Grounding the Teaching of Anatomy and Physiology in Indigenous Pedagogy

Natalia Bilton[a]

Corresponding author: Natalia Bilton (nbilton@csu.edu.au)
[a]Lecturer in Human Anatomy and Physiology, School of Biomedical Sciences, Charles Sturt University

Keywords: Indigenous pedagogy, anatomy and physiology, student engagement

International Journal of Innovation in Science and Mathematics Education, *26*(2), 35–43, 2018.
Special Issue: Supporting Indigenous Student Engagement with STEM in Higher Education

Abstract

This article demonstrates how Indigenous pedagogy (IP) can be used in anatomy and physiology education in the tertiary sector. We propose that bringing IP to tertiary education may increase the engagement of Indigenous students in the first year of university study. Current literature focuses on IP applied to primary and secondary education and only one study to date has been published in the tertiary sector. In this paper, we present a series of IP informed learning activities designed to increase student engagement with anatomy and physiology across a broad range of educational settings. We will present a total of 4 activities each focusing on a different aspect of IP. This paper aims to provide examples and a starting point where academics can foster creativity in their teaching practice and help build on the discourse of Indigenous andragogy in the tertiary education sector.

Background and rationale

Students working towards a degree in the Health Sciences are required to undertake two first-year subjects in anatomy and physiology and this is the context of this work. We know that our students are likely to vary significantly in their education prior to university (Anderton, Evans, & Chivers, 2016) and are likely to be kinaesthetic learners (Farkas, Mazurek, & Marone, 2016). Unfortunately, it has been reported that many of these students either drop out or decide to repeat these subjects before progressing in their chosen field (Entezari & Javdan, 2016; Schutte, 2016). Furthermore, students have reported that they underestimate the amount of content and comprehensiveness of a first year anatomy and physiology subject and that the teaching methods used can influence their ability to learn the content (Eagleton, 2015).

As educators, we need to rethink about how we teach these students to ensure quality in our practice. We need to get back to basics, and one way we can do this is to use the teaching method used by people for thousands of years. I asked myself the following question posed by Hughes (1987). "What can I do to provide a better learning experience that will allow *all* students to learn?"

In 2009, Tyson Yunkaporta published his PhD thesis entitled "Aboriginal pedagogies at the cultural interface". In this work, he presented 8 ways of learning that emerged from his Indigenous research in Western NSW. The research was done by and for Aboriginal people within Aboriginal communities and draws on knowledge and protocol from communities, Elders, land, language, ancestors and spirit. Yunkaporta (2009) presented a pedagogical framework that described the middle ground between three Aboriginal knowledge systems and western learning systems that align with constructivism. This teaching framework contained

best practice of each perspective and was recommended for use in the Aboriginal language classroom. Since then, the 8 Ways framework (Yunkaporta, 2009) has been used extensively in primary and secondary education but has yet to be implemented in the teaching of anatomy and physiology at the tertiary level.

Indigenous students are underrepresented in science, technology, engineering and mathematics (STEM) higher education (Sharkawy, 2015). Furthermore, Indigenous student's participation in STEM subjects in higher education needs to accelerate quickly in order to reach parity with that of other fields of study (Department of Education and Training, 2015). Rectifying this discrepancy is the current challenge that science educators face today. Grounding the teaching of anatomy and physiology in Indigenous pedagogy is one way that we can value Indigenous culture in our core business of teaching at university and aid in the retention of Indigenous students and in the educational success of *all* students.

Sample activities

Way number 1: Story sharing

Elders transfer knowledge through traditional stories (Hogue, 2016) and traditional Indigenous society placed great importance upon the act of listening (Hughes, 1987). Traditionally, learners are first given information verbally and then the learner would attempt the given task. According to Yunkaporta (2009), entire units of work can be built around this process involving stories. The example below shows how a story can be constructed using anatomy and physiology content.

The learning outcome of the following activity is for students to be able to demonstrate an understanding of circulation. This topic has traditionally been taught in the lecture format using images and summarised text displayed on PowerPoint slides. The author created the following story as an alternative presentation of the subject content.

