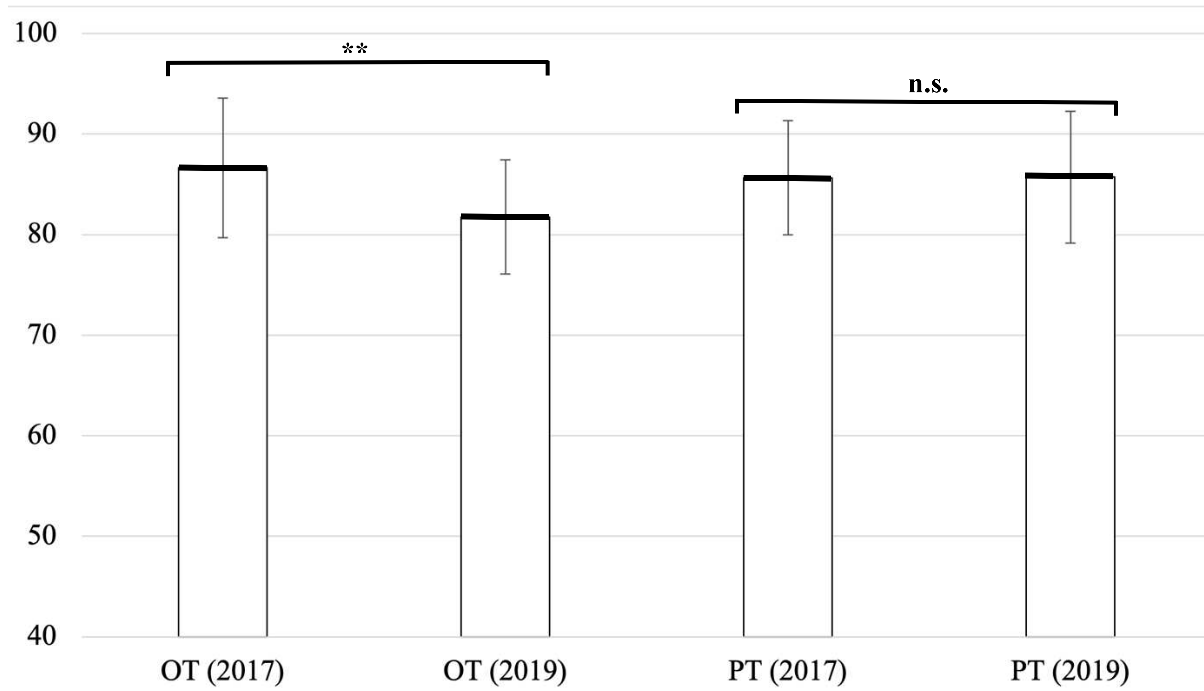

Figure 25: Boxplots of student grades in traditional versus modernized gross anatomy course design. n.s.= not significant. Stars represent significant differences between the groups (** $p < 0.001$).

Student perceptions toward death and the use of cadavers in traditional and modernized course design

This segment of analysis targets the sixth objective of the study, *to examine how the use of donated cadavers in the traditional and modernized course design provides a foundation for professional learning and interaction.* Students enrolled in one of the courses with a traditional, dissection-oriented, course (Group 1; Primary Survey, n=38) were asked to reflect on their perceptions of death and the use of donated cadavers. Thematic analysis of their responses revealed two themes (Table 35). Students highlighted the role of cadavers in their learning and professional development, expressing respect and appreciation to their "first patients and teachers."

Table 35: Themes and subthemes revealed from student elaborations on the impact and value of using donated cadavers (Group 1).

Themes	Subthemes
Provided humbling experience	Appreciation and respect
	Ability to cope with cadaver-based learning
Reinforcing an understanding of the course substance	-

As shown in the word cloud below (Figure 26), student comments frequently referred to ***learning***, ***bodies*** and ***cadaver(s)***.

Figure 26: A word cloud of student elaborations on the impact and value of using donated cadavers (Group 1). Larger font size represents more frequent mentioning.

Students claimed that the use of cadavers provided a humbling experience:

> "***Cadaver***-based ***learning*** is the most beneficial ***learning*** in this course. I have the utmost respect for those who have donated themselves to my ***learning*** and will be a better healthcare professional because of them."

> "It is a precious gift indeed. I think one should appreciate this "gift" and be prepared for the dissection, study before the dissection as a way to show respect to the persons who donated their ***bodies***."

> "It has made me appreciate the sacrifice that these individuals have made to further the ***learning*** of health professional students. Some families may have a hard time with the knowledge of what we are doing with their loved one's ***bodies*** but, it is allowing us to learn so that we may better the lives of other people during the course of our careers."

> "Yes. I knew that death is inevitable and natural in an abstract sense but seeing and working directly with human remains has given me more peace about death, as well as an increased appreciation for life."

> "I learned that we truly are all the same deep down."

Handling of cadavers entails care and respect, which enabled students to cultivate an ability to cope with learning and interacting with cadavers:

> "At first, I really struggled with the concept of cutting up a dead body but throughout the labs I've grown to really appreciate the woman who has given me such a great ***learning*** experience. There really is no better way to learn anatomy than to see it first-hand."

> "At first I thought it would be really difficult. During the lab orientation, I was very nervous to see my first ***cadaver***. But, even after just a few short weeks my opinion has completely changed. Working with human ***bodies*** is a wonderful way to truly understand the material …"

> "I think that forcing the students to interact with the ***cadavers*** allows for the students to be prepared for many situations that may arise in their respective professions."

Students expressed gratitude to being privileged to learn from donated cadavers. Compared to textbook diagrams and other plastic and virtual models, the use of cadavers provided superior learning, reinforcing an understanding of the course substance:

> "This experience has allowed me to have a more concrete understanding of the materials presented in class. I've taken multiple anatomy classes in my post-secondary career, and this is the first time I truly feel confident in my abilities and level of understanding."

> "The human body has always carried a sense of mysticism for me. For example, when I would get a massage, and my massage therapist would talk about how a lot of fascia and fluids had been moved around, I never fully believed that this was a true, scientific statement. I am now ***learning*** to accept and believe that our ***bodies*** are much more complicated, functional, and intricate than I had previously been able to wrap my head around. Seeing is believing."

> "I think ***cadaver***-based ***learning*** has vastly improved my knowledge of the human body and the way it moves. You absolutely cannot get out of a textbook what you get out of actually being in the lab and seeing and feeling with your own eyes and hands the way the tissues move."

> "***Cadaver***-based ***learning*** has been such a huge privilege throughout my undergrad degree, as well as now in graduate work. ***Cadaver***-based ***learning*** has had a huge impact on my ***learning*** and understanding of the human body and human functions. It is only because of these experiences that I will feel proficient upon graduation, as I will have had lots of exposure to ***cadavers***, catalyzing my knowledge and proficiency in this subject area."

Next, students in courses with a modernized design, comprised of OT and PT students, who took gross anatomy in separate courses and without the use dissection (Group 4), were asked to reflect on their perceptions around death and the use of donated cadavers. The analysis of their responses (n=34) revealed learning and interaction outcomes (Table 36) comparable to those expressed by the previous cohort who had dissected in interprofessional groups (Group 1). Students expressed appreciation and respect, highlighting the valuable experience the use of cadaveric materials (prosections) provided.

Table 36: Themes and subthemes revealed from student responses to elaborate on impact and value of using donated cadavers (Group 4A & 4B).

Themes	Subthemes
Provided humbling experience	Appreciation and respect
	Ability to cope with cadaver-based learning
Provided superior understanding of the course content compared to textbook diagrams	-

As shown in the word cloud below (Figure 27), students frequently mentioned the following words: ***body(ies)***, ***learn(ed & ing)***, ***cadaver(s)*** and ***understand(ing)***.

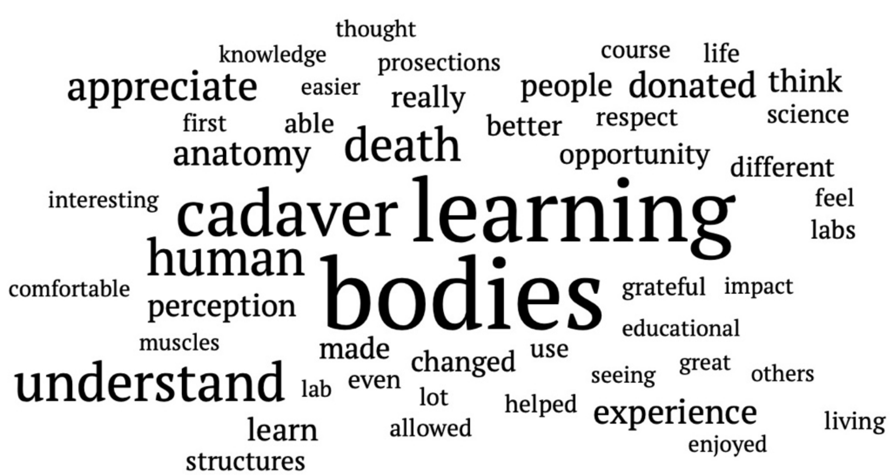

Figure 27: A word cloud of student responses to elaborate on impact and value of using donated cadavers (Group 4A & 4B). Larger font size represents more frequent mentioning.

