Review Article

Clay modeling as a learning tool for medical trainees in urology: a narrative review and pilot study

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Background and Objective: Coronavirus disease 2019 (COVID-19) necessitated a transition to virtual education which limits hands-on opportunities and student engagement. To adapt, a pilot study investigating clay modeling as an alternative educational tool for medical students was incorporated in a virtual and in-person sub-internship for prospective urology applicants. We aim to review the literature supporting the use of clay modeling in medical education as well as describe our experience with the activity as a way to engage trainees and evaluate early surgical skills.

Methods: The current literature on clay modeling in medical and early surgical education was reviewed using multiple search queries in PubMed. A total of thirteen publications were identified and analyzed, with zero articles specifically discussing urological anatomy or surgery. The pilot study was conducted through the traditional in-person sub-internship as well as through a novel virtual sub-internship at a single academic U.S. Urology residency program. Students were instructed to create a three-dimensional model of a genitourinary organ using modeling clay. Anonymized surveys were collected. Responses of virtual and in-person students were compared.

Key Content and Findings: Clay modeling has been shown in the literature to be beneficial in medical and early surgical education through the use of active learning. Twenty-five total virtual (N=6) and in-person (N=19) students participated in the clay modeling activity. Survey ratings were mixed, with 100% positive responses amongst the virtual group in the areas of “relevance” and “creatively challenging” compared to the in-person cohort, 31.6% of whom responded positively to “relevance” and 47.4% for “creatively challenging” respectively. Overall, students responded positively for the exercise being “creatively challenging” (n=15, 60%) and “enjoyable” (n=16, 64%). Positive results echoed the student perspectives described in the current literature on clay modeling.

Conclusions: Clay modeling has previously been used in the in-person classroom setting as a learning supplement or replacement for dissection classes but has not been previously described for use in the virtual learning environment or within the field of Urology. With ongoing need to develop novel teaching modalities, clay modeling may be a unique tool to enhance learning, and evaluate technical skill, and boost engagement for medical trainees.

Keywords: Clay model; virtual learning; urology; coronavirus disease 2019 (COVID-19); surgical education

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic drastically altered our ability to travel and conduct in-person encounters. This affected not only our daily activities but has also forced us to rethink how we educate medical trainees. Early in the pandemic, there was concern that infection could be spread from trainees to patients, or from patients to trainees. Students were removed from clinical rotations due to risks of disease contraction or transmission, with further reduction of educational content due to cancelation of elective procedures and limitations on available personal protective equipment (1). In addition, in the Spring of 2020 the Society of Academic Urologists (SAU) joined multiple other organizations including the Association of American Medical Colleges (AAMC) and the Accreditation Council for Graduate Medical Education (ACGME) in recommending against in-person rotations for external students (2-4). In the light of these recommendations, residency programs had to reimagine the way medical education was offered by transitioning to virtual programming when possible. Virtual training has significant limitations particularly for surgical specialties as students lack hands-on training opportunities and programs are not able to readily assess applicants' surgical aptitude. Because of these limitations, it is imperative to develop alternative strategies for programs to remain flexible with the times and allow for additional hands-on interaction with trainees and prospective applicants.

One potential way to enhance student engagement through a virtual platform is utilizing art education in medical and early surgical education. Several studies have investigated the incorporation of fine arts in medical school through creative artistic projects, such as sketching a picture of real patient encounters or describing a photograph of a patient with a medical disease (5-9). Medical students who participated in these exercises were noted to have more detailed observations and less observational mistakes when graded on a predefined objective scale, which may have implications in improving diagnostic accuracy amongst these future physicians (5). The same goal can potentially be accomplished with clay modeling. Clay modeling has been used as a learning supplement to augment traditional lecture-style learning (6-9) but has also been used along with virtual reality as a replacement for conventional dissection classes (10).

