Title:

Enhancing Medical Education through Clay-Modeling: A Cross-Sectional Study on Teaching Facial Muscle Anatomy

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ABSTRACT.

Background

Clay-modeling in anatomy education is an engaging activity that complements cadaveric dissections. The post-COVID-19 cadaver shortage further necessitates alternative practical modalities.

Methods

A student-centered clay-modeling practical activity was developed towards the study of the muscles of facial expression due to a shortage of cadaveric material. Student feedback in the form of a questionnaire with closed- and open-ended questions was used. 21 students completed the questionnaire. Thematic analysis was inductively and manually performed to generate the primary and secondary themes associated with the open-ended questions.

Results

Four themes were generated: fun, collaboration, active learning, and bittersweet. Closed-ended questions revealed that respondents found the activity motivational and enjoyable. However, students expressed mixed emotions during the disassembly of their anatomical models. Some students described a sense of sadness, while others reported feeling devastated, reflecting the emotional investment and attachment they had developed toward their work. Conclusion

The outcome of this study presents the opportunity for further work to link discussions around the humanistic considerations of anatomy and the study of human remains, utilizing clay modeling as a crucial resource. This approach offers a sustainable, engaging alternative to traditional cadaver-based anatomy education, especially in resource-limited settings.

Key Words: clay-modeling, anatomy education, practical, facial muscles, active learning, medical education innovation, cadaver alternatives.

INTRODUCTION.

Dissecting the muscles of facial expression is particularly challenging and time-consuming, especially in formalin-embalmed cadavers.[1] This holds particularly true in instances where cadaveric material presents with decreased skeletal muscle mass, central adiposity[2], and facial fat atrophy.[3] Furthermore, the global shortage of cadaveric material due to the COVID-19 pandemic necessitates alternative approaches to the delivery of anatomy as a subject.[4–6]

One such alternative is clay-modeling.[7] Studies have shown that teaching anatomy through art activities increases the observational skills and memory of students as well as encourages engagement in the learning process. An 8-week first-year course of 'Art in Medicine' has been implemented at Brighton and Sussex Medical School and has proven successful according to student feedback.[8] Clay models are especially used as an alternative to classical cadaveric dissections or as an adjunct.[2] Globally, there are institutions without access to cadaveric material and animal specimens, such as pigs or cats, are used for routine dissections and surgical training.[9] Furthermore, dissection is not a uniform learning experience and complementary innovative learning methods, such as clay-modeling, should be incorporated.[10]

Anatomical education traditionally relies on cadaveric dissection, but challenges such as limited cadaver availability necessitate alternative learning methods. Clay-modeling provides a hands-on, interactive approach that enhances spatial understanding and anatomical visualization, offering a valuable complement to traditional teaching. [2,11,12]Unlike dissection, which involves deconstruction, clay-modeling enables students to actively construct structures, reinforcing three-dimensional comprehension.[7] Studies have demonstrated that students who engage in clay-modeling show improved anatomical knowledge, increased engagement, and better retention compared to those using passive learning methods. [11]Additionally, collaborative clay-modeling fosters problem-solving, communication, and creative thinking skills. Research further supports its effectiveness as an alternative to animal dissections, with Motoike et al. demonstrating superior learning outcomes in clay-modeling compared to cat dissections. [13]Given its cognitive benefits and accessibility, clay-modeling presents a viable and engaging supplement to cadaver-based learning in anatomy education.

[2]

The current study presents a cost-effective and participatory innovation to the practical learning of the muscles of facial expression through clay-modeling. The authors hypothesized that clay-modeling, through its tactile and visual engagement, would enhance students' understanding of facial muscle anatomy and foster positive emotional and collaborative learning experiences. The overall aim of the study was to determine the feasibility of a cost-effective clay-modeling approach and gain students' perceptions on the modality. Furthermore, the study also explores the value of clay-modeling as a potential alternative to cadaveric dissection to facilitate students' learning of the muscles of facial expression.

METHODS

A cross-sectional survey study design was followed involving second-year medical students and relied on convenience sampling. Thus, an observational cross-sectional study utilizing a mixed-methods approach, incorporating both quantitative and qualitative data collection, was conducted. The intervention was presented as part of students' practical laboratory session on the muscles of facial expression and was necessitated by a shortage of cadaveric material due to the COVID-19 pandemic. White concrete skulls were made after obtaining silicone cake molds (Fig. 1). The silicone molds were first secured in wet sand, serving as a master mold and to prevent distortion (Fig. 1), before the cement slurry was added. Once cured, the casts were removed and sprayed with white paint.