A sample of student responses included:

> "I've never worked with a dead ***body*** before, and actually being able to experience ***learning*** through interaction with a ***body*** was incredible. It has increased my awareness and respect for those who have donated their ***bodies*** to science and ***learning***."

> "It was a privilege to have this opportunity and it greatly impacted my ***learning***, as well as my professionalism. It reminded me different ways to be empathetic, respectful, and mindful of my actions."

> "I became more comfortable with working with the ***cadavers***, but I would not say my perception of death has changed. I ***learned*** how much I can adapt to situations that are uncomfortable and foreign at first."

Students expressed gratitude to being privileged to learn from donated cadavers. The use of cadavers provided superior understanding of the course content compared to textbook diagrams:

> "***Cadaver***-based ***learning*** has allowed me to put my textbook and lecture knowledge to practice. Occupational therapy is a very "hands-on" job, so it is very beneficial to see ***cadaver*** prosections to fully ***understand*** movements of the ***body***."

> "I think it has helped my ***learning*** greatly, it's amazing how drastically different the impact of using the prosections can be compared to only studying with unrealistic images. It helped me ***understand*** everything a lot better and put it in a real context."

> "I am very grateful to the people who donated their ***bodies***, and their families for ***understanding*** their choice. I think it is vital for the evolution of medicine to have access to ***cadavers*** in ***learning*** environments. I found ***learning*** with the brains to be the most helpful, as the images never allowed me the same depth of ***understanding***."

> "It helps so greatly with my ***learning***. At the university where I completed my undergrad, we did not have ***cadaver*** labs. I ***learned*** so much in this anatomy course from this experience. I am so appreciative of those who have donated their ***bodies*** and the laboratory staff who have made this such a great ***learning*** experience for us."

5.4 Discussion

5.4.1 The readiness for interprofessional learning

There is a growing body of literature supporting the evidence that IPE can enhance student perceptions and attitudes toward IPC. Effective IPC between health professionals can decrease medical error and improve professional relationships, ultimately resulting in better health outcomes (Cullen et al., 2003; Norman, 2005; Reeves et al., 2013). Since anatomy is essential for various health professions, it constitutes a common subject for many health professional students, thus, providing a strategic opportunity to design shared learning with common objectives (Sytsma et al., 2015).

The first objective of this study was to examine how the traditional dissection-based teaching and course design provided a foundation for interprofessional learning and interaction between OT and PT students. Using the Readiness for Interprofessional Learning Scale (RIPLS; McFadyen et al., 2005), a class of OT and PT students (ANAT-5217) reported readiness for interprofessional learning at the start of the course (Entry Survey). The level of readiness was not altered by participation in the course, as indicated by RIPLS values reported at the end of the course (Exit Survey) that were not significantly ($p>0.05$) different from RIPLS values at the start of the course. These results differ somewhat from a study conducted by Fernandes et al. (2015) that demonstrated small but significant differences in two RIPLS subscale scores (Teamwork & Collaboration and Positive Professional Identity) after participation in an interprofessional anatomy course featuring dissection. However, similar to the results reported here, each RIPLS sub-score reported by Fernandes et al. (2015), prior to the course, indicated readiness for IPE.

Qualitative analysis revealed that students were generally open to engage in teamwork and collaborative activities with students from other health professional programs while acknowledging and respecting their specific future roles. These findings also correspond with those reported by Fernandes et al. (2015); their study indicated that interprofessional anatomy education was highly appreciated by the students, who were able to uphold a clear understanding of their respective scope of practice.

It was hypothesized (Hypothesis 1) that there were differences between OT and PT student readiness for interprofessional learning. Although there were some differences in OT versus PT student sub-scores, none of these differences were statistically significantly different. However, qualitative analysis of student responses revealed an important theme, which indicated a difference between OT and PT members of the class. Students highlighted that there was a knowledge differential between their professional programs, which they claimed to have influenced teamwork dynamics in the laboratory. Since PT students appeared to have had more anatomical background, they might have found themselves leading collaborative learning activities in the laboratory. This seemed to have benefited OT students learning from PT students, and left PT students feeling that they did not get as much from this interprofessional encounter.

To gain insights into teamwork dynamics in dissection-based laboratories, the second objective of the study intended to identify factors influencing interprofessional group collaboration between students. OT and PT students highlighted various factors such as the need for more structured and balanced dissection activities, smaller number of students per a group, and greater instructional guidance, especially at the beginning and the end of the laboratory activities. Those interprofessional students also suggested the use of icebreakers, enforcing grades on participation, having tutors from OT and PT professions, and implementing aspects of the flipped classroom strategy with a sense of competition between students.

5.4.2 The perceived usefulness of dissection versus prosections

The third and fourth objectives of the study explored student perceived usefulness of dissection and prosection in a traditional (includes dissection and prosections) and modernized (prosections only) course design. This was examined first in two iterations of the same course (for OT and PT students, held in 2017 and 2018) and a DDS course (2017). Quantitative analysis revealed that each group of students perceived dissection and prosections as useful but prosections were valued highly and more than dissecting. Qualitative analysis revealed feedback responses that were congruent with quantitative results. Students highlighted various advantages of dissection; it provided a tactile experience, which facilitated a multidimensional understanding of the human body. Yet, they frequently expressed concerns about dissection as being time-consuming, thus a slow learning approach. Students also reported a sense of frustration toward dissection activities due to their lack of dissection skills. Previous research into the improvement of dissection-based learning similarly highlighted the need for more instructional assistance and an introduction dedicated to show students how to dissect (Jeyakumar et al., 2020). Students praised prosections as the most useful way to learn as they provided clean and clear visuals, making them easy to learn from.

Additional quantitative results supported the hypothesis (Hypothesis 2) that students perceive prosections as more useful than dissection in learning the course content because they facilitate straightforward learning facilitated via direct visualization of structures. Quantitative analysis showed that students agreed that 1) dissection required more time and patience, 2) dissection needed more instructional guidance, and 3) students were worried about cutting through structures that needed to be preserved. Also, students agreed that 1) prosections were simple and easy to understand and learn from, 2) prosections enabled focused visualization of structures and application of lecture knowledge, which 3) enabled efficient and confident learning. These results support the hypothesis, which highlights the efficient learning that the use of prosections provides.

The perceived usefulness of prosections was followed up by quantitative and qualitative analysis of two (separate) classes of OT and PT students in modernized courses that solely employed prosections. There was strong agreement that prosections were useful for learning course content and for fostering collaborative and hands-on learning activities.

Few studies have examined student preference for prosections versus dissection. While there are reports of prosection preference (Wisco et al., 2015; Karaer & Barut, 2017) others report the opposite (preference for dissection) (Pushpa et al., 2019) or no preference (Snelling et al., 2003; McWatt et al., 2021). However, several studies report student satisfaction with prosections (independent of comparison with dissection) (Overbeck-Zubrzycka et al., 2012; Romo-Barrientos et al., 2019; Schurr et al., 2022). Taken as a whole, the results reported here are consistent with the general preference, or at least satisfaction, of using prosected specimens as a learning aid in anatomy.

5.4.3 Student performance and modernized course design

The study's fifth objective was to compare student performance in the traditional versus modernized course designs. The final mean grade of separate groups of OT and PT students were compared, with one set taught using the traditional approach (2017, dissection and prosections) and the other employing a modernized approach (2019, prosections only). Analysis of grades revealed no significant differences between PT students enrolled in 2017 and those enrolled in 2019. This supports the argument that the use of prosections was effective and could be used as primary pedagogical means in gross anatomy education. Several studies investigating the usefulness of dissections versus prosections in anatomy courses in terms of performance outcomes concluded that both designs (dissection and prosections) promoted meaningful learning and desirable outcomes (Williams et al., 2019; Lackey-Cornelison et al., 2020; Aziz et al., 2020; McWatt et al., 2021; Koh et al., 2021). Nevertheless, there is much debate in the literature about the most suitable or effective way to teach anatomy. In a critical review of best teaching practices in anatomy education, Estai and Bunt (2016) indicated that,

> "To date, no single teaching tool has been found to meet all curriculum requirements. The best way to teach modern anatomy is by combining multiple pedagogical resources to complement one another, students appear to learn more effectively when multimodal and system-based approaches are integrated."
> (p. 151)

In fact, there was a significant decrease (86.64% to 81.75%) in the grades of OT students in 2019 (prosections only) compared to OT students in 2017 (dissection & prosections). Although this could be interpreted as evidence for the superiority of using dissection versus prosections alone, there are various reasons that could also explain this difference. The most notable is that OT students in 2017 were learning with, and to some extent from, PT students; therefore, missing the interprofessional peer-assisted learning activities with PT students could have impacted learning for OT students.

Modernizing gross anatomy teaching and learning was possible through a more balanced course design that provided students with adequate instructional presence and dynamic support. Such an "Intellectually Stimulating" environment could provide students with various advantages, as described by Pike and Kuh (2005):

> "Students at these colleges are engaged in a variety of academic activities and have a great deal of interaction with faculty inside and outside the classroom. They also tend to engage in higher-order thinking and work with their peers on academic matters (i.e., collaborative learning)." (p. 202)

In the modernized course design, students worked together in groups to identify target anatomical structures on prosections and quiz each other's knowledge. Students rated prosections as strongly useful in learning the course content and in facilitating collaborative and hands-on activities. They highlighted the utility of prosections in terms of how they allow focused structure visualizing with reasonable hands-on engagement. Moreover, the accessibility of prosections outside of class time allowed students additional learning opportunities. Yet, if access to prosections is limit due to the number of specimen available, this could impede learning.

