“Pump up the Volume”

Using Team Based Learning Strategies to Teach Factors That Affect Blood Flow

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Abstract: The purpose of this action proposal is to implement Team Based Learning into a lesson on factors that affect blood flow. This lesson will be delivered to one general Biology class period per teacher, for a total of three classes. Data will be collected and reported to compare the learning gains of the students taught using the TBL method of lesson delivery to the class periods receiving lecture-based instruction. This lesson will also be incorporating models and laboratory demonstrations to visualize the vocabulary and content associated with the standard. Finally, there will be an application based component for students to work together to find a solution to a cardiovascular disease, atherosclerosis. Therefore**,** If two groups of students are taught the biology standard *SC.912.L.9.12.14.36* using two different instructional methods (lecture-based instruction or Team Based Learning with hands on applications), then the class taught using the Team Based Learning method and hands on application will show an increase in their learning as evidenced in their pre and post assessment data. In addition, the students in the classes that received the team based learning initiatives will be polled on their personal viewpoints of how team based learning has affected their performance.

Rationale: Leesburg High School is a Title I school with the highest percentage of student absenteeism in the Lake County school district. The truancy rate has had a negative impact on our school standardized test data, including our Biology EOC scores. The data shows a large percentage of our student body are not meeting reading or science competency levels. Our data has continued to decline, with a current 54% pass rate for all students taking the Biology End of Course Assessment for 2016. The high truancy rate suggests students have apathy towards their education. It is a struggle to get students to feel accountable for their own educational outcomes and take the initiative to stay focused on the content. As a team, we have been open to new strategies to get the students interested in Biology and increase their performance despite the lack of support for schooling. The following table shows the data of **general** biology students' pass percentage on the Biology EOC:

2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
39%	55%	60%	41%	40%

In addition to absenteeism, student accountability for knowledge of content has declined. Many students do not keep up with the content needed to achieve learning goals they are required to know. Students often expect the teacher to supply all of the content within the class period and expect to pass the class based on this alone. Students who rely solely on the teacher for direct instruction are not as successful as students who take initiative to interact with the content and reinforce concepts outside of the classroom and collaborate to apply the content. Many students fail to complete homework unless they feel it will benefit their grade, which leaves them unprepared for mastery of content. For high school teachers, the time constraint to cover all required content often leaves us spending too much time on lecture based instruction in order to teach students the basic backbone to the content, which could potentially be done without teacher intervention. Taking so much time for the basics leaves little

time for the application- based challenges that spark student interest. “While large lecture classes may seem like a simple solution to diminishing resources, this method of teaching has been criticized as resulting in poor attendance, high student apathy, and passive and impersonal learning environments” (Fertig 2010; Vevea and Harris 2011). Lecture-based instruction identifies essential content and presents it to the students. This is an effective way to communicate pertinent information; however, it does not permit the students to effectively apply the information and as Fertig et al. states, it may contribute to student apathy. The Team Based Learning strategy incorporates the application component which is necessary for student understanding of the content. Also, the students are introduced to the lesson using a different method. The lesson objective is taught through assigned readings prior to class time in the form of homework. This way, students are obtaining the information on their own and applying it once they are in class. Hands on applications are also a great tool for engagement and student understanding. Adding this component will increase the students’ desire to participate.

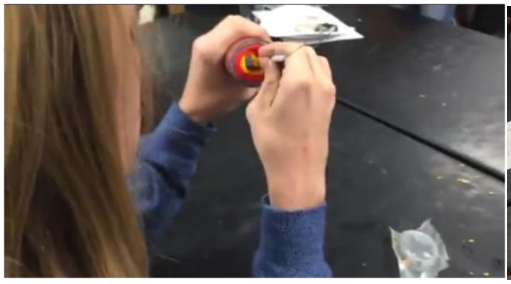
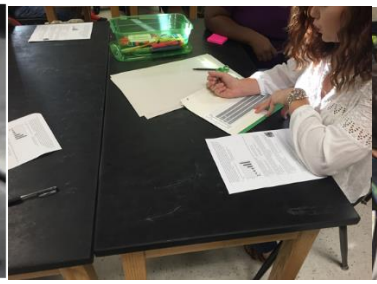
Intervention: This lesson will be delivered to one general Biology class period per teacher. Honors students will not be utilized due to the high percentage of competent students that could potentially curve the score reports. Data will be collected and reported to compare the learning gains of the students taught using the TBL method of lesson delivery to the class periods receiving lecture based instruction. Both groups will take the same pre and post assessments, but the method of obtaining the lesson information will vary. This lesson will also be incorporating models and laboratory demonstrations to visualize the vocabulary and content associated with the blood flow standard. Finally, there will be an application based component for students to work together to find a solution to a cardiovascular disease, atherosclerosis. This application will require the students to create a biomedical device that will be able to successfully remove plaque from an arterial wall without damaging the wall itself. Students will be provided the various materials to potentially use to engineer their device such as pipe cleaners, straws, toothpicks, paper clips, tongue depressors, cotton swabs, scotch tape, and rubber bands.

