Finding the Right balance:
Integrating Old and New Approaches for Anatomy Teaching

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Although anatomy is one of the core knowledge pillars within medical teaching, the level of knowledge covered in the modernized medical curricula in recent years around the world has declined considerably, due to the use of old-fashioned pedagogical methods. This study examines available approaches to anatomy teaching and how to improve student learning in this area, while also targeting higher skills and knowledge for future medical personnel. Using a mix of qualitative and quantitative methodologies to collect data, mini-interviews and online surveys were conducted with a sample of four participants (a student, a resident, and two medical educators) to explore the different aspects of anatomy learning and its key challenges. From this small sample of medical students and educators, data was collected around four key themes: fundamental introductory learning, technology-based education, teaching techniques, and updated curriculum. A thematic analysis of the participants' insights revealed that, while technology-based alternatives were considered effective tools, dissecting cadavers was the preferred means of learning anatomy.

Keywords: *anatomy, teaching techniques, learning, innovative approaches, technology-based education, computer, curriculum update, problem-based learning, online games*

Bien que l'anatomie soit l'un des piliers de l'enseignement de la médecine, le niveau de connaissances couvert par les programmes actuels de médecine dans le monde a considérablement diminué en raison de l'utilisation de méthodes pédagogiques désuètes. Cette étude examine les approches disponibles pour l'enseignement de l'anatomie et la manière d'améliorer l'apprentissage des étudiants dans ce domaine, tout en visant des compétences et des connaissances plus poussées pour le futur personnel médical. À l'aide d'une combinaison de méthodes qualitatives et quantitatives pour récolter des données, des mini-interviews et des enquêtes en ligne ont été conduits sur un échantillon de quatre participants (un étudiant, un résident et deux enseignants en médecine) afin d'explorer les différents aspects de l'apprentissage de l'anatomie et ses principaux défis. . À partir de ce petit échantillon d'étudiants en médecine et d'éducateurs, les données ont été rassemblées en quatre thèmes principaux : les apprentissages fondamentaux, l'enseignement fondé sur la technologie, les techniques d'enseignement et les programmes actuels. Une analyse thématique des idées des participants a révélé que, même si les alternatives technologiques

étaient considérées comme des outils efficaces d'enseignement, la dissection de cadavres était le moyen privilégié d'apprentissage de l'anatomie.

Mots-clés : *anatomie, méthode d'enseignement, approches innovantes d'apprentissage, technologie de l'éducation,ordinateur, mise à jour curriculaire, apprentissage par problème, jeux en ligne*

Based on my personal experience of teaching anatomy for 25 years to both undergraduate students and post-graduates in health-related professions (e.g., medical students and residents), it was clear that anatomy-teaching needed to be better integrated within the evolution of the modernized medical curriculum around the world (Bhangu, Boutefnouchet, Yong, Abrahams, & Joplin, 2010). The progressive development in medical knowledge over the last three decades, the continuous update of curricula to be clinically relevant (Johnson, Charchanti, & Troupis, 2012), as well as various technological advancements (Peterson & Mlynarczyk, 2016), have required that medical educators adapt to rapid changes. Given the misconception that anatomy is too detailed and lacks clinical relevance, anatomy curricula and teaching methods have gone through many changes to ensure that students have the skills and knowledge required for their medical careers (Bhangu et al., 2010; Johnson et al., 2012).

Although anatomy is mandatory for all medical specialties, the teaching of anatomy has struggled to cope with this progression. Indeed, anatomy still tends to be taught using conventional pedagogic methods, such as didactic lectures, textbooks and two-dimensional (2D) pictures. These traditional methods are typically paired with cadaveric dissection laboratories, which require maintenance as well as prolonged, intensive student work. For a variety of reasons, this approach came to be seen as old-fashioned and no longer appropriate (Johnson et al., 2012). For example, the increased cost of maintaining the dissection room, with a simultaneously diminishing number of cadavers, presented additional challenges (Johnson et al., 2012). Further, the decreasing number of anatomy staff who are qualified for teaching became a more prominent issue as well (Patel & Moxham, 2006). While I consider anatomy to be a vast and exciting branch of medicine, these reasons, as well as others explored in this paper, favor the decline of anatomy in the medical curriculum, subsequently crippling students' educational experience. Thus, over the past few decades, teaching hours dedicated to anatomy have generally been reduced, human dissection diminished, and the level of anatomical knowledge expected decreased

in the modernized medical curriculum, as the whole body was studied in only three or four semesters (Johnson et al., 2012). Consequently, there has been a recurrent need to devise a different clinically oriented and integrated anatomy curriculum that focuses on clinically related topics to be taught efficiently (Patel & Moxham, 2006).