5.4.4 Professionalism

Donated cadavers are the precious gifts of many conscientious people and their next-of-kins who care about the development of science and medicine. Being a product of death, cadavers evince humility and respect for the human body. Therefore, the sixth objective of the study was to examine how the use of donated cadavers in the traditional and modernized course designs provided a foundation for professional learning and interaction.

Through the two course designs, students demonstrated that they cultivated appreciation, care, and respect toward their "first patients and teachers" (Sheriff & Sheriff, 2010; Granville & Baker, 2014) Such attitudes toward donated cadavers enabled students to cope with cadaver-based learning. Cadaver-based learning offers a transformative experience which contributes to their preparation for various situations in their future careers. In a recent survey study, thematic analysis of qualitative data collected over two years from four dissection-based anatomy classes revealed similar themes identified in this study. Specifically, students developed mechanisms for coping with the reality of working with deceased individuals; they demonstrated respect and gratitude for donated cadavers as more of patients and less of learning tools (Parker & Randall, 2020).

The use of cadavers in health professional education aids students to develop objective distance, a distinction that lends itself to effective practitioner-patient relationship. According to Peterson (1994):

> "I am convinced of the value of human gross anatomy as taught with human cadavers in preparing students to be successful clinical practitioners. Charts and models can never take the place of the cadaver in developing a true understanding of the intricacies of human systems and a deep respect for the uniqueness of life."
> (p. 87)

5.5 Limitations

A specific limitation in this study, relevant to the comparison of dissection and prosections, was that the dissection courses surveyed were not purely dissection based. In these courses prosections were also available. Although much of the formal laboratory time was focused on dissection activities, limiting the time spent with prosections, prosection use outside normal laboratory hours, could have played an important part of student learning. The obvious solution to this limitation, to restrict student access to prosections, was (and is) neither practical nor ethical.

5.6 Conclusion

The study demonstrated that traditional dissection-based gross anatomy course design provided a foundation for interprofessional teaching and learning. Students expressed openness to engage with students from other health professional programs while respecting their specific roles in future healthcare settings. However, dissection is a mindful process that requires interest, patience, and guidance. Therefore, students in the traditional course design often became apathetic to dissection, especially when compared to prosections. The tendency to privilege (prefer) prosections seemed to have been emanating from the convenience of visual learning that prosections provide, which may have caused students to neglect participation in optional (voluntary and ungraded) dissection collaborative activities. Most factors influencing student perceptions and attitudes toward traditionally designed dissection activities were structural, related to the time available and course design. Though students appreciate the value of dissection, they expressed a need for greater instructional guidance throughout the process, which may be addressed by having an instructor assigned to each group of students or by providing them with instructions before starting dissection. When appropriately structured and facilitated, dissection allows students to learn anatomy by manipulating structures on cadaveric specimens without being concerned about preserving the integrity of these structures. Being able to cut and displace superficial structures to see deeper structures clearly reinforces student spatial understanding of anatomy. Students suggested the hand as one of the areas that they would prefer to dissect due to such advantages. The numerous muscles and tissue layers in the hand are best appreciated when they are dissected. Likewise, dissecting the brain (another area students preferred to dissect) is less time-consuming, unlike other body regions with abundant connective tissue. The relationships between the different parts of the brain are sometimes hard to appreciate after the brain has been dissected.

The study revealed that the use of either cadaver-based modalities, dissections and/or prosections, provided a foundation for professionalism among students - respect, care and appreciation attitudes toward donated cadavers which contributes to their learning and preparation for their future careers. Since the use prosections in the modernized course design facilitated collaborative and hands-on activities, they can provide a foundation for shared learning required for IPE.

5.7 Design recommendations

Students in both course designs pointed out that some of the prosections were dry or damaged, which prevented them from seeing the details of specific structures. When students in the modernized course design were asked to specify regions of the body where dissection could be more useful to understand the anatomy, they listed a number of organs and regions including the brain, hand, foot, forearm, arm, and brachial plexus. Based on student feedback, the study proposes designing intermittent (occurring irregularly) structured dissection activities to allow students to dissect and see these structures in greater details. As previously discussed in Section 5.4.2, creating a dissection-based learning environment requires a great deal of instructional guidance and an even greater deal of commitment from learners. Collaborative dissection activities can feel unnecessarily intense, especially when they are unstructured and ungraded. Since teaching influences student perceptions and approaches to learning through the way assessment is implemented (Gijbels & Dochy, 2006), the use of rubrics to facilitate peer evaluation and feedback is recommended. Peer evaluation and feedback can be facilitated using Kritik (Kritik, n.d.). Kritik is an online platform which allows students to anonymously evaluate each other as individuals or as groups (see Section 4.8 in Study I). This addition has the potential to promote teamwork dynamics in group activities. Another suggestion is to use prosections to host (guide) interprofessional activities as the survey results reported in this thesis indicate the potential of prosections to foster collaborative and hands-on learning.

CHAPTER 6: GENERAL DISCUSSION

6.1 Overview

The work in this thesis sought to understand how different modes of teaching and course design influenced student perceptions and attitudes toward interaction and collaboration. The specific objectives were intended to use student feedback on learning in two different environments, namely technology-based and cadaver-based anatomy education (TBAE and CBAE), to analyze the potential of those environments in fostering shared learning necessary for IPE (see Chapter 2).

In Chapter 2 (Literature Review), the opportunity to promote IPE in human anatomy was highlighted; and the thesis's pragmatic approach, which involved collecting and analyzing two types of data from student feedback was established. The specific objectives were then addressed in the subsequent chapters. In Chapter 4, Study I examined how technology-based course design provides a foundation for independent and personalized anatomy learning. Possible correlations between students' perceived ability for independent learning and their perceptions towards three types of interaction were explored. In Chapter 5, Study II examined how the use of donated cadavers in traditional and modernized course designs provides a foundation for professional and interprofessional learning and interaction. Factors influencing interprofessional student collaboration during dissection-based group activities were identified.

Chapter 6 will recapitulate the major findings from the two thesis studies. Then, implications will be discussed based on interpretations of the findings in relation to the existing literature on IPE. Finally, the limitations of the overall work are discussed, and directions for future research in this field are provided.

6.2 Discussion of major findings

Human anatomy is a fundamental part of health professional education. The multimodal approach to anatomy teaching and learning is an essential part of shaping the identity of health professionals (Cotter & Cohan, 2010).

In the 20th century, and extending into the present, human anatomy education has been subject to change. Various issues related to long-term retention of knowledge (page 14) and other limitations in teaching time and resources (page 16) heralded a growing trend among institutions to modernize the learning environment, emphasizing innovative teaching alternatives. One of the common alternatives is the use of educational technology in introductory human anatomy courses, such as MOOCs and digital learning resources, to supplement an existing F2F learning environment (Chapter 3: Study I). Another common alternative is the use of prosections instead of dissection in modern gross anatomy laboratories, which creates a learning environment different from that of the traditional dissection-based laboratory (Chapter 4: Study II). Since using these alternatives impacts the learning environments in different ways, it was important to survey the perceptions and attitudes of students to better appreciate the effects, especially in relation to interaction and collaboration. Using feedback from students on learning in these environments helps ensure high quality education in human anatomy, especially in the context of the growing importance of IPE.

6.2.1 Study I: Technology-Based Anatomy Education (TBAE)

The impact of course design on student interaction and motivation

The design of the Basic Human Anatomy course at Dalhousie University fostered a “high-tech, low-touch” learning environment in which most students did not perceive the need for social interaction. Despite the heterogeneity of student populations in the course, both F2F and distance education students perceived great confidence about their ability to learn independently and a limited need for S-S interaction. While F2F students were neutral, distance education students disagreed that S-I interaction was needed.

The impact of the course design on student interaction can be attributed to the flexibility of the technology provided (Pike & Kuh, 2005). The use of educational technology enabled the implementation of self-learning pedagogies in the course. Together, the accessible and flexible user-centred design of Brightspace and the interactive nature of WileyPLUS provided a foundation for independent and personalized learning for students enrolled in different sections (formats) of the course (F2F and distance education). According to Liu (2008), the time and space separation in online learning allows students to manage their own time and activities; therefore, technology provides more control over learning and enables individualism that is driven by the convenience of independent learning.

F2F students and lecture attendance

Research shows that F2F students can benefit from attending lectures by making connections and building rapport with peers, transforming the process of learning into a collective experience that can create shared understanding (French & Kennedy, 2017). In Study I, the ability to resource information and learn independently reduced student motivation to attend F2F lectures, thus, depriving students of the benefits of social interaction with peers.

The impact on student participation in the DAL project

The DAL project was intended to foster S-S interaction and learning in the course but there was limited participation in this optional activity. Some of the main reasons for this, as identified by the students, were: participation was optional; they did not know what to make the video about;

the activity seemed cumbersome - the grade worth was not appealing; it was difficult to join or form a group. Although the DAL project was not a success, the intent to foster S-S interaction was commendable given the evidence of reduced social interaction in the course. Therefore, it might be beneficial to address the suboptimal participation of students by making it a mandatory activity, making the grading more attractive, and suggesting a list of topics that students could choose from.

