Hard-wiring for Success: Simplified Teaching and Assessment of the Mammalian Heart Dissection

Daniel L. Martin*, Ryan Littlefield, Justin Roberts, Rachel Beebe, Juan Mata
Biology Department, University of South Alabama, Mobile, AL 36688
*dmartin@southalabama.edu

Introduction

At the University of South Alabama, we are teaching the age-old exercise of mammalian heart dissection in an innovative, more active way, using easily accessible materials (colored wire and Velcro). The simple methodology was hypothesized to work effectively at a variety of levels, but mainly **by increasing:**

i)cost-effectiveness, since it is inexpensive, re-useable, and time-saving, and even allows re-use of hearts if pre-dissected;

ii)student engagement, as the challenge of self-assessment balances success to make it fun – particularly for groups, and, the concept is expandable – for more detailed projects;

iii)reinforcement of concepts, since basic functional attributes of the circulatory system must be understood to complete this activity correctly;

iv)Assessment efficiency, as expectations are clear and precise, problems are detected rapidly as working groups are visited, and the very same method may be used in a practicum;

v)learning outcomes, as the method should aid comprehension.

Tested Hypotheses: ***i) learning outcomes (quiz grades) are affected by teaching method (old vs. new); ii) new methods helped lower-performing students.***

Methods

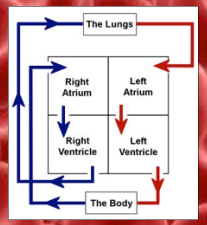
After examining or dissecting a heart, some students were expected to practice their knowledge of basic circulation using new materials (two sizes and colors of wire and Velcro strips) to trace the flow of blood through a real heart and a virtual body. Rather than simply pointing to structures and trying to recite their function, the specific materials were meant to help them build (metaphorically and literally) a logical understanding of the system. The physical appearance of the wires and Velcro (see below) were chosen to reflect basic functional aspects; e.g., Velcro fuzz mimics the high surface area and small size of capillary vessels. Arterioles are featured specifically (relative to major and minor arteries) due to their importance in regulating flow to capillary beds; venules were included due to their similarity in size/structural role (but not flow-regulatory function) to that of the arterioles. Such functional aspects were emphasized in lecture.

New Approach: Colors and Materials Codified by Function

- **RED** = oxygenated
- **BLUE** = deoxygenated
- **LARGE WIRE** = major & minor arteries or veins
- **SMALL WIRE** = arterioles or venules
- **LARGE VELCRO** = one side of systemic capillary beds
- **SMALL VELCRO** = one side of pulmonary capillary beds

LECTURE **(SELF)ASSESSMENT**

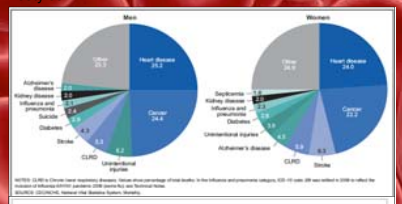
ACTIVITY

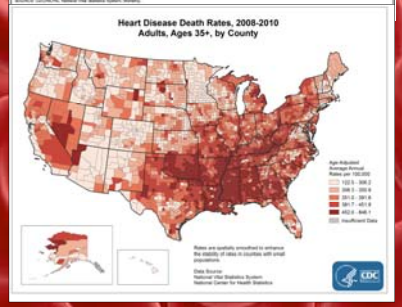


Why study the heart?

Beyond the obvious, central role of circulation...

- Heart disease: number 1 cause of natural death in the U.S.
- Heart disease: largely preventable through healthier lifestyles.





Other images: heart-torso= http://www.wire.wisc.edu; heart-lung circulation= www.teachpe.com; red blood cell= http://cord3d.cgpociety.org

All students (N = 207, from 10 sections taught by 4 different instructors) worked in small groups (usually 2), and were provided with a pre-dissected sheep heart, a general instruction sheet, and a lecture on circulation and heart disease. Each instructor provided roughly half of their students with the "new" wire/Velcro method, and brief supplementary instructions on how to use it. A subset of 5 quiz questions/points were standardized across all lab sections, and were written by an independent lab coordinator (i.e. not by one of the current instructors). To investigate whether the new method aided lower-performing students, final course performance scores were compared amongst those who did well on the specific quiz. All results were analyzed using two-tailed, un-paired Student's t-test ($p \leq 0.05$).

Results

Quiz scores were higher, but not significantly so, for students utilizing old versus new methods (below). Lower performing students were *not* better represented in the 'high quiz score' group, even after rank-adjusting performance uder each instructor.

	Method		
	Old (none) max n = 101 mean (SD)	New (wire) max n = 106 mean (SD)	t-test p-value
All students: quiz grade (out of 5 points)	3.2 (1.545)	2.8 (1.468)	0.0803
Best quiz performers (4-5 points):			
Overall Performance Scores			
Raw	89.3 (6.6)	89.1 (10.1)	0.929
Instructor adjusted percentile	0.67 (0.24)	0.68 (0.27)	0.914

Conclusions

Efficacy: Despite *apparent* advantages, this active learning method failed to make a difference in learning outcomes. Together, our results suggest the 'new method' students may not have studied as well, and that general study habits trumped methodology in this instance; i.e., good students did well, regardless. Assuming (for the sake of argument) that the new method can in fact help to increase learning outcomes, some possible causes and cures are proposed:

- **Irrelevant to the unmotivated and/or unprepared?** (With a university mean ACT score < 22, our introductory courses are rife with such challenges.)
  - incentivize (offer credit, for the proposed activities below).
  - suggest tutoring, learning communities, FYE course, etc.
- **Not enough time spent on reinforcement?**
  - require re-assembly of the system, without notes.
  - send students home with wire kits, to practice assembly.

Expandability: For classes with more time, these basic methods may be expanded upon (e.g. ad more materials) to yield more challenging activities:

- **Major capillary beds:** e.g., intestinal, hepatic, renal, etc.
- **Surface areas of capillary beds:** relative measures
- **Flow differences:** during rest and exercise
- **Flow differences:** mean, among all vessels
- **Pressure differences:** mean, systemic vs. pulmonary
- **Major arteries and veins:** include branching points, names
- **Valve types and placement:** heart and vessels
- **Improve current methods:** [currently, < $2 per specimen]