Being a graduate of the Faculty of Medicine, at Ain Shams University in Egypt, which is one of the largest schools of medicine that follows a traditional system of teaching, most of my education in the twentieth century was based on professors' lectures, studying detailed textbooks and dissecting cadavers to gain practical experience. In my experience, there was not enough diversity in the teaching tools employed. Thus, students struggled to memorize detailed information, were unmotivated, and gained only a minimal understanding of the practical relevance of anatomy (Patel & Moxham, 2006). This experience was not confined only to anatomy; this was characteristic of the overall educational system where some professors might simply read their slides and students had little opportunity for interactive learning (Johnson et al., 2012).

Through my work experience, as well as through medical education literature, I found that the struggle to engage students in anatomy learning was becoming increasingly difficult, resulting in basic core knowledge gaps among students (Johnson et al., 2012; Patel & Moxham, 2006; Turney, 2007). Students in the same cohort were not learning at the same pace. Although many students were eager to learn, the amount of information, the use of traditional teaching techniques, and standardized evaluations based mostly on memorization, were major obstacles. Although much of my own learning was deeply influenced by old-fashioned pedagogical techniques, I challenged myself to motivate and engage students in a transformative introspective learning process, also known as perspective learning, which includes psychological, behavioural and convictional aspects (Kaufman, & Mann, 2010). For instance, to alleviate the anxiety of summative assessments, I provided frequent formative assessments, along with opportunities for my students to connect the theoretical portions of the curriculum to more practical elements. Not only did it seem clear to me that they enjoyed this approach, but I also observed an increase in the quality of the students' learning outcomes from formal assessments.

The aim of the present work is to explore different methods of teaching and learning anatomy, in order to identify preferred means of learning anatomy. I also investigate through this study whether alternative technology-based tools are appropriate to replace (or could at least be complimentary) to cadaveric dissection. In order to address my research objectives, I first conduct a literature review to provide an overview of recent anatomy

teaching and learning advancements in medical schools. I then report the results of a study using both interview and survey methods to examine the learning preferences of members in the Faculty of Medicine at the University of Ottawa. Finally, I discuss the implications of the present study's findings in light of my own professional experience in medical education.

Literature Review

Medical schools around the world have faced a steady decline in students' interest in anatomy (Bhangu et al., 2010). The authors conducted a three-year cohort study using a questionnaire answered by medical students to highlight this decline in student interest. Although the study's response rate had massively decreased after three years, the vast majority of participants agreed that clinical anatomy (i.e., the practical application of anatomical knowledge to clinical problem solving) helped them significantly with their clinical practice and placements. However, it also demonstrated that students felt a lack of knowledge in anatomy and would prefer more participation in surgeries. This study was important because it raised awareness on students' opinion around the suggested decrease of anatomy teaching hours.

Conversely, Patel and Moxham (2006) conducted a study to compare the attitudes of anatomists towards the medical curricular change within Continental Europe, including the introduction of new modern techniques and decreased students' exposure to cadaveric dissection for anatomy learning. Modernists were in support of curricular changes, while traditionalists refuted the hypothesis that cadaveric dissection and macroscopic anatomy were not crucial or preferred anymore. Over 100 anatomists responded to a matrix questionnaire, which entailed those qualified professionals to associate course objectives to appropriate teaching methods, to determine their preferred teaching method; the results were very surprising. Cadaveric dissection and prosection were significantly preferred, with 98% of professionals arguing the importance of gross anatomy (i.e., topographical, regional or systemic anatomy) in clinical medicine (Patel & Moxham, 2006). This study was important as it analyzed anatomy professionals' point of view, unlike others discussing students' and curricular committee's opinion.

