Exploring the Experience of Entry-Level Occupational Therapy Doctoral Students on the use of Anatomage® Table to Learn Anatomy – A Survey

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Abstract

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Keywords

Anatomy, cadaver, surveys & questionnaires, educational technology

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ABSTRACT

Technology has transformed health science education delivery over the past decade. Students in all health science disciplines must learn and master anatomy to be successful in their education and career. Several virtual resources are available to learn anatomy. The University of Texas Medical Branch introduced Anatomage Table to its entry-level occupational therapy doctoral (OTD) students in 2021 to supplement anatomy learning. As students' usage of educational technology depends on perceived usefulness, user-friendliness, and positive user experience, this study explored the experiences and perceptions of the students regarding the use of Anatomage Tables to learn anatomy. Students in the class of OTD 2024 were asked to complete an anonymous survey. Thirty valid responses were received. Around 80% of the respondents perceived the Anatomage Table as a useful resource and reported a positive experience using the table. Nearly half of the respondents perceived the table as user-friendly. Respondents stated that the table helped them review learned materials, visualize anatomical structures, self-assess their anatomy knowledge, and avoid the hassle associated with cadaver lab requirements and restrictions. Results suggest that Anatomage Table may be a useful supplemental resource to teach anatomy for entry-level OTD students. However, students may need adequate training and orientation at the beginning of the semester to successfully utilize the resource.

Technology has become an integral part of our lives. The emergence of educational technology, mostly in the past two decades, has changed the way students engage with and learn the material (Moro et al., 2017). Anatomy education is imperative to the graduate healthcare curriculum, providing foundational knowledge to support subsequent coursework. Within the past several years, the approach to anatomy

education has been influenced by numerous factors including, but not limited to, large class sizes, limited resources (e.g., cadavers), hybrid learning, and advanced technological supports (Clunie et al., 2018). Students pursuing medical, nursing, and allied health degrees are expected to master anatomy to be successful in their educational program and licensure examination (Ahmady et al., 2019; Elkins, 2015; Griffiths et al., 1995). Given the importance of student mastery in anatomy, contemporary healthcare institutions have been integrating computer-based anatomy learning resources to teach anatomy. One such resource is Anatomage® Table.

The Anatomage Table is a technologically advanced and fully segmented human 3D anatomy visualization system for anatomy education (Anatomage Inc., Santa Clara, CA). It allows students to virtually dissect a digital life-sized human cadaver and interact with all human body systems. The Anatomage Table has been a positive economic alternative to traditional cadaveric dissections, as the use of cadaver labs has been on the decline due to time and costs associated with cadaveric embalming and operational costs (Alasmari, 2021; Baratz et al., 2019). Like other educational resources, the table has multiple advantages and disadvantages. The advantages of Anatomage Table include low maintenance or recurring cost, no embalming products, high anatomical accuracy, and availability of multiple views of body structures (Martin et al., 2018). The disadvantages include high purchase cost, limited student experience due to the lack of opportunity to experience the human body structure with all senses, and limited access due to its size and space requirements.

Experiential learning theory (ELT), or "learning by doing" enhances positive educational outcomes for students (Smart & Csapo, 2007; McCarthy, 2010). The theory embraces a holistic adaptive method of learning that combines experience, perception, cognition, and behavior (Kolb, 1984; Kolb & Kolb, 2005, 2017). Academics generally believe that offering students an active role in the learning process offers optimization in acquiring, applying, and retaining new skills (Gleason et al., 2011). As Anatomage Table provides the ability to virtually view, dissect, and examine human body structures, it shall be construed that it offers experiential learning opportunities. These opportunities may enhance the understanding of anatomy and bodily structures. Occupational therapy (OT) students may benefit if OT educators provide these opportunities connecting theory to practice.

Learning, according to the ELT, is a system where the learner generates knowledge through the conversion of experience. As a result, knowledge develops as a mixture of understanding and transforming experience (Kolb, 1984). Experiential learning is a cyclical process through which learners transform their experience into meaningful knowledge (Roberts, 2006). Anatomy is a course that students traditionally struggle through during the first semester of an entry-level OT program (Donovan, 1994; Romo-Barrientos et al., 2019). Using the experiential learning model to teach anatomy may allow educators to guide the students through the cyclical process of learning experiences.