To adapt to the growing need for virtual rotations, the Division of Urology at our institution (Virginia Commonwealth University) developed a two-week for-credit virtual sub-internship that enabled students to participate in online didactic sessions, simulated telehealth patient encounters, and other virtual activities. A unique aspect of this virtual sub-internship was a clay modeling activity in which participants were asked to construct urological anatomic structures and present them in a group setting. The purpose of the clay modeling activity was three-fold: to teach urological anatomy, to assess technical skills, and to boost student engagement and interaction within the virtual learning environment. Given the positive benefits of clay modeling activities noted in other studies and the ability to conduct these exercises virtually, our clay modeling exercise was subsequently incorporated into our institution's standard in-person sub-internship rotation. Here we propose that clay modeling may be a simple project that is easy to implement at minimal cost to augment anatomical teaching to medical students rotating on the Urology service. We hypothesize that clay modeling fosters engagement and interaction, enhances understanding of anatomical structures, and acts as a way to assess creativity, dexterity and early surgical skills. To our knowledge, use of clay modeling for urological education has not previously been reported. In this paper, we will review the existing literature on the utilization of clay modeling as a learning tool and will highlight our experience with clay modeling as part of our virtual and in-person sub-internship's pilot program. We present this article in accordance with the Narrative Review reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-23-57/rc).

Methods

This study was deemed exempt by the Virginia Commonwealth University Institutional Review Board (IRB) under Category 4, "Secondary data or specimen research that does not require consent". Under this category, participants are not required to provide informed consent as the information is recorded "*in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects*". This study was also conducted in accordance with the Declaration of Helsinki (as revised in 2013).

We reviewed the current literature regarding the utilization of clay modeling in education in order to draw comparisons to our own experiences with our pilot study. The following search query was conducted on PubMed (*Figure 1*, *Table 1*): (clay[Text Word]) OR (3d sculpting[Text

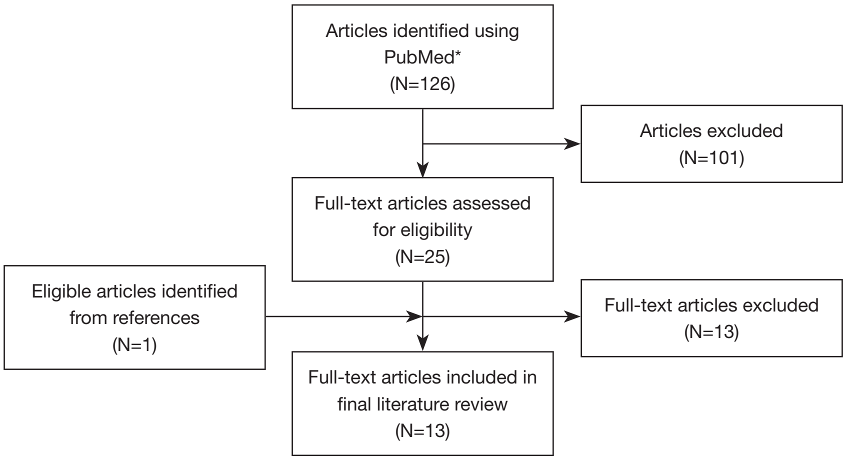

Figure 1 Article inclusion criteria. *, search query: (clay[Text Word]) OR (3d sculpting[Text Word]) AND (anatomy[Text Word]). Not relevant to topic of anatomy (N=9), not relevant to topic of education (N=3), or not available in English (N=1).

Table 1 Narrative review search strategy

Items	Specification
Date of search	December 7, 2020 to April 29, 2021
Databases and other sources searched	PubMed
Search terms used	(clay[Text Word]) OR (3d sculpting[Text Word]) AND (anatomy[Text Word]). See *Figure 1* for more details
Timeframe	None specified
Inclusion and exclusion criteria	Inclusion: articles pertinent clay modeling or three-dimensional sculpting AND education or anatomy. Exclusion: articles written in languages other than English
Selection process	The method of article selection was developed by all authors. The selection process was independently conducted by the first author. The selected articles were verified and confirmed for narrative review by all authors
Any additional considerations, if applicable	One article was retrieved from the references section of another article obtained via search terms

Word]) AND (anatomy[Text Word]).