Due to various challenges facing both anatomy educators and students, such as extensive time-consuming cadaveric preparation and limited resources, it is crucial to find the most effective and efficient alternative method for practical laboratory for human anatomy. To investigate this issue, Carlyle (2005) explored the effectiveness of three different learning techniques or methods: computer learning, combined computer/cadaver

learning, and cadaver learning methods. Based on a survey, Carlyle (2005) found no significant difference between the three techniques, however, the students preferred the cadaver. This work enlightened the reader on different anatomy teaching cultures and advantages; however, additional research is also important to compare the cost of acquiring a sufficient number of computers to replace cadavers.

Peterson and Mlynarczyk (2016) performed a study to identify the most beneficial type of teaching method: using traditional learning tools (e.g., lectures and cadaveric dissection), or using a combination of dissection with three-dimensional (3D) digital teaching technologies. From this experiment, the researchers found that assessments of the material utilizing the 3D augmented tools were better. There was a significant increase in correct answers for questions covering topics taught using the augmented modality. Critically, however, this perception of enhancement to their medical education was not recognized by those students who ranked the traditional learning tools as superior to the augmented one. Nonetheless, Peterson and Mlynarczyk's (2016) research still showed that 3D augmented tools helped knowledge retention, which meant it increased their medical abilities. Given the promising benefits, but mixed student preferences, this study pointed out digital technology was supplementary to traditional learning rather than a replacement. Some limitations to this study included the variability in choosing students, which ranged from undergraduate to doctoral student, as well as a lack of information about students' spatial abilities, which impeded a full assessment of the benefits of 3D modalities.

Johnson et al. (2012) argued that the progressive increase in expectations regarding the level of students' medical knowledge, together with decreased teaching hours, challenged medical educators to revise and modernize the anatomy curriculum. Researchers have tried to modify anatomical teaching in undergraduate medical education by promoting active learning, introducing clinical correlation, radiologic anatomy lectures, problem-based and team-based learning and providing time to work through clinical problems (Johnson et al., 2012). According to Johnson et al. (2012), today's technological teaching tools are very beneficial, but instructors still have a role to play in all laboratories. Traditional methods, such as lectures, were not omitted, but were taught by clinical faculty members and used as a base for all new teaching methods that were implemented to give a multi-dimensional approach to anatomy classes. Students' scores and performance progressively improved with the development of new skills, such as team collaboration, professionalism and leadership (Johnson et al., 2012). This study discussed the efficiency of implementing modern techniques into lectures and dissection in a multimodal curriculum.

An innovative active way to approach anatomical education was presented by Hoffman, Murray, Curlee, and Fritchle (2001), which implemented virtual reality-based anatomy resources. This program, created at the university of California, San Diego was called anatomic VisualizeR, and provided virtual dissection through 3D models, that allowed students to interact directly with anatomical structures. It was a learner-centered program that encouraged creativity and discovery through active learning. The 3D models were constructed by various sources and modified to enhance the user's experience (Hoffman et al., 2001). Introducing such alternative techniques in the dissecting room would result in decreased number of cadavers, alleviate negative emotional reactions by students, and reduce the off-putting smell.

Terrell (2006) illustrated that anatomy instruction had evolved from lecturing to student-centered learning as Universities' missions tended to make students less dependent on their instructors, thus enhance students' information processing. Terrell's (2006) study identified four major learning theories that education at the time revolved around: behavioural theories, information-processing theories, meta-cognitive theory, and social-constructivist theory. The behavioural and information-processing theories were aimed at learner's acquiring facts, skills and concepts with the help of the instructor. The former theory's learning strategies were superficial, consisting of memorization and practice, whereas in the latter theory depended more on the learner's prior knowledge activation combined with content-organizing strategies. The goal of the meta-cognitive theory was to enhance students' content and cognitive knowledge. Its learning strategies included planning, reflecting, self-testing and goal setting. The social-constructivist theory aimed to engage students' in deeper learning, as learners built new knowledge in a social context facilitated by the instructor (Terrell, 2006). This study signified a marked shift in medical education strategies, many of such changes I witnesses first-hand throughout the span of my teaching experience.

