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Abstract

Hybrid occupational therapy (OT) students transitioning from certified OT assistants (COTAs) to OTs can successfully learn graduate-level anatomy in a compressed format with limited synchronous instruction time. The effectiveness of a human anatomy course with limited synchronous instruction time for transitional hybrid occupational therapy students was investigated. A retrospective, non-randomized study was used. A university graduate level human anatomy course for transitional OT students used prosected (previously dissected) cadavers. Students (n=46, 32 instruction hours over 16 weeks) final anatomy course grades for three cohorts were measured retrospectively. There was a 98% first-time pass rate and 100% second time pass rate. Less than 5% of the students needed to either repeat the course (one student) or withdrew from the course prior to course completion (one student). Results suggest that a hybrid learning model with limited synchronous instruction time is effective for transitional OT students learning human anatomy. Programs should consider how instruction time and distribution impacts anatomy learners, and when there is limited time in the classroom, investigate alternative pedagogies for those few students who would benefit from a more immersive-learning environment. Anatomy knowledge is essential in progressing through occupational therapy curriculums and is needed for client management. Understanding what factors impact learning anatomy could assist in creating more effective anatomy courses for occupational therapy students.

Keywords

Anatomy, synchronous learning, hybrid education

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ABSTRACT

Hybrid occupational therapy (OT) students transitioning from certified OT assistants (COTAs) to OTs can successfully learn graduate-level anatomy in a compressed format with limited synchronous instruction time. The effectiveness of a human anatomy course with limited synchronous instruction time for transitional hybrid occupational therapy students was investigated. A retrospective, non-randomized study was used. A university graduate level human anatomy course for transitional OT students used prosected (previously dissected) cadavers. Students (*n*=46, 32 instruction hours over 16 weeks) final anatomy course grades for three cohorts were measured retrospectively. There was a 98% first-time pass rate and 100% second time pass rate. Less than 5% of the students needed to either repeat the course (one student) or withdrew from the course prior to course completion (one student). Results suggest that a hybrid learning model with limited synchronous instruction time is effective for transitional OT students learning human anatomy. Programs should consider how instruction time and distribution impacts anatomy learners, and when there is limited time in the classroom, investigate alternative pedagogies for those few students who would benefit from a more immersive-learning environment. Anatomy knowledge is essential in progressing through occupational therapy curriculums and is needed for client management. Understanding what factors impact learning anatomy could assist in creating more effective anatomy courses for occupational therapy students.

Changes in teaching pedagogy along with time (Drake et al., 2009) and cost constraints (Gabard et al., 2012) have resulted in compressed human anatomy curricula with limited face-to-face (F2F) instruction for allied health and medical programs (Gabard et al., 2012). Compressed courses are designed with fewer hours of F2F student-instructor interactions compared to traditional courses, with or without a change in length of the course. Human dissection has been commonly used to teach anatomy, but dissection is time intensive and costly. The benefits of dissection compared to using prosected (previously dissected) cadavers for learning anatomy has shown contrasting results (Ashdown et al., 2013; Estai & Bunt, 2016; Whelan et al., 2018) and medical students have reported learning anatomy through prosection was sufficient for a basic understanding of anatomy (Wisco et al., 2015). Furthermore, a recent meta-analysis failed to find cadaveric dissection to be a superior laboratory pedagogy over prosections for the instruction of anatomy content (Wilson et al., 2018). The apparent equal efficacy of the two methodologies in short-term anatomy performance has prompted many programs to discontinue cadaveric dissection in favor of prosections, with substantial savings in both money and the amount of time students and faculty are required to be in the classroom.

Hybrid programs include a combination of online and F2F learning experiences. While providing much greater flexibility for the learner, they also have significantly compressed F2F time compared to more traditional curricula. The addition of technology is particularly important in the current reality of hybrid programs. Literature supports the idea of including some technology resources as an alternative or supplementary method of learning because of reduced curriculum time (Bakr et al., 2016; Mitrousias et al., 2018; Topping, 2013).

