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Abstract

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Keywords

Anatomical models, educational techniques, upper extremity

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Occupational Therapy Students' Perceptions of Participation in a Novel Educational Intervention to Learn Hand Anatomy

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ABSTRACT

Learning anatomy via cadaver dissection is considered a best practice in anatomical education. However, occupational therapy programs commonly use alternative or adjunct teaching methods when teaching anatomy. The purpose of this study was to investigate students' perceptions of learning hand anatomy through participation in the Dell Hand Instructional Module (DHIM), a novel educational intervention incorporating an animated video series and a translucent, three-dimensional model of the hand. Participants attended one anatomical instructional session and one assessment session, completed a questionnaire about their experiences, and participated in a focus group. Participants agreed or strongly agreed that the DHIM made learning about hand anatomy more interesting and enjoyable, was an effective learning tool, and helped them to understand spatial relationships between the hand structures. Thematic analysis of focus group responses resulted in five themes: instructor impact, learning environment, learning preferences, interaction with the model, and perceptions of the educational intervention. Findings suggest this novel intervention supported hand anatomy instruction and was helpful to student engagement in the learning process. Future research should assess learning outcomes associated with the DHIM, as well as investigate the use of trained graduate students as DHIM facilitators.

Introduction

Learning anatomy via cadaver dissection is considered a best practice in anatomical education, yet occupational therapy programs commonly use alternative or adjunct teaching methods when teaching anatomy (e.g. three-dimensional models, computer software applications, virtual dissection platforms). In fact, research suggests that use of non-cadaver anatomy teaching modalities is just as effective for short-term learning, however, students perceive cadaver-based learning as more favorable than other modalities (Wilson et al., 2018). While a lack of studies exists comparing the educational effectiveness of 3D models to cadaveric dissection, the use of such models has promise for teaching anatomy and students perceive them as beneficial to their learning (Chytas et al., 2020).

Recent studies described the use of 3D models in the teaching of specific areas of anatomy. Findings from a survey and focus group of the undergraduate students enrolled in an anatomy course indicated several positive aspects of using 3D printed models of the upper limb (Mogali et al., 2018), although participants described the 3D printed models as less realistic than models created from plastination, which is “an alternative tissue preservation technique in which polymers replace water and lipids resulting in benign, dry, and anatomically authentic specimens” (Klaus et al., 2018, p. 282). Another study assessed the perceived satisfaction of 3D printed models by first- and second-year health professions students in comparison to real bone samples (Ugidos Lozano et al., 2019). Overall, the students provided a positive evaluation of using the 3D models with satisfaction of the 3D models exceeding that of real bones.