Following these earlier pedagogical shifts, Thomas, Kern, Hughes and Chen (2015) more recently presented six steps which can be used to improve curriculum development in medical education. Step 1 identified the need for curricular update due to the development of knowledge in medical and technological fields. In Step 2, the developers adapted curriculum to be more learner-centered and in Step 3, they set out new curricular objectives. Step 4 indicated that after the determination of the curriculum content, multiple educational methods (e.g., lectures, discussion, team-based learning etc.,) must come into place, depending on the specific objectives desired. With today's technology, education has changed and so has the curriculum in medical education, leaning towards

learner-centeredness and creativity. In Step 5, developers (Thomas et al., 2015) tried to implement these strategies within medical education. Finally, in Step 6, they evaluated the balance between the needs of the learners and the methodological rigor. Thomas and colleagues' (2015) book sheds light on educational strategies and their influence on curriculum development. It would be crucial to know if implementing technology results in accomplishing educational objectives.

Recently, Bridges, Green, Botelho and Tsang (2015) introduced new educational methodologies to problem-based learning (PBL). PBL is about engaging small groups of students in exploring clinical cases, whether theoretical or real, to solve inquiries in a process of active, collaborative learning. These new techniques, such as utilizing interactive white boards, as well as online and digital resources, reinforced students' individual and collective knowledge. Not only could students share documents and tools, and had the ability to manipulate digital objects, but these new techniques also supported learning through inquiry within a realistic problem cycle (Bridges et al., 2015). This study had a significative impact on the medical education field's understanding of PBL, as it discussed the role of new techniques and technologies to increase cognitive systematized knowledge and took evidence-based approach to the medical curriculum through interactive discussions.

Nilsen (2015) claimed that the human body was the most complex structure ever studied. At the time of Nilsen's study, while multiple teaching techniques were used (including text books, lectures and human dissections), most of these techniques had proven to be ineffective as they failed to engage students. Thus, Nilsen's (2015) dissertation illustrated how games engaged students and how they complemented the traditional anatomy teaching techniques. Games offered students the ability to practice any time and as many times as they wanted. The premise of this dissertation suggests an educational framework where configurable games and learning activities can be used to complement students' other means to learn anatomy. Nilsen (2015) developed a system aimed to cover most anatomy curriculum, which made it a reliable anatomy encyclopedia that teachers could rely on.

It is clear from the present literature review that finding methods to engage students in anatomy is challenging and that many researchers have sought to examine the most effective ways to engage students. Many of these methods include student collaboration and the use of technology, which of course require new teaching approaches for instructors.

Study Framework

In the following sections, I employ different study techniques in order to identify the current and most preferred methods for anatomy teaching and learning. Drawing from the literature review and my teaching experience, several questions initially emerged, including: Is it more effective for anatomy learning to be spread throughout the years of medical education, or to condense it in the first few semesters? Can student preferences around frequency and type assessments (formative or summative) impact the achievement of learning outcomes? What is the relative cost of implementing more technology-based educational aids, such as a sufficient number of computers to replace cadavers? Should we consider shifting to computer-based learning due to a modernist question of ethics regarding dissecting cadavers? How might computer-based programs (e.g., online games and courses) help students to master anatomical structures or help students with different levels of spatial abilities? How best can teaching entities (e.g., universities) conduct continuous reviews and sufficiently update their anatomy curriculum?

Given the scope of the present study, not all questions could be answered and, thus, four main themes of questions were identified in order to focus the study and guide the analysis. These themes include: (1) introductory fundamental learning, (2) technology-based education, (3) teaching technique, and (4) curriculum update suggestions.

From an exploratory perspective, I identified the following questions to be addressed through this primarily qualitative study. For the introductory fundamental learning theme, I focused on: What is considered the best method(s) of studying anatomy? Which method(s) help students to understand anatomy concepts the most: 2D, 3D, dissecting real cadavers, or prosected cadavers? In terms of technology integration, it was important to identify from participants: Could computer programs replace anatomy lab instruction or enhance the learning experience enough to become the primary method of teaching? Regarding the teaching technique theme, questions were framed around student and teacher preferences, including: Is there a preference between teaching techniques, such as lectures or PBL or peer teaching; cadavers or models? Finally, in terms of pedagogical updates to match the continuous development of medical and technological knowledge, one main question was considered: What techniques are necessary to improve student engagement and the overall learning experience?

Methodology

Study Design

After exploring the different aspects of anatomy learning and the key challenges facing modern anatomy teaching, a mixed methods approach, was used to address the research questions. A rating-scale survey was conducted online to examine participant experiences and preferences regarding different anatomy teaching and learning methods. Along with the survey, brief (10-20 minute) interviews were conducted with current and recently graduated medical students. The findings from the interviews (a qualitative instrument) provided deeper understanding of the survey's (a quantitative instrument) findings (O'Leary, 2017).