The university in which this study was conducted introduced Anatomage Table to its students learning Anatomy in Fall 2021, including those pursuing their entry-level occupational therapy doctoral (OTD) degree. The anatomy instructor who taught the anatomy course for the entry-level OTD students incorporated the use of Anatomage Table during didactic classes throughout the semester (14 weeks). Students were divided into groups of 7 or 8 with each group assigned to one table. Students were exposed to the table during 21 didactic lecture classes (30 minutes each class) and two review classes (1-2 hours per class). The first didactic class was used for the orientation to the Anatomage Table in which the instructor demonstrated how to operate the table and allowed students to explore its user-interface. On average, each student spent 12 hours with the Anatomage Table in addition to didactic lectures, two cadaver lab visits, and lab classes during the semester. In addition, students were allowed to use optional virtual applications (Visible Body, Anatomy Atlas App, etc.) to supplement their learning. Prior to each visit to the Anatomage Table, the instructor covered the structures to be reviewed through didactic lectures and other traditional teaching methods. The instructor was available to assist as needed during all visits to the Anatomage Table.

According to the Unified Theory of Acceptance and Use of Technology (UTAUT) model, the intent to use technology is influenced by performance expectancy, effort expectancy, and social acceptance; and usage behavior is affected by intention and facilitating conditions (Venkatesh et al., 2003). As the educational community develops and incorporates modern technologies for student learning, it is essential to explore students' experiences with the technologies to determine their intent to use them, which in turn may influence their usage behavior. This would help educators and educational institutions effectively incorporate the technology into their curriculum to augment student learning, better invest their resources, refine existing and innovate new resources, and uphold student-centered education.

Anatomage Tables are costly, requiring technical support and space, but can be very useful and effective in improving the learning of anatomy in healthcare education (Baratz et al., 2019; Fyfe et al., 2013). Thus, understanding how students perceive this technology and how effective it is to support the learning of foundational knowledge is crucial to guiding future decisions and investments. Hence, to help the educational community learn the benefits of and students' inclination towards Anatomage Table, this study explored the experiences and perceptions of the entry-level OTD students regarding the use of Anatomage Tables to learn anatomy.

Methods

The institutional review board at the University of Texas Medical Branch approved the study (IRB # 22-0034). A survey was created to explore the experiences and perceptions of entry-level OTD students regarding the use of Anatomage Tables to learn anatomy.

Survey Creation

The survey was created by the authors based on the research question under consideration, literature review, and adapting items from the survey tool developed by Dr. Jeremy Kemp (Kemp, 2011) after obtaining due permission from the author. REDCap™, an online software program, was used to develop the survey with 12 items (excluding the first item of the survey that requested participants' consent to participate in the study). The first six items were related to demographics including age, gender, self-perceived tech savviness, prior exposure to Anatomage Table, use of additional virtual resources to learn anatomy, and perception regarding the use of virtual resources to support student learning. Item 7 explored the perceived usefulness of the Anatomage Table with six Likert scale statements. The next item identified the perceived user-friendliness of the table with four Likert scale statements. The subsequent item examined the user experience with five Likert scale items. Item 10 asked respondents' level of agreement to the statement that it is favorable to the use of the Anatomage Table in anatomy classes. For items 6-10, respondents rated each statement on the scale of 'strongly agree' to 'strongly disagree'. The last two items were open-ended items and inquired about what could have enhanced their experience and learning with Anatomage Table; and whether they would use Anatomage Table in the future and why. The survey did not collect any personal identifying information. The survey was reviewed by all authors for readability, comprehension, and face validity. The first section of the survey requested participants to review the 'information sheet' pertaining to the study and click 'I agree' to proceed responding to the survey. Participants were prompted to "End the Survey" when they selected "I disagree". The response time to complete the survey was approximately 15 minutes, and the survey remained open for data collection for 3 weeks.