The practical sessions followed theoretical lectures on the embryology of the face and muscles of facial expression. Traditionally, practical sessions would require around eight students in their respective groups to dissect the muscles of facial expression on one cadaver for 115 minutes. The same practical on the same material had to be repeated to ensure that the entire cohort gains exposure to the material and addresses the intended learning objectives. The alternative approach outlined here was designed to match, as best possible, the duration of our traditional dissection approach. Within the current modality, groups of students were provided with one concrete skull cast between them, a practical worksheet, and resources. The resources consisted of an anatomy atlas, and a laminated worksheet with the respective muscles, their functions, and origins and insertions. Artistic sculpting clay (circa 400g) was provided for each group of four students. Eighteen groups, comprising 73 students, participated in the practical sessions. The first cohort of 36 students, consisting of nine groups and four students per group, was tasked with a practical laboratory session to model the muscles of facial expression (Table 1). This activity was duplicated for the second cohort on the same day and totaled 37 students (one group had five members instead of four). Thus, two consecutive practical sessions, both relying on clay-modeling, were conducted. An outline of each session and the duration of each phase is provided in Table 1 and each session lasted one hour and 50 minutes. This afforded all staff 10 minutes to prepare for the next session. Lecturing staff served as facilitators during each practical session and rotated among the groups of students.

Fig. 1. Please insert here.

Table 1. An outline of the practical session and expected outcomes.

Phase (duration)	**Activity**
Phase 1 (10 minutes)	Familiarization with the practical task and planning.
Phase 2 (70 minutes)	Execution: *Use the resources provided to model the muscles of facial expression.* *Model the branches of the facial nerve.* *In a table, indicate which specific branch of CN VII innervates which muscles.*

Phase 3 (10 minutes)	Peer assessment and feedback (informal)
Phase 4 (10 minutes)	Disassembly and cleaning of the workstations.

Student feedback was collected using a questionnaire comprising both closed- and open-ended questions. The open-ended questions were adopted from the work of Akle et al. and expanded to evoke reflective responses (Appendix I).[14] Key questions included whether the activity allowed for independent task performance, its motivational and enjoyable aspects, adequacy of resources, and overall effectiveness as a learning experience. Students were also asked about their recommendations, learning outcomes, and thoughts on modeling in clay.

Ethical considerations

Participant recruitment was done through electronic announcements via email and the course management system (Moodle). Only volunteering participants, after recruiting and providing written consent, completed the questionnaire after the practical sessions in August 2023. Students who were part of the practical sessions were included in the study and any student who was absent was excluded. To ensure anonymity, no identifying information was collected, and responses were coded. Confidentiality was maintained by securely storing the data and limiting access to the research team only. Ethical approval for the data collection was obtained through the Namibian Ministry of Health and Social Services (Ref#TC2022).

Data analysis

Data associated with the closed-ended questions were analyzed and presented as percentages. Next, responses to the open-ended questions were subjected to manual thematic analysis (TA). An inductive approach for latent themes was followed.[15] TA was manually performed to generate the primary and secondary themes associated with the open-ended questions.[16] The generation of primary and secondary themes followed a similar approach to the work of Radzi et al. and the six-phase approach of Braun and Clarke.[17,18] Briefly, the phases followed data familiarization, coding, identification of themes, reviewing of the themes, definition, and reporting.[18] . TA was used to identify and analyze patterns of meaning within the questionnaire responses by identifying latent themes and to understand the attitudes and perceptions of second-year medical students' exposure to clay-modeling.[15,16,19] A reflexive approach was adopted where the researchers were immersed in data familiarization, coding, and theme development, rather than coding reliability and using a codebook approach.[16,20]

RESULTS.