Participants

Four individuals with different backgrounds and experiences in anatomy learning were chosen to participate in the current study, and each took part in both the survey and interviews. The sample included participants that are currently studying anatomy or have just finished their medical studies, as well as educators that teach anatomy using various tools. The purpose of selecting students and recent graduates as participants was to examine the challenges they have faced in their studies to grasp the knowledge and skills required for their career in the medical field. The purpose of asking teaching staff was to gain an understanding of the other party involved in anatomy education. The participants involved were all from the Faculty of Medicine at the University of Ottawa and included: a graduate-student who is currently learning anatomy in his first year at the Faculty of Medicine and who had taken undergraduate anatomy courses; a resident who had finished her anatomy courses; and two medical educators. Although the teaching staff had both studied anatomy using traditional techniques (e.g., lectures, atlases and cadaveric dissection), they currently work with more modern techniques, such as 3D technology, virtual reality simulations and other technological advancements.

Procedure

Online Survey. Twenty-nine survey questions were constructed and classified into the four sections aligning with the themes discussed earlier. The first section focused on participants' preferred means to learn anatomy (e.g., whether 2D, 3D, dissecting real cadavers or prosected ones), as well as their preferred study method(s) to understand anatomy concepts most effectively. The second section assessed technology integration and

whether computer programs could replace anatomy lab instruction. The third section of the survey focused on attitudes towards new teaching techniques, such as PBL, games, online courses and models, and participants' preferences in comparison to lectures and cadavers. The last section of the questionnaire focused on participants' suggestions to update the curriculum to match continuous developments in medical and technological knowledge. Participants were asked to choose the techniques necessary to improve student engagement and learning experience.

Quantitative survey items were rated on a 5-point Likert scale (1 = "*Strongly Disagree*" and 5 = "*Strongly Agree*") and were obtained from relevant literature, such as "I found the smell of the cadaver impaired my learning of anatomy." (Peterson & Mlynarczyk, 2016; Patel & Moxham, 2006). Other items, developed by me, were phrased in the form of short-answer questions, such as "Do you benefit when you teach? Does it help you understand and recall back the information better?", and "Yes" or "No" questions, such as "Do you enjoy working with computers?".

Phone Interviews. Following the online survey, I conducted ten- to twenty-minute phone interviews with each participant who completed the online survey in order to further explore their preferred anatomy learning methods. The interviews also delved further into the aspect of traditional teaching techniques versus technological alternatives. The interviews included such questions as: "Should we always look to modernize anatomy teaching techniques or are there fundamental methods, such as dissection, that are crucial to its understanding?" and "Would there be a day where professors' expertise is replaced by virtual reality program?".

Data Analysis

The data was analyzed primarily by looking for recurring themes in the interviews, based on the four thematic areas identified earlier: introductory fundamental learning, technology-based education, teaching techniques, and curricular update suggestions. The analytic process also included looking for similarities and differences in the responses between the interview and survey data and triangulating this information with previous research findings and my own teaching experience.

Results and Discussion

The interviews and online surveys conducted in the current research were enlightening as the findings provided new insights around anatomy teaching and learning from both medical students and educators. Through analyzing the data and making

connections with previous research findings and my own teaching experience, answers to the present study's research questions were found.

Introductory Fundamental Learning Theme

Regarding the introductory fundamental learning theme, three out of four participants felt that they had benefited from their anatomy courses and still retain some of the material they were taught. The graduate student mentioned remembering vague details from introductory anatomy courses which helped him in understanding material later on in medical school. These findings connect with those of Bhangu and colleagues (2010) who raised awareness on students' lack of knowledge in anatomy due to suggested decreases in anatomy teaching hours. Indeed, there was increased student enrollment in anatomy courses with the objective of increasing their confidence in surgeries, indicating the potential importance of prolonged anatomy learning to enhance future medical study and practice.

