RESEARCH ON LEARNING

What's Behind That Smile: Using Analogies, Facial Expressions, and Special Senses to Demonstrate the Interactions Between Body Systems in Anatomy and Physiology Lab Classes

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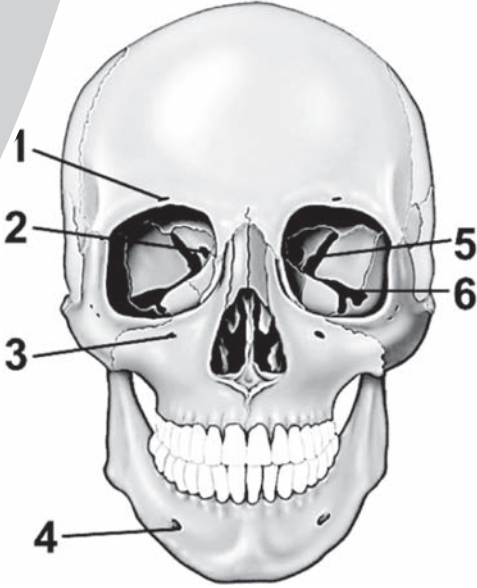

Abstract

Human anatomy and physiology classes for pre-nursing students at Gordon State College are taught using the body systems approach, focusing on one organ system in each learning unit. The body systems approach does not always generate a deeper understanding of the interdependence of organ systems. To address this issue we developed an analogy-based lab activity consisting of four modules (Module 1, cranial bone markings; Module 2, cranial nerves; Module 3, facial and neck muscles; and Module 4, inter-relationships that produce common activities, such as smiling, frowning, chewing, olfaction, vision, eyeball movements, gustation, etc.). Unlike traditional lab exercises that follow the body systems approach, this set of lab activities can emphasize the specific interactions between body systems for common body functions, such as smiling. This linking method utilizes a number of the hands-on lab activities featuring text, diagrams, and models. Assessment of these activities demonstrates that students can effectively learn the relationships between different organ systems by using a series of lab activities that emphasize creativity and fun.

Key Words: *pre-nursing students; modular systems approach; linking organ system interaction; analogy; effector functions; hands-on lab activities of cranial bone markings; facial muscles; cranial nerves.*

○ Introduction

Human Anatomy and Physiology lab is often taught using a systems approach that presents the anatomical features and physiological processes particular to each body system. The body systems approach provides a focus for students to concentrate on one set of structures and functions at a time with a sharper focus. However, this approach may cause students difficulty appreciating the interrelationships that occur between organ systems.

An analogy can provide a conceptual framework for assimilating new ideas. Students connect what they are learning to what they already know (Ambrose et al., 2010; Aubusson et al., 2006). Analogy, if used effectively in anatomy laboratory activities, provides a successful strategy to help students understand structures and processes that are often foreign to everyday experience. Aubusson et al. stated that thinking without metaphors is like a world without pictures or a colorless landscape. Whether your interest be learning, teaching, or research, metaphor and analogy offer new ways of thinking and the potential to revitalize science teaching, teacher education and professional development, curriculum and research (Aubusson et al., 2006). The activity described in this paper uses analogy to describe a set of anatomical structures and functions in the cranial and neck region. For the purposes of this exercise, the brain and related structures in the head and neck are described as a walled city—the city of Brainington. Brainington is the capital city of the country Humaneous Anatomeous. The country of Humaneous Anatomeous consists of other regions. These regions include Thoraconeus (thoracic region), anchored by the twin cities of Cardiacus (heart) and Respironia (lungs); inferior to Thoraconeus lies the region of Abdominous (abdomen); within this region lie the cities of Hepaticus (liver), Alimentarius (intestine), and the twin cities of Renae (kidneys).

Using this analogy, we developed four laboratory modules that relate to a set of motor and sensory functions of the head and neck. These modules were posted to an online learning platform prior to the lab activities. First, students completed the three individual anatomy laboratory modules focused on the cranial bone markings, cranial nerves, and facial muscles. Second, students submitted the fourth "putting it all together" module. Third, students performed the hands-on laboratory group activities using the laboratory models of cranial bones, facial muscles, and pipe cleaners as cranial nerves labeled I–XII for matching into the proper cranial bone openings. Finally, students created and submitted lab activity posters composed of figures provided for the first three modules and pictures of their hands-on lab activity demonstration.