A total of 21 students, 8 males and 13 females (aged 19 to 24, mean age = 20 ± 1.40), completed the questionnaire (27.8% response rate) and provided written consent. On average, 20.6 (±0.84) participants responded "yes" to the survey questions, with a range of 20 to 21 affirmative responses. Similarly, the mean number of "no" responses was 0.4 (±0.84). A total of 20/21 (95%) of participants felt that they were able to perform the tasks independently (Figure 2), while 1/21 (5%) indicated that group work limited their ability to model all the muscles themselves. All participants (21/21, 100%) found the activity motivational and enjoyable. Additionally, 20/21 (95%) indicated that the resources were sufficient, although one participant noted that supporting resources (paper diagrams) could have been limited without textbook access. In terms of learning outcomes, 20/21 (95%) of participants reported gaining new knowledge, while one participant expressed that, although they did not necessarily learn something new, the activity helped them appreciate the complexity of facial expressions in a small anatomical area. All participants (21/21, 100%) responded positively, with some suggesting further applications of this activity, such as modeling the muscles of the hand
Figure 2. Please insert here.

The themes generated from the students' responses are shown in Figure 3 and four themes were generated: Fun, Collaboration, Active Learning, and Bittersweet. These themes in turn point towards cooperative learning.

Fig. 3. Please insert here

Theme 1: Fun

Most respondents found the practical session with clay-modeling highly enjoyable. Students also noted that they were actively playing while learning the muscles of facial expression.

> "It showed that learning could be fun instead of stressful"
> "It was motivational as it gave me the chance to learn as well as have fun at the same time"
> "We had the opportunity to link having fun to studying in a way"

A participant also mentioned that they wanted to spend more time on the activity.

> "I wish the session was longer"

Participants self-declared that the clay-modeling session inspired their creative side and felt that they were actively playing and having fun while learning the muscles of the face. Clay-modeling permitted creativity and allowed students to put theory into practice and form linkages.

Theme 2: Collaboration

Collaborative learning experiences, in the form of practical teams, helped encourage communities of practice in learning and foster deeper learning approaches.

> "We had the help of the lecturers to guide us and our fellow students were also willing to help one another"

"The teamwork, having to plan and think creatively was very fun"
"Wonderful bonding exercise and funner way of learning anatomy"

Respondents perceived the group work as being valuable in their learning experience. The participants recognized that such strategies increased their motivation and enhanced their engagement while learning anatomy.

Theme 3: Active Learning

The students perceived that the active and engaging learning strategy of clay-modeling can be used as a constructive learning tool in anatomy.

"It was different from just looking at 2D pictures in a textbook"
"It helps a student to think about the anatomy of the muscles (in relation to each other)"
"It helped me in understanding which muscles are positioned where and what they do and how superficial or deep the muscles are"

Some participants commented on the fact that creating the anatomical clay models reinforced the learning of that structure. Students can physically manipulate and mold the clay to create a more accurate representation, which can help them remember the structure better.

"By modeling the muscles and learning their anatomical relations to one another, it makes it easier to retain the knowledge"
"It also made learning the muscle easily because the activity required to take into account the origin and insertion of each muscle"

The clay models also allowed the students to express their creativity and artistic abilities while learning about anatomy.

"Learn the muscles of the face in a more creative manner"
"Express my creativity and gave me a platform to freely learn without any external pressure"

Participants commented on the fact that creating the models allowed them to learn through hands-on experience. This can be particularly helpful for students who are tactile learners and prefer to learn by doing.

"I loved the fact that I could get my hands dirty while actually learning"

"practical way of learning facial muscles and not just memorizing them from an atlas"
"I find I prefer hands-on learning more than just being told about it"

In a learning system of parrot-fashion memorization, muscle actions, origin and insertion of facial muscles have little context and, thus, are less relevant to students and become difficult to learn and remember. Rather, interacting in a hands-on manner with clay-based modeling can help students better visualize the facial muscle.

Theme 4: Bittersweet

The students had conflicting emotions regarding the building and the breaking down of the clay models after the session was completed.

> “It was a bittersweet moment”
> “It felt emotional because we put in a lot of effort”
> “It was really devastating destroying something we created”
>
> These sentiments highlight the significant emotional investment students made in the modeling process, suggesting that their connection to the models extended beyond mere academic exercise. A participant even articulated that the clay-modeling process of building and breaking down reminded them of the cycle of life and death, stating: “It made me realize I don't really like the concept of "the cycle of life."

These insights underscore the profound nature of the learning experience, indicating that the act of creating and then dismantling the models may evoke reflections on broader existential themes. Exploring these emotional responses can provide valuable insights into how such activities contribute to students' personal growth and understanding of complex concepts within anatomy education.