For the clay modeling pilot study, students participating in our institution's urology virtual sub-internship were each mailed a clay modeling kit and basic clay modeling tools, with the same kits provided to in-person participants (*Figure 2*). On the day of the activity, students were instructed to construct a three-dimensional clay model of any genitourinary organ with these tools. Students were allotted three hours of protected time with additional time in between scheduled activities to complete their models. All students who participated in the sub-internships were required to complete the clay modeling activity as part of the curriculum. During a virtual session with students, residents, and faculty, final models were presented and documented photographically. The session was used by faculty to informally assess student dexterity, attention to detail, and creativity.

Statistical analysis

Anonymized surveys were collected at the end of the sub-internships asking students for feedback on the clay modeling activity, which were answered on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree" (*Figure 3*) and additional space was left for comments about the activity. Comparisons of responses between the virtual and in-person groups were then made. Results are reported as mean ± standard error. Statistical analysis was performed using a one-tailed Students *t*-test.

Results

In our literature, review a total of 126 articles were initially identified. Titles and abstracts were screened for relevance in the topic of clay modeling, education, and anatomy, which excluded 101 articles. Twenty-five full-text articles were assessed for eligibility. Thirteen articles not pertinent to clay modeling or three-dimensional sculpting, not relevant to the topic of education or anatomy, or not available in English were further excluded, which resulted in a subtotal of twelve articles. An additional full-text article was retrieved from the references section from one of these full-text articles, assessed for relevance, and later deemed eligible. Therefore, a total of thirteen articles were ultimately included. There were no articles identified in the current literature on the utilization of clay modeling in urology. See *Table 1* for a tabularized summary of this review search.

Figure 2 Clay modeling kit distributed to sub-internship participants.

A total of 25 fourth-year medical students over four academic years participated in our virtual (N=6) and in-person (N=19) urology sub-internships. The chosen genitourinary organs constructed included kidney, ureter, bladder, prostate, urethra, penis, and testicle, a sample of which are presented in *Figure 4*. Degree of positive response rates on the anonymized survey varied by whether the students participated in the virtual or in-person rotation (*Figure 5*). All six virtual students answered "strongly agree" or "agree" when queried as to whether the clay modeling activity was a valuable learning experience, whether the subject area was relevant, whether the activity was creatively challenging, and whether the activity was enjoyable. Responses were less favorable from in-person students. A response of "strongly agree" or "agree" was obtained from 3 students when queried whether the exercise was a valuable learning experience (15.8%), 6 when queried whether the subject area was relevant (31.6%), 9 when queried whether the activity was creatively challenging (47.4%), and 10 when queried whether the activity was enjoyable (52.5%). In-person participants had significantly lower positive response rates across all questions (P<0.001). One student reported that the objectives of the activity were not clearly described, and two students reported that the activity did not improve their knowledge of the subject area. Several students described the activity as a valuable anatomy teaching tool. Students commented that the activity was a "good quick review of genitourinary anatomy" and "a great way to immerse yourself in anatomy", "helped [the student] better understand inguinal and scrotal anatomy", was "effective at reinforcing anatomical relationships in a reasonable timeframe", and allowed the participant to pay "higher attention to the anatomy of my cross-section

Indicate your agreement with the following items using the 5-point scale provided.	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Objectives were clearly described.	○	○	○	○	○
Overall, this was a valuable learning experience.	○	○	○	○	○
This activity improved my knowledge in this subject area.	○	○	○	○	○
Subject area was relevant.	○	○	○	○	○
I found this activity to be creatively challenging.	○	○	○	○	○
I found this activity to be enjoyable.	○	○	○	○	○

Figure 3 Questionnaire. Distributed to participants following completion of the sub-internship rotation.