The story of Henry, the disillusioned erythrocyte

Let's start our story of Henry's journey in the body's pump, which is the heart. Henry, the erythrocyte, finds himself in the left ventricle of said heart. He doesn't know how he got there and is currently asking himself "what am I doing here?" Before he gets a response to his question, the left ventricle of the heart contracts, and Henry is pushed out into an artery. One of Henry's friends, Roger, once told him that arteries were the "pipes" that are used to carry blood away from the heart and around the body (except the lungs!). So at this point, Henry is enjoying his trip through the artery but then all of a sudden, he finds that the artery has become narrower. Henry's other friend, Steve, was nearby and told him that the blood vessel that connects an artery to a capillary is called an arteriole. Henry says goodbye to Steve and then they sort of float apart.

After flowing through the arteriole for a little bit, Henry finds himself being wedged between two other erythrocytes. In fact, all of the erythrocytes must travel in a single file through the next section like this.

Whilst Henry and the other erythrocytes were passing though the capillary something weird happened. All of the oxygen that was inside of each of them left and diffused into the tissue. To make matters worse, a whole stack of carbon dioxide made its home in Henry's body. Henry was not pleased at all, but he couldn't do anything about this because this all sort of just happened automatically.

After flowing through the capillaries and after the horrid "gas exchange" that he was subjected to, Henry found himself in a venule where he found that he had more room to float around. One of the other erythrocytes told him that they will soon enter the veins. Henry knew that veins were the other set of "pipes" that the body uses to bring blood back from the capillaries to the heart. Henry was a little annoyed because his journey in the veins was taking significantly longer than it did when he was in the arterial system. Nevertheless, eventually, he was dumped in the right atrium of the heart.

Then things started to happen rather quickly, from the right atrium he fell through to the right ventricle and then the right ventricle contracted and he was pushed into another artery. This time, it was a different kind of artery because it didn't go to the body, it went to the lung instead. Henry was not a big fan of the lungs. Nevertheless, he's in there and subsequently flowed through the arteriole and then into the capillaries of the lung and again, in a single file please!

Whilst in the lung capillary, Henry was subjected to another round of gas exchange but this time it happened in reverse. The carbon dioxide went into the alveolar space and four oxygen molecules filled every one of Henry's haemoglobin proteins. After this, he flowed through the venule of the lung and then through the vein coming out of the lung. Before he had a chance to think about things he found himself in the left atrium of the heart and then he fell through to the left ventricle of the heart. Henry thought, "I think I have been here before" and he was right, because he had been there before. In fact, he will keep going on multiple journeys around both the systemic and pulmonary circuits of the cardiovascular system for about 120 days, after

which Henry will be pulled apart, dismantled and his body parts recycled. Thanks Henry! The end.

The story above, was incorporated into the curriculum in the following way: Students were instructed to listen to the story and to make notes as the story was read aloud. The educator would read the story aloud to the group pausing intermittently to allow students to write their notes. After this, the students were given a copy of the story but with key terms blanked out. Students were given time to complete this fill-in-the-bank activity and then answers were provided for students to mark their work.

Way number 2: Non-verbal learning

According to the 8 ways framework, deepest knowledge can be represented by the meaning behind the work of hands. Yunkaporta states that knowledge can be explored through the eyes and sharing knowledge can be done through images and experiences (Yunkaporta, 2009). Non-verbal learning is knowledge that can be understood and transferred in a kinaesthetic way. In the next activity, scenario based learning and body painting are combined to teach students about surface anatomy and relative positions of bones that comprise the human skeletal system.

The learning outcome of this activity is for students to describe the structure of the skeletal system. In the past and during lecture time, this content was taught in the traditional method using PowerPoint slides containing labelled structures. In the practical classes, students would inspect the bones of the skeleton and label images in their laboratory manual. The author created the body painting activity described below to increase the authenticity of this task and to support peer learning in the laboratory. The following activity was incorporated into a practical class it took the students approximately 20 minutes to complete. Students were presented with the following information and given the materials required. This activity is one of my faviourites because it forces students to slow down their thinking and their actions. It forces them to engage with the material in a manner that is brain friendly and due to its multimodal aspect, it serves to increase recall of the content in the future (Zull, 2002).

Body painting activity

Imagine this scenario: An unconscious patient has been brought to you. Although the patient cannot tell you what is wrong or "where it hurts," you can assess some of the injuries by observing surface anatomy. More specifically, you can examine skeletal and muscular landmarks to discover whether joints are dislocated or whether bones are broken. Examination of surface anatomy can often substitute for interviewing the patient, and when the health-care professional is a keen observer, it may be very accurate in assessing illness or injury. This activity is designed to help you practise this skill.

