The Use of Clay Sculpting as a Method of Learning about Muscles in an Introductory Human Anatomy Course

Kevin Antonishen
University of the Fraser Valley (Canada)
Kevin.Antonishen@ufv.ca

Abstract

Students of kinesiology are expected to graduate with elaborate knowledge of the bodily structures involved in producing, resisting, and controlling motion. Appreciation of functional anatomy of the musculoskeletal structures is crucial for satisfactory assessment and treatment of related disorders, and it involves visual-spatial cognition. To date there is scant, though growing, research literature which addresses the importance and impact of spatial and three-dimensional learning for learners of human anatomy. An uncommon method thought to promote the learning of the spatial relationships of musculoskeletal structures was adapted, and subsequently evaluated among 129 undergraduate students at the University of the Fraser Valley. Exam scores were compared between two groups, where the only intentional difference in instructional methodology was the use of clay modeling with one group and not the other. No significant differences were found between experimental and control groups when comparing the mean scores of the same exams. Despite a significant reduction in hands-on time with the other models being used for muscle examination, it would seem the learning through clay modelling transferred to the contexts of the other muscle exam questions. Directions for future research include using mixed methodologies research design and investigating the impact of this teaching and learning modality on long term retention.

Introduction

Human anatomy is one of the curricular fundamentals in the field of kinesiology. It is inherently a spatially-oriented discipline (notwithstanding the space-time attributes of development and ageing), and students may encounter conceptual difficulties learning three-dimensional (3-D) information, especially when interaction with the parts is constrained to pictures or static models [7]. As human movement specialists, kinesiologists are expected to possess elaborate knowledge of the bodily structures involved in producing, controlling, and resisting motion. Appreciating the functional anatomy of musculoskeletal structures is crucial for being effective at solving most human movement problems, and it involves visual-spatial cognition.

Only very recently has the relationship between spatial ability and learning anatomy been the subject of concerted investigation, with results demonstrating that although in certain contexts the association is weak [13], there is typically a positive association [14]. The relationship appears to be bidirectional; not only does good spatial ability help with learning anatomy, but learning anatomy may also improve spatial ability [4, 13].

This directly relates to a significant pedagogical issue which has only recently seen some focus in the literature: How can we teach and learn 3-D information such as human anatomy most effectively [5, 8, 9, 10, 11]?

Cadaver dissection, traditionally considered the gold standard method for learning anatomy, is too resource-intensive for most schools [6]. Animal dissection is a popular alternative, although ethical concerns have led some institutions to substitute the practice with computer simulations [12]. Data show that computer assisted instruction in the anatomy class has generally yielded no improvement in student performance on exams [1, 16]. Principles of visual perception suggest learning gross anatomy would be easier if it started with empty body cavities, progressively adding structures from deep to superficial [11]. A few studies have investigated the efficacy of modelling human musculature with clay in post-secondary settings, although the designs involved comparing the method to animal dissection [2, 12, 15]. To date, no one has reported on the efficacy of clay modelling as a supplement to the use of other standard, fabricated human anatomy models.

The purpose of this study was to determine the effect of a clay modelling experience as an adjunct to the use of other models on the exam performance of undergraduate students enrolled in a human anatomy course.

Method

Undergraduate students (n =129) enrolled in a one-semester basic human anatomy course were allocated into control or experimental groups. The difference between groups designed into the study was the use of the Zoologik® Maniken™ Scholastic Anatomy in Clay models during the muscular system learning labs. Both groups received similar introductory lectures, orientations to the individual muscles, and had access to the other conventional, pre-fabricated muscle models in the lab, as well as a clay-modelled Maniken™ pre-designed by the instructor to serve as another study model.

Working in pairs, students in the experimental group actively modelled muscles (shaping the clay and placing the accumulation of muscles on the skeletal model) while guided by the instructor, whereas the control group did not. For all non-muscular system labs (tested in exam 1 and exam 3), students were exposed to basically the same information and studied using the same models. Exam conditions were the same between groups.

Student performance on lab exams was evaluated by comparing mean exam scores between the control and experimental groups via independent samples t-test (SPSS 15.0).

Results

There was no significant difference in the group mean score (%) on the muscle exam for the group using clay (M= 70.2, SD= 20.2) and group not using clay (M=70.4, SD= 19.2); t(126)= -.091, p= 0.928. Furthermore, no significant differences were found between groups when comparing the mean scores of exam 1 [t(126)= 0.643, p= 0.521] as well as exam 3 [t(126) = 1.028, p = 0.306].