The recent advances in modern technology have offered alternatives for studying anatomy through a variety of methods. Resources such as three-dimensional (3D) software (Estai & Bunt, 2016; Mitrousias et al., 2018; Peterson & Mlynarczyk, 2016), online 2D learning (Bakr et al., 2016) and computer aided instruction and videos with traditional learning (Topping, 2013) may increase student performance when compared with traditional learning methods alone. However, not all technology has been found to enhance the learning experience. Other technology resources such as computerized non-cadaver courses in physical therapy programs (Bukowski, 2002) and AnatomyTV online software (Mathiowitz et al., 2015) have shown either no effect (Bukowski, 2002) or a decline in overall student academic performance when compared with cadaver prosection in a gross anatomy lab (Mathiowitz et al., 2015). This conflicting evidence suggests the need for further research to determine if the type of technology or other factors are responsible for the results.

One possible such factor may be the amount of compression of hours of F2F interactions given. Researchers have suggested a compressed curriculum of limited hours in the cadaver dissection laboratory does not affect students' subjective opinions or anatomy examination performances (Halliday et al., 2014; Ogard, 2014). However, it is unknown if the total amount of compressed F2F instruction influences anatomy course academic performance, regardless if students are using prosected cadavers or using prosected cadavers in conjunction with technology. Wilson et al. (2018) argued that the most effective learning environment likely requires "meaningful and purposeful interactions between the students, the approach(es) chosen, and the educator(s)" (pp. 129-130). Less time spent working with an instructor in a human anatomy course for allied health students therefore may have a detrimental effect on academic performance.

The question then arises if the amount of time spent with an instructor in a human anatomy course with a compressed curriculum schedule influences students' learning of anatomy while taking the course. The varying results in research and personal perspectives provide inconclusive answers to this question. Further research is warranted to determine how varying course interaction time and compressed curriculum impacts anatomy performance. Therefore, the authors investigated if a compressed course with limited synchronous instruction time is effective for hybrid occupational therapy (OT) students' learning of human anatomy. It was hypothesized that successful course completion would not be negatively impacted with a significant reduction of F2F instruction time. Understanding the influence of compressed F2F instruction time is beneficial for OT students' current and future success and will influence the curriculum design of anatomy courses for upcoming OT students.

Material and Methods

Research Design

This was an observational study that examined the effects of a compressed hours, six-credit human anatomy course on final anatomy course grades. The study was nonrandomized and consisted of three cohorts of students seeking a Master's of Occupational Therapy (MOT) degree over a three-year period. Data was collected and analyzed retrospectively. The Occupational Therapy Department's program chair gave written consent to use data for this study and the authors' university Institutional Review Board approved the study, reference number 18-32.

The student group received a hybrid learning format consisting of a combination of asynchronous online studying with once a month F2F sessions. The group did not participate in any human dissection but worked with prosected (previously dissected) cadavers only. Course F2F learning activities were all led by the instructor but required students to actively participate. The studied 16-week anatomy course was taken simultaneously with two back-to-back 8-week three-credit courses in an accelerated format (a total of 12 semester credits). Students (n = 46) had eight hours of F2F time once a month for four months, totaling 32 hours. This group met one time a month for two weekend days with four hours dedicated to laboratory time and four hours dedicated to discussion/active learning activities each month. While students were encouraged to seek out synchronous individual time with the professor or a tutor using digital means (e.g., course learning management system, Facetime, Skype), or F2F when possible, no additional synchronous time was required of students beyond the 32 weekend hours.

Inclusion criteria were that students were certified occupational therapist assistants (COTAs) accepted and enrolled in the transitional MOT bridge program and completed the degree required six-credit human anatomy course with a cadaveric laboratory. As a MOT program admission pre-requisite, students were required to complete eight credits of anatomy and physiology with a grade of B or better from a university Biology, Anatomy, or Physiology department or an equivalent course as determined by syllabus review. These students were more likely to have their pre-requisite coursework at a technical or community college. In addition, the students completed an anatomy course one semester prior to enrolling in the six-credit graduate anatomy course used for this study. The university admissions committee required completion of this course because most of these students had not completed a recent anatomy course (i.e., within two to three years prior to graduate school). The exact year from completion of the last anatomy course for each student was unavailable to the authors. Exclusion criteria included students who had previously taken the studied anatomy course prior to the start of this study.