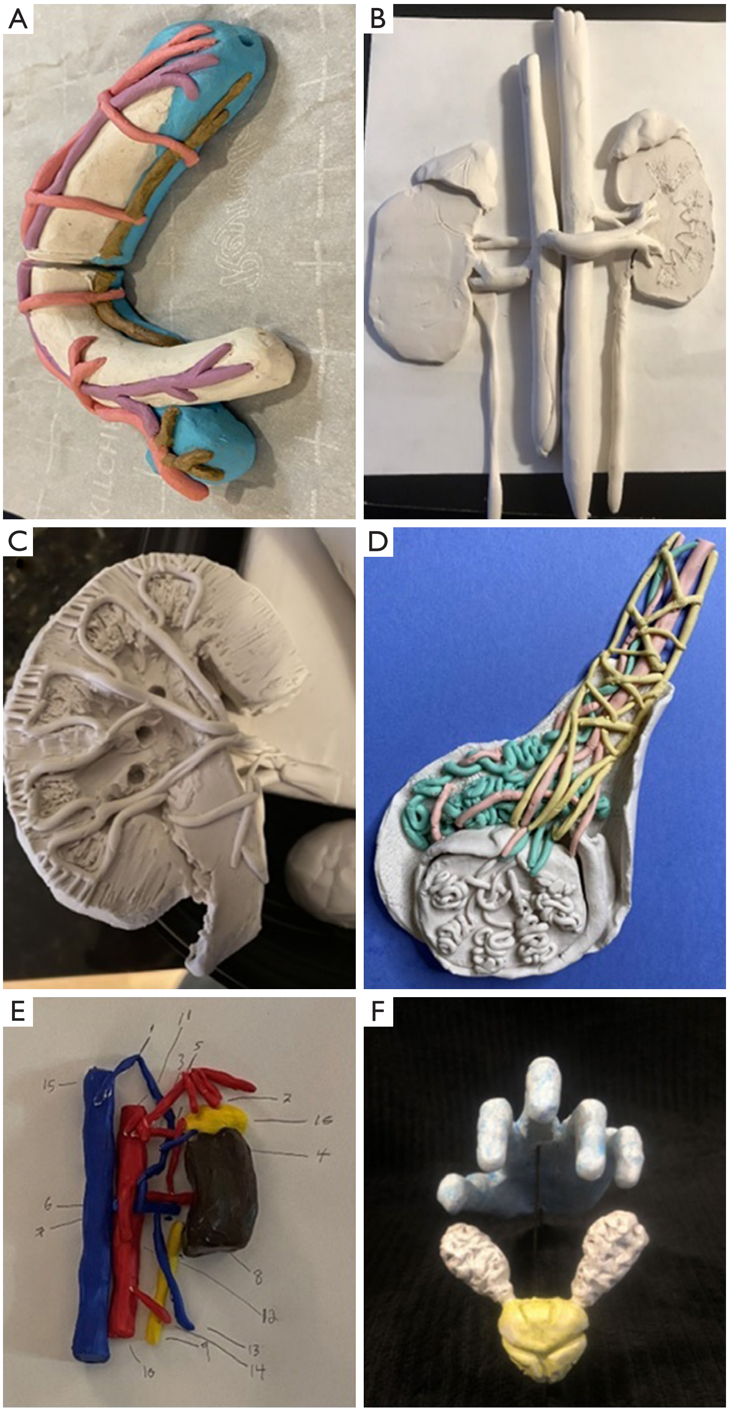

Figure 4 Student-constructed clay models. (A) Penis; (B) bilateral kidneys and vasculature; (C) internal renal anatomy; (D) testis, epididymis and spermatic cord contents; (E) left renal anatomy and vasculature; (F) prostate and seminal vesicles.