Table 1. Group mean and (SD) of exam scores

Group	*Exam 1*	*Exam 2*	*Exam 3*
Experimental	65.8 % (21.8)	70.2 % (20.2)	67.4 % (21.6)
Control	63.8 % (20.3)	70.4 % (19.2)	63.5 % (19.3)

Discussion

This study aimed to to determine the effect of a clay modelling experience as an adjunct to the use of other models on the exam performance of undergraduate students enrolled in a human anatomy course. Analysis of the data suggests the methods used in this study did not result in a significant improvement of learning as measured by group mean scores. However, the experimental group performed as well as the control group despite having only half the time (45 minutes per lab) available to handle and study other muscle models. This suggests students are able to apply what they learned via clay modeling to other human muscle models, and this transfer of learning appears to be diminished with animal dissections. In order to better understand the teaching and learning implications of the clay modelling method, more data are required.

Anecdotally, most students enjoyed the experience of modelling and claimed it was a valuable method for helping them learn human muscular system anatomy. This information came by anonymous written feedback provided by students in the week following the muscle exam.

For this study, the learning style preferences of the subjects are not known. In the future, we plan to use Fleming's VARK questionnaire to investigate if there is a relationship between preferred learning style and exam scores in the context of using clay modelling. In a study by Dobson [3], only 4-5% of undergraduate physiology students were found to have kinaesthetic learning style preference. Three years prior to data collection for the study presented here, VARK data of students in our anatomy course were gathered, and results were similar to those of Dobson, reflecting about 5% kinaesthetic. If similar prevalence was characteristic of the subjects in our

clay modeling study, this could have explanatory value regarding why the clay modelling did not significantly improve exam scores on average.
Yet to be investigated are relationships between spatial ability and retention of knowledge associated with deep or superficial learning strategies, and aspects of visual perception such as comparing when models are used as halves (one side) versus whole.

References

[1] Bukowski EL. 2002. Assessment outcomes: computerized instruction in a human gross anatomy course. Journal of Allied Health 31(3): 153-158.
[2] DeHoff ME, Clark KL, & Meganathan K. 2011. Learning outcomes and student perceived value of clay modeling and cat dissection in undergraduate human anatomy and physiology. Advances in Physiology Education 35(1): 68-75.
[3] Dobson JL. 2009. Learning style preferences and course performance in an undergraduate physiology class Advances in Physiology Education 33(4): 308-314.
[4] Fernandez R, Dror IE, Smith C. 2011. Spatial Abilities of expert clinical anatomists: comparison of abilities between novices, intermediates, and experts in anatomy. Anatomical Sciences Education 4(1): 1-8.
[5] Gangata H. 2008. An innovative approach to supplement the teaching of the spatial gross anatomy relationships of muscles to undergraduates in health sciences. Clinical Anatomy 21: 339-347.
[6] Gillingwater TH. 2008. The importance of exposure to human material in anatomical education: a philosophical perspective. Anatomical Sciences Education 1(6): 264.
[7] Goodwyn L, Salm S. 2007. Modeling muscles. Science Teacher 74(9): 49-52.
[8] Marks Jr. SC. 2000. The role of three-dimensional information in health care and medical education: the implications for anatomy and dissection. Clinical Anatomy 13: 448-452.
[9] Marks Jr. SC. 2001. Recovering the significance of 3-Dimensional data in medical education and clinical practice. Clinical Anatomy (14): 90-91.
[10] Mathewson JH. 1999. Visual-spatial thinking: an aspect of science overlooked by educators. Science Education 83: 33-54.
[11] Miller R. 2000. Approaches to learning spatial relationships in gross anatomy: perspective from wider principles of learning. Clinical Anatomy 13: 439-443.
[12] Motoike HK, O'Kane RL, Lenchner E, Haspel C. 2009. Clay modeling as a method to learn human muscles: a community college study. Anatomical Sciences Education 2(1): 19-23.
[13] Sweeney K, Hayes JA, Chiavaroli N. 2013. Does spatial ability help the learning of anatomy in a biomedical science course? Anatomical Sciences Education Nov 12.
[14] Vorstenbosch MA, Klaassen TP, Donders AR, Kooloos JG, Bolhuis SM, Laan RF. 2013. Learning anatomy enhances spatial ability. Anatomical Sciences Education 6(4): 257-262.
[15] Waters JR, Van Meter P, Perrotti W, Drogo S, Cyr RJ. 2005. Cat dissection vs. sculpting human structures in clay: an analysis of two approaches to undergraduate human anatomy laboratory education. Advances in Physiology Education 29: 27-34.
[16] Yip, GW, Rajendran, K. 2008. Snapanatomy, a computer-based interactive tool for independent learning of human anatomy. Journal of Visual Communication in Medicine 31(2): 46-50.