6.2.2 Study II: Cadaver-Based Anatomy Education (CBAE)

The perceived readiness for interprofessional learning

Students learning in the traditionally designed gross anatomy laboratories generally expressed openness to engage in teamwork and collaborative activities with students from other health professional programs while acknowledging and respecting their own specific future roles. Students highlighted various factors that could enhance interprofessional group collaboration. These factors included using icebreakers, grading students on participation, having tutors from the different professions involved, and implementing aspects of gamification and flipped classrooms. Students also highlighted the need for more structured and balanced dissection activities, fewer students per group, and greater instructional guidance, especially at the beginning and the end of the activities. Previous research also suggested that more instructional support and guidance is needed to facilitate dissection-based learning (Jeyakumar et al., 2020). Small group activities have been effective in facilitating student engagement in IPE as fewer students per group enhances their involvement, encourages close interaction, and a shared sense of community, leading to a more meaningful experience (Burgess et al., 2017; Burgess et al., 2019). Nonetheless, smaller group size means fewer individuals, which can slow or hinder task completion and student learning.

The usefulness of dissection versus prosections

In the traditional course design, dissection and prosections were perceived as useful means to learn the course content. Dissection provided a tactile experience, facilitating a multidimensional understanding of the human body. Students listed a number of organs and regions, including the brain, hand, foot, forearm, arm, and brachial plexus, where dissection could have been more useful for learning. Being able to cut and displace superficial structures to see deeper structures clearly, enhances student spatial understanding into the intricacy at these regions. However, students repeatedly expressed concerns that dissection was time-consuming and required advanced knowledge and skills. On the other hand, students praised prosections as significantly more useful for learning because these specimens were professionally dissected thereby providing clean and clear visuals, making them easy to learn from. In the modernized design of gross anatomy courses, students perceived prosections as strongly useful for learning the course content and facilitating collaborative and hands-on activities. Students also underlined the utility of prosections in terms of how they allowed focused visualization of structures with reasonable hands-on engagement. Similarly, McWatt et al. (2021) indicated that using either dissection or prosections in gross anatomy courses is useful in promoting a meaningful learning experience and achieving desirable outcomes.

Student performance in traditional versus modernized designs

Regarding student performance in the traditional versus modernized gross anatomy courses, the grades of PT students were not different, but the grades of OT students were significantly less (~5%) in the modernized course. A possible reason is that OT students had the opportunity to learn from PT students in the traditional course design, which resembled aspects of near-peer instruction (Shields et al., 2015). Therefore, missing the near-peer interprofessional learning activities with

PT students could have impacted negatively the learning of OT students. Previous research shows that the grades of students who benefited from near-peer tutoring sessions were significantly higher than students who did not (Morgan et al., 2017).

Professional learning outcomes

Students in both traditional and modernized designs of gross anatomy courses demonstrated that they could cultivate appreciation, care, and respect for the cadaveric specimens, their "first patients and teachers" (Bohl et al., 2011; Souza et al., 2020). Such professional perceptions toward donated cadavers enabled students to cope with the challenges associated with dealing with death that comes with exposure to cadavers. These findings agree with Parker and Randall (2020), who found that student respect and gratitude toward donors serves as coping mechanism for dealing with the deceased. Cadaver-based learning therefore offers a transformative experience which contributes to students' preparation for various situations in their future careers.

6.3 Implications of study findings on interprofessional education (IPE) design and implementation

Student-student (S-S) interaction and collaboration provide the basis for shared learning, a foundation for IPE. Study I revealed that S-S interaction was a major issue in the high-tech, low-touch learning environment (TBAE), where student communication and teamwork were particularly challenging. More structured interactive activities are needed in such an environment to enhance student lecture attendance, to promote active learning, and interaction with peers. Study II revealed that dissection or prosections could facilitate collaborative and hands-on activities. However, overlooking potential knowledge differential (KD) between students in the design of collaborative activities could impact interprofessional teamwork dynamics. It is important, therefore, that students be made aware that they are in an interprofessional setting and the potential benefits that come from this experience. Designing more structured cadaver-based activities, providing instructional guidance proportional to the complexity of the activities, and using peer evaluation and feedback are some essential strategies to optimize the implementation of collaborative cadaver-based pedagogies.

Two issues that appeared to limit TBAE and CBAE learning environments from being supportive to IPE are related to instructional resources and course design. Harden (2015), prescribing a strategy for IPE development, similarly highlighted two crucial issues to IPE success: resources available for IPE, and the design and implementation of IPE.

6.3.1 Resources available for interprofessional education (IPE)

Harden (2015) indicated that institutions should be encouraged to create and foster educational environments that support IPE. Such environments should be celebrated in the institution's vision and mission. Since IPE can provide cost-effective solutions that reduce duplication of teaching efforts and better allocate limited resources to greater educational gains (Lavin et al., 2001), time and resources should be made available to facilitate IPE. Organizing IPE should enable proper utilization of the assets each profession can offer, which guarantees that each profession will have clear roles to play. Course organizers and faculty members should sympathize with IPE with positive attitudes to promote favorable reception among students (Willhelmson et al., 2012). Staff need to be committed to IPE initiatives, and their contribution should be recognized through career advancement criteria.

6.3.2 Interprofessional education (IPE) design and implementation

Differences in background knowledge (KD) and expected learning outcomes exist between the students of different health professional programs. According to Harden (2015), looking at the curricular maps of different programs enables identification of common learning outcomes between programs. The expected learning outcomes of IPE and how it contributes to the achievement of content-related learning outcomes needs to be clearly stated. Assessment must reflect the interprofessional experience and focus on students' learning and knowledge of anatomy and their achievement of other generic outcomes, such as communication and teamwork.

Harden (2015) further elaborated that the mere gathering of students from different professional programs may not allow an equitable contribution by each group. In such an unproductive environment, interprofessional learning may feel diluted, leading students to ignore or resent the other participating groups (Carpenter & Hewstone, 1996). Addressing student knowledge differential (KD) can be done by designing a shared learning process facilitated through peer-based or near-peer-based activities (Shields et al., 2015). Near-peer activities help students develop confidence in their area of expertise (Youdas et al., 2015), fostering mutual respect and knowledge of other students' anatomical knowledge and passion (Harden, 2015).

According to Thistlethwaite (2015), an IPE session should highlight clinical relevance to facilitate linkage between theory and practice (basic and clinical sciences). An IPE session should also begin with a focus on the theory (the concept of collaborative interprofessional practice and how it is important to achieve quality care) to set the tone for the remainder of the session (Harden, 2015). Examples of such theoretical activities include professional role-focused discussions and presentations (Fernandes et al., 2015), which should aim to emphasize how different professions are expected (in fact responsible) to actively participate (within their own scope of practice) in advancing such interprofessional collaboration. Moreover, interprofessional learning must be designed to occur through balanced exchange with others (Harden, 2015). Overemphasis on the scientific content and failure to appreciate contributions of individual professions can devalue IPE and result in possible tensions among students (Carpenter & Hewstone, 1996). Students should be reassured that their precious time is not spent on what might be perceived as non-vital topics (Thistlethwaite, 2015). According to Brashers et al. (2016), the effectiveness of IPE lies in its inclusion as part of the process of teaching specific competencies in health professional curricula rather than as a random or solo activity.

6.4 Impact of COVID-19 pandemic on anatomy education

Following the outbreak of coronavirus (COVID-19), a global pandemic was declared, and various public health measures were implemented (WHO, 2020), from mask mandates to social distancing and self-quarantine (Brooks et al., 2020). In response, institutions of higher education became more lenient about attendance, instructors were required to transition to online teaching utilizing various virtual platforms to foster learning and interaction (Kalman et al., 2020; Ahmady, 2021) and students had to deal with mental health and time management issues (Alhasani et al., 2022). Anatomy instructors were not spared the challenges of delivering content mostly or entirely virtually and a wide variety of approaches were embraced (Iwanaga et al., 2021; Gasmalla et al., 2022; Ghosh et al., 2022; Shin et al., 2022; Xiao & Evans, 2022). In effect, responding to COVID accelerated the modernization of anatomy teaching that began in the 20th century (Harmon et al., 2021; Papa et al., 2022; Xiao & Evans, 2022). This ultimately stimulated pedagogical comparisons and cost-effectiveness evaluations between traditional F2F and modern online modes of delivery in relation to student learning and outcomes, especially as surveys of anatomy instructors reported that adjusting to COVID resulted in reduced levels of anatomy teaching and a move away from dissection (Harmon et al., 2021; Attardi et al., 2022; Papa et al., 2022). It is interesting, therefore, to compare student perceptions of the impact of COVID-mandated changes in anatomy teaching with those features examined in this thesis, features that were implemented by design rather than in response to a crisis.

Studies of student perceptions of anatomy courses that employed a greater degree of online learning and reduced dissection revealed a generally positive (or at least neutral) degree of satisfaction with the delivery of the content and on the resulting knowledge gained (Bani Hani et al., 2021; Schurr et al., 2022; Alsharif et al., 2022; Gasmalla et al., 2022; Tayem et al., 2022), although there were some reports of dissatisfaction (McWatt, 2021; Pollock, 2022; Potu et al., 2022). It was also found that student performance, that is grades achieved before and during COVID, were comparable (Stunden et al., 2021; Thom et al., 2021; McWatt, 2021; Zarcone & Saverino, 2022). These findings are consistent with the results reported in this thesis that demonstrated positive reactions to technology-facilitated learning and similar performance in an environment with less dissection.