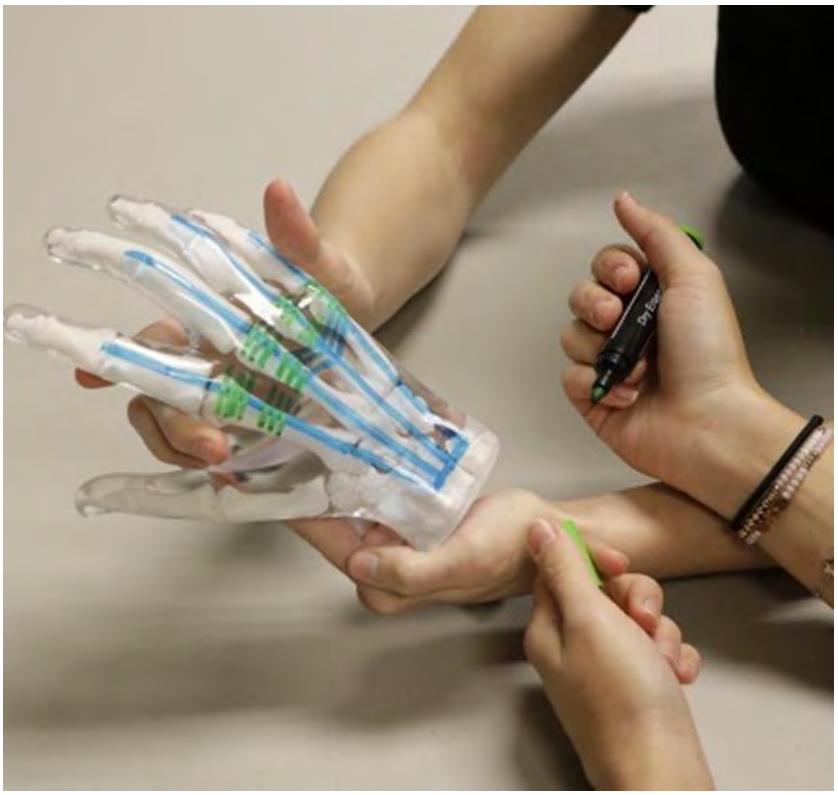
Learning anatomy requires an extensive attention to detail and spatial abilities that may be challenging for learners (Roach et al., 2021). While holding and visualizing a 3D model is an important adjunct to teaching anatomy, students benefit from drawing on a 3D model as well. For example, Backhouse et al. (2019) engaged students in a “co-creation learning task” in which they drew, narrated, and modeled components on a 3D printed orbit (i.e. bony cavity in the skull that holds the eyeball; p. 521). Findings of an anonymous, self-report questionnaire showed that students liked the co-creation task and the model, with most students responding agree/strongly agree that the 3D model helped them understand the spatial relationship between orbital bones.

Occupational therapy students considering specialization in hand therapy, such as becoming a certified hand therapist (CHT), need a detailed understanding of hand anatomy to provide optimal patient care and engage in interprofessional communication with hand surgeons and others on the care team (Schofield, 2017; Valdes et al., 2022). The Dell Hand Instructional Module (DHIM; UE | Applications, 2022) was developed to meet this need. The DHIM is a professionally animated and recorded video series and a 3D translucent model of the hand and wrist with a skeleton inside (i.e. the Dell Hand; see Figure 1). Dry erase markers, a cleaning solution, and cloth allow learners to draw directly on the model and wipe away mistakes. DHIM protocol includes having learners work in groups of three, taking turns drawing hand and wrist anatomical structures (e.g.

muscles, tendons, ligaments) directly on the model, narrating how to draw, and filming the drawing on their cellphone. The purpose of this study was to investigate students' perceptions of learning hand anatomy through participation in the DHIM.

Figure 1

Dell Hand



Method

Research Design

The study used an exploratory research design. Students participated in the DHIM over two, four-hour sessions, Students were enrolled in one of two groups during the middle of the fall semester or the beginning of the spring semester during their first year of their program. A researcher-developed survey and focus group gathered data on students' perceptions of their learning experience. The Institutional Review Board at the authors' institution approved the study. All participants provided informed consent to take part in the study.

Participants

The researchers aimed to recruit twelve participants from the first-year student cohort of a Doctor of Occupational Therapy (OTD) program in the southeastern United States. Participation was voluntary. Inclusion criteria were enrollment in the first year of the OTD program and no previous training in hand anatomy, except for an applied human anatomy prerequisite course.

Development of the DHIM

Two teaching and learning approaches provide the basis for the DHIM: (1) social learning theory (Bandura, 2005) and (2) the multisensory approach (Fleming & Mills, 1992). The social learning theory framework posits that "students learn via observational learning and modelling" in a social setting (Horsburgh & Ippolito, 2018). For the DHIM, social learning occurs in a small group with each student having an opportunity to both model and observe. Observation of a peer using the Dell Hand and subsequent reproduction of hand anatomy using the Dell Hand may potentially support the learner's self-efficacy, the individual's belief in their own ability to successfully learn the content presented in the DHIM (Bandura, 2005). Per social learning theory, as self-efficacy develops, motivation to learn increases.