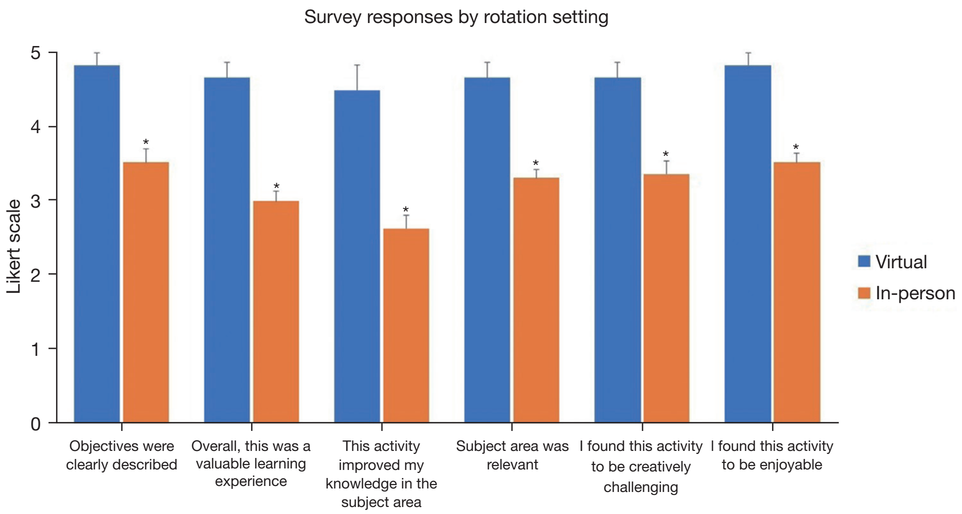

Figure 5 Student survey responses by rotation type. Responses to questionnaire comparing virtual (N=6) to in-person (N=19) rotating urology sub-interns regarding perception of the clay modeling activity, on a Likert scale of 1 to 5 (1= strongly disagree, 2= disagree, 3= neither agree nor disagree, 4= agree, 5= strongly agree). Values are displayed as mean ± standard error of the mean. *, P<0.001.

since [they] "knew [they] could be asked questions about it during the presentation". Additional comments included that the activity "was a good icebreaker when talking to residents and faculty," and "The kit was very comprehensive and nice. I enjoyed getting to show some physical product to the residents as well, instead of just showing them a PowerPoint".

Discussion

Clay modeling has been used to augment education as a hands-on learning tool which may enhance retention and improve test scores. Given previously reported positive benefits of clay modeling in a medical education setting, we attempted to incorporate a clay modeling exercise in our virtual, and subsequently in-person, urology sub-internship rotation. We hypothesized that clay modeling fosters engagement and interaction, enhances understanding of anatomical structures, and acts as a way to assess creativity, dexterity and early surgical skills. Our results suggest that clay modeling was felt to be more beneficial in a virtual setting. Below we review the existing literature on the utility of clay modeling in an educational setting and discuss the findings of our pilot study.

Clay modeling and improvement of educational outcomes

Unlike the passive learning style of lectures and modules that predominate the learning environment, clay modeling is an active learning exercise. Active learning has been shown to increase student engagement and, as a result, student performance. In one study, undergraduate students in science, technology, engineering, and mathematics courses who only participated in passive learning were 1.5 times more likely to fail than students in active learning courses (P<0.001) (11). Although information can be passively received, such as through lectures and modules, constructivist theories suggest that long-lasting understanding and retention rely on active engagement (12). Students participate in active learning by problem-solving, creating, and manipulating structures, such as clay models, with their hands. By manually building clay models, students utilize the sense of touch and receive haptic feedback throughout the activity. This may explain why students who constructed clay models of anatomic structures performed better on exams when compared with students who simply watched a video of the clay modeling activity (5.37±1.40 *vs.* 5.00±1.57, P<0.05) (8). Curlewis *et al*. theorized that the sense of touch during the manual task of assembling clay models enhances three-dimensional understanding, which is important for comprehending spatial relationships in anatomy and surgery (12). Indeed, Zhou *et al*. found that haptic feedback decreased cognitive load and improved surgeon performance when using laparoscopic surgical trainers. The haptics group had a shorter learning curve and higher learning rate when compared with the no-haptics group, as demonstrated by faster average suture and knot-tying times [haptics group $F(17, 1,226)=38.8$, $P<0.001$ *vs.* no-haptics group $F(17, 2,737)=65.2$, $P<0.001$] (13). Like these surgical trainers, clay modeling may also reduce cognitive load through haptic feedback, thus resulting in improved foundational knowledge and exam scores.