For this task you will need: students to work in pairs, black whiteboard markers, white body paint, paintbrushes, skin cleansing wipes and reference images of the human skeleton.

Instructions:

- Decide which student will be the canvas and which student will be the artist for this task.
- The students first spend 10 minutes using reference images to identify all of the bones of the upper limb.
- The artist must now prepare the canvas by palpating the arm to examine its surface anatomy and to identify each bone under the skin.
- The artist then draws the outline of each of the bones on the canvas with the marker.
- The artist then paints each bone white and then students swap over where the artist now becomes the canvas.
- When both the canvas and the artist have all of the bones outlined and painted white and the paint is dry, each student must label each bone to complete this activity.

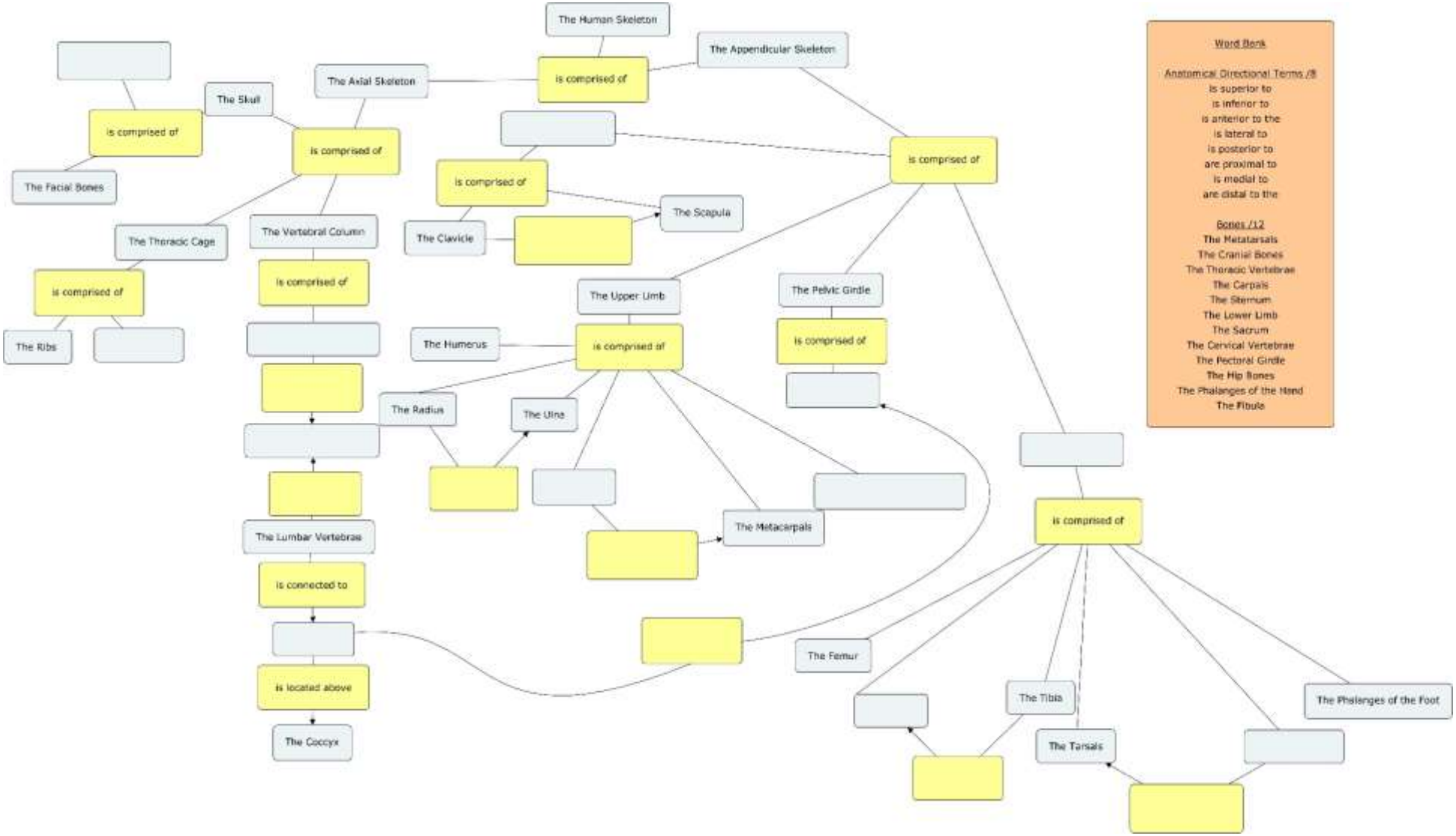
The above activity can be extended to include different bones and muscles and for the multimodal teaching and learning of surface anatomy. Body paint is a great addition to the anatomy and physiology teaching laboratory because of its versatility, ease of use and relatively low cost.