Students may benefit from the opportunity to use different ways of taking in new information through multiple sensory channels (i.e. visual, auditory, tactile, kinesthetic; Fleming & Mills, 1992). The DHIM supports multisensory learning by giving students the opportunity to use their tactile sense when touching the model, visual sense when viewing the model (including during recording), auditory sense when listening to a peer narrate, and kinesthetic sense when drawing on the model.

The DHIM is an educational program developed by the second author. The DHIM includes: 1) an animated, case study-based video platform designed for occupational and physical therapy students, as well as practitioners, and 2) the Dell Hand (see Figure 1), a translucent model of the hand and wrist which was professionally sculpted by the fourth author. The high upfront cost of 3D printing and the inability for a 3D printer to produce the highly transparent, glasslike quality resulted in the Dell Hand's creation through a series of casting and modeling techniques. The Dell Hand's interior skeleton was modelled from a true-to-form human skeleton of the hand and wrist and the overall hand shape was created through life casting techniques to maintain true anatomical accuracy.

The video portion of the DHIM shows dissection of normal intrinsic anatomy, including the dorsal and palmar interossei and lumbricals. The Dell Hand model provides an artistic rendering of the human hand and wrist, including the natural contours of the hand. The translucent exterior of the Dell Hand provides a smooth surface in which the student can illustrate anatomic structures with dry erase markers that have the capacity for a fine tip and broad stroke. All markings easily wipe completely clean. Two components of the DHIM were utilized for this study: 1) an illustration of select anatomical structures of the hand and wrist presented through the video series (see Table 1 for list of structures), and 2) the Dell Hand. The DHIM videos present the extrinsic and intrinsic anatomical structures of the hand in a clinically relevant and relational manner, while students physically handle and draw on the model.

Table 1

List of Anatomical Structures Identified on the Model

Extensor Digitorum Communis
Extensor Retinaculum
Juncturea Tendinum
Sagittal Bands
Transverse Fibers
Oblique Fibers
Lateral Slips
Proximal Interphalangeal Joint Volar Plates
Superficial Bellies of Dorsal Interossei
Medial Tendons
Deep Bellies of Dorsal Interossei
Lateral Tendons
Flexor Digitorum Profundus
Palmar Interossei
Lumbricals
Lateral Bands
Conjoined Lateral Bands
Terminal Tendon
Transverse Retinacular Ligament
Triangular Ligament
Origin of extrinsic extensor and flexors in forearm discussed but not identified on the model

Procedures

The study was implemented in the fall semester of 2022 and the spring semester of 2023. Participants were separated into groups of three at the beginning of the intervention. Participants participated in two sessions held approximately one week apart.

Session One

The first session was a four-hour in-person anatomical instructional session, directed by the second author, who was a CHT. The participants followed the step-by-step instructions featured on the professionally animated and recorded video series. Within each small group, one participant was assigned to draw on the Dell Hand, another assigned to narrate the drawing, and the third participant assigned to video record the anatomical illustration and narration via cellphone. Throughout the four-hour anatomical instructional session, and within the small group, the participants rotated roles after the drawing, narration, and recording of five anatomical structures. Role rotation ensured each participant had an opportunity to actively participate in drawing, narrating, and recording of the selected anatomical structures. The second author facilitated student learning by answering questions, correcting student errors, and providing feedback.

Session Two

One week after session one, the second author directed a four-hour in-person competency session. At the outset of the competency session, each participant was provided with a Dell Hand, dry erase markers, cleaning supplies, and an ordered listing of the anatomical structures detailed in the initial four-hour anatomical instructional session. The participants practiced drawing and reciting, on video via recording on their cell phone, the origin, insertion, and function of all anatomical structures detailed in the aforementioned list.

Data Collection

Collected data included quantitative data from a self-report questionnaire and qualitative data from focus groups conducted over the Zoom videoconferencing platform (Zoom Video Communications, Inc., San Jose, CA). All data were de-identified and anonymous. A unique identifier was used for all focus group participants.