A major finding of this thesis was that online learning did not promote student-student (S-S) or student-instructor (S-I) interaction. It is interesting, therefore, that several studies that examined these dynamics in the face of changes required during COVID, suggested that online teaching (with synchronous sessions) promoted teamwork and S-I interaction (Shurr et al., 2021; Alsharif et al., 2022; Tayem et al., 2022). However, a closer examination of these findings revealed that in many cases students had more of a mixed view (some negative, some neutral, some positive) about the impact of online teaching on student interaction with other students or instructors. Herriott & McNulty (2022) compared focus group and survey data collected from students enrolled in an interprofessional anatomy course (utilizing case-based learning) taught in-person in 2019 and, because of COVID, virtually in 2020. The results showed that virtual learning may be less effective in cultivating communication and teamwork than learning in-person. Students who took the course online highlighted less engagement and accountability and a lack of bonding and teamwork compared to their experience in in-person courses before the pandemic. They reported that collaboration was particularly challenging because of an added difficulty associated with creating dialogue that ensures inclusivity (difficulty in overcoming silence and hesitation and preventing inadvertently domineering discussions). As S-S is deemed important for IPE, a foundation of future IPC (see Section 2.2), reduced S-S, resulting from COVID-induced changes in teaching, would be counter to the promotion of IPE and IPC.

Another perspective on the impact of COVID on anatomical learning comes from Oliveira et al. (2023), who piloted (during COVID) a virtual interprofessional cadaveric dissection (ICD) course and compared the results of RIPLS to that obtained when the course was delivered (before COVID) in-person. No significant differences between the RIPLS results in the two courses were found. Their study suggested that the in-person and virtual course formats have had comparable effects on student perception of readiness for interprofessional student learning. Nonetheless, qualitative analysis of student responses enrolled in the virtual course identified advantages and disadvantages, positive experiences, challenges and preferences. Notably, students highlighted a preference for the in-person (F2F) setting in order to permit dissection opportunities. Feedback from students examined in this thesis made it clear that interactions with cadaveric material provided opportunities for professionalism and to consider issue related to death and dying. The reduction or absence of such opportunities in anatomy learning during COVID was regarded by some authors as an undesirable limitation of professional development (Naidoo et al., 2021; Onigbinde et al., 2021).

It was suggested above that changes in anatomy education in response to COVID may have accelerated the modernization of anatomy teaching. This will only be true if the changes implemented will continue now that the pandemic is subsiding. Supported by evidence collected prior to COVID, such as the data in this thesis, certain innovations (e.g., implementation of technology, use of prosections) are welcomed by students, while other changes (e.g., reduced interactions, loss of exposure to cadaveric material) may be undesirable. As highlighted by Evans & Pawlina (2021), a negative outcome would be to embrace the changes of anatomy education that emerged during the pandemic only to cut costs, without appreciating the impact of such changes on learning and retention. To that end, studies of the impact of changes in anatomy teaching on student perceptions and performance before COVID, such as the results reported in this thesis, provide valuable insights that should guide decision making in the post-COVID period. In addition, further studies are needed to assess fully the impact of the changes in anatomy teaching during COVID and, perhaps more importantly, changes that have persisted into the post-COVID era.

6.5 Limitations

There are inevitable factors that limit the reach of this study. The most notable is the contextual factor in educational research. The study sample, limited to students from Dalhousie University in Canada only, was chosen because of its accessibility. Thus, generalization to students in other educational institutions cannot be assumed. Generalization of findings of such research require the inclusion of students from different institutions that adopt teaching methodologies similar to those practiced at Dalhousie university. Another limiting factor is the bias existing in convenience sampling with potential differences between the students included in the study and students who chose not to participate. To minimize this type of bias, future sample participants should be randomly selected and encouraged to provide feedback.

Another major limitation of this study is self-reported data. Although self-reporting remains a common approach for evaluating student perceptions and attitudes (Pekrun 2020), data obtained from responses of participants can be vulnerable to bias (Althubaiti, 2016). To mitigate potential response bias, students were informed of the anonymous nature of the survey, which would have encouraged them to respond to the survey questions sincerely, reflecting on their state of mind (Tavakol & Sandars, 2014). Nonetheless, the main strength of this thesis work was its specificity (targeting student interaction and collaboration) and its methodological approach. The thesis pragmatic approach, involving teaching observations and consultations with the course instructors, utilized survey-based combinations of quantitative (close-ended) and qualitative (open-ended) questions to collect and analyze feedback from students of different health professions. This approach allowed capturing student perceptions of the learning experience with views on positive and challenging aspects of teaching and course design from multiple perspectives. The examination of both types of data allowed for broad issues to be explored quantitively across student populations (using statistical analysis), and for individual views to be presented qualitatively (using thematic analysis).

6.6 Future directions

An area of future investigation would be to determine to what extent online instruction (delivered as a recorded lecture or lab demonstration) is regarded by students as S-I or S-C interaction. It is possible that students may underappreciate the impact of S-I interaction when such content is not delivered live. Another avenue of future research would be to employ a sequential approach (Attardi et al., 2016) where students first experience (within the same course) F2F or online instruction and then crossover to the other form of instruction. At the end of the course, the students are surveyed about their perceptions after experiencing both teaching modalities. The strength of such an approach is that it allows students to experience both forms of teaching strengthening their ability to make "decisions about their learning preferences based on what might be advantageous or detrimental about both formats" (Attardi et al., 2016).

The students surveyed in this study reported consistent readiness for interprofessional learning (Section 5.3.2). This result is consistent with some (Fernandes et al., 2015; Oliveira et al., 2023) but not all (Herriott & McNulty, 2022) studies. Given such contradictory findings, more investigation is needed to evaluate the effectiveness of IPE in anatomy. Different directions should be explored to uncover whether the effectiveness is dependent on the length (short vs. long; single or multiple), timing (introductory vs. upper-level courses), pedagogical methods (activity design: F2F vs. online; dissection vs. prosections; mandatory vs. optional; more vs. less instructional guidance), or number and types of health professional students involved in IPE (Thistlethwaite, 2015). In addition, evaluation studies should employ more rigorous designs, such as randomized controlled trials, controlled before and after studies or interrupted time series studies with large sample sizes (Reeves et al., 2008). However, qualitative components remain essential to analyzing IPE processes and outcomes (Reeves et al., 2013). MacLeod and Ajjawi (2020) argue that future research into health professional education should view and examine student interaction through a sociomaterial lens, which would help provide insights into relationships between students and the nonliving materials in the environment.

When students are surveyed for feedback on learning in an environment, they are likely to respond with more details when the experience is still fresh in their minds. However, when students are surveyed at the beginning or in the midst of a course (and when their views might not have been developed yet), they are likely to provide feedback that is influenced (or biased) by short-term concerns (about learning and course assessment), which could possibly change after completing the course or the program. Thus, the majority of data in this thesis was collected right after the final exams. Nonetheless, to assess the potential long-term effects of any learning environment on student development, it is important to collect feedback from students at later stages of their programs (during their preparation for professional licensing exams) or after they are involved in practice. A longitudinal study design can therefore be employed to follow up and evaluate student perceptions and attitudes toward interprofessional collaborative practice after graduation and working with other health professionals (Zheng et al., 2019).

6.7 Recommendations

Minor refinements to the design of the Basic Human Anatomy course could facilitate S-S interaction and collaboration, representing an early exposure to interprofessional interaction and collaboration (communication and teamwork). The use of classroom response systems (like Top Hat, see page 42-43) could facilitate peer-based learning activities during F2F lecture time (like TBL). Collaborative learning activities have the potential to enhance classroom attendance, S-S interaction, and active learning, especially when implemented in pop-up quizzes format with a small percentage of grade. The design recommendations of the DAL project (see page 87-89) shall inform a third iteration, which could provide opportunities for students to interact and collaborate with their peers in the virtual environment of the course.

To optimize the implementation of collaborative cadaver-based pedagogies, the study recommends structuring the activities, providing instructional guidance proportional to the complexity of the activities, and facilitating peer evaluation and feedback (page 148).

Students should be involved as partners in the design, delivery, and evaluation of interprofessional courses and sessions (Harden, 2015). In order to maintain a closed feedback loop, professional development initiatives should focus on enhancing the quality of the process of student feedback, ensuring that relevant programs are available to students and instructors alike. For example, workshops or information sessions can specifically be designed to introduce students and instructors to the purpose and process of acquiring quality student feedback. This includes information for students regarding how feedback is used and for instructors about the resources available to support them address student feedback. Seldin (1989) highlighted the importance of having a culture within universities that value student feedback as an important source of information (page 20-21). Therefore, enhancing the effectiveness of student feedback involves enhancing the presentation of results for instructors and supporting them to understand, evaluate and act on it: this way, meaningful change can be initiated toward creating learning environments that are supportive to IPE.

