Bringing Anatomy to the Big Screen:
The Use of 3D Digital Anatomy in Undergraduate Anatomy Labs

HS 2300a/b & Kin 2222a/b: Systemic Approach to Functional Anatomy

Traditionally, anatomical education employs 2D images through lecture slides and class notes, and emphasises the importance of dissection for students to gain a 3D appreciation of the information. Despite the seemingly obvious emphasis on both 2D and 3D knowledge acquisition in these courses, there is no guided link between the two, thus requiring students to make this cognitive link unaided. As such, the cognitive leap from 2D instruction to 3D application is a common stumbling block for novice students. Furthermore, anatomy courses in Health Sciences and Arts streams of Kinesiology face additional challenges regarding the lack of 3D verification, namely cadaveric labs. These courses are taught with labelled 3D plastic models that limit the ability for students to dissect structures and become familiar with anatomical variation and characteristics. Moreover, these models can lack structures, restrict the field of view available to students, or encourage memorization of labels instead of the anatomy due to their inherent limitations.

Given the aforementioned limitations of resource availability as well as the difficulty in transitioning between 2D and 3D modes of learning, we endeavoured to create a series of 3D digital models to be used in laboratory sessions as an intermediate step in students' learning. Though this goal of using 3D technologies to bridge this dimensional gap had been attempted in years past, this foray was the first time that 3D sessions were integrated as part of the course curriculum for all students and were formally created for tutorial use. With tech-savvy millennial students arriving at universities annually, we anticipated this modified blended learning approach to not only strengthen the process of knowledge acquisition for students but also present an exciting and innovative way to learn.

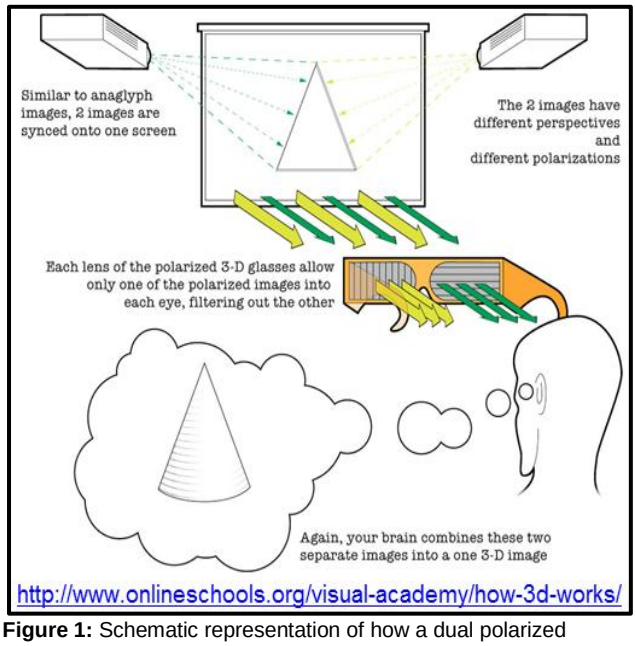

Figure 1: Schematic representation of how a dual polarized projection system, with glasses, works to create a 3D image

The goals of this activity were to:

1. Increase class engagement with the material through the availability of a single model to the entire class at one time through a blended learning environment
2. Facilitate the transition from 2D images into 3D application with hands-on models
3. Create a virtual dissection and syncretion (building up) opportunity for students to present spatial information in an uninhibited fashion (full or partial transparency of and number of structures)
4. Emphasise and develop key concepts presented in lecture

Resources:

- TAs trained in both the technology and anatomical material
- 3D projection system
    - Computer, 2 projectors with polarizers + 3D glasses
    - 3D models (from the dept of Anatomy and Cell Biology – CRIPT Lab)

Activity Details:

3D anatomy sessions were presented for 30min every two weeks to each laboratory section. These models were presented on a large translucent screen via a dual polarized projection

system in the Health Sciences Building Anatatorium. Visualization of the models in 3D stereoscopy was aided by 3D glasses (Fig 1). Each session was delivered by an anatomy TA with extensive experience with both the technology and anatomical material.