All participants in the present study agreed that their preferred method of studying and understanding anatomy was through dissecting cadavers. There are many well-documented benefits for using cadaveric dissection as a teaching and learning tool compared to other techniques. For instance, cadaveric dissection provides 3D views of the internal interrelationships of the human body (Carlyle, 2005). From my point of view, providing students with more opportunities for this kinesthetic type of learning provides crucial skills and tools that are directly applicable to future clinical practice. In addition, the psychomotor learning that occurs in physical dissection also helps in cognitive processing and development. Similarly, Peterson and Mlynarczyk (2016) highlighted the importance of accurate visualization and understanding the orientation of structures within the body to develop the spatial aptitude. The ignorance of anatomy has led to increased surgical liabilities and malpractice (Johnson et al., 2012). Thus, focusing on anatomy as a fundamental core of medical practice is essential. In the absence of cadavers, 3D models were favoured. This finding is in line with Peterson and Mlynarczyk's (2016) recent study which found that 3D augmented models significantly improved students' success on assessments, yet students tended not to recognize the enhancement to learning provided by the 3D models, as they also ranked the traditional learning tools superior to the augmented one.

Technology-based Education Theme

When addressing the technology-based education theme, all participants considered computer-based activities an effective medium to learn anatomy and complete assessments

such as quizzes. While this unanimous response is promising for technological educational enhancement, it may also be related to the fact that all participants also expressed their enjoyment of using computers and computer-based activities to assist in their learning. Although both educators and the graduate student agreed that online games would help in mastering anatomical structures of the human body, the resident could not comment as she had never used them. Even though two out of the four participants were not taught using online games and technology, they have now been exposed to this technology through their working experience and reported the value it brings to their teaching practice. These findings support Nilsen's (2015) conclusion that games have the capacity to uniquely engage students and to complement the traditional anatomy teaching techniques. For example, games offer students the ability to practice any time and as many times as they wanted (Nilsen, 2015).

In terms of preferences regarding cadavers versus technological alternatives, all participants agreed that cadavers were an effective medium for learning anatomy. They argued that it enabled them to touch the structures and to work in groups. Moreover, the notion that the cadaver is a difficult tool to learn from compared to computer-based options was rejected. Only the resident indicated that the smell of the cadaver impaired her learning ability. These responses are generally in line with the survey performed by Carlyle (2005), which explored three different learning methods (computer learning, combined computer/cadaver learning, and cadaver learning) where student respondents preferred the cadaver, although there was no significant difference in the students' learning outcomes between the three techniques. However, in another study by Peterson and Mlynarczyk (2016), it was found that adding digital technology teaching tools significantly improved students' understanding compared to cadaveric dissection. Although students' performance in their laboratory exams also improved, the same study still emphasized that digital tools were supplementary to traditional learning and not a replacement. As such, while there is still room for future investigation into sensory issues associated with cadaveric dissection, the present study's findings indicate that the use of cadavers remains a relevant and effective learning method, which are only enhanced by the use of technological supports.

Teaching Techniques Theme

In terms of teaching techniques, rote memorization of lectures alone was rejected as an approach to study anatomy by all study participants. Rather, memorization through understanding concepts was endorsed by all participants to retain information longer. This finding supports Terrell's (2006) assertion that such behavioural learning strategies are

superficial and should instead consist of a memorization process in which the learner acquires facts, skills and concepts with the help of the instructor. Further, to improve student engagement and overall learning experience, the graduate student suggested that teachers should spend more time on explanations using cadavers accompanied with 3D models to enhance understanding.

When lectures are compared with PBL teaching techniques, PBL was preferred by all participants as they felt that students are challenged to find the information for themselves. It is relevant to note that one of the educators emphasized the importance of combining both techniques, to create diverse learning experiences for the students. Although PBL has many benefits, such as, reinforcing students' individual knowledge by combining it with their group's knowledge, supporting inquiry learning within a problem cycle, and improving sharing documents and tools along with manipulating digital objects (Bridges et al., 2015), it does not cover all anatomy topics. As noted by one of the educator participants, lectures can still be turned to as an effective teaching technique to fill in this critical gap.