These lab modules are designed to aid students in learning about the interrelationships of the body systems; the foci of these lab activities are common functions such as smiling, smelling, seeing, eyeball movement, tasting, etc. Based on student responses, these basic modules provided an effective hands-on teaching and learning experience.

The American Biology Teacher, Vol. 80, No. 9, pp. 661–667, ISSN 0002-7685, electronic ISSN 1938-4211. DOI: https://doi.org/10.1525/abt.2018.80.9.661.

○ Goals

The exercises that are presented in our modules were developed with three goals in mind:

1. To expose students to hands-on active learning modules using an analogy-based approach.
2. To help students link body systems in ways that highlight their interactions using anatomy models of skull, head muscles, and pipe cleaners as cranial nerves.
3. To evaluate student learning and gather student responses concerning the ease and effectiveness of these learning activities.

○ Instructional Methods: Use of Analogies

Analogies can be powerful teaching tools because they can make new material intelligible to students by comparing it to material that is already familiar (Orgill & Bodner, 2004). Analogy provides a conceptual framework on which new information can be absorbed and assimilated. Effective use of analogy in laboratory activities provides a successful strategy to help students understand structures and processes that are often foreign to everyday experiences. Instructors frequently make the mistake of expecting their students to easily understand complex information that we have accepted as common knowledge. We must have high expectations for our students (Wong & Wong, 2005), but we as instructors must present the information in ways our students can effectively process it.

○ Materials and Methods

The four modules introduce students to the relevant anatomy of the skull, facial and neck musculature, and cranial nerves that innervate the muscles. The skull, through this on-going narrative, is compared to a city, the city of "Brainington," which is the capital of the country "Humaneous Anatomeous." The structure and function of each body system is explained in terms of city services. This comparison, despite the limitations of analogy, will help learners assimilate new concepts more effectively.

The first module introduces the skull; students identify the cranial bones, their locations, and their features. The second module introduces students to pertinent functional brain areas and the cranial nerves that innervate the facial muscles, including each nerve's origin and pathway through the skull. The third module explains the musculature of the skull as well as the muscles' functions. The fourth module links the first three modules in relation to particular cranial nerve functions such as winking, smiling, and frowning. Normally one week prior to the relevant lab sessions, these modules are posted in an online platform for the students to submit their finished work as an extra credit assignment before coming to the relevant lab sessions. The modules supplement the required pre-lab study, which is based on the lab manual (Marieb & Smith, 2016).

This series of lab activities is used to reinforce and enhance what is learned in lecture. Students are exposed in lecture to the basic anatomy and physiology of the skeletal system; in lab they identify the bones making up the cranium. Likewise, they focus, in lecture, on the muscles of the face and neck as a component of the unit on the muscular system, and identify the major muscles of the face and the neck in lab. The Brainington activity is included as a part of the lab work associated with the Central Nervous System and is completed as an aid in learning the structure and function of the cranial nerves. In addition, the Brainington activity affords students the opportunity to review the skeletal and muscular anatomy of the region and to explore the structural and functional connections that exist between structures. These activities are completed both at home and in lab. In lab, students access the human skull, torso, and brain models. Relating anatomical structures on models to the diagrams from their textbooks help them build a 3D perspective of the body. The Brainington student handouts for all four modules can be accessed through this link: http://faculty.gordonstate.edu/clee.

The City of Brainington: Module 1—Skeletal System

This module guides students to identify cranial bone markings in terms of the Brainington analogy. The city of Brainington is surrounded and protected by a sturdy wall composed of plates of cranial bone, collectively known as the skull. The skull provides effective protection for the city and its inhabitants. There are a series of openings in the wall to allow for the passage of vital structures. In this module we will explore those openings in the skull, especially those that provide passageways for the twelve pairs of cranial nerves. (See Figure 1.)