Survey Sample

An email invitation message was sent to all OTD students (n=59 [originally there were 60 students in the cohort and one student left the program prior to the beginning of the study]) in the class of 2024 with the link to the survey. The email described the purpose of the study and requested interested participants to complete the survey. Three reminder emails were sent during the survey response period to augment the response rate.

Data Analysis

All data were exported from REDCap to a Microsoft Excel spreadsheet. Microsoft Excel Toolpak (Microsoft, 2018) was used to perform quantitative data analyses while the qualitative data obtained through 'open-ended' items were analyzed for themes using the phases proposed by Nowell et al. (2017). Descriptive statistics were used to describe sample characteristics. Non-parametric tests were used to determine the association between variables. For qualitative analyses, the first author completed the coding of the data which was reviewed and confirmed/agreed upon by other authors. Disagreements or differences in perspectives were discussed and sorted through virtual or in-person meetings as needed.

During the analyses, the 'strongly agree' and 'agree' categories were grouped; and 'strongly disagree' and 'disagree' categories were grouped due to low frequency values. Undecided responses were excluded from inferential analysis. Despite the grouping, the frequency values were too low to conduct Chi Square tests to examine the association between the variables. Hence, Fisher's exact test with Freeman-Halton extension were performed as needed.

Results

By the response deadline, 34 responses were received, of which four were incomplete and excluded from the analysis. Table 1 presents the demographics of the remaining 30 respondents.

Table 1

Participant Demographics

Baseline characteristics	N	(%)
Gender		
Female	28	93.3
Male	1	3.3
Non-binary	1	3.3
Age range		
<25 years	26	86.7
25 years 1 day - 35 years	4	13.3
Tech Savviness		
Very much tech savvy	4	13.3
Somewhat tech savvy	21	70.0
Not at all tech savvy	5	16.7
Previous Anatomage experience		
No	28	93.3
Yes	2	6.7
Use of other virtual anatomy resource in addition to Anatomage		
Yes	20	66.7
No	9	30.0
Not sure	1	3.3

Two-thirds of the respondents (n=20) reported using other virtual anatomy resources in addition to Anatomage Tables. The resources used by respondents include Anatomy App, Visible Body®, Anatomy TV, Anatomy Atlas App as well as other applications available on smartphones and tablets.

Around 87% (n=26) of the respondents believed that the use of virtual resources in education is essential to support student learning. Two respondents expressed disagreement with the statement while another two respondents chose 'undecided.' Interestingly, two respondents who used additional virtual resources to learn anatomy disagreed to the statement of virtual resources being essential to support learning.

Table 2 presents the level of agreement of respondents to the statements pertaining to the usefulness of the Anatomage Table to learn anatomy. Nearly 80% of the respondents found the Anatomage Table useful (n=23) and reported that it helped them learn anatomy better (n=24). Around half of the respondents reported that the table helped them learn anatomy faster (n=14) and more in-depth (n=18). One-third of the participants (n=10) reported that the table increased their chances of obtaining a better grade. There was no 'strong agreement' or 'strong disagreement' for the statements of 'Anatomage Table helping learn anatomy faster' and 'Anatomage Table increasing the chances of a better grade'. Except for one respondent, all those who strongly agreed to the statement of virtual resources being essential for student learning also expressed strong agreement to usefulness statements.

Table 2

Level of Agreement to Perceived Usefulness of Anatomage Tables

Level of Agreement	Found useful in my studies	Helped me learn anatomy better	Helped me learn anatomy faster	Helped me learn anatomy more in-depth	Increased my chances of getting a better grade	Made the classes more interesting
Strongly Agree	3	2	0	3	0	8
Agree	20	22	14	15	10	14
Undecided	3	2	8	7	12	3
Disagree	4	4	8	5	8	4
Strongly Disagree	0	0	0	0	0	1
Total	30	30	30	30	30	30

Table 3 presents the level of agreement to the statements related to the perceived user-friendliness of Anatomage Table to learn anatomy. Around half of the respondents found the table easy to use (n=17), easy to learn (n=17), easy to master (n=15), and compatible with other resources (n=16). Interestingly, one respondent who reported being very much tech savvy disagreed to the user-friendliness statements and another respondent who reported being not at all tech savvy responded affirmatively to the user-friendliness statements.