Through both interviews and surveys, participants expressed that teaching a concept to others (also known as peer teaching) greatly helped them retain new knowledge. Through my teaching experience, I always found peer teaching to be a very helpful pedagogic technique for better knowledge acquisition, comprehension and easier recall of information. At the beginning of my classes, I consistently encourage students to teach each other and share their knowledge. Through this practice, they benefit from their various experiences and I provide support by reinforcing the knowledge gained and clarifying the difficult concepts. In Thomas and colleagues' (2015) book *Curriculum Development for Medical Education: A Six-Step approach,* they illustrate that there are many advantages for peer teaching, which include the development of teaching skills in students as well as a safe environment for the new learners. In the same book, it was highlighted that there is also a need for creativity in medical education curriculum and in teaching methods. Despite the advantages of peer teaching, I find that a fixed teaching technique does not allow students to develop the best cognitive skills when analyzing all the different scenarios possible. Thanks to recent technological advancements, altered principles of education and the development of a new clinically-oriented medical curriculum, multiple pedagogical methods using a learner-centered approach are desired, which may include lectures, discussions, and team-based activities. I personally lead team-based activities, as well as lectures, and find that students benefit differently from each exercise. This emphasizes the need for a variety of teaching techniques.

Curricular Update Suggestion Theme

A major curricular update that both educators suggested was that anatomy should be taught throughout medical education, rather than the current method which condenses the study of the whole body into three or four semesters. Another suggestion proposed by the resident and graduate student was to implement review courses on regular basis. These findings reflect those of the three-year cohort study conducted by Bhangu et al. (2010), where they found that the vast majority of students felt a lack of knowledge in anatomy.

In terms of preferences regarding different kinds of learning assessment, a combination of summative type assessments and frequent quizzes were favored by all but one of the participants, as they tend to motivate students to study continuously and always be well prepared. While one participant mentioned that frequent quizzes can sometimes become stressful, all participants still recommended that students should be quizzed more frequently than at the current rate. Thus, implementing continuous review and assessment practices for explicitly formative purposes may be most appropriate. Further, all participants recommended increasing assessment questions that link clinical cases to anatomical structure identification. These insights, combined with those of Bhangu and colleagues' (2010), indicate that curricular updates may be most effective if they extend the anatomy curriculum across the medical degree program and integrate a focus on the practical application of anatomical knowledge to clinical problem solving.

Finally, the resident recommended increasing the use of PBL, computer programs and group quizzes to encourage a better grasp of the concepts. Similarly, one of the educators advised that using different software programs could enhance the visual and mental abilities of the students. Through these programs, the students can imagine the position of different structures and see their relations within the body. Thus, they would have a better understanding of the human body overall. The other educator emphasized that students should be aware of the importance of studying anatomy as a basic science as it would add to their clinical skills in the long run. These insights point to the importance of building medical curricula with specific teaching techniques and technological tools in mind, rather than leaving it up to individual educators to determine whether or when to employ certain tools that have been shown to be effective for anatomy learning.

Limitations

It is important to mention the potential limits to this study. Due to time constraints (as this study was part of a coursework project), it was only possible to select four participants for the survey and interview. First, this small sample size is a limitation because I could not make statistical inferences. Second, there was a limitation present in the methodology due to time constrains, which is that participants were hand-picked for the survey and phone interviews. Thus, the few participants did not allow for a fully representative sample. Despite the limitations of this sampling method, however, the study participants ranged from undergraduate and graduate students to academic teachers.

Conclusion

This paper's purpose was to investigate the current problems in anatomy teaching and to explore available approaches to improve anatomy learning by critically comparing traditional and new pedagogical strategies. Anatomy education needs new methods to adapt to the continuous progression of medical knowledge and technological advancements. Multiple research papers were used to preface this study as each identified a problem related to anatomy teaching, as well as suggested solutions mostly supported by empirical evidence. In light of the available literature, I conducted a study using both qualitative (interview) and quantitative (survey) methods.

Through this study, it was identified that the preferred means of learning anatomy (suggested by both students and educators), was through cadaveric dissections, despite all of the emergent computer-based games and 3D models available. These findings are in accordance with my previous teaching experience, where cadavers were the medium of preference for me as well as my students. Technology-based alternatives were effective tools to help enhance the learning experience but could not replace the core benefits of cadaveric dissection. A secondary finding was that problem-based learning (PBL) was greatly appreciated by students as it challenged them to find the answer for themselves and helped them retain knowledge more effectively. The PBL group setup also provided additional skills, such as teamwork, problem solving, self-directed learning and communication skills. However, PBL still does not cover all anatomy topics, which is where lectures are still considered an important information-based tool to fill in this gap.