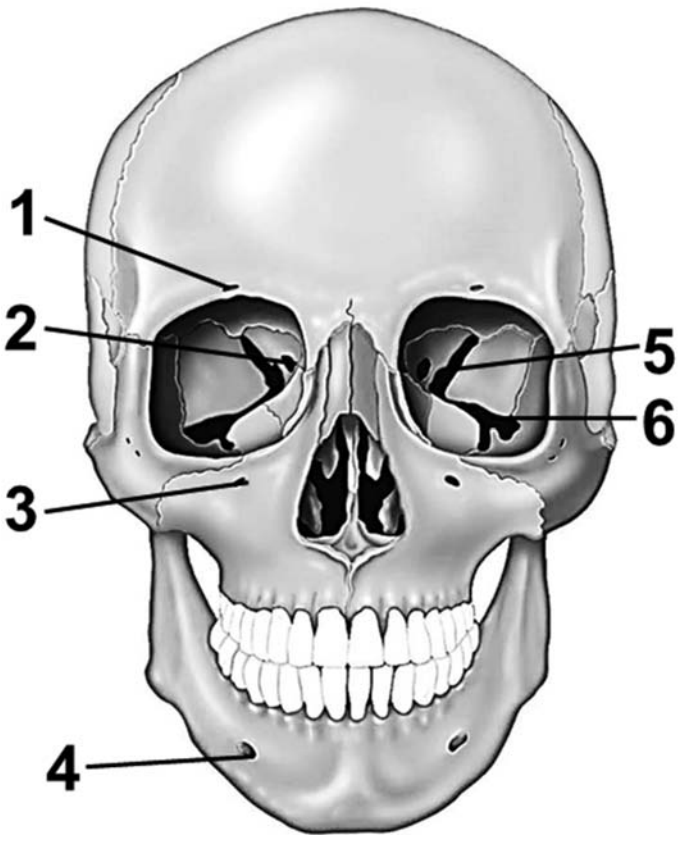

Figure 1. Frontal view of cranial bones. An exercise example of Module 1: Students are given key words to match the numbered cranial bone markings (Marieb & Smith, 2016).