Connections to Bench to Bedside summer institute: During the Bench to Bedside institute,. Dr. McCormack was very helpful in demonstrating the concept of Team Based Learning, which is our primary focus. In order to increase student accountability and performance we will incorporate the concept of the “flipped classroom” and have students complete both individual readiness assurance tests (IRAT) and team readiness assurance tests (TRAT) to measure achievement in a collaborative environment. In addition, the blood flow atherosclerosis lab activity was adapted from the activity that was demonstrated by Dr. Hudalla and his team. We modified it into a STEM based lesson that uses the TBL method to allow students to understand the factors that affect blood flow (Standard: SC.912.L.14.36). In addition to what was presented regarding vessel radius due to cardiovascular issues, we are going to identify how changes in viscosity, pressure, and vessel length affected blood flow in order to align with the standard.

Data collection and analysis: Student knowledge will be assessed and collected using a Unit pretest and posttest. The pretest will be given prior to assigning readings for homework. In addition, the students in the classes that received the team based learning initiatives will be polled on their personal viewpoints

of how team based learning and hands on applications have affected their performance compared to traditional classroom strategies. This will give both qualitative and quantitative observations. Student IRAT and TRAT scores will also be documented as part of the TBL process for the classes that are part of that method of teaching and learning. Student attendance will also be tracked to see if there is a correlation between attendance and student learning gains. All of these factors will be taken into consideration with data reported for each component. The results of using the Team Based Learning (TBL) strategies are indicating below in the data table provided. The conclusion from this activity is that incorporating the TBL strategy with a hands-on activity provided students will a 21 point increase in their mastery of blood flow content. We did discover that classes that are heterogeneous and where students that were on reading grade level enjoyed this process more than homogeneous classes with students that were below grade level in reading. The TBL strategy is a useful team building method to increase mastery. As teachers, we liked how the strategy engages students and pushes them to hold each other accountable. Also, this process allows students to use deductive reasoning which is a high order thinking strategy that is warranted in finding solutions to problems. The only barriers we discovered with the blood flow lab is that it is a bit messy and we were challenged with time constraints of our district course calendar which doesn't give us a lot of time for this topic. The other barrier is that we discovered was that it was difficult creating a STEM challenge with this topic that aligned with this standard. We would have never been able to have had the time to create this lesson plan and lab experience without the financial support of the Bench to Bedside grant that supplied us with the lab materials

GROUP (CONSISTS 4-5 STUDENTS)	IRAT SCORE AVG.	TRAT SCORE AVG.
GROUP A	40%	75%
GROUP B	60%	80%
GROUP C	74%	95%
GROUP D	82%	90%
TOTAL	**64%**	**85%**


Literature cited:

Fertig, Jason. 2010. “Student Apathy: Public Enemy Number One.” Minding the Campus, November. Retrieved June 19, 2014 (http://www.mindingthecampus.org/2010/11/ student_apathy_public_enemy)

Stamatel, Janet P., Shawn Bushway, and William Roberson. 2013. “Shaking Up Criminal Justice Education with Team-based Learning.” Journal of Criminal Justice Education 24(3):

Permissions: This proposal will be submitted for approval to the principal of our school, Mr. Dennis Neal. Parent permissions are not needed because student data is being reported as a whole and anonymously. We will share this action proposal with the rest of our Biology department so that they can be informed of the Team Based Learning initiatives.

Lesson Plan

TITLE: “Pump Up the Volume” A Team-Based Learning Lesson on Factors That Affect Blood Flow

KEY QUESTION(S): The rate at which blood flows through the human body changes in response to many factors. Describe these factors and the effect on blood flow.