CHAPTER 7: CONCLUSIONS

Knowledge pertaining to human anatomy is essential to facilitate clinical investigation and the communication of findings with other health professionals using shared terminology. Human anatomy is essential for various health professions constituting a common subject for all health professional students, thus, providing a strategic opportunity to design shared learning and objectives. Innovative teaching alternatives have increasingly been utilized to modernize learning environments in human anatomy education. Examples of these alternatives include the use of massive open online course (MOOC) design in introductory human anatomy courses and the use of prosections instead of dissection in the modern design of gross anatomy laboratories. The work in this thesis sought to understand how different modes of teaching and course design influenced student perceptions and attitudes toward interaction and collaboration. The specific objectives were intended to use student feedback on learning in two different environments, namely technology-based (TBAE) and cadaver-based anatomy education (CBAE), to analyze the potential of those environments in fostering shared learning necessary for IPE. In the TBAE, it was found that the flexibility of the design enabled students to become independent learners. The ability to learn independently impacted student motivation to attend F2F lectures and hindered social interaction between them. Promoting S-S interaction and collaboration is essential in such an environment as a basis for shared learning in introductory anatomy courses. Thus, the thesis includes recommendations to design structured collaborative activities during the lecture time to enhance student attendance, active learning, and interaction with peers. In CBAE, it was found that the use of either dissections or prosections facilitated collaborative and hands-on learning, providing a means for shared learning in gross anatomy courses. However, students reported a sense of frustration toward complex dissection activities due to their lack of dissection skills.

Moreover, the findings revealed that differences in backgrounds and anatomical knowledge between students in a group influences teamwork dynamics. It is essential to educate students about the need and benefits of IPE and make them aware of the fact that "there is something in it for everyone" despite differences. To optimize the implementation of collaborative cadaver-based pedagogies, the thesis recommends designing more structured activities, allocating resources to expand the provision of instructional guidance proportional to the complexity of the activities, and facilitating peer evaluation and feedback. Two issues related to instructional resources and design appear to limit TBAE and CBAE learning environments from being supportive to IPE. Accordingly, successful IPE design and implementation in human anatomy entails enabling and embedding student interaction and collaborative activities in health professional programs. Assessment of student outcomes should not be confined to learning and knowledge of human anatomy but should also include generic outcomes such as communication and teamwork. Interprofessional student encounters would give rise to a spiral curriculum that extends across the years of education.

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Appendix A: Description of the Digital Anatomy Learning (DAL) project

DAL project is an activity that allows you to work within a group of classmates, of your choice, to produce video clip(s) of topic(s), of your choice, related to the course content. You can submit your work by uploading your video(s) on BrightSpace for other classmates to view, comment, learn and vote. This activity is absolutely **optional**; however, top videos will be awarded **bonus grades**. The activity aims to promote learning anatomy and knowledge retention, and to foster teamwork and communication skills through interactions with classmates. The goal is to help you become more creative, critical, and collaborative, which will benefit your career.

Guidelines:

- **5-minute** anatomy video production (acting, drawing, singing limericks, reports, comparisons...etc.)
- **Group project** (no more than 3 students)
- **You choose the Topic** (allows you to become invested, relate to your own experiences and interests)
- **Be critical and analytical** using current media and social technologies
- The **integrity** and **correctness** of the video(s) content is your responsibility
- There will be **two Seasons**, you can participate in making **one** video for each season
- Submission **instructions** and student grading methodology are outlines below
- Submission and student grading **deadlines** for Season 1 & 2 are outlines below
- Top projects may be utilized for future teaching in this course

Topic Selection

The topic is your choice; you can choose the topic that may interest you. However, topics for **Season 1** videos should cover material from Block 1 and or Block 2, and topics for **Season 2** videos should cover Block 3 or material from all Blocks. **When selecting a topic, consider the following**:

- Why do you want to explore this topic?
- What information do you need to collect?
- How do you plan on collecting the data and which sources will you use?
- Why is this topic important to you?
- What have you learned from reading and researching this topic?

- Use the following websites to help produce your video project or post a website with the best (free) movie making software for Microsoft or Mac:
  http://www.freetech4teachers.com/2009/11/six-easy-ways-for-students-to-create.html#.VubIt_B6WrU
  http://filmora.wondershare.com/video-editor/free-video-editing-software-windows.html#windows

Submission Instructions:

You can submit your work by uploading your video(s) to Discussion Board (DAL Project Thread). Video(s) must be in a **proper format** that is compatible with popular media players (MPEG preferred).

Grading:

Projects will be graded in two steps:

- Student votes by selecting +1 or -1 (Located upper left side of your video post window). Voting will be enabled after submission dates have been reached.
- Only the top 3 projects with the most votes from each season will be selected to enter the Final Competition.
- Anatomy Judges will vote on the top 3 projects and award grades as follows:

  1st Place: 5 points/contributor (max of 15 points)
  2nd Place: 4 points/contributor (max of 12 points)
  3rd Place: 3 points/contributor (max of 9 points)

Submission & Grading deadlines:

- **Season 1:** Anatomy videos covering material from Block 1 and or Block 2 must be submitted by October 21. Grading will be permitted from October 22-Nov. 4.
- **Season 2:** Anatomy videos covering Block 3 (or material from all Blocks) must be submitted by November 25. Grading will be permitted from Nov. 26-Dec.7.

Appendix B: Evaluation rubric of the Digital Anatomy Learning (DAL) project

Criteria	Level 4	Level 3	Level 2	Level 1
Message content and Quality	Content imaginative and original work that could be used in anatomical education	Content is appropriate and grammatically correct. Easy to listen to by introductory student audience.	Content appropriate but could use more focus and precision. Narrative tone could be improved.	Content unclear and incomplete. Many errors and lacks accuracy.
Message impact	An original, unique and imaginative approach. Creates a compelling sequence that is correct and informative.	Video gains attention and uses audio and video technique in an informative way.	Helpful and informative not a good learning tool.	Video lacks clarity and precision. Message has low impact on learning issues.
Audience fit	Video content show high level of insight into the class. Message is informative, attractive and entertaining.	Message is appropriate; but the flow of objective is not attractive to a wide audience.	Some good examples but not all inclusive.	Shows little insight into this type of audience. Message is not inclusive or appropriate.
Technical aspects: visual and sound	Video is skilled and sound is linked, professional quality.	Video and sound suitable organization. Well composed and focused.	Video and sound is mostly good but could use improvement.	Video has aspects that hard to watch and may incline audience to quit before it is completed.

Appendix C: Refined description of the Digital Anatomy Learning (DAL) project

DAL project is an activity that allows you to work within a **group** of classmates, of your choice, to produce video clips of topics, of your choice, related to the course content. You can submit your work by uploading your video on Brightspace for other classmates to view, comment, learn and vote. This activity is **absolutely optional**; however, videos will be awarded **bonus grades**. The activity aims to promote learning anatomy and knowledge retention, and to foster teamwork and communication skills through interactions with classmates. The goal is to help you become more creative, critical, and collaborative, which will benefit your career.

<u>Guidelines:</u>

- **5-minute** anatomy video production (acting, drawing, singing limericks, reports, comparisons...etc.)
- **Group** project (no more than 3 students)
- You choose the Topic (allows you to become invested, relate to your own experiences and interests)
- Be critical and analytical using current media and social technologies
- The integrity and correctness of the video(s) content is your responsibility
- Submission instructions and student grading methodology are outlined below
- Top projects may be utilized for future teaching in this course

<u>Topic Selection:</u>

The topic is your choice; you can choose the topic that may interest you. However, topics for Season 1 videos should cover material from Block 1 and or Block 2, and topics for Season 2 videos should cover Block 3 or material from all Blocks. When selecting a topic, consider the following:

- Why is this topic important to you?
- What information do you need to collect?
- How do you plan on collecting the data and which sources will you use?
- What have you learned from reading and researching this topic?

Grading:

Projects will be graded in two steps:

- Student votes by selecting +1 or -1 (Located upper left side of your video post window).
- Anatomy Judges will vote on the projects and award grades as follows: up to 5 points/contributor (max of 15 points for the project).
- Highest marks will be considered for the following criteria:
    - Content and quality: imaginative and original work that could be used in anatomical education.
    - Message impact: an original, unique, and imaginative approach. Creates a compelling sequence that is correct and informative.
    - Audience fit: video content show high level of insight into the class. Message is informative, attractive, and entertaining.
    - Technical aspects: video is skilled, and sound is linked. Professional quality.

Submission Instructions:

You can submit your work by uploading your video to Discussion Board (DAL Project Thread). The video must be in a proper format that is compatible with popular media players (MPEG preferred).

Submission deadline:

Anatomy videos covering material from any block must be submitted by December 2nd, 2019.

Grading deadline:

Grading will be permitted until December 9th, 2019.

Use the following websites or other video editing resources to help produce your video project or post a website with the best (free) movie making software for Microsoft or Mac.

- YouTube creators
- Building an educational channel on YouTube
- Byrne R. Six Easy Ways for Students to Create Videos Online

Appendix D: Top Hat description

We will be using the Top Hat (www.tophat.com) classroom response system for both in class and online students. You will be able to submit answers to questions using Apple or Android smartphones and tablets, laptops, or through text message.

This optional activity aims to increase in-class participation, engagement, attention levels, and get real-time feedback and answers.

For in-class students, two to four multiple choice questions will be displayed on the screen during the lecture. One minute will be allowed for the entire class to respond using remote devices. The results are collected, summarized, and presented to the class in visual format. Responses are always anonymous to peers, but your response is associated with the account on Top Hat for calculating the bonus marks. During the lecture, log in to your Top Hat account from a portable device and you will be notified when a question is presented.