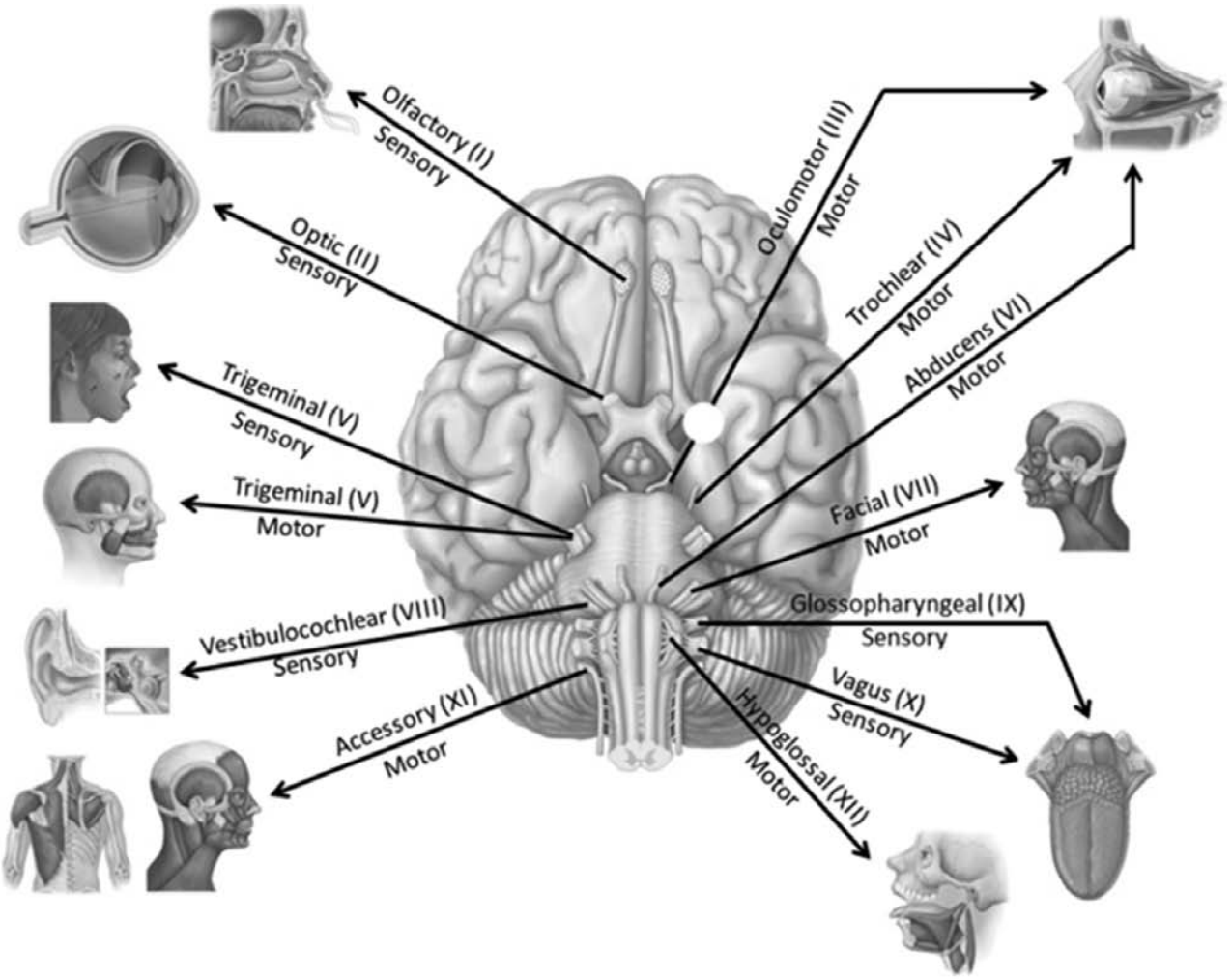

Figure 2. Inferior aspect of brain showing names and functions of cranial nerves I–XII. An exercise example of Module 2: Students are given matching questions for names and motor and sensory functions. Cranial nerves I–XII are shown to reach their areas of innervations shown at the tip of the arrows (Encyclopædia Britannica, 2016).

The Information Highway: Module 2—Functional Brain Centers and Cranial Nerves

This module guides students to identify the name, pathway, and functions of each of the twelve pairs of cranial nerves, which support the inhabitants of Brainington in terms of the governmental municipal offices of the town. (See Figure 2.)

The Labor Force: Module 3—Musculature

This module introduces students the muscles of mastication and deglutition as well as for facial expression. The rocky (bony) terrain of Brainington is populated by the city workers—the skeletal muscles and the receptors for special senses. (See Figure 3.)

What's Behind That Smile: Module 4—Putting It All Together

This module provided students the opportunity to "put the pieces together" as they explored the interactions between skeletal architecture, cranial nerves, and cranial musculature. An accurate understanding of body system interactions is critical for medical professionals to correctly evaluate pathology and plan interventions. In this module, students focused on motor functions of facial expressions, mastication and deglutition (Table 1), and the sensory functions (Table 2) related to cranial nerves. Provided with an action, such as smiling, students have to identify the cranial nerves involved and which cranial bone markings serve as passageways through the skull to reach the effector muscles (see Table 1). For each sense, students fill in the cranial nerve, and the location where the nerve passes through the cranium. (See Supplemental Materials for blank Tables 1 and 2.)

Students Laboratory Hands-on Activities and Poster Presentation

Working in groups at the lab, students use skull models and pipe cleaners to identify the pathway for cranial nerves I–XII. Figure 4 shows a student-generated model that demonstrates the spatial relationships between cranial nerves and cranial openings. Figure 5 shows the student's poster project depicting skeletal, nervous, and muscular system interaction during smiling. Figure 6 shows an example of a student-generated presentation that demonstrates their understanding