Since this learning activity spanned the semester-long course, topics covered were diverse and included:

- Skull and Vertebral Column
- Shoulder and Hip Joints
- Eyes and Eye Movements
- Muscles of Mastication (Chewing)
- Brachial Plexus

As many of these topics are known to be spatially complex, using a guided 3D digital approach to exploring the spatial relationships between structures further linked lecture content with the lab and proved very helpful. To contextualize the challenges associated with current practice and the place of 3D digital models in the classroom, Figure 2 depicts 3 aforementioned modes of teaching the muscles of mastication, which are oriented in a spatially complex manner. As evidenced pictorially, traditional methods of using just 2D pictures or plastic models in teaching limits students' understanding to either a 2D pane lacking depth and spatial information or to a 3D structure with highly limited interaction and obstructed views. 3D digital models are able to move past these limitations with a blended learning twist. As a learning adjunct, digital models allow students to hone in on what is important, see limitless 3D orientations and manipulate the model's transparency & detail to see the anatomy more clearly. When used together, these 3 modes of teaching converge to create a more complete mental representation of both specific and overall concepts for students. From a class structure standpoint, after experiencing both the lecture and the 3D laboratory session, students are free to explore the plastic models independently in small groups during lab sessions to solidify their knowledge. The timely repetition of the material through this tiered learning process also contributes to reduced forgetfulness as well as appeals to multiple learning styles and offers opportunities for peer instruction through small-group work.

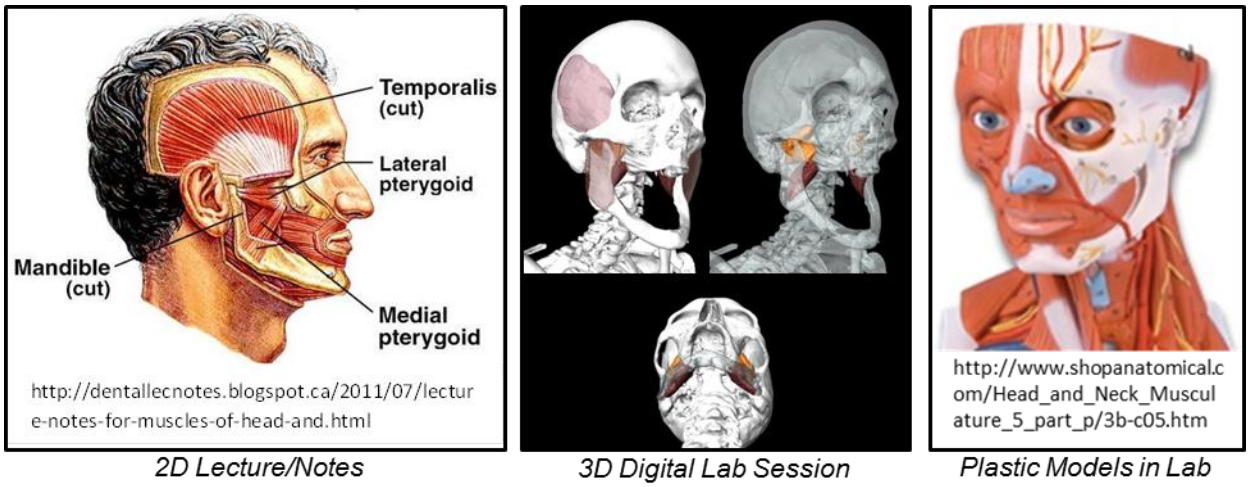

Figure 2: Three modes of teaching for the muscles of mastication (chewing) using 2Dslides as well as 3D digital and plastic models

Though seemingly subject specific, the introduction of this novel 3D digital approach to learning is transcendent in its attempt to work around educational limitations to create new learning opportunities for students. Given some inherent limitations of a newly employed technology-based teaching method, we saw great success with students both engaging with the material more and reflecting positively on their lab experiences. These sessions are now in their 4th semester of use in the Kinesiology and Health Sciences 2nd year curriculum.

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