For online students, the questions will be available in the "Assigned" folder only on the day when the lecture is scheduled (see page 8 for the Study Schedule).

<u>Grading:</u>

You will get 0.5 mark for participation and 0.5 mark for correctness. By the end of the course, your total score will be calculated out of 5% and added to the course grade as bonus marks.

<u>Top Hat Registration:</u>

You can visit the Top Hat Overview (https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide) within the Top Hat Success Center which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system.

Course join code is **547601** for in-class students [Anat1010/1020/DEHY2851]
Course join code is **222599** for online students [Anat1010 Sec2 and Sec69]

Top Hat may require a paid subscription, and a full breakdown of all subscription options available can be found here: www.tophat.com/pricing.

Top Hat Assistance:

Should you require assistance with Top Hat at any time, because they require specific user information to troubleshoot these issues, please contact their Support Team directly by way of email (support@tophat.com), the in-app support button, or by calling 1-888-663-5491

Appendix E: Fall 2016 survey (Study I; Basic Human Anatomy course)

Title: Student perceptions, attitudes and learning styles in Basic Human Anatomy course

Component 1: learning and interaction (L&I)

Q1: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

Rate the following statements based on your learning experience in the course	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I was able to develop my own learning style through independent study of the course materials available on BrightSpace					
Interactions with classmates were necessary to understand the course content					
Interaction with the course instructor was necessary to understand the course content					
WileyPLUS was helpful to stay engaged with course content and progression					
The ability to resource information and learn anatomy independently allowed me to skip lectures with or without excuses					

Q2: Please describe your approach in learning the course content.

Q3 Any comments or suggestions for improvement?

Component 2: participation in the DAL project (DAL)

Q4: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

I didn't participate in DAL project because	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Participation was optional					
I didn't know what to make the video about					
The activity description was complicated					
The activity seemed cumbersome; the grade worth was not appealing					
It was difficult to find or make a group					

Q5 Any comments or suggestions for improvement?

Appendix F: Winter 2017 survey (Study I; Basic Human Anatomy course)

Title: Student perceptions, attitudes and learning styles in Basic Human Anatomy course

Component 1: learning and interaction (L&I)

Q1: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

Please rate the following statements based on your learning experience in the course	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I was able to develop my own learning style through independent study of the course materials available on BrightSpace					
Interactions with classmates were necessary to understand the course content					
Interaction with the course instructor was necessary to understand the course content					
WileyPLUS was helpful to stay engaged with course content and progression					
The ability to resource information and learn anatomy independently allowed me to limit my interaction with the course instructor or other student					

Component 2: participation in the DAL project (DAL)

Q2: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

I didn't participate in DAL project because	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Participation was optional					
I didn't know what to make the video about					
The activity description was complicated					
The activity seemed cumbersome; the grade worth was not appealing					
It was difficult to find or make a group					

Appendix G: Fall 2017 survey (Study I; Basic Human Anatomy course)

Title: Student perceptions, attitudes and learning styles in Basic Human Anatomy course

Q1: Which section of the course were you registered in?

- o Classroom section
- o Distance education section

Component 1: learning and interaction (L&I)

Q2: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

Please rate the following statements based on your learning experience in the course	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I was able to develop my own learning style through independent study of the course materials available on BrightSpace					
WileyPLUS assignments were helpful to prepare for the course exams					
WileyPLUS was helpful to stay engaged with course content and progression					
The availability of recorded lectures and videos in the virtual anatomy lab were helpful to understand the course content					
Interactions with classmates were necessary to understand the course content					
Interaction with the course instructor was necessary to understand the course content					
The ability to resource information and learn anatomy independently allowed me to skip lectures with or without excuses					
I web-searched most of the course content to learn from various learning resources available online (ex: YouTube and Wikipedia)					
I web-searched most of the course content just to look up answers and I did not learn much					

Component 2: participation in the DAL project (DAL)

Q3: Did you participate in DAL project?

- o Yes
- o No

Q4: Please rate the following statements based on your learning experience in the course (Strongly Disagree-1 to Strongly Agree-5):

I didn't participate in DAL project because	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I did not hear or know about it					
This course was easy, and I did not feel the need to participate					
Participation was optional					
The activity description was complicated					
I didn't know what to make the video about					
The activity seemed cumbersome; the grade worth was not appealing					
It was difficult to find or make a group					

Appendix H: Fall 2017 survey invitation (Study I; Basic Human Anatomy course)

Dear Student,

Basic Human Anatomy course is designed to provide students with tools for independent study (BrightSpace and WileyPLUS). The course uses online, open book, unsupervised exams to facilitate anatomy learning during examination in a private, comfortable environment. This pedagogical approach is believed to enable students to resource information rather than memorizing.

Recognizing the importance of fostering various types of interactions, we have designed and implemented the DAL project to improve student engagement and learning through improved student interactions. However, student participation in the project was not up to expectations. The course instructors, Dr. A. and Dr. J., are inviting you to help them understand and interpret poor participation in the DAL project. As a participant in the survey, you will be asked to share information regarding your learning experience during the course.

Information that you provide will be collected anonymously, which means that there will be no questions asked in the survey that asks for identifying details such as your name or email address. Your participation is entirely your choice. You do not have to answer questions that you do not want to answer, and you are welcome to stop the survey at any time if you no longer want to participate.

Please click the link below to start the survey. Thank you for your participation
https://www.surveymonkey.com/r/RPMY5C5

Best wishes,
The instructional team

Appendix I-a: Fall 2017 Part 1 survey (Study II; Functional Anatomy Course)

Title: Student perceptions and attitudes toward cadaver-based interprofessional learning in Functional Anatomy course (Pre; Fall, 2017).

Q1. Develop your own 'Personal Code' by using the following formula: the day of your date of birth and first three letters of your mother's first name'; for example, 01CAT.

Q2. Program of Study

- o Occupational Therapy (OT)
- o Physiotherapy (PT)

Component 1: interprofessional anatomy learning (IPAL)

Q3: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Learning with other students will help me become a more effective member of a healthcare team					
Patients would ultimately benefit if healthcare students worked together to solve patient problems					
Shared learning with other healthcare students will increase my ability to understand clinical problems					
Learning with healthcare students before qualification would improve relationships after qualification					
Communication skills should be learned with other healthcare students					
Shared learning will help me to think positively about other professionals					
For small group learning to work, students need to trust and respect each other					
Team-working skills are essential for all health care students to learn					
Shared learning will help me to understand my own professional limitations					

Q4: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I don't want to waste my time learning with other healthcare students					
It is not necessary for healthcare students to learn together					
Clinical problem-solving skills can only be learned with students from my own program					

Q5: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Shared learning with other healthcare students will help me to communicate better with patients and other professionals					
I would welcome the opportunity to work on small-group projects with other healthcare students					
Shared learning will help to clarify the nature of patient problems					
Shared learning before qualification will help me become a better team worker					

Q6: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The function of therapists is mainly to provide support for doctors					
I'm not sure what my professional role will be					
I have to acquire much more knowledge and skills than other healthcare students					

Q7: How is your interprofessional learning experience with other healthcare students from other programs in this course?

Component 2: cadaver-based learning (CBL)

Q8: Perceptions and attitudes change throughout life. Has your perception of death changed since you started the course? What did you learn?

Q9: "Precious gifts." You have been granted a privilege to make use of human bodies, organs, and tissues in your education; yet, only by actively participating in teaching laboratories, you can express your appreciation. Please express any impact cadaver-based learning may have had on you.

Q10: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is cadaver dissection in learning the course content?

Q11: Based on your laboratory experience so far, please elaborate on your answer to the previous question.

Q12: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is the use of prosections in learning the course content?

Q13: Based on your laboratory experience so far, please elaborate on your answer to the previous question.

Appendix I-b: Fall 2017 Part 2 survey (Study II; Functional Anatomy Course)

Title: Student perceptions and attitudes toward cadaver-based interprofessional learning in Functional Anatomy course (Post; Fall, 2017).

Q1: Program of Study

- Occupational Therapy (OT)
- Physiotherapy (PT)

Component 1: interprofessional anatomy learning (IPAL)

Q2: How was your interprofessional learning experience with students from other programs in this course? Did you learn with, from and about each other?

Q3: Did you complete the RIPLS in the beginning of the course?

- Yes
- No

Q4: Please indicate your personal code to allow us to correlate your responses to the surveys. Develop your code by using the following formula: the day of your date of birth and first three letters of your mother's first name'; for example, 01CAT.

Q5: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Learning with other students will help me become a more effective member of a healthcare team					
Patients would ultimately benefit if healthcare students worked together to solve patient problems					
Shared learning with other healthcare students will increase my ability to understand clinical problems					
Learning with healthcare students before qualification would improve relationships after qualification					
Communication skills should be learned with other healthcare students					
Shared learning will help me to think positively about other professionals					
For small group learning to work, students need to trust and respect each other					
Team-working skills are essential for all health care students to learn					
Shared learning will help me to understand my own professional limitations					

Q6: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I don't want to waste my time learning with other healthcare students					
It is not necessary for healthcare students to learn together					
Clinical problem-solving skills can only be learned with students from my own program					

Q7: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Shared learning with other healthcare students will help me to communicate better with patients and other professionals					
I would welcome the opportunity to work on small-group projects with other healthcare students					
Shared learning will help to clarify the nature of patient problems					
Shared learning before qualification will help me become a better team worker					

Q8: Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The function of therapists is mainly to provide support for doctors					
I'm not sure what my professional role will be					
I have to acquire much more knowledge and skills than other healthcare students					

Q9: In your opinion, what would have made your laboratory group more effective, i.e., number or type of students (OT/PT), learning approaches, please elaborate on your answer if possible?