Descriptive statistics were run for each cohort separately in addition to all three cohorts combined (see Table 1). Because one student failed the studied anatomy course in Year 1 and repeated the course in Year 2, Year 2 descriptive statistics were run both with and without the repeating student. Demographics examined included the number of students in each cohort and the average number of students per year, average age and age range of students, final anatomy course grade in percent, and the number of students passing and not passing the class. Students reported working in addition to going to school, however, the hours worked for each student was not collected. The number of students and the age of the students is reported as mean (standard deviation [SD]) in the table.

Table 1

Subject Demographics

Number of Students	**Mean Number of Students (standard deviation)**	**Mean Age of Students (standard deviation)**	**Student Age Range**	**Final Anatomy Grade (standard deviation)**	**Number of Students Passing**	**Number of Students Failing**	**Number of Students Repeating Course**
Year 1	18	33 (7) years	22-42 years	82 (6) %	17	1	0
Year 2	17*	33 (8) years	25-49 years	83 (5) %	17	0	1
Year 2	16**	32 (8)	25-49	84 (5) %	16	0	0
Year 3	12	29 (5) years	25-43 years	81 (5) %	12	0	0
Average	16 (3)***	32 (2) years	NA	82 (5) %	15 (3)	NA	NA

*Includes one student repeating the course
**Excludes the score of the student who repeated course
***Average row includes years 1-3. This Average row does not include year 2 (16 students) which is the year that excludes the student who repeated the course

To minimize the influence of variation in instruction and assessment, students were taught by the same instructor and same laboratory assistant each year, used the same curriculum, same textbooks, and used the same 3D human anatomy software for assignments (BioDigital, 2020). Having the same instructor limits variations in teaching and testing styles which may influence performance outcomes (Michel et al., 2009). Additionally, course material, quizzes and exams were given at the same intervals throughout each course and study material for the tests consisted of the same structures. Furthermore, while the specific structures on the tests varied year-to-year (i.e., different muscles, blood vessels, connective tissues, or nerves selected), all tests used the same format and the same question style. Students completed testing online and during F2F interactions, with the same amount of time allocated for each test. The instructor had worked as a licensed physical therapist for about two decades and the laboratory assistant had worked as a licensed occupational therapist for over forty years prior to the study period. Additionally, both the instructor and the laboratory assistant received mentorship by clinician anatomists who taught the courses for at least 10 years previously.

Data Collection and Analysis

The following objective measures were gathered retrospectively from university records over three years: final course grade in percent and student age (see Table 1). A passing course grade was considered a 73% or higher.

Data was analyzed using Statistical Package for the Social Sciences (SPSS, version 26.0, IBM, Chicago, IL). Data was screened for outliers (> 3 SD from the mean) and for normality of the data using the Shapiro-Wilk test. Shapiro-Wilk indicated the assumption of normality was met for course grade ($p > 0.05$) but was violated for age in the second- and third-year cohorts ($p < 0.05$). Therefore, differences in final anatomy course grades were assessed using ANOVA, whereas differences in age between cohorts was assessed using an independent samples Kruskal-Wallis test. To account for potential skewing of the class average in year 2, averages were calculated, and the ANOVA was run both with and without the course grade of the student repeating the class.

Results

One student was excluded due to having taken the studied course in the year prior to this study with a different instructor. Additionally, one student started the course and withdrew from the OT program after the first week of classes. The student that withdrew is not included in the 46-student total and was excluded from data analysis.

No outliers were identified for either age or course grade. Forty-five of 46 students (97.83%) passed the anatomy course the first-time with an average course grade of 82.58%. One student in the year 1 cohort was unsuccessful in passing the course, but successfully repeated the anatomy course with a repeat course grade of 78.11%; a second time pass rate of 100%. Overall, fewer than 2% of the students needed to repeat the course and the average course grade for all 46 students after successful completion was 82.48%.

There were no statistically significant differences in age and final anatomy grades between the three cohorts ($p > 0.05$). There were also no statistically significant differences in age and final anatomy grades between the three cohorts ($p > 0.05$) for the first time pass students only.