A self-report questionnaire was adapted, with permission, from a study of the use of a 3D model to teach orbital anatomy (Backhouse et al., 2019). Eight attendees of a continuing education course using the DHIM piloted the questionnaire. No revisions were needed. The questionnaire was used to collect data on student perceptions of the learning experience. It included Likert scale items and open-ended questions. Items were rated from 1 (least preferred/strongly disagree) to 5 (most preferred/strongly agree). The questionnaire was completed anonymously, online through Qualtrics software (Qualtrics, Provo, UT) with the link emailed to participants after session two.

Participants were invited to a focus group facilitated by the third author which was held one week after session two. The first and third author developed the focus group questions, including open-ended and think-back questions to encourage wide-ranging ideas and opinions from participants (see Table 2).

Data Analysis

Questionnaire data were analyzed using IBM SPSS Statistics (Version 28). Descriptive statistical analyses were performed. Qualitative data from the focus group was thematically analyzed using the protocol outlined by Braun and Clarke (2006). The third author transcribed the data and then each author read and re-read the transcriptions. The authors then individually coded the data, meeting to discuss the individual codes and develop initial codes with definitions. The authors then re-coded different sections of the transcript, meeting to discuss the codes and come to consensus. Once consensus was reached, the team counted codes and analyzed the codes for themes. The team then met to review the themes and generate definitions. The study team assured trustworthiness of the qualitative analysis through prolonged engagement with the data, researcher triangulation, and documentation of team meetings and coding/theme decisions.

Table 2

Focus Group Questions

Questions
1. Think back to Session 1. a. How would you describe your overall experience of participating in the hand anatomy training session (Session 1)?
2. What aspects of the Dell Hand Instructional Module enhanced the quality of your learning experience (ex. Using the 3D model, narrating, video recording, use of instructional videos) in Session 1?
3. Think back to Session 1 when you were participating in the group learning activities. a. What aspects of learning in a group helped or hindered your learning?
4. Think back to when you were in the second session and being assessed on your knowledge. a. Describe your experience of using the drawing, narration, and recording without the help of the instructional videos. b. Describe your experience of completing the assessment in a group. How do you think this is different from completing the assessment individually?
5. If you have experience learning anatomy in other ways, how does the Dell Hand Instructional Module compare to those more traditional ways of learning anatomy?
6. Final questions a. Have we missed anything? Is there anything else you would like to add or discuss regarding the Dell Hand Instructional Module?

Results

All participants (n = 12) completed both DHIM sessions. Six participants were in the fall 2022 sessions and six participants were in the spring 2023 sessions. Participants joined a focus group held approximately 1 week after completion of Session 2 in fall (n = 6) and spring (n = 6). All participants were female and their ages ranged from 22 to 30 years-old. Ten participants responded to the survey.

Questionnaire

The first section of the questionnaire included items specific to participants' perceptions of learning and knowledge gained through the DHIM (see Table 3).

Favorable Perceptions

Several findings from the questionnaire showed participants' positive experiences with the DHIM. All respondents (n = 10; 100%) agreed or strongly agreed that the DHIM made learning about hand anatomy more interesting, enjoyable, was an effective learning tool, and helped them to understand the spatial relationships between the hand structures. The majority of participants (n = 9; 90%) agreed or strongly agreed that the DHIM helped their learning and they liked that they were able to draw on the Dell Hand, as well as have a turn to narrate while a group member drew on the Dell Hand. Most participants agreed or strongly agreed that their knowledge of hand anatomy had improved, indicating that they felt confident in locating and identifying bones (n = 9; 90%), visualizing anatomical structures of the hand (n = 9; 90%), and describing structures (n = 9; 90%).