DISCUSSION

Clay-modeling involves constructing anatomical models to represent the three-dimensional structure of organs and systems..[11] Through this hands-on, interactive approach, the building of clay models allows for an improved understanding of spatial relationships between structures and the precise location of structures. This form of anatomy teaching is creative and fun, allowing students to actively enhance their long-term retention of anatomical knowledge in an enjoyable, positive environment.

The current study presents some limitations. Firstly, the rather small response rate could reflect respondent bias.. It could be that only those who really enjoyed and valued the activity responded to the survey, with those who had neutral feelings potentially not engaging in the survey. It may also be that allowing the students a week post activity to complete the surveys meant that some could have felt they didn't feel that they were adequately able to remember their feelings about the session, requiring students to complete the questionnaires immediately post sessions might have yielded higher response rates. Equally offering the opportunity to answer online and in hard copy may have been a means to increase response rate. Secondly, the intervention was not compared with a control group such as a standard approach of dissections or other modalities such as demonstrations. Our primary motivation was driven by a lack of resources (human remains) and an already congested curriculum in terms of time. Exploring comparator groups within the scheduled curriculum time increases the cognitive load on students by having to process at least two different modalities of delivery of the same material and this can reduce student satisfaction with such learning, as they find themselves having to repeat the same material when they feel they may be able to utilize their time more productively. Equally running additional sessions for students purely to participate in research of novel methodologies beyond their allocated curriculum time may be viewed as unequitable and discriminate against students who have responsibilities beyond their scheduled curriculum commitments. Finally, another limitation relates to external validity due to feedback on the innovation that is restricted to one university. It is therefore difficult to generalize the findings of the current study.

Our findings show that student engagement was increased during study and students' grasp of the anatomical relationships in the human body was improved. These findings correspond to the work of Kooloos et al. who demonstrated that clay-modeling is an active and tactile learning tool.[7] Research has shown that, for effective learning, students must actively participate in the learning process.[21] Furthermore, in this study, the active learning process was employed when the students were required to build and manipulate the models.[18] However, research suggests that clay-modeling does not improve anatomical knowledge compared to students who only employed video material.[2] The most important pedagogical advantage of clay-modeling, as noted by Kooloos and colleagues, is active involvement.[2]

The building of anatomical clay models adds a tactile approach to learning, which offers an alternative approach to the comprehension and retention of information. Furthermore, respondents from the current study also commented that they would prefer different colors of clay. According to Akle et al., adding color-coding structures may also supplement the learning effect as there have been correlations between color recognition and the recall of information.[14] A possible solution within the current context would be to add a color pigment to the clay. Furthermore, on a technical note, we found that artistic clay is easier to clean compared to plasticine and easier to model compared to wax.[22] This in turn optimizes the time students can spend learning

and reduces the time between sessions spent by staff on recalibrating stations, enabling them to focus on other aspects of student learning, such as questions.

Other, more pragmatic factors make clay models a useful educational tool. For example, clay specimens are convenient to store, odorless, easy to handle and relatively cost-effective, particularly compared to traditional cadaveric resources.[23] Clay-modeling allows students to construct models rather than spend hours dissecting and potentially damaging important structures, which is of benefit in an educational climate that is seeing reduced contact hours for anatomy education.[24,25] Furthermore, clay-modeling allows for the re-use of both the clay and skull template and it enables students to build their own 3D representation of the task, which can be helpful in their own learning journey to understand the representation of 2D structures seen in textbooks. This also applies to online resources and how they translate into the 3D anatomical structures they are required to gain an understanding of. The proposed concrete alternative as presented in the current study serves as a cost-effective modality in resource-constrained settings. This alternative has the potential to permit students to model the muscles of facial expressions remotely and thus serve as an extracurricular activity. Therefore, to a degree, clay models make an excellent complement to traditional dissection and a potential alternative where cadaveric material is not feasible due to scarcity or affordability issues. could also be presented in a hybrid or blended format where online lectures are complemented with face-to-face practical sessions. Post-covid trends in anatomy education indicate students' preferences towards such approaches [26]. The Covid-19 pandemic necessitated a shift to digital technologies and studies on their effectiveness have been subjective [27]. A pre-covid meta-analysis by Wilson and colleagues provides potential insights into the effectiveness of alternative educational modalities. They found that students' performance in anatomy was equivalent when comparing traditional dissections with alternative modalities such as digital media, 3D models, prosections, and hybrid approaches [28]. However, Curlewis and colleagues noted that clay-modeling cannot serve as a complete substitute for human tissue as it lacks detailed anatomy.[21]