Overall, a diversity of teaching techniques and technological methods are necessary to provide better anatomy learning experiences and outcomes for students. While this study

emphasizes how crucial the old techniques are to maintain, it also demonstrated how essential it is to use them in combination with new techniques for the ideal anatomical learning experience. Learning entities (e.g., medical education institutions) should therefore continue investigating the integration of the suggested methodologies in this paper, as well as new ones that will further contribute to making education an enjoyable, interactive and effective experience.

With a view to identifying more progressive ways of thinking and teaching that better represent the type of educator I aspire to be, the present study focused on the search for more effective teaching techniques and new motivational ideas. Critically, the overall findings revealed that we do need to find new advanced study methods (e.g., 3D programs, games and virtual reality to stimulate the intellect of students), yet we must use their capabilities thoughtfully and in *addition to* our tried-and-true traditional methods (e.g., cadaveric dissection and lectures). In this way, the present study also highlighted that we should try to focus on quality in our teaching rather than quantity, in order to enrich students' knowledge and promote a high-level of competency. This progressive way of thinking might reinvigorate students and engage them in active learning, which would help them succeed in their education and future clinical practice.

References

Bhangu, A., Boutefnouchet, T., Yong, X., Abrahams, P., & Joplin, R. (2010). A three-year prospective longitudinal cohort study of medical students' attitudes toward anatomy teaching and their career aspirations. *Anatomical Sciences Education*, *3*(4), 184-190.

Bridges, S., Green, J., Botelho, M., & Tsang, P. C. S. (2015). Blended learning and PBL: An interactional ethnographic approach to understanding knowledge construction in situ. *In* A. Walker, H. Leary, C. Hmelo-Silver, & P. Ertmer, (Eds.), *Essential readings in problem-based learning: Exploring and extending the legacy of Howard S. Barrows*, (pp. 107-130). West Lafayette, IN: Purdue University Press.

Carlyle, K. J. (2005). *A comparison of cadaver, computer and cadaver/computer laboratory classes in teaching anatomy to undergraduate university students.* (Master dissertation). Retrieved from Library and Archives Canada (ISBN: 0-494-03746-6)

Hoffman, H., Murray, M., Curlee, R., & Fritchle, A. (2001). Anatomic visualizeR: Teaching and learning anatomy with virtual reality. *In* M. Akay and A. Marsh (Eds.), *Information technologies in Medicine: Medical simulation and education*, Volume I (pp. 205-218) New York, NY: John Wiley and Sons, Inc.

Johnson, E. O., Charchanti, A. V., & Troupis, T. G. (2012). Modernization of an anatomy class: From conceptualization to implementation. A case for integrated multimodal–multidisciplinary teaching. *Anatomical Sciences Education*, *5*(6), 354-366.

Kaufman, D. M., & Mann, K. V. (2010). Teaching and learning in medical education: How theory can inform practice. In T. Swanwick (Ed.), *Understanding Medical Education: Evidence, Theory and Practice (pp. 16-36).* Dundee: Association for the Study of Medical Education.

Nilsen, T. T. (2015). Ontology-driven education: Teaching anatomy with intelligent 3D games on the Web (Doctoral dissertation), Retrieved from https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/33983/Nilsen_washington_0250E_14638.pdf?sequence=1&isAllowed=y

O'leary, Z. (2017). *The essential guide to doing your research project* (3rd ed.). London, UK: Sage Publications Ltd.

Patel, K. M., & Moxham, B. J. (2006). Attitudes of professional anatomists to curricular change. *Clinical Anatomy*, *19*(2), 132-141.

Peterson, D. C., & Mlynarczyk, G. S. (2016). Analysis of traditional versus three-dimensional augmented curriculum on anatomical learning outcome measures. *Anatomical Sciences Education*, *9*(6), 529-536.

Terrell, M. (2006). Anatomy of learning: Instructional design principles for the anatomical sciences. *The Anatomical Record*, *289*(6), 252-260.

Thomas, P. A., Kern, D. E., Hughes, M. T., & Chen, B. Y. (2015). *Curriculum development for medical education: A six-step approach.* Baltimore: The Johns Hopkins University Press.

Turney, B. (2007). Anatomy in a modern medical curriculum. *Annals of The Royal College of Surgeons of England, 89*(2), 104-107.