Clay modeling as an augment to traditional dissection

In a study by Akle *et al.* comparing clay modeling to traditional lecture-style anatomy learning, the clay modeling group scored significantly higher compared to the lecture-only group on a 5-point scaled quiz (4.25±0.5 *vs.* 3.64±0.6, P<0.0001) (6). Another study by Myers *et al.* demonstrated that only the clay modeling group was observed to maintain long-term retention when given delayed examinations eight weeks later. The clay modeling group scored 24.1±4.6 whereas the control groups scored between (16.8–19.0)±(3.7–6.7) on a 35-point examination (P<0.001) (7). A study by Herur *et al.* similarly demonstrated higher exam scores in students utilizing clay models 30 days after the activity when compared to the control group (50.4±6.8 *vs.* 23.9±7.8, P<0.001) (14). These data suggest that clay modeling is an effective tool to supplement traditional learning modalities and improve retention of knowledge.

Because of benefits to use of clay modeling as a learning tool, this modality has been used as a replacement for conventional dissection classes. Studies have compared clay modeling to animal dissection to teach human anatomy (15-17), though there are no studies directly comparing clay modeling to human cadaver dissection. When students were tested on lower-order questions (i.e., identifying names or functions of anatomical structures), those who solely performed the clay modeling activity scored higher than the students who participated in animal dissections in three separate studies by DeHoff *et al.* (77.3±22.4 *vs.* 61.0±28.7, P<0.01), Haspel *et al.* (82.5±19.8 *vs.* 78.0±23.1, P<0.005), and Waters *et al.* (83.9% *vs.* 56.3%, P<0.000001) (15-17). Though a difference in scores on lower-order questions was noted, there was no statistically significant difference when higher-order questions (i.e., analyzing novel situations not presented in-class) were compared between the clay modeling groups and control groups. These studies suggest that clay modeling may be equivalent, or even superior, to animal dissection in ability to teach human anatomy and could be considered as an alternative teaching strategy to formal dissection. More study is needed to determine if clay modeling could be used as a supplement to, or in place of, human dissection labs to promote anatomy teaching.

Clay modeling in other medical fields

Clay modeling has been predominantly used for anatomy classes at the undergraduate level to facilitate teaching of musculoskeletal and neuroanatomy, but it is beginning to enter the curriculum in higher-level medical education. For example, this technique has been employed in Dermatology training as a teaching tool for Mohs surgery (18). In this setting, models were constructed using various colors of clay representing different layers of the epidermis, dermis, mucosa, and tumors. These models were then used to demonstrate the process of cutting a layer and flattening the bevel to mimic the appearance of a biopsied skin lesion on a histological slide.

In addition, clay models have been used as a method of instruction for radiology in which models of human organs and bones were constructed and subsequently cut into cross-sections as they would appear in radiological images. Students who were assigned to study these cross-sections performed significantly better on their computed tomography exam when compared to the control group (70% *vs.* 50%, P<0.001) (19). Similar courses have been developed using clay modeling activities to train practicing Obstetric/Gynecology and Plastic Surgery physicians (7,20). In an article mentioned earlier by Myers *et al.*, Obstetric/Gynecology residents who participated in the clay modeling activity to learn pelvic anatomy demonstrated better memory retention [24.1±4.6 *vs.* (16.8–19.0)±(3.7–6.7), P<0.001] (7). Cingi *et al.* argue that although not always practical, three-dimensional tools such as clay models allow plastic surgeons to physically manipulate and incorporate the integral element of touch, which may reduce risk and improve surgical outcomes (20). Together, these findings suggest that clay modeling is useful not only as an adjunct to teaching of basic human anatomy, but may also promote increased understanding of surgical and radiological technique and interpretation, leading to improved patient outcomes.

Urological applications for clay modeling

In our study, we found that subjectively for the evaluators, the clay models provided an opportunity to evaluate students' dexterity, attention to detail, and creativity, which are critical skills important for future surgeons. While clay modeling has been used in graduate surgical training and has been demonstrated to improve anatomical knowledge (7), to our knowledge there has been no study on the ability of this activity to assess dexterity, attention to detail or creativity as they relate to surgical training. It is imperative that we as urological educators identify ways to assess students' innate surgical abilities, hand-eye coordination and spaciotemporal reasoning through a virtual platform given the growing need for virtual training which is not likely to diminish in the near future.