Component 2: cadaver-based learning (CBL)

Q10: Please describe how you would utilize dissection and prosections to learn in the laboratory.

Q11: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful was the use of prosections in learning the course content?

Q12: Elaborate on your answer to the previous question if you wish.

Q13: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful was cadaver dissection in learning the course content?

Q14: Elaborate on your answer to the previous question if you wish.

Q15: When students were asked to rate the usefulness of dissection in learning the course content, they rated dissection 7.5 out of 10. In your opinion, what might have impacted on student perception toward dissection in comparison with prosections?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Dissection requires more time and patience to learn from					
Dissection requires more instructional guidance					
Students worry that they might cut through structures that need to be preserved					
Dissection requires interaction with cadavers					
Dissection requires interaction with other students					

Q16: Any comments on your answers to the previous question or suggestions for improvement?

Q17: When students were asked to rate the usefulness of prosections in learning the course content, they rated prosections 9.5 out of 10. In your opinion what might have promoted student perception toward prosections in comparison with dissection?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Prosections are simple and easy to understand and learn from					
Prosections enable focused structure visualization and application of lecture knowledge					
Prosections enable efficient and confident learning					
Prosections require interaction with cadavers					
Prosections require interaction with other students					

Q18: Any comments on your answers to the previous question or suggestions for improvement?

Q19: If you could rely on prosections as a guide for dissection, lab instructors would have more time to facilitate deeper and collaborative learning. In your opinion, what would the potential role of a lab instructor be?

Appendix J-a: Fall 2017 Part 1 survey (Study II; Dental Gross Anatomy course)

Title: Student perceptions and attitudes toward cadaver-based interprofessional learning in the Dental Gross Anatomy course (Pre; Fall, 2017).

Component 2: cadaver-based learning (CBL)

Q1: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is cadaver dissection in learning the course content?

Q2: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is the use of prosections in learning the course content?

Appendix J-b: Fall 2017 Part 2 survey (Study II; Dental Gross Anatomy course)

Title: Student perceptions and attitudes toward cadaver-based interprofessional learning in the Dental Gross Anatomy course (Post; Fall, 2017).

Component 2: cadaver-based learning (CBL)

Q:1 When students were asked to rate the usefulness of dissection in learning the course content, they rated dissection 6 out of 10. In your opinion, what might have impacted on student perception toward dissection in comparison with prosections?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Dissection requires more time and patience to learn from					
Dissection requires more instructional guidance					
Students worry that they might cut through structures that need to be preserved					
Dissection requires interaction with cadavers					
Dissection requires interaction with other students					

Q2: When students were asked to rate the usefulness of prosections in learning the course content, they rated prosections 9 out of 10. In your opinion what might have promoted student perception toward prosections in comparison with dissection?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Prosections are simple and easy to understand and learn from					
Prosections enable focused structure visualization and application of lecture knowledge					
Prosections enable efficient and confident learning					
Prosections require interaction with cadavers					
Prosections require interaction with other students					

Appendix K: Fall 2018 survey (Study II; Functional Anatomy course)

Title: Student perceptions and attitudes toward cadaver-based interprofessional learning in Functional Anatomy course (Fall, 2018).

Q1: Program of Study

- Occupational Therapy (OT)
- Physiotherapy (PT)

Component 2: cadaver-based learning (CBL)

Q2: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful was the use of prosections in learning the course content?

Q3: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful was cadaver dissection in learning the course content?

Q4: When students were asked to rate the usefulness of dissection in learning the course content, they rated dissection 7.5 out of 10. In your opinion, what might have impacted on student perception toward dissection in comparison with prosections?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Dissection requires more time and patience to learn from					
Dissection requires more instructional guidance					
Students worry that they might cut through structures that need to be preserved					
Dissection requires interaction with cadavers					
Dissection requires interaction with other students					

Q5: When students were asked to rate the usefulness of prosections in learning the course content, they rated prosections 9.5 out of 10. In your opinion what might have promoted student perception toward prosections in comparison with dissection?

Using the scale below, (Strongly Disagree-1 to Strongly Agree-5), please rate the following statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Prosections are simple and easy to understand and learn from					
Prosections enable focused structure visualization and application of lecture knowledge					
Prosections enable efficient and confident learning					
Prosections require interaction with cadavers					
Prosections require interaction with other students					

Appendix L: Fall 2019 survey (Study II Functional and Clinical Anatomy courses)

Title: Student perceptions and attitudes toward prosections-based gross anatomy learning (Fall, 2019).

Component 2: cadaver-based learning (CBL)

Q1: Perceptions and attitudes change throughout life. Has your perception of death changed since you started the course? What did you learn?

Q2: "Precious gifts." You have been granted a privilege to make use of human bodies, organs, and tissues in your education; yet, only by actively participating in teaching laboratories, you can express your appreciation. Please express any impact cadaver-based learning may have had on you.

Q3: Please describe how you learn in the laboratory.

Q4: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is the use of prosections in learning the course content?

Q5: Using the slider below (Strongly Not Useful-0 to Strongly Useful-10), how useful is the use of prosections in fostering collaborative and hands-on learning activities?

Q6: Are there any specific regions of the body that dissection could have been more useful? please be specific.

Appendix M: Fall 2017 Part 1 survey invitation (Study II; Functional Anatomy course)

Dear Student,

Functional Human Anatomy (ANAT-5217) course is designed to enable Occupational Therapy and Physiotherapy students to engage in learning with, from and about each other. Interprofessional learning experiences in this course are framed around team-based activities that require active participation in small and large group discussions and hands-on learning.

Assessment of student perceptions and attitudes toward interprofessional learning can determine student readiness for interprofessional learning and change. Therefore, you will be asked to complete the Readiness for Interprofessional Learning Scale (RIPLS) Questionnaire at the beginning and end of this course. As a participant in the survey, you will also be asked to share information regarding your cadaver-based learning experience.

Information that you provide will be collected anonymously, which means that you will not be asked for identifying details such as your name or email address. Your participation is entirely your choice, and you are welcome to stop the survey at any time if you no longer want to participate.

Your input would be appreciated. Click the button below to start the survey. Thank you for your participation!

Best wishes,

The Instructional Team,

Appendix N: Fall 2017 Part 2 survey invitation (Study II; Functional Anatomy course)

Dear Student,

Functional Human Anatomy (ANAT-5217) is a graduate-level course, designed to enable Occupational Therapy and Physiotherapy students to engage in learning with, from and about each other. You were invited to complete the Readiness for Interprofessional Learning Scale (RIPLS) Questionnaire at the beginning and end of this course. Thank you for those who completed the survey at the beginning of the course; your response to the of the present survey is crucial to assess interprofessional learning in the course. If you did not participate before, we look forward to receiving your responses to the second part of the survey pertaining to cadaver- based learning.

Recognizing the importance of collaborative cadaver-based learning, we have used dissection and prosections as learning modalities to improve student engagement and learning the course. Prosections are professionally pre-dissected teaching and learning resource. The use of prosections provides a clear and intact presentation of anatomy. On the other hand, dissection is an active, exploratory process that clarifies aspects of anatomy, which prosections would not, such as layers, depth, and relation. Dissection also enables application of knowledge in a semi- patient scenario. However, when we asked students to rate the usefulness of these modalities, their perceptions were different. We are inviting you to help us understand and interpret this discrepancy ultimately to optimize the use of cadavers.

Information that you provide will be collected anonymously, which means that you will not be asked for identifying details such as your name or email address. Your participation is entirely your choice, and you are welcome to stop the survey at any time if you no longer want to participate.

Click the button below to start the survey. Thank you for your participation!

Best wishes,
The Instructional team.

Appendix O: Fall 2018 survey invitation (Study II; Functional Anatomy course)

Dear Student,

Functional Human Anatomy (ANAT-5217) is a graduate-level course, designed to enable Occupational Therapy and Physiotherapy students to engage in learning with, from and about each other. Recognizing the importance of collaborative cadaver-based learning, we have used dissection and prosections as learning modalities to improve student engagement and learning in the course.

Prosections are professionally pre-dissected teaching and learning resource. The use of prosections provides a clear and intact presentation of anatomy. On the other hand, dissection is an active, exploratory process that clarifies aspects of anatomy, which prosections would not, such as layers, depth, and relation. Dissection also enables application of knowledge in a semi- patient scenario. However, when students in previous years were asked to rate the usefulness of these modalities, their perceptions were different. We are inviting you to help us understand and interpret this discrepancy ultimately to optimize the use of cadavers.

Information that you provide will be collected anonymously, which means that you will not be asked for identifying details such as your name or email address. Your participation is entirely your choice, and you are welcome to stop the survey at any time if you no longer want to participate.

Click the button below to start the survey. Thank you for your participation!

Best wishes,

The Instructional Team.