Table 3

Survey Results for Dell Hand Instructional Module Items (n = 10)

Survey Items	M	SD	% Agreed and Strongly Agreed
The Dell Hand Instructional Module:			
made learning about hand anatomy more interesting.	4.7	.48	100% (n = 10)
was an effective tool to help me learn about hand anatomy.	4.7	.48	100% (n = 10)
made learning about hand anatomy enjoyable.	4.7	.48	100% (n = 10)
helped me to understand the spatial relationship between the bones, nerves and tendons of the hand.	4.8	.42	100% (n = 10)
The Dell Hand Instructional Module helped my learning because:			
it motivated me to learn hand anatomy.	4.3	.68	90% (n = 9)

I could touch and feel the model.	4.9	.97	100% (n = 10)
it suited my way of learning.	4.4	.97	90% (n = 9)
it offered me a highly personalized learning experience.	4.2	.92	90% (n = 9)
I liked that I was able to:			
draw on the model.	4.9	.32	100% (n = 9)
narrate while a group member drew on the model.	4.1	.57	90% (n = 9)
record while my group members drew on the model and narrated.	3.1	.99	30% (n = 3)
Because of the Dell Hand Instructional Module I am confident I can:			
locate and identify the different bones of the hand.	4.3	.95	90% (n = 9)
understand the spatial relationships between the bones of the hand.	4.7	.48	100% (n = 10)
visualize the spatial relationships between the bones of the hand.	4.6	.52	100% (n = 10)
visualize the important structures in hand anatomy.	4.5	.53	90% (n = 9)
describe the important structures in hand anatomy.	4.0	.82	90% (n = 9)

Note. 1 = strongly disagree, 5 = strongly agree

The second section of the survey asked participants to rate resources in terms of their preference for learning hand anatomy (see Table 4). The most preferred learning resource was “viewing a cadaver” (ratings of 4-5, n = 9; 90%). and the least preferred resources were “2D images” (ratings 1-3, n = 7, 70%) and “using my own resources” (ratings 1-3, n = 7; 77.7%).

Table 4

Survey Results for Hand Anatomy Learning Preferences (n = 10)

Survey Items	M	SD	% Ratings 4-5	% Ratings 1-3
Rate the following resources in terms of your preference for learning hand anatomy.				
Lectures	3.4	1.17	50% (n = 5)	50% (n = 5)
Viewing a cadaver	4.3	.67	90% (n = 9)	10% (n = 1)
Disarticulated bones	3.2	1.14	40% (n = 4)	60% (n = 6)
Written text	2.5	1.51	50% (n = 5)	50% (n = 5)
Videos/animations	3.6	1.07	60% (n = 6)	40% (n = 4)
Discussing with the tutor	3.7	1.16	60% (n = 6)	40% (n = 4)
2D images	3.3	.82	30% (n = 3)	70% (n = 7)
Using my own resources	3.0	.87	22.2% (n = 2)	77.7% (n = 7)

Note. 1 = least preferred, 5 = most preferred.

Respondents described being able to draw on the Dell Hand (n = 4), seeing the structures inside the Dell Hand (n = 2), being able to hold the Dell Hand (n = 2), and the interactive nature of the DHIM (n = 1) as the best aspects of the DHIM in terms of their learning.

Unfavorable Perceptions

Respondents like recording the least, with only 30% (n = 3) of respondents agreeing that they liked being able to record while their group members drew on the Dell Hand and narrated. Respondents described difficulty keeping the hand clean (n = 1), lack of

written information provided for each hand structure (n = 4), music in the background of the video (n = 1), recording their own videos (n = 1), and narrating for the video (n = 1) as the worst aspects of the DHIM in terms of their learning.

Focus Group

Thematic analysis of focus group responses resulted in five themes (see Table 5 for sample quotes): learning environment, learning preferences, interaction with the model, perceptions of the educational intervention, and instructor impact.

Learning Environment

The theme *learning environment* represents the physical and social variables of the learning environment that contribute to student engagement with content. This includes the physical layout of the classroom (i.e. space, noise levels, audiovisual modalities, availability of class resources) and social interaction with other learners (i.e. hearing and seeing how others learn, learning from others' successes and failures, accountability with material).

Learning Preferences

The theme *learning preferences* describes participants' preferred methods of learning hand anatomy. Preferences included learning through manipulative activities (e.g. drawing, holding, rotating) and frequent confirmation of correctness of content understanding against a credible resource (e.g. the instructor, a fact sheet).