Table 3

Level of Agreement to Perceived User-friendliness of Anatomage Tables

Level of Agreement	Easy to use	Ease of learning	Ease of mastery	Compatibility with other resources
Strongly Agree	1	0	0	3
Agree	16	17	15	13
Undecided	4	4	5	11
Disagree	7	8	8	3
Strongly Disagree	2	1	2	0
Total	30	30	30	30

Table 4 shows the data pertaining to the user experience of the Anatomage Table as reported by the respondents. Nearly 80% of the respondents enjoyed using the table and reported a positive experience overall (n=23). Around 40% of the respondents reported feeling apprehensive (n=14) and intimidated (n=12) to use the tables. The overlap in the percentages could be the result of some respondents failing to read and comprehend the statements properly as they expressed agreements to both positive (likeability & fun) and negative feeling (intimidated & apprehensive) statements.

Table 4

Level of Agreement to the Statements Exploring User-experience of Anatomage Tables

Level of Agreement	Likeability	Fun	Felt Apprehensive	Felt Intimidated	Overall experience
Strongly Agree	4	5	0	0	2
Agree	18	21	14	12	21
Undecided	5	2	3	2	5
Disagree	2	2	10	13	1
Strongly Disagree	1	0	3	3	1
Total	30	30	30	30	30

Interestingly, of the two respondents who had experience with the Anatomage Table before Fall 2021, one expressed agreement to all statements (usefulness, user-friendliness, & user experience) and another student expressed agreement only to user-friendliness statements and disagreed with the rest of the statements.

Twenty-five respondents either 'strongly agreed' or 'agreed' that it was a good idea to use the Anatomage Tables in anatomy classes. Only one respondent expressed disagreement and others (n=4) reported being undecided.

Two-thirds of the respondents (n=20) responded to the open-ended item that inquired about the factors that could have enhanced their experience and learning with Anatomage Tables. Twelve respondents stated that in-depth training and/or video resources on how to use the Anatomage Table would have enhanced their learning and experience. Four respondents identified that working with the table in smaller groups (<5) would have enhanced their experience as it may have provided everyone an opportunity to work with the table during the class. Three respondents suggested reducing the time spent on the tables during class time while two respondents asked for more time or access to the tables outside the class hours. One respondent stated that the tables may need to be adjusted for sensitivity by the manufacturer to ensure selection accuracy.

For the last open-ended item, 80% (n=24) of the respondents reported they will use the Anatomage Table in the future while 17% (n=5) of the respondents answered contrarily. One respondent answered 'n/a'. The reasons identified by the respondents who answered affirmatively include the table being helpful in: (i) reviewing the learned material, (ii) enhancing the learning and understanding of the content, (iii) exploring the human body, (iv) visualizing the location of anatomical structures, (v) solidifying anatomical concepts, (vi) learning anatomy without cadaver lab requirements and restrictions, and (vii) self-assessing knowledge. One respondent stated the tables have the potential to be a lot more helpful as it has features like case library, diagnostic images repository, etc., in addition to the virtual cadavers.

The respondents who answered non-affirmatively to the last item stated they enjoyed learning from a different resource, completed the anatomy course, and preferred to use the smartphone/tablet applications as needed as they are easy to use. One respondent reported that he/she felt the tables wasted time.

The analyses examining the association between the age range and 'level of agreement to the usefulness, user-friendliness, and user experience statements' yielded non-significant p values ranging from 0.22 – 1.00. However, percentage values indicated those who were younger (<25 years) found the table more useful and user-friendly compared to their older counterparts. The analyses examining the association between self-perceived tech-savviness and the level of agreement to perception statements yielded non-significant p values ranging from 0.23 – 0.99. Analyses between 'favorable view toward the use of virtual resources in education' and 'level of agreement to perception statements' yielded similar results.