A study by Weber *et al*. found a positive correlation between the ability to draw a surgical procedure and the ability to perform that same procedure (21). Medical students, surgical residents, and attending surgeons who correctly drew a 4-strand cruciate tendon repair were found to score higher on assessments in performing the procedure on a simulated model (P=0.004). Weber *et al.* argue that the manual task of drawing not only requires the utilization of visuospatial skills but also is a form of planning and rehearsal for a procedure. We believe that clay modeling activities may provide the same benefits as drawing in improving surgical skills through the active engagement and repeated practice of visuospatial learning. In our pilot study, we found that students displayed wide ranges of creativity, dexterity and attention to detail. For future rotations, we plan to develop a formalized grading system to score models based on creativity and level of detail. Additional work needs to be done to identify the most objective and effective way to evaluate the clay modeling activity as a measure of early surgical skill.

Education and engagement in the post COVID-19 pandemic period

Although it has been over two years since COVID-19 was declared a pandemic, its effects on the educational system are still prominent. Educators have learned to adapt and personalize the teaching and learning experience through methods which are now the "new normal" (22). Such changes have included asynchronous learning, inquiry-based learning, and increased usage of flipped-classroom approaches (22). With the return of face-to-face learning over time, an increase in student reports of shorter attention spans has been noted (23). A recent study found increases in negative feelings amongst students surveyed at high school, undergraduate, and postgraduate levels throughout eight weeks of lockdown during 2020 (24). The survey also demonstrated that students across all levels expressed lower levels of energy and higher levels of anxiety and stress (24). To rectify these negative feelings reported by students, authors encouraged making the learning process more interactive as one of many potential solutions (23,24).

Students engaged in clay modeling exercises have also reported subjective benefits including decreased perceived difficulty of the study topic, increased student engagement, and perception of a more positive learning environment (6,7,9,11,12,25). In a study performed by Akle *et al*., initial survey responses prior to performing the clay modeling activity indicated an overall negative attitude towards the clay modeling activities due to a perceived juvenile nature, but most responses were predominantly positive after completion of the activity. Students reported spending less time studying and perceived the material to be less difficult for the topic that utilized clay modeling (6). Students also reported that clay modeling promoted a positive learning environment by encouraging communication (6). Other studies confirmed these findings with some students preferring clay modeling as the primary method of instruction when learning anatomy (17). While most students report positive experiences with clay modeling activities, a study by Oh *et al*. reported that some students felt disengaged due to their "poor artistic ability" (19). Allowing clay modeling to be a part of the educational experience reduces the monotony of online lectures and virtual hiccups, increases student interest, and restores engagement on multiple levels in an educational environment disrupted by COVID-19.

Clay modeling pilot study

To our knowledge, there are currently no studies investigating the utility of clay modeling in urological education. Because residency programs were encouraged to offer virtual sub-internships during the COVID-19 pandemic, the Urology Residency Program at our institution developed an entirely virtual curriculum for rotating students. In order to incorporate a wide variety of virtual learning activities, our institution piloted a unique clay modeling activity. The clay modeling exercise was initially used as a tool for virtual visiting medical students to showcase their knowledge in urological anatomy, to foster student and faculty engagement, and to examine the possibility of utilizing clay modeling as a subjective approximation of student dexterity, creativity, and attention to detail. Given initial positive feedback, the activity was quickly rolled out to in-person visiting sub-internship participants as well. Our pilot study survey

Table 2 Student perspectives of clay modeling in medical education reported in the existing literature

Positive	Negative
Activity promoted positive learning environment (Akle *et al.* 2018)	Activity seen as juvenile and kindergarten-like (Akle *et al.* 2018)
Activity encouraged communication between students (Akle *et al.* 2018)	Activity taking time away from other learning opportunities (Akle *et al.* 2018)
Activity was fun (DeHoff *et al.* 2011)	Felt disengaged from activity due to poor artistic ability (Oh *et al.* 2009)
Perceived decreased difficulty of subject with the activity (Akle *et al.* 2018)	
Spent overall less time studying in subject with the activity (Akle *et al.* 2018)	
Preferred activity as primary method of instruction for anatomy (DeHoff *et al.* 2011)	

findings are similar those in other disciplines and that of the current literature (*Table 2*), demonstrating 100% positive perspectives towards clay modeling when completed in a virtual-learning environment, yet more mixed responses when completed in-person (*Figure 5*) (7,18-20). The reduced satisfaction among participants in an in-person setting may be due to the fact that their anatomical education is mainly addressed by in-person operative learning.