Interaction with the Model

The theme *interaction with the model* describes the characteristics of the Dell Hand that participants identified as enhancing their learning, such as three-dimensional aspects and translucency. Participants expressed how interacting with the Dell Hand through wiping off the marker and starting over, holding the Dell Hand in their hands, and visualizing it from multiple perspectives supported their learning. This theme also includes differences and preferences related to other types of anatomy teaching tools and media.

Perceptions of the Educational Intervention

Participants' experiences of drawing, narrating, and recording, as well as completing the assessment activities were encompassed in the theme *perceptions of the educational intervention*. This theme also includes suggestions for improvement, as well as how the instructional design and teaching methods were or were not beneficial to learning. Suggestions included the addition of elastic bands to the model in order to increase understanding of the structures' function, a note sheet with muscle details (i.e. function, origin, insertion) for reference or individual study, and time to plan out scripts for each recording between the first and second sessions in order to make sure the recordings were accurate for future review.

Instructor Impact

The category of *instructor impact* describes instructor influence on the learning experience. Participants expressed how the instructor's knowledge of the subject matter and ability to resonate with the learner (positive or negative), the instructor's emotional intelligence, and the instructor's utility of therapeutic-use-of-self influenced teaching effectiveness. The instructor's proficiency in the teaching of specific subject matter, communication skills, and interpersonal skills had a direct impact on students' willingness to engage with, understand, and feel safe with new content.

Table 5

Thematic Analysis of Focus Group Data (n = 12)

Theme/Code Count	Definition	Sample Quote
Learning environment (n = 45)	Encompasses the physical and social variables of the learning environment that contribute to student engagement with content.	"Um, I definitely think, being in a group, we were kind of able to like build off of each other, and like teach, guide, and correct each other, which I found really helpful. Like if one person had forgot the origin and insertion, we could kind of guide them to the right answer, and we could help each other learn." (Student 8) "Not only do you feel challenged, but you can also rely on the people in your group to help you remember then, what was going on, or maybe they remember the structure or the function of a structure kind of thing. So maybe I remembered the function, and someone else remembered exactly where it went. So, working together and kind of building on teamwork in that respect was beneficial." (Student 12)
Learning preferences (n = 53)	Participants' preferred methods of learning hand anatomy.	"Yeah, I do agree that it was helpful to be able to actually touch and hold the physical model. When I took anatomy courses for the prerequisites, they actually occurred during COVID. So most of my learning materials were virtual, or through a textbook, which I feel does not really add the extra layer of understanding to have it physically in front of you. So I do appreciate that part of it." (Student 10) "I also like the fact that there's a lot of rotation, um, that made me feel comfortable and understanding where things were visually." (Student 7)

Interaction with the Model (n = 74)	Describes the characteristics of the model that participants identified as enhancing their learning.	"I also liked how you could literally take the hand and like draw on it this way, then flip it over and draw on it this way and still see like every line. And it was also nice that if you did make a mistake you could just easily wipe it off and start all over again and it wasn't like the end of the world if you messed up at all." (Student 3) "I'd say like the added benefit of the Dell Hand is having that three dimensional edge. Like for me, tracing anatomy, I often draw everything, and there are muscles that do span front to the back. So it's kind of cool to have the hand. You were able to literally see how some bands wrap around like from the front of the finger to the back of the finger and still see that in completion. In my mind I would be like drawing the front; drawing the back. And having to remember, 'Oh that connects to that.' Whereas, it was similar, but it had that added benefit of the three dimensional aspect." (Student 1)
Perception of the educational intervention (n = 52)	Participants' experiences of drawing, narrating and recording, as well as completing the assessment activities in session two and suggestions for improvement.	"I did really like about the module, how it kind of follows that 'watch-do-teach' type of learning method. I find that to be really helpful because we like, watched the video, explain the structure, and like, point it out and where it's at, and then we would draw it ourselves. And if you were the one narrating in the group, you were kind of teaching because you were saying, like describing, what the function of the anatomical structure was, and that was really helpful for me." (Student 9) "…having a word card there with all of the names of the muscles, their origin, action, and insertions on that card, would be really important just to add in that other aspect of learning of being able to read. And also just for self-study. If you're doing this by yourself it's really difficult to just come up with everything correctly off of memory like we've said before. Just having that card there to refer back to if you're confused or uncertain would be a great addition." (Student 2)
Instructor impact (n = 31)	Describes instructor influence on the learning experience.	"I think that everything that makes him a great therapist makes him great at instructing. He was able to read our faces and know when we were confused. He was able to communicate it in a way