Other potential advantages, such as students being able to work on the anatomical variability that occurs with muscle and nerve courses. The dissection room provides exposure to some of these normal variants, but it is not always present in each donor cohort and therefore clay-modeling may provide a useful adjunct to students looking to convert the 2D presentation they see in textbooks into 3D resources. The challenges of observing nerves such as the facial nerve, or chorda tympani in the dissecting room are well documented and clay-modeling may present a resource that enables students to visualize the course and relationship with neighboring structures without having to dissect for prolonged periods in the hope that they can observe all the necessary structures and their relationships.[29] The importance and value of clay in increasing student performance on peripheral nervous structures has been shown by DeHoff and colleagues in undergraduate anatomy class.[30] One possible drawback within the current study relates to the anatomical accuracy of the casts that were used. However, staff ensured that the necessary anatomical landmarks were present, and all students found them identifiable enough to permit completion of the task at hand, as evidenced by student feedback, with no reference to issues relating to origin or insertion points.

Our study shows the value of clay-modeling for medical students in their learning of anatomy. It has also recently been shown that clay-modeling is a valuable tool to postgraduate students as a revision resource to

increase their confidence in pelvic anatomy knowledge amongst obstetrics and gynecology residents, demonstrating that clay-modeling has longevity in learning and revision across the healthcare spectrum.[23]

Our findings also highlight the importance of collaboration among students. This collaboration, along with social interaction, active learning, problem solving, and group work to achieve the indented objective of understanding the muscles of facial expression, is the cornerstone of cooperative learning [31]. The importance of collaborative learning in anatomy is well-documented and includes students' ability to learn communication and leadership skills.[32] From our findings, we noticed that students were forced to plan in a group during the planning phase of the activity, grappling with translating theoretical knowledge into practice. They had to think of the layering of the muscles (superficial to deep) and the associated origin and insertion of each. The alignment and portrayal of muscle fascicles was another element students had to compete with and portray in their clay model. Although not assessed, it is believed that discussions between group members increased their practical knowledge. This co-construction of new knowledge, expansion of students' existing theoretical understanding through experiential learning, and guidance by academic staff follows a social constructivist paradigm.[33] The peer assessment and feedback phase provided a further opportunity for collaboration and cooperative learning. The sharing of knowledge, though informal, is encouraged and is advantageous even if not formally included in the learning outcomes.[34] In hindsight, a formal peer-assessment checklist could be used to further foster collaborative learning and could include specifics such as muscle fascicle orientation, anatomical accuracy for the origin and insertion, and muscle layering.

Emotional responses

Finally, and certainly an interesting finding of our study, students' experiences associated with the disassembly of the models revealed feelings of loss and grief among some respondents. Dueñas and colleagues highlight the lack of research on coping strategies employed by students and staff when faced with stressors within an anatomy practical laboratory.[35] Our findings reflect varied responses associated with the activity of disassembly of students' clay models. Gross anatomy laboratories elicit emotional responses, and much understanding has been gained around students' first experience with death.[36–38] It should be noted that students within the current study have had prior exposure to cadavers and cadaveric material. However, the varied emotional responses ranging from "sad" to "devastating" further support the need to bolster humanistic considerations in anatomy education. The emotional responses from our respondents were associated with clay-modeling and not linked to the cadaveric material, which was unexpected but given the time and effort invested in creating their learning resources, being asked to disassemble, it is not surprising that it evokes a sad feeling. These responses highlight the need to be actively cognizant of students' emotional well-being at all times and demonstrate that these kinds of activities are capable of activating learning and skills beyond the purely anatomical intended objectives. The incorporation of reflective writing is one possible and future approach to better understand students' emotional responses and personal experiences within the gross anatomy laboratory.[39] An interdisciplinary and formal approach to dealing with death is not new and exists within many anatomy programmes.[40,41] The unearthing of these responses may also be valuable as a resource to trigger teaching and learning around sciences beyond anatomy, such as body ownership and the ethical dilemma that comes with death. Aligning with other learning outcomes beyond anatomical may help to

alleviate some of the congestion that occurs in a medical curriculum and aligns with clinical experiences that students will encounter in the future, where the biomedical treatment is only one factor in the care of a patient.