To determine whether the incorporation of the Anatomage Table led to an increased number of students with high grades, the data regarding the number of students with 'A', 'B', & 'C' grades were extracted from the learning management system for the classes of 2023 and 2024 and compared. It is important to note that both classes were taught by the same instructor using the same curriculum. However, the didactic lecture classes were conducted virtually for the class of 2023 due to the coronavirus pandemic. Both classes had 60 students. In the class of 2023 (no exposure to Anatomage Table), of the 60 students, 30 secured an 'A' grade, and the other 30 secured a 'B' grade. In the class of 2024 (exposed to Anatomage Table), 31 of 60 students secured an 'A' grade, 27 students secured a 'B' grade, and two students secured a 'C' grade.

Discussion

The purpose of this study was to explore the experiences and perceptions of entry-level OTD students related to the use of Anatomage Table to learn anatomy. Overall, the results indicated that entry-level OTD students have a favorable view toward the use of Anatomage Table. Though the students like to use the Anatomage Tables to learn anatomy, some students found them less user-friendly and felt the need for more training and orientation on how to use the tables at the beginning of the course.

This is the first study to report the experiences and perceptions exclusively of graduate OT students related to the use of Anatomage Table. Kar et al.'s (2020) study reported the perceptions of graduate OT and physician assistant students combined. Other studies (Gonzalez Sola et al., 2019; Mathis et al., 2020; Meyer et al., 2021) reported in the literature were pertaining to undergraduate health science students, including OT students. A few studies (Rosario, 2021a; Rosario, 2021b) reported the use of a 3D anatomy application in OT courses.

The results of this study indicate that OT graduate students who utilized the Anatomage Table to learn anatomy found the table useful. This finding is in alignment with the literature as Custer and Michael (2015), who examined the perceptions of medical imaging students, reported that nearly 96% of the students found the Anatomage Table beneficial. In a study conducted in Nigeria, medical students who were exposed to Anatomage Tables reported that the tables increased their interest in anatomy and helped with better visualization of anatomical structures (Memudu et al., 2022). Baratz et al. (2019) found that first-year medical students were more excited and perceived a greater degree of learning when studying on the Anatomage Table. Ward et al. (2018) stated that Anatomage Tables are a beneficial resource to radiological science students. Though the participants in the current study perceived the Anatomage Table as a useful resource, it appeared the incorporation of Anatomage Table did not necessarily influence their grades as there was no notable increase in the number of students with 'A' grades when compared to the previous cohort (no exposure to Anatomage Table).

Similar to the findings in the literature, nearly half of the respondents in the current study reported concerns regarding the user-friendliness of the table. Kar et al. (2020) surveyed graduate OT and physician assistant students who used Anatomage Tables

and reported that students praised the tables for image size, realism and high-resolution regional anatomy while criticizing user-friendliness (touch and rotation functions). The students in the current study also reported concerns with selection accuracy.

Literature reveals that students enjoyed features of Anatomage Tables such as the ability to rotate images and highlight structures (Fyfe et al., 2013). However, none of the respondents in the current study commented on the features of the Anatomage Tables in the open-ended items, though 26 of the 30 respondents found the tables fun to use.

Earlier studies (Fyfe et al., 2013; Fyfe et al., 2018) reported the students had concerns about the graphical quality of the images in the Anatomage Table. However, no concerns related to the graphical quality of the images were reported in the current study. This could be due to the fact that the Anatomage Table software has constantly been updated resulting in higher graphical quality. The students in this study used 'Anatomage Table 7'. An updated version (Anatomage Table 8) is available at the time of this writing.

Recent studies reported Anatomage Table as a good supplement to cadaver dissections (Kar et al., 2020; Memudu et al., 2022). This study supports this assertion as the students in the current study reported that Anatomage Table helped them learn anatomy without the cadaver lab restrictions and requirements. It is also important to note that two-thirds of the participants used other virtual anatomy resources to support their learning in addition to Anatomage Table. This indicates that they considered the Anatomage Table as a supplemental resource.