	that I'm sure he does with clients, to make them understand what's going on in their own body. It worked for us too. We need that base understanding to go in depth. He was just really good at communicating that." (Student 6)
	"Also with the way he presented structures and functions, when he was doing like the teaching part of it, when he would repeat himself to emphasize, I felt that was the one thing that I would remember when I had to narrate. So I thought that was a good um thing that he would, I guess, emphasize important functions and structures, while, before we needed to narrate it, for us to remember." (Student 12)

Discussion

This study investigated students' perceptions of participating in a novel education intervention, the DHIM, for learning hand anatomy. The DHIM consisted of three main elements: drawing on the Dell Hand, narrating what to draw, and recording the drawing. The authors envisioned that the multisensory learning inherent in these three different roles would benefit student learning. The drawer benefits from the kinesthetic experience of marking structures directly on the Dell Hand while the others visually appreciate the drawn anatomy; the narrator provides audible voice to the origin, insertion, function, and clinical relevance of the drawn structures; and the videographer captures both the visual and audible experience, allowing the group to replay, study, and correct recorded content. Most participants described drawing on the Dell Hand and narrating for the video as useful, enjoyable, and helpful in understanding the relationship between structures. Many participants identified the actions of touching and feeling the Dell Hand as an optimal complement to their learning preferences. Findings from the questionnaire and focus group suggested that the recording was less helpful to learning. Moving the Dell Hand around and drawing on it provided a personalized learning experience, whereas the participants perceived the recording as less interactive. The second author observed that those assigned to the videographer role first appeared to be less engaged until transitioning into another role. Previous studies of anatomical education with 3D printed models have reported similar findings. Students preferred handling models over wet specimens (Garas et al., 2018) and liked being able to touch and manipulate the models without gloves on their hands (Mogali et al., 2018).

Participants appreciated the opportunity to erase mistakes and re-draw corrections on the Dell Hand. In a study investigating the use of 3D printed models to teach the anatomy of the eye, participants were hesitant to draw on the model because they could not change it if they made errors (Backhouse et al., 2019). One benefit of the Dell Hand is the student's ability to draw on details as they follow along with the DHIM instruction. This type of active, multisensory learning positively influenced the participant's confidence, suggesting that self-efficacy regarding hand anatomy also improved.

Following the intervention, all participants endorsed the ability to understand and visualize the spatial relationships between the structures. Similarly, Na et al. (2021) found that anatomy students' spatial visualization improved with the integration of drawing of structures. Most students using the Anatomy Glove Learning System (AGLS), a glove with a printed skeleton that students draw structures on combined with narrated videos, also reported an improved understanding of hand anatomy (Lisk et al., 2015) and confidence related to hand anatomy (Murphy & Eglseder, 2022).

Participants described how the translucency of the Dell Hand allowed them to see the skeleton as they drew, which supported their learning. Most participants identified that they could locate and identify different bones of the hand and wrist, as well as visualize and describe important structures. Previous studies using 3D models to teach anatomy reported similar findings regarding student confidence and understanding of spatial relationships among the structures (Backhouse et al., 2019; Chen et al., 2017; Yammine & Violato, 2016). However, unlike the Dell Hand, these models lacked translucency, thus prohibiting the learner from seeing the inside of the body part.