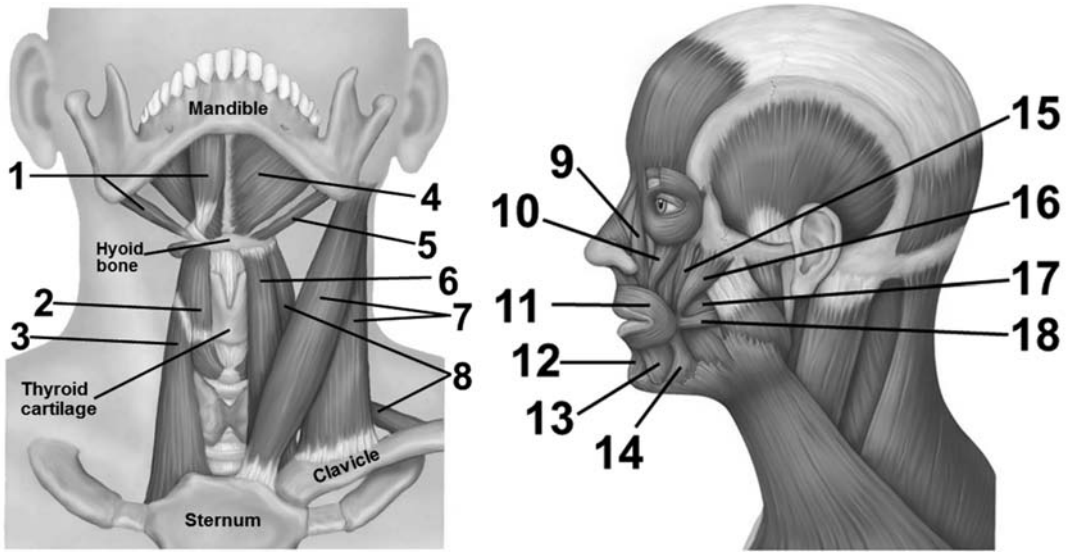

Figure 3. Muscles of the anterolateral neck and throat (on the left) and lateral view of superficial muscles of head (on the right). An exercise example of Module 3: Students are given questions that ask them to match names of facial and neck muscles with functions (Marieb & Smith, 2016).

Table 1. Facial Movements.

Action	CN involved	Passageway through cranium	Distribution: Muscle & areas involved
Smiling	VII	Stylomastoid foramen	Zygomatic major & minor
Rolling Eyeballs	III, V, VI	Superior orbital fissure	Extrinsic eye muscles
Winking	III	Superior orbital fissure	Levator palpebrae superoris
Chewing	V	• Ophthalmic, superior orbital fissure • Maxillary, foramen rotundum • Mandibular, foramen ovale	masseter
Swallowing	IX, X, XII	• Jugular foramen • Hypoglossal canal	Tongue & pharyngeal muscles, soft palate
Head & Shoulder Movement	XI	Jugular foramen	• Cranial portion-muscles of pharynx, larynx. • Soft palate • Spinal portion, sternocleidomastoid & trapezius
Swallowing & Speech	IX	Jugular foramen	Tung, pharyngeal, soft palate

Table 2. Special Senses.

Sense	CN Involved	Passageway through Cranium	Distribution: Areas involved
Vision	II	Optic foramen	Eye
Olfaction	I	Olfactory foramina of cribriform plate	Nasal mucosa
Salivation	V	• Ophthalmic, superior orbital fissure • Maxillary, foramen rotundum • Mandibular, foramen ovale	Cutaneous sensations of three areas
Hearing & Equilibrium	VIII	Internal auditory meatus	Semicircular canals & cochlea of ear
Taste & Somatic Sensation	IX, X	Jugular foramen	Tongue, pharyngeal muscles, parotid gland

of the interactions between the skeletal, nervous, and muscular systems that produce common functions.

Results

Of the 28 students enrolled in Anatomy and Physiology I class in the Spring Semester of 2016, 20 (71.4%) provided feedback and rated the activity after completion of modules. No incentives were given for the students' responses to the modules. Surveying was done using the Likert scale from 1 to 5, with 1 being strongly disagree and 5 being strongly agree. Table 3 shows the questions that were asked for the survey and the students' responses.

Figure 4. Laboratory hands-on activities using anatomy model of the skull and pipe cleaners as cranial nerves. Superior view of cranial floor of cranial cavity is shown. Pipe cleaners were labeled with cranial nerve numbers of I–XII, and students positioned them through the correct cranial foramina (Marieb & Smith, 2016).