Discussion

This study suggests a compressed human anatomy course with a significant reduction in F2F synchronous instruction time is an effective pedagogy for hybrid OT learners transitioning from COTA to MOT. Although the duration of the studied course was the traditional 16 weeks, the number of F2F instructional hours was compressed to just 32 hours over the course of the semester. The results suggest that the limited amount of F2F instruction time was adequate for the majority of these students. All cohorts received material at the same time and only met with the instructor one weekend a month. Yet this limited instruction time with synchronous F2F active learning and laboratory activities was sufficient to reinforce the online asynchronous assignments and allowed students enough time to process course information.

Previous studies have shown that the type of anatomy laboratory pedagogy used (dissection versus prosection) does not influence short-term anatomy performance (Wilson et al., 2018). To our knowledge, however, no prior study has investigated the number of F2F instruction hours used for anatomy instruction and how those hours affect learning for transitional OTAs.

The majority of students passing the first-time is not surprising as these students were able to use clinical experience as COTAs to aid in their anatomy performance (van Gog et al., 2005). Adult learning theory indicates people learn new knowledge and skills most effectively when using real-life application (van Gog et al., 2005). Furthermore, these students had completed an anatomy course immediately prior to enrollment in this study's anatomy course. Having recently acquired additional knowledge of anatomy may have assisted the students in being better prepared to complete the course. Therefore, one must use caution in interpreting these results as they may not be generalizable to other OT students who do not have the training and clinical experience of a COTA.

Another item to consider when examining the effects of compressed curricula and limited synchronous instruction time on human anatomy academic performance is the distribution of study time with the cadavers. Other investigators have suggested that distributed learning can be more effective in learning medical (Andersen et al., 2015; Mackay et al., 2002) and motor skills (Shea et al., 2000) than mass learning for some students. Despite the mass learning of the cadaver material over a weekend as was used in the investigated course versus weekly distributed learning and reviewing of cadaver material as occurs in many anatomy courses, 98% of these students were still successful in learning anatomy and passing the course on the first try. Thus, this study's results suggest mass practice with cadaveric material may still be effective for learning for many students. What is not known, however, is how much this mass practice may have adversely affected the one student who failed to achieve a passing grade the first time. It is quite possible that this student may have demonstrated better academic performance had the student participated in a more distributed learning environment.

All of this study's students were ultimately successful in passing the course. Thus, a compressed curriculum with a reduction in F2F instruction time to as little as 32 hours with mass learning of cadaveric material and a low frequency of F2F interactions was still adequate for learning of anatomy content. Future research needs to tease out the individual factors contributing to student success or failure, and to determine ways of predicting how variations in course delivery might impact individual students. This would allow for individualized advising and instruction of students based upon pedagogical principles.

To promote more effective learning experiences for those students who require a more immersive educational environment with more distributed learning, graduate programs should consider providing alternative or supplementary teaching methods when increasing instruction time and/or frequency is not possible for human anatomy courses. Additionally, students may want to use this information in deciding which OT program will be best suited for their needs. The challenge remains to find the most effective teaching methodologies when instruction time is limited and distributed learning is not possible, particularly with asynchronous e-learning environments.

Limitations

Several limitations to this study were unable to be controlled. First, the students were a convenience sample rather than a purposive sample (Etikan et al., 2015). This led to differences between cohorts in clinical experience and familiarity with and use of technology. Groups with higher mean age may possess more experience or maturity (Navarro et al., 2015). However, age and learning styles do not appear to have affected anatomy academic performances in these cohorts of students (Berrios Barillas, 2019).

Additionally, prior knowledge of anatomy may have influenced the study results (Peterson & Mlynarczyk, 2016). Students may have had varying levels of anatomy knowledge both within and between groups before beginning the anatomy course (Azer & Eizenberg, 2007). While all students were required to complete eight credits of anatomy and physiology with a B grade or better, the rigor of prior science courses may have differed depending on course instructor and college/university. Despite potential differences in initial knowledge, the majority of the students passed the course successfully on the first try, suggesting that the amount of compressed F2F instruction time and its distribution may not have had a significant impact on learning anatomy on most.