While participants in this study least preferred two-dimensional images and most preferred viewing a cadaver for learning anatomy, not all occupational therapy programs offer the option of cadaver dissection or viewing cadavers (Schofield, 2017). The DHIM offers an alternative or adjunct to cadavers as students have the ability to draw structures on the Dell Hand while viewing videos of cadaver specimens. This allows them to see the fine detail and engage in a hands-on learning experience at the same time. Similarly, Reid et al. (2019) incorporated haptic (i.e. tactile and proprioceptive sensation) and visual observation with drawing into anatomy instruction, finding students reported the multisensory approach helped them to create a mental picture of the studied anatomical object. The authors conceptualized that this mental picture may distribute the cognitive load of learning about the structure across multiple senses (i.e. vision, haptics) resulting in a more organized working memory and subsequent integration into long-term memory. Multisensory learning may be especially beneficial for students who struggle with spatial-oriented tasks.

Most participants positively viewed learning in a small group. The social aspect of learning supported the development of participants' self-efficacy as they took turns modeling the drawing of structures on the Dell Hand, corrected other students when mistakes were made, and gave each other support to recall structures. Shapiro et al. (2020) described similar findings of positive student perceptions after participation in an anatomy education drawing intervention. Additionally, students participating in an anatomy course with reciprocal peer teaching (i.e. students alternated roles of teacher and learner) reported higher confidence in their learning than those in a traditional course (Manyama et al., 2016).

Participants perceived the instructor's involvement in the DHIM as important to their experience. While DHIM videos provide the basic procedure for drawing on the model, having a trained and knowledgeable instructor improved the quality of the participants' learning experience. The participants suggested that the presence and the calm

demeanor of the instructor increased a feeling of safety and decreased stress during the sessions, as the instructor could help identify mistakes, answer questions, and further explain the relationships between anatomical structures. Like our study, participants in Radzi et al. (2022) recommended additional faculty demonstration and guidance on using the models and identifying images correctly in a learning activity with 3D and plastinated models. Future research investigating the use of trained graduate teaching assistants as facilitators for the DHIM could help determine if an experienced CHT is a necessary component of the intervention or if using less experienced facilitators would yield positive learning outcomes.

Limitations

The second author created the DHIM and the fourth author was the sculptor of the Dell Hand, so to address bias during analysis of focus group data, all authors participated in coding (i.e. multiple coders), engaged in discussions of codes and themes as they emerged, and obtained a final consensus on themes. The authors also obtained data from multiple sources (e.g. survey, focus group), resulting in a sufficient amount of data to validate the findings for this group, although the small sample size limits generalization. The lack of assessment of participant learning is another limitation of this study. Future research could include a learning assessment and a larger sample of students to determine hand anatomy learning outcomes of students using the DHIM.

Implications for Occupational Therapy Education

This study supports hand anatomy instruction by utilizing a novel teaching approach in a OTD academic program. Guided interactive learning with a translucent 3D model of the hand may enhance students' confidence and self-efficacy, specifically when students can manipulate the model according to learning preferences, draw on the model, and correct their mistakes. Occupational therapy students may find that elements of the DHIM, such as repetitive drawing of anatomical structures of the hand and wrist while viewing a video of a dissected cadaver, improve their ability to apply foundational anatomy knowledge to future learning about hand pathologies. Incorporation of a translucent 3D model or other 3D learning technologies with a group interaction component may be beneficial to student engagement in the learning process, as well as result in increased satisfaction with course instruction.

Conclusion

Participant perceptions of the DHIM indicated that this novel educational intervention supported hand anatomy instruction and was helpful to student engagement in the learning process. Findings from the focus groups suggested that aspects of the DHIM addressed students' learning preferences, such as the ability to engage directly with the model and discuss learning with others in a group setting. Future research should investigate whether students taught using the DHIM have better recall of anatomical structure and function when compared to students taught using traditional anatomy teaching methods (i.e. cadaver, two-dimensional images).

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