Discussion

Students submit their finished work on each lab module before starting their lab activities on the same topic. The majority of the students agree that Module 1 (skeletal structures), Module 2 (cranial nerves), and Module 3 (facial and neck muscles) are relatively straightforward. However, Module 4 (putting it all together) requires more time to complete. In addition, students comment that the actual hands-on group lab activity using skull bone models with pipe cleaners as cranial nerves (Figure 4) is very informative. The process of making posters using all the resources from Modules 1–4 and pictures taken from the lab activities reinforces their understanding of the linkage between the three organ systems of skeletal, nervous, and muscular functions in the head for specific actions such as smiling (Figures 5 & 6). Students' responses to the survey on the modules show that they saw improvements in their understanding of anatomical relationships and physiology based on the activities described in this paper. Students find linking form and function of different body systems to be challenging. This is particularly true in the head region, which has diverse sensory and motor functions taking place in a relatively small area as well as numerous bone markings to be mastered. After activities structured around the city of Brainington, students said that they better understood anatomy and physiology of the region. They said that the activities helped their understanding more than the lecture or textbook study.

In conclusion, linking different anatomical structures for effector functions can be very complex to Anatomy and Physiology I students. The four modules presented a creative way of developing an understanding of body system interactions. This method provided students an enjoyable way of understanding effector functions in the cephalic region by the interactions of different organ systems. If desired, the Brainington analogy could be extended to other body regions and systems. For example, the environment of the city of Brainington makes contracts with other areas of the

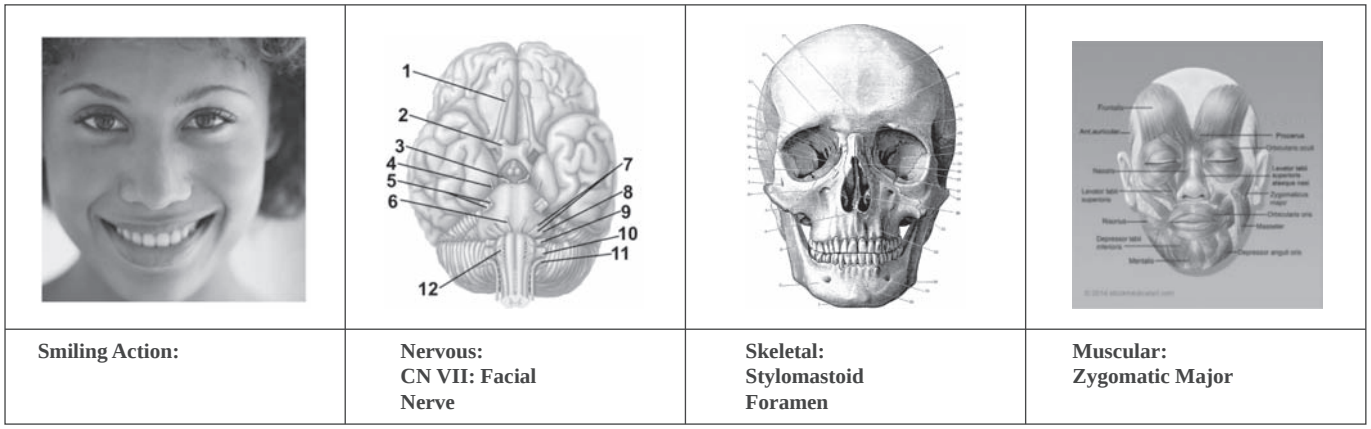

Figure 5. Smiling action by linking three organ systems of cranial nerves, skeletal markings, and facial muscles for sensory and motor functions of the head and neck (smiling action shown) (Marieb & Smith, 2016).