Another possible factor to consider in this study is the amount of time each group worked outside of class and attended to other family and school obligations which may have negatively affected academic performance. All cohorts were encouraged to work limited hours while in graduate school, however, many students may have continued to work part- or full-time due to financial need (Carnevale et al., 2015). For this study's specific students, hours worked was not collected and it is unknown if one student worked more than the other. However, students from a similar cohort reported a mean of 28.375 ± 7.655 hours worked per week (range 17-40 hours, n = 20). One might assume that the more a student works, the less time they have for studying which could affect their academic performance. On the other hand, some students have reported anecdotally that work or other family obligations required them to maintain a regular schedule with their studies and therefore did not negatively affect their grades. Importantly, despite these outside commitments, 98% of students were able to successfully pass the course on their first attempt.

Lastly, unsupervised time in the laboratory or time spent with the instructor or a tutor was not controlled. Students had the gross anatomy laboratory available to them seven days a week, 7am-10pm for self-study when classes were not in session in the laboratory. As students were distance learners, their ability to take advantage of this resource was significantly curtailed. Furthermore, the instructor provided 10 hours office weekly to students (virtually or in-person), answered discussion board posts within 48 hours and some students had tutors. This leaves a wide range of hours in which students may have taken advantage of these optional resources or additional time in the laboratory.

Implications for Occupational Therapy Education

Learning and understanding human anatomy is essential to OT for classroom and clinical success and there are many ways to learn anatomy. One trend in some OT programs is to use hybrid learning formats (a combination of F2F time and asynchronous online studying). The following questions should be considered when employing hybrid human anatomy formats:

- Will the format reduce time and cost constraints that are present with traditional human dissection teaching methods?
- What alternative or supplementary teaching methods can be used when increasing instruction time is not possible?
- Does the OT program have the available technology support to run the online portion of the course?
- How much time should be dedicated to F2F interactions and how should these hours be distributed?
- Is it possible to include synchronous time in the online environment (e.g., ZOOM) in order to supplement the traditional F2F time?

Hybrid human anatomy courses could be useful in many curriculums to provide anatomy knowledge. A hybrid anatomy course may help ameliorate time and cost constraints for the student as well as the OT program. Additionally, hybrid human anatomy review courses have the potential to be an exciting future teaching method for the provision of anatomy continuing education programming for clinicians who want to review and update their anatomy knowledge.

Conclusions

Thirty-two hours of compressed F2F instruction time concentrated one weekend a month over 16 weeks in a graduate human anatomy course may be effective for student learning of anatomy as demonstrated by a 98% first-time pass rate over 3 cohorts of distance learners. However, for those students who are not successful, it is not yet clear whether it is the limited amount of F2F instruction, the distribution of that learning, or a combination of the two that had the greatest effect on academic performance. Therefore, to promote higher-level mastery of anatomy content, there remains a need to continue to identify alternate means of disseminating material when more direct, distributed student-instructor interaction time is not feasible, particularly in asynchronous learning environments.

It is also important to continue to investigate if compressed curriculums affect student success not only in the classroom, but also beyond the classroom. The effects of reduced supervised instruction time on the long-term retention of anatomical knowledge, and on the ability of learners to apply this knowledge for clinical problem-solving is not yet known. Furthermore, as the impact of compressed instruction time on student learning is likely to be multifactorial, it is important to investigate which factors have the greatest influence on learning. Future research will provide a more in-depth assessment of exam scores and academic performance over time, both within the studied course and in future clinical coursework for which anatomy knowledge is a key feature (e.g., orthopedics). Additionally, analyses of long-term outcomes such as the retention of anatomy knowledge over the duration of the curriculum, and the relations of compressed F2F instruction time to clinical fieldwork performance and students' ability to pass licensing exams will be explored. Discovering the impact of compressed F2F instruction time is important for future OT curriculums. This study has provided the start of demonstrating that significant reductions in compressed F2F instruction time for human anatomy courses may not adversely affect human anatomy learning for most students transitioning from COTA to MOT.

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