Way number 3: Non-linear

In the Indigenous worldview, learning doesn't go from one place to another in a linear fashion. Learning is more about finding your own way in how you approach a topic or end goal (Yunkaporta, 2009). One way we can remove the linearity in our teaching of anatomy and physiology is by using concept maps. Concept mapping is a technique that can be used to help students construct new knowledge (Merriam & Bierema, 2013). In concept mapping, a concept is defined as anything that can be observed and a meaningful learning is fostered by linking concepts using key words (Novak & Gowin, 1984). The activity below illustrates how content can be presented to students in a non-linear way. In the activity that follows, a student can approach the content in any way they like, using their prior knowledge and experience as a starting point for their learning.

The learning outcome of this activity is to describe the human body using appropriate anatomical terminology. Previously, in this subject, students were not provided with opportunities to practise using these important terms. The author created the following activity to provide practise and feedback in the use of directional anatomical terms. Students were given the following page as a handout on A3 paper at the beginning of the class. The students were then given 20 minutes to complete the concept map after which answers were provided.

Concept mapping activity: This concept map is printed on an A3 size paper and in colour. Students are instructed to fill each blank box with a word from the Word Bank. To increase peer learning, students sometimes work on this "challenge" in pairs.

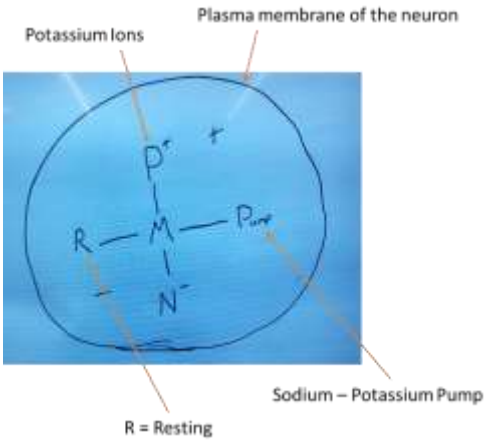


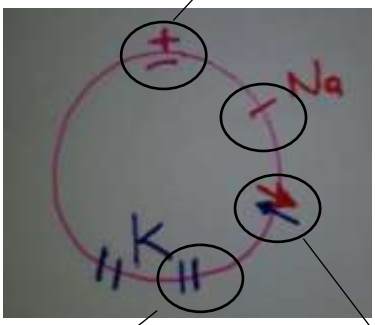
Way number 4: Symbols and images

A simple symbol can contain deeper information and understandings. Indigenous thinking about concepts is often done in images or shapes rather than by using words (Yunkaporta, 2009). Symbols and shapes can be used to link a concept to the student's own reality and furthermore, by doing this, students take ownership of the representation of the concept which serves to support meaningful learning (Zull, 2002). Some concepts, related to neurophysiology are very difficult for first year students to grasp. Sometimes, I encourage my students to draw symbols that represent some of these cognitively challenging concepts.

The learning outcome of this activity is to demonstrate an understanding of the resting membrane potential. Traditionally, this concept has been taught in a lecture format with the educator presenting discrete components of this dynamic system often in a serial and stepwise manner. The author created this learning activity to support students understanding and future recall of this complex concept. This activity was incorporated in a lecture in the following way: the lecturer would describe each component of the resting membrane potential whist simultaneously drawing and adding more and more components to their symbol. Students are then given 10 minutes to create their own symbols that represent the resting membrane potential. When finished, students swap symbols and discuss with their peers the meanings behind each component of their symbol.

