Building Text Analysis Models for Scoring Structure and Function

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Introduction

- Structure and function is a core concept identified in anatomy and physiology yet students may have difficulty with the concept (AAAS, 2011; Michael & McFarland, 2011)
- Formative written assessments are a low stake opportunity for students to demonstrate their understanding (Bell & Cowie, 2001)
- However, these assessments are not often used as they are time consuming to grade (Ha et al., 2011)
- Lexical analysis of written assessments may decrease grading time and increase grading consistency (Nehm & Haertig, 2012)

Research Objectives

- Build predictive models using text analysis to effectively examine student writing about anatomy & physiology
- Understand how students relate structure and function

Methods & Results

- We collected written responses over three semester to the questions below from students in sophomore level Anatomy & Physiology II and junior level General Physiology at a large southeastern public university.
- Responses were coded for the presence or absence of structure and function and whether students related structure to function.
- We also used text analysis to extract relevant terms from student responses and group similar terms into categories.
- Logistic regression was used to build predictive models of human grading.
- Human coding and text analysis categorization for one question (Q1) is displayed. Summary of model results for six questions is shown.

Example question (Q1): The structure of arteries and arterioles is important in blood pressure regulation. Based on structure reflecting function, explain how the structure of these vessels contributes to blood pressure regulation. N=379

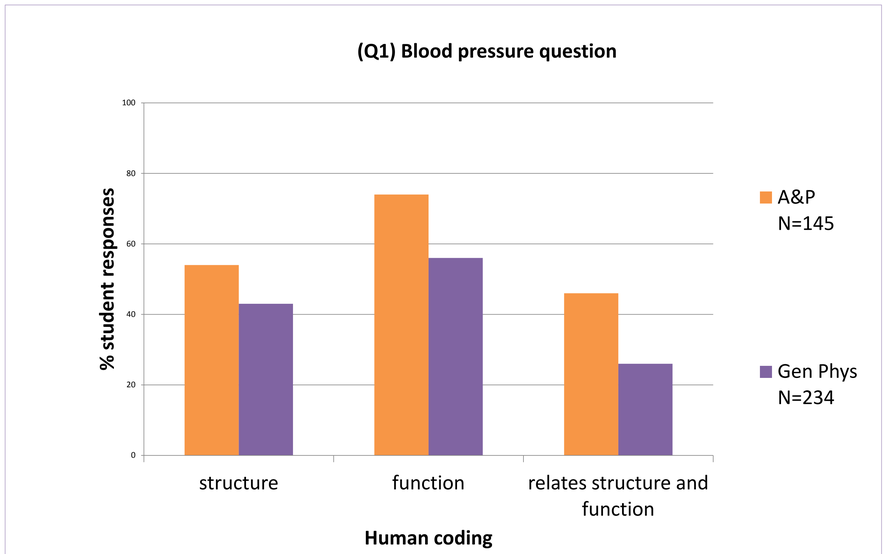
Example student responses

Both arteries and arterioles are expandable in order to accommodate dilation of the vessels. By them being able to expand or compress, they help control the blood pressure and flow of blood throughout the body. *(function/A&P)*

Arteries carry oxygenated blood and are narrow but thick which allows them to maintain a high blood pressure. They have smaller branches which are arterioles which are much smaller and thus also have a high pressure but carry a smaller volume of blood (*structure/Gen.Phys.)*

Arteries and arterioles contain smooth muscle which can contract, constricting the diameter of the blood vessels and raising blood pressure, or relax and cause the opposite effect. (*relates/A&P*)

46% of students in A&P and 26% of students in General Physiology related structure and function when asked to apply the concept



Structure: text analysis categories	Percent student responses
biomolecules	8.2
cells	5.2
cell components	0
tissues	7.9
tissue components	0
organs	35.9
organ components	3.2
organ systems	4.5
complex structures	1.8
part	4.0
properties of structures	21.8
structures	24.2

Function: text analysis categories	Percent student responses
cellular level	1.5
organ level	2.6
organ system level	2.6
organism level	0
disorders	0.2
general	36
function	8.7

Human coding	kappa
Q1. Arteries and arterioles are important in blood pressure regulation. Based on structure reflecting function, explain how the structure of these blood vessels contributes to blood pressure regulation. (n=379)	
structure	.731
function	.726[a]
relates	.760
Q2. Define the principle of complementarity (n=572)	
structure	.904
function	.693
relates	.800[a]
Q3. Give an example of the principle of complementarity from the human body (n=835)	
structure	.877[a]
function	.920
relates	.837[a]
Q4. Your patient was recently diagnosed with celiac disease, which is an autoimmune disease in which gluten damages the villi of the small intestine. Based on form reflecting function, relate the damage of villi to the functions of the digestive system. (n=368)	
structure	.911
function	.946[a]
relates	.913
Q5. Victims of third degree, or full thickness, burns have their epidermis and dermis damaged. Relate the loss of functions with losing these layers of the skin. (n=321)	
structure	.879[a]
function	.931
relates	.804[a]
Q6. A medical examiner is called to a crime scene to investigate the circumstances of a recent death. The victim is clutching a syringe in one hand and the medical examiner is unable to remove it. Based on form reflecting function, explain the role of actin and myosin in the process of rigor mortis. (n=415)	
structure	.705
function	.803[a]
relates	.700

[a] = p<0.025

Students held misconceptions about:
- -Relationship between resistance, flow and pressure
- -Diffusion of nutrients, wastes and gases
- -Blood pressure throughout system
- -Direction of blood flow

Conclusions

- Students used multiple levels of organization when describing structures to define the core concept
- Primarily organs, biomolecules and tissues were used to describe structures to apply the concept
- Overall, students mentioned structure and function in their responses but had difficulty linking the concepts
- Text analysis tools can be used to measure student understanding of core concepts in physiology to assess student conceptions and misconceptions, and enhance instructor effectiveness
- Future research will include collecting student responses to improve lower performing models and testing models on different student populations (e.g. at 2-year institutions)

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