Critical reflection by the participants presents the opportunity for future work to link discussions around the humanistic considerations of anatomy and the study of human remains, such as “ownership”, morality, ethics, loss, and grief. The inclusion of critical reflection provides an opportunity for transformative learning. The authors believe that the breakdown of the clay models and students’ consequent perceptions could serve as a primer towards the discourse on loss, bereavement, and ethics. It is important to ensure that where these themes have arisen from clay-modelling or more traditional anatomical teaching methodologies, that an appropriate opportunity for reflective practice and consolidation of discussions can occur. This should follow constructive alignment with curricular learning outcomes linked to ethics, resilience, body ownership and many other non-biomedical sciences themes. Students’ emotional response can affect learning, memory and recall.[42] Intense negative emotions such as distress and fear can impair learning and memory but are dependent on an individual’s past experiences. On the other hand, low-intensity negative emotions can enhance recall of specific details of an event and is known as the “memory narrowing effect”.[42,43] The effect of emotional responses on students’ learning and memory was not explored but warrants further investigation. A further and future approach would entail the assessment of student performance when comparing clay-modeling with traditional practical dissections or online video tutorials which become popular through Covid and are still an adjunct to practical sessions. In planning these future comparative studies, careful thought needs to be given to student cognitive load, time availability and equity of access.

In conclusion, clay-modeling presents a resource which can allow for the development of multiple skills as well as knowledge acquisition in the presence and absence of traditional cadaveric dissection. Clay-modeling offers a cost-effective, engaging alternative to cadaveric dissection, fostering active learning, collaboration, and emotional engagement. Future studies should explore its comparative effectiveness in larger, diverse student populations.”

SUMMARY - ACCELERATING TRANSLATION

Main Problem to Solve:
Traditional methods of studying facial muscles, such as cadaveric dissections, are time-consuming, resource-intensive, and affected by global shortages of cadaveric material due to the COVID-19 pandemic. Finding effective alternatives to teach anatomy, particularly the intricate muscles of facial expression, is crucial.

Aim of Study:
This study aimed to assess the effectiveness and student perceptions of using clay-modeling as an alternative method for learning the muscles of facial expression among medical students. The study also sought to explore the emotional responses associated with this learning approach.

Methodology:
A cross-sectional survey study design was employed involving second-year medical students. Due to a shortage of cadaveric material, white concrete skull casts were made using silicone molds. Practical sessions were conducted where students, working in groups, modeled the muscles of facial expression using artistic sculpting clay. A questionnaire with closed- and open-ended questions was used to gather feedback from participants. Thematic analysis was inductively and manually performed on the open-ended questions.

Results:
Twenty-one students participated in the study, with overwhelmingly positive feedback. Participants found the activity motivational, enjoyable, and conducive to learning. The themes from the responses included enjoyment, collaboration, active learning, and bittersweet feelings associated with disassembling the clay models.

Conclusion:
Clay-modeling emerged as a cost-effective, enjoyable, and effective method for teaching facial muscle anatomy. It promoted collaboration, active learning, and creativity among students, while also highlighting the importance of addressing emotional well-being during the disassembly phase of the activity. This study underscores the potential of clay-modeling as a valuable complement or alternative to traditional cadaveric dissections, particularly in resource-constrained settings or during times of cadaveric material shortages. Given its accessibility and low-cost nature, clay-modeling could be scaled and integrated into curricula as a sustainable, hands-on learning tool, enabling a more inclusive approach to anatomy education that benefits a broader range of institutions and students.

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FIGURES AND TABLES.

Fig. 1. A: The cake mold was secured in loose and wet sand to prevent distortion of the soft silicone. B: The cement slurry after pouring. C: The cured concrete skull after it has been coated with white paint. D: A student layering the muscles (both 2D resources and cadaveric prosections were at their disposal). E: Corrections and additional muscles added. F: The addition of fascicle direction towards a near complete product.

Figure 2. Responses to the closed-ended questions for both males and females (n = 21).