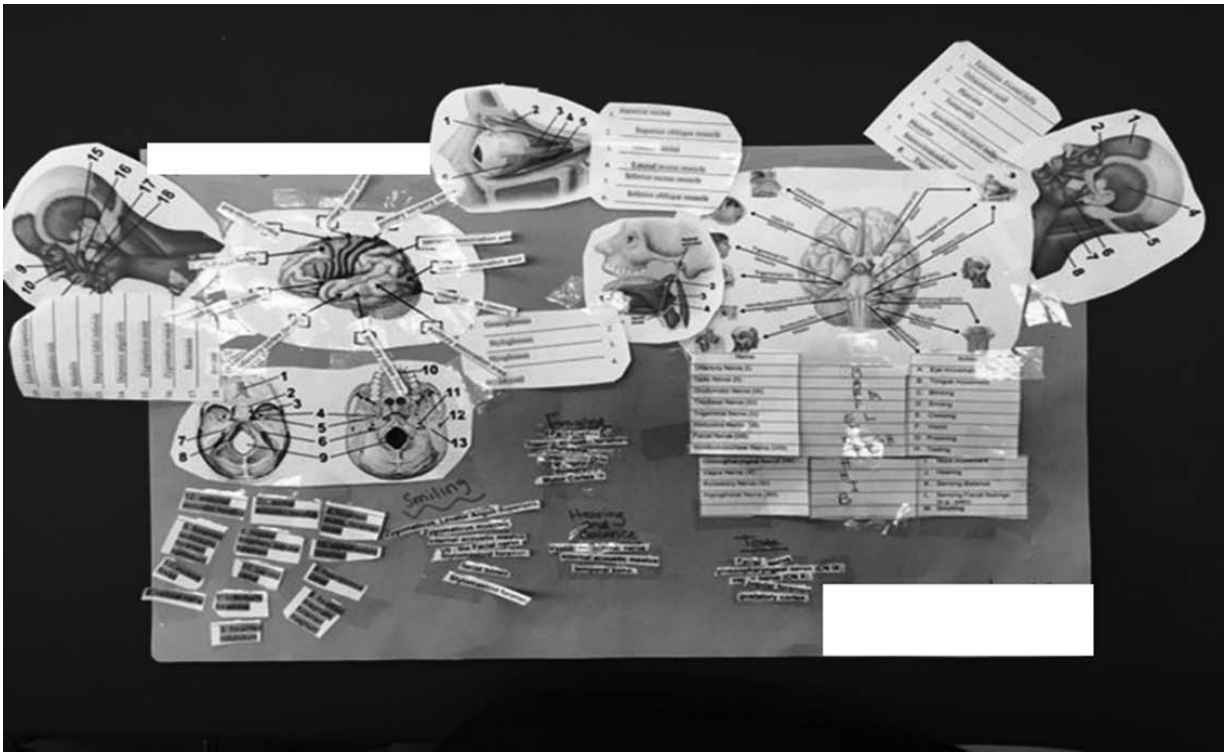

Figure 6. Student's poster showing the selected figures from four modules to link three organ systems for the actions of cranial sensory and motor functions: smell, vision, eyelid and eyeball movement, chewing, taste, facial expression, salivation, equilibrium and hearing, swallowing, taste, and somatic sensation from body, head and neck movements, and speech.

Table 3. Mean score of students' survey of the modules.

	Statement	Mean
1	Before the semester began, I did not know how skeletal markings linked with nerves.	4.2
2	Overall, I understand how cranial nerves pass through skeletal marking to get to the effectors.	3.9
3	Before the semester began, I was familiar with skeletal, muscular and nervous system.	3.2
4	Overall, this exercise improved my understanding and appreciation for the processes and techniques used to analyze each organ system's contribution for smiling, chewing etc.	4.3
5	I have a better understanding of the relationship between the anatomical structures and processes of physiology after performing those exercises than if I had just heard about them in lecture or read a textbook.	4.5
6	Linking organ systems was easier than I initially thought it would be.	4.1
7	I feel more comfortable using the online resources and hands-on activities at anatomy lab now than I did before starting this exercise.	4.6

country (Humaneous Anatomeus), such as with the respiratory and renal systems to regulate the pH of body fluids.

○ Acknowledgements

We would like to acknowledge Adam Davis, Linda Hyde, and Chris Swars at Gordon State College, ChulHee Kang at Washington State University, and Brian Ciliax at Emory School of Medicine for helpful suggestions on the manuscript, and the students enrolled in Anatomy and Physiology I class during Spring Semester of 2016 at Gordon State College. This work was presented at the 2016 and 2017 Teaching Matters Conferences hosted by GSC, University System of Georgia.

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