While our pilot study is limited by our small number of participants, the clay modeling exercise completed by the sub-internship students was a unique way to enhance learning of urological anatomy and boost student engagement. We demonstrated that this activity was able to be successfully completed using a virtual platform and was readily scalable to a larger number of participants. In addition, this activity could be easily performed at the resident educational level and could be adapted to a higher level of anatomical and urological knowledge depending on the target audience.

Other limitations have been identified in our pilot study. While clay models may provide rudimentary representations of anatomical structures, it may not be as detailed as required for advanced surgical procedures. However, Wilson *et al*. theorized that increased cognitive load diminishes learning, due to overload of processing required to interpret novel information and to subsequently integrate it with existing knowledge (26). When compared with traditional dissection, clay modeling is thought to decrease cognitive load. Clay models take away unwanted anatomical detail and stimuli that would be present in the analogous dissected structure from a cadaver (12). By doing so, this prevents cognitive overload and thus improves learning (26). For students who are beginning their surgical training, clay models may be a useful educational tool by focusing learning on the most important aspects of an anatomic structure. As a result, trainees may more easily achieve the strong foundational anatomic knowledge that is necessary to excel in surgery.

It is also possible that any students who had prior artistic training would tend to answer the survey more positively due to their already established interest in art. These students may also be more likely to construct highly detailed and impressive models, which could potentially lead to confirmation bias when relying on this activity as an educational tool for students with limited artistic abilities. Additionally, these students were participating in a sub-internship with an assumed interest in applying to our Division of Urology's residency program, so it is possible the students felt inclined to answer the survey more positively despite surveys being collected in an anonymous fashion.

For this pilot study, we hypothesized that clay modeling enhances engagement, promotes learning of anatomic structures and acts a surrogate for in-person assessment of early surgical skills. Our results suggest that this may be most effective as an educational tool in a virtual setting, but can allow evaluators to virtually asses participant's dexterity and creativity as an approximation of early surgical skills. More work needs to be done to be done to develop an objective evaluation system for the clay models and to determine whether participating in clay modeling exercise translates to longer term improvements in urological knowledge both at an institutional level and on a wider scale.

Conclusions

As increasing emphasis is being placed on developing untraditional ways to educate students, with an increased virtual presence, the use of hands-on activities such as clay modeling deployed virtually may improve engagement and education of medical trainees and approximate preliminary assessment of early surgical skills. Virtual learning has been typically predominated by passive learning methods such as formal didactic sessions and review of pre-recorded educational videos. Clay modeling, an active learning process, has previously been demonstrated to be superior to lecture-based or video-based teaching when learning anatomy (6,7,9), which suggests that clay modeling may be a useful supplement or even replacement when teaching anatomy online. Though as educators we have been able to resume some of our more traditional teaching modalities, the need to develop innovative training tools persists. We believe clay modeling has been an underutilized training modality and should be considered as an engaging and effective training tool to promote anatomical knowledge and may be used to assess certain aspects of student performance and early surgical skills, especially in a virtual learning environment.

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Footnote

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-23-57/rc

Peer Review File: Available at https://tau.amegroups.com/article/view/10.21037/tau-23-57/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-23-57/coif). The authors have no conflicts of interest to disclose.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was deemed exempt by the Virginia Commonwealth University Institutional Review Board (IRB) under Category 4, "Secondary data or specimen research that does not require consent". Under this category, participants are not required to provide informed consent as the information is recorded "*in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects*". This study was also conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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