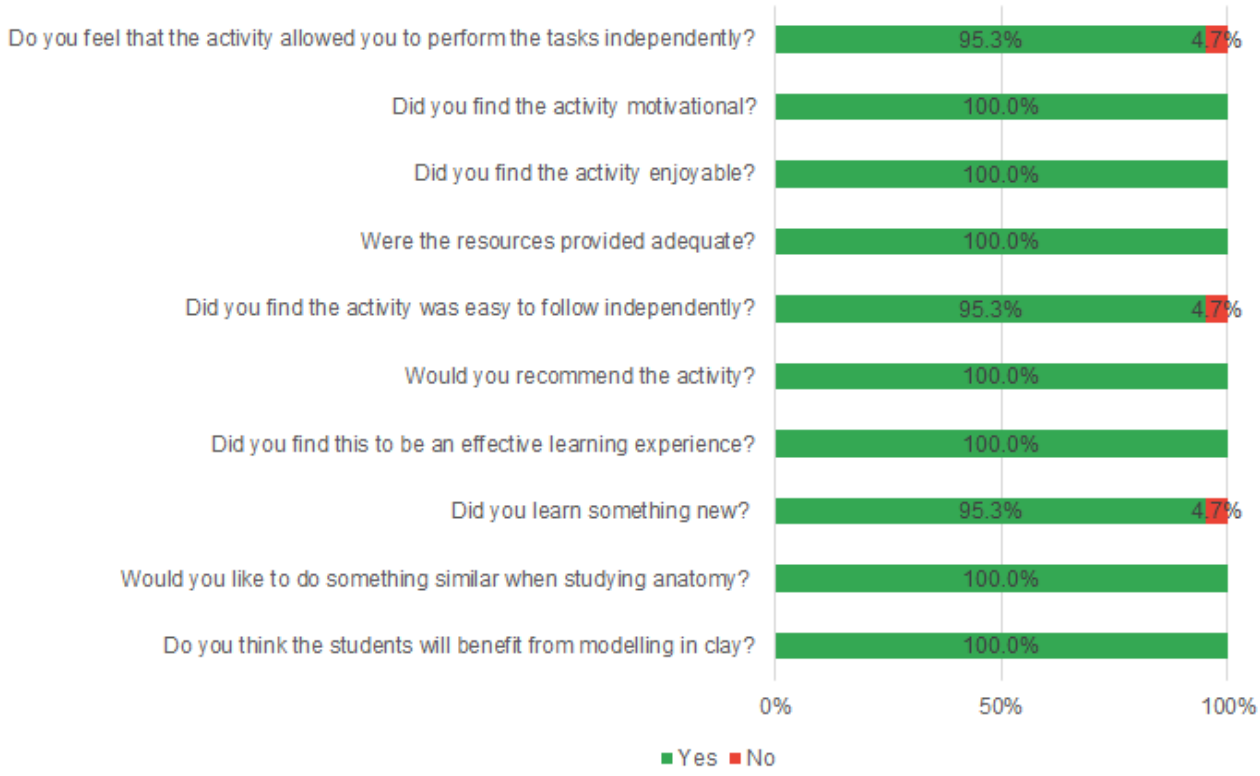
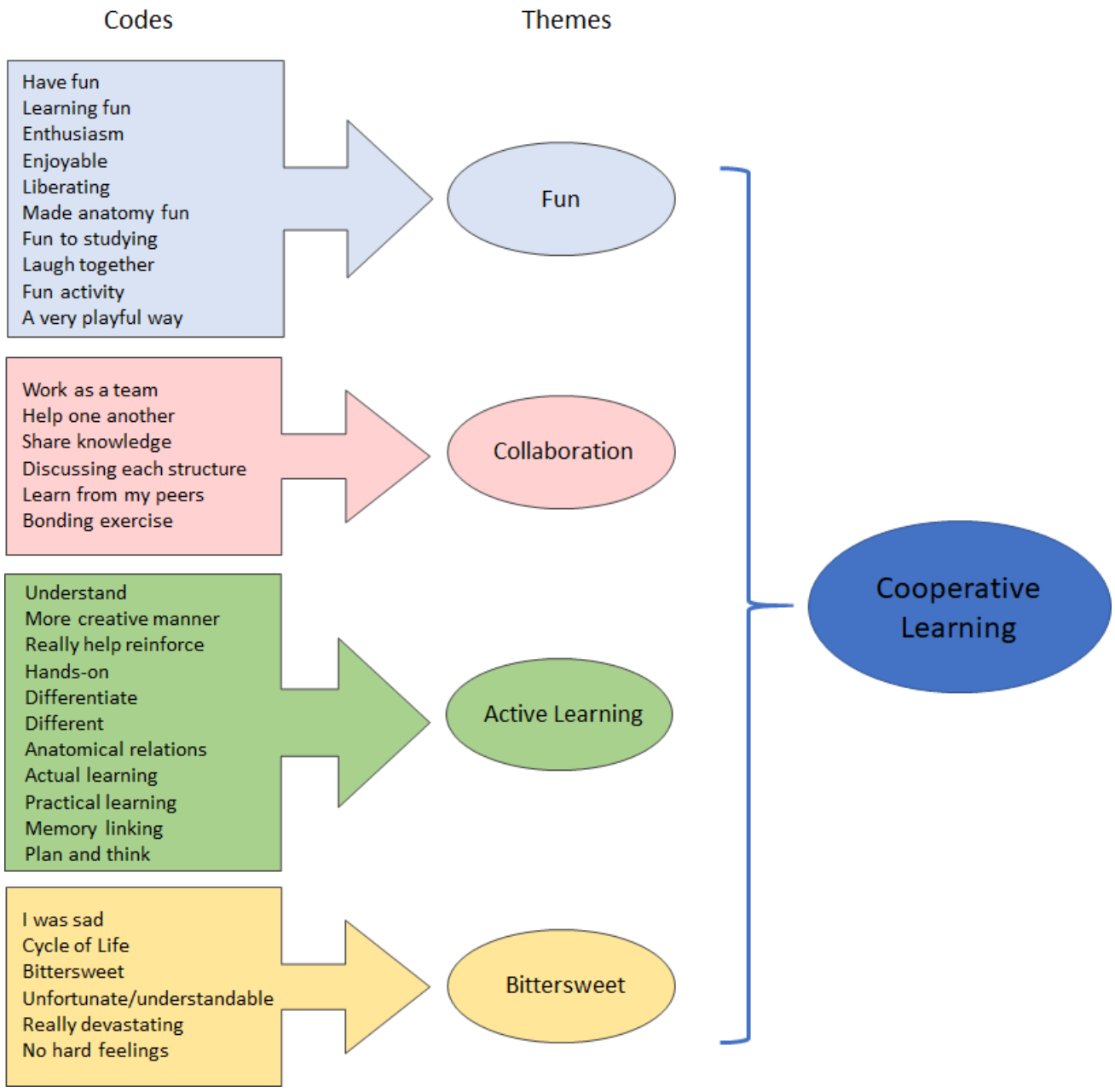