One of the disadvantages reported in the literature pertaining to Anatomage Table was its ability to allow only one user at a time (Fyfe et al., 2013). Students' comments in the current study resonated the same as they reported difficulty in working with the table for adequate amount of time in group settings. Fyfe et al. (2018) reported that eight students may be too large a group around an Anatomage Table. Supporting this assertion, the students in this study reported that working in smaller groups may have enhanced their learning experience.

The students in the current study perceived the need for adequate training and tutorials to better use Anatomage Tables. This perception aligns with Fyfe et al.'s (2018) recommendation related to the need for training for staff and students when using touch-screen technology resources such as Anatomage Table.

Strengths & Limitations
The strengths of this study include the high response rate and timing of the survey. Typically, email surveys were reported to yield a 30% response rate (Nayak & Narayanan, 2019). This survey yielded a 51% response rate. The survey was administered after the students had a full semester of exposure to the Anatomage Table in the previous semester. This may have helped students retain a fresh memory of their experiences but mature enough to be able to reflect and formulate their perspectives.

This study has several limitations. Despite the high response rate, the actual number of respondents was small (30/59 students), affecting the statistical significance of the findings. Also, this study surveyed only one cohort within one program and thus limiting the generalization of findings. Further, 66% of the respondents indicated using other virtual resources to support their learning of anatomy, which may have affected their perceptions of the Anatomage Table.

Future Research
More in-depth mixed method studies, longitudinal studies, and comparative studies across different programs and/or cohorts may provide valuable insights regarding the educational value of the Anatomage Table. For instance, mixed method studies may yield qualitative information (e.g., perceived facilitators and barriers associated with the use of Anatomage Table) to supplement the quantitative data (e.g., duration of use, change in scores/grades, etc.) related to the use of the Anatomage Table in anatomy courses. Longitudinal studies may help in determining the efficacy of the Anatomage Table in helping students retain anatomical knowledge over time. Comparative studies across medical, nursing, and allied health students may reveal differences in student experiences and perceptions related to Anatomage Table across disciplines.

Implications for Occupational Therapy Educators

- Anatomy instructors in occupational therapy educational programs may consider Anatomage Table as a viable supplemental resource to teach anatomy.
- Occupational therapy educators can use Anatomage Table's quiz mode to help students self-evaluate their anatomy knowledge.
- Occupational therapy educators may use the table to help students explore and visualize the complex arrangement of body structures that are critical to function. For instance, relationship of the rotator cuff muscles to the shoulder joint.
- Occupational therapy educators may explore the feasibility of using Anatomage Table's case library and other features in courses like neuroscience and physical dysfunctions.
- Occupational therapy educators must take student input into consideration when planning to use Anatomage Table as a supplementary resource to teach anatomy or other subjects.

Implications for Other Stakeholders

- When using Anatomage Tables, the instructors may consider providing adequate training/tutorials on how to operate the table to maximize learning. An orientation class at the beginning of the semester and 24/7 accessible video resources may be helpful.
- As students may find different virtual resources user-friendly, it may be beneficial for anatomy instructors to introduce a variety of virtual anatomy resources.
- Anatomy instructors should consider restricting the number of students around each table and carefully design class activities/schedules so that all students have an opportunity to work with the table.
- Anatomy instructors may prepare a handout identifying how to operate the table and attach it with each table for the reference of users.

- Students using Anatomage Tables should familiarize themselves with the features and capabilities of the table and obtain adequate training on how to operate the table to maximize their learning.
- Anatomage Table manufactures may explore the feasibility of multi-user capabilities to support collaborative learning using the table.
- Universities with health science programs may invest in a variety of virtual anatomy resources, including Anatomage Table, to support student learning.

Conclusion

Successful use of technology in higher education depends on students' perceptions of technological resources. This study explored the experiences and perceptions of entry-level OTD students who used Anatomage Tables to supplement their anatomy learning. The findings suggest that Anatomage Table could be considered as a useful supplemental resource to teach anatomy. However, students must be given adequate orientation and training regarding the functionalities of the Anatomage Table to enhance user-friendliness and optimize their learning experience.

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