Creating Symbols Activity





Represents the fact that the inside of the neuron is relatively more negatively charged than the outside.

There are comparatively less sodium leaky channels than there are potassium leaky channels in the neuronal plasma membrane.

Represents the sodium potassium pump which removes sodium and transports potassium into the neuron.

We are all different in terms of the prior knowledge that we bring to the learning experience. Furthermore, each of our brains are made up of neural networks that are unique to us (Zull, 2002). This activity generates a visual output that is driven by those two underlying processes. This activity, results in students creating symbols that are vastly different from each other. No two symbols are ever alike. The explanation of the symbol to a peer and the inevitable discussion that ensues, helps to consolidate and further reinforce engagement with the concept.

Discussion and conclusion

In this paper, I have provided a description of how I have attempted to merge Indigenous pedagogy with the teaching of anatomy and physiology. These two content areas are very different and it has taken a significant amount of cognitive effort to try and create an interface between these two worlds. It is my hope to eventually merge the Indigenous cultural world with the science world of anatomy and physiology, because it has been previously established that valuing students' cultural resources in education leads to greater cognitive and affective engagement with the content (Sharkawy, 2015). Furthermore, greater student engagement serves to foster the notion that a career in STEM is accessible and attainable for all students.

The current work is also about being creative in our teaching and about how sources of inspiration can drive our teaching practise. It's also about being brave, and trying different techniques to help our students grasp difficult concepts.

In the years 2015 and 2016, I taught first year human anatomy and physiology using the traditional tertiary education framework. This involved students attending 2 two-hour lectures and one two-hour laboratory practical per week for a total of 13 weeks. In these two years, the retention rate of Indigenous students was 33% and 25%, respectively. In 2017, I taught exactly the same content as pervious years but this time, activities such as those described in this paper, were incorporated throughout the entire subject. The retention rate of Indigenous students in the year 2017 was 87%. Whilst this figure certainly is promising, more data needs to be collected in years to come to determine whether retention rates for Indigenous students can be increased using Indigenous pedagogy in our teaching. If this is shown to be the case, the teaching of anatomy and physiology driven by Indigenous educational principles, has the potential to become an exciting new field of research in the scholarship of teaching and learning.

References

Anderton, R. S., Evans, T., & Chivers, P. T. (2016). Predicting academic success of health science students for first year anatomy and physiology. *IJHE, 5*(1), 250–260.

Department of Education and Training. (2015). *ATSIHEAC Background paper: Indigenous science, Technology, engineering, and mathematics (STEM).* Retrieved from https://docs.education.gov.au/system/files/doc/other/atsiheac_background_paper_stem.pdf.

Eagleton, S. (2015). An exploration of the factors that contribute to learning satisfaction of first-year anatomy and physiology students. *Adv Physiol Educ, 39*(3), 158–166.

Entezari, M., & Javdan, M. (2016). Active learning and flipped classroom, hand in hand approach to improve students learning in human anatomy and physiology. *IJHE, 5*(4), 222–231.

Farkas, G. J., Mazurek, E., & Marone, J. R. (2016). Learning style versus time spent studying and career choice: Which is associated with success in a combined undergraduate Anatomy and Physiology course? *Anatomical Sciences Education, 9*(2), 121–131.

Hogue, M. (2016). Aboriginal ways of knowing and learning, 21st century learners, and STEM duccess. *In Education, 23*(1), 161–172.

Hughes, P. (1987). *Aboriginal culture and learning styles: A challenge for academics in higher education institutions*. Armidale, N.S.W.: University of New England.

Merriam, S. B., & Bierema, L. L. (2013). *Adult learning: Linking theory and practice* (First edition. ed.).

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. Cambridge [Cambridgeshire]: New York: Cambridge University Press.

Schutte, A. F. (2016). Who is repeating anatomy? Trends in an undergraduate anatomy course. *ASE, 9*(2), 171–178.

Sharkawy, A. (2015). Envisioning a career in science, technology, engineering and mathematics: Some challenges and possibilities. *Cultural Studies of Science Education, 10*(3), 65–664.

Yunkaporta, T. (2009). *Aboriginal pedagogies at the cultural interface.* (Doctoral Dissertation), James Cook University.

Zull, J. E. (2002). *The art of changing the brain*. Virginia: Stylus Publishing.