Fig. 3. The four themes that were generated were based on thematic analysis of the open-ended survey questions. The link between the themes is cooperative learning.


Codes
Themes
Have fun
Learning fun
Enthusiasm
Enjoyable
Liberating
Made anatomy fun
Fun to studying
Laugh together
Fun activity
A very playful way
Fun
Work as a team
Help one another
Share knowledge
Discussing each structure
Learn from my peers
Bonding exercise
Collaboration
Understand
More creative manner
Really help reinforce
Hands-on
Differentiate
Different
Anatomical relations
Actual learning
Practical learning
Memory linking
Plan and think
Active Learning
I was sad
Cycle of Life
Bittersweet
Unfortunate/understandable
Really devastating
No hard feelings
Bittersweet
Cooperative Learning

Appendix I

Do you feel that the activity allowed you to perform the tasks independently?

Did you find the activity motivational? In what way? If not, please explain.

Did you find the activity enjoyable? In what way? If not, please explain.

Were the resources provided adequate? If so, in what way? If not, please explain.

Did you find the activity was easy to follow independently? Please explain.

Would you recommend the activity? Why or why not?

Did you find this to be an effective learning experience? In what way? If not, please explain.

Did you learn something new?

Would you like to do something similar when studying anatomy?

Do you think the students will benefit from modeling in clay? In what way? If not, please explain.

What could change? What would you do differently next time?

What were your thoughts and experiences when you had to dismantle the model? I.e. remove the clay?