SCIENCE SUBJECT: Biology

GRADE AND ABILITY LEVEL: 10th Grade Regular Biology

SCIENCE CONCEPTS:

- Describe the factors that affect blood flow through the cardiovascular system
    - Understand the components of blood and blood vessels
    - Understand systolic and diastolic blood pressure and the effects of hypertension
    - Understand lifestyle choices that can prevent cardiovascular diseases, such as arteriosclerosis and atherosclerosis

OVERALL TIME ESTIMATE: 3 class periods, 50 min. each

LEARNING STYLES: Visual, auditory, tactile, and kinesthetic. This lesson is meant to encompass all learning modalities.

VOCABULARY:
Blood, Blood vessel, Vein, Artery, Capillary, Blood volume, Blood vessel radius, Blood vessel length, Blood pressure, Blood viscosity, Systolic pressure, Diastolic pressure, Cardiovascular system, Cardiovascular disease, Plaque, Arteriosclerosis, Atherosclerosis, Resistance

LESSON SUMMARY: This lesson will introduce the factors that affect blood flow in a TBL format, which entails the student reading the information ahead of time and completing an individual and team readiness assessment in class. The application phase will have the students testing viscosity, vessel length, vessel diameter, and blood volume in a lab setting as well as completing a design challenge to create a biomedical device that will remove "plaque" from an arterial wall using the materials provided and within time constraints given. Students will then test their devices as a class and data will be recorded based on the following:

- Time it takes to remove plaque
- Direction of removal (pulling or pushing in)
- Amount of damage to the epithelium
- Amount of materials used (minimal materials received higher score)

To follow up the application, teacher will do a mini-lecture to review concepts that students continue to struggle with, and students will complete analysis and conclusion question to sum up their learning experiences.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

1. Demonstrate the positive and negative factors that affect blood flow through the cardiovascular system, and the ways to reduce the effect of lifestyle factors that can lead to cardiovascular disease. Standard: SC.912.L.14.52

2. Understand how to successfully apply knowledge of content using the team based learning process, which includes student collaboration to find a solution to a problem with blood flow.

MATERIALS:

- **ESSENTIAL:**
    - Several sets of polyethylene tubing as well as various other materials enough for groups of 2-4. Each set should contain tubing of different length, diameter, and thickness. Recommend items are list below. Make sure each group has a large tray or sink to work over because the lab will be messy.

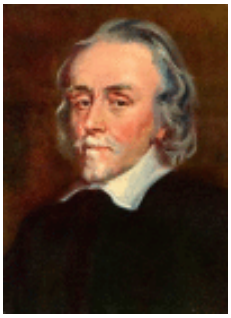
    - **Tubing (can be purchased on Amazon.com)**
        - polyethylene tubing: (1) 6 inch, (1)12inch, (1) 24 inch, same diameter, length, and thickness for all three to test viscosity
        - (1) tube with an inside diameter 0.1875 in. outside diameter 0.3125 in. 5/16'' pipe size,
        - (1) tube with an inside diameter- 0.25in. Outside- 0.375 in.
        - (1) with an inside diameter 0.170 in. outside diameter 0.25in.
        - (1) with an inside diameter 0.375 in. outside diameter 0.5 in pipe size ½ in.
        - Red and yellow modeling clay (can use Play-Doh or alternative brand). This will simulate the arterial wall and plaque accumulation

- **SUPPLEMENTAL:**
        - paper clips, cotton balls, rubber bands, tongue depressors, straws, long balloons, plastic spoons, and pipe cleaners to construct biomedical device
        - Liquids of varying viscosity ranges (can modify as needed) : water, buttermilk or egg nog, applesauce, ketchup
        - Large funnels, three per group
        - stopwatch/timer

BACKGROUND INFORMATION: *to be used as pre-reading for TBL, compiled from multiple sources cited below:*

The Discovery of Blood Flow

Before the 1600s most physicians believed that **blood** was pumped to the body by the lungs and there was a lack of understanding of blood circulation. Not only did they not understand blood flow but they



also believed blood was recreated each time an individual ate and then consumed by the tissues. The heart was thought to play a role in this process by providing heat for the creation of blood. It wasn't until **William Harvey**, a medical doctor in England, observed the movement of the heart in living organisms that physicians learned the heart pumps blood to the **vessels** of the body, blood circulates back to the heart, and blood does not originate from food. In his findings he wrote... *"this [blood flow] occurs in such an amount, with such an outflow through the arteries and such a reflux through the veins, that it cannot be supplied by the food consumed. It is also much more than is needed for nutrition. It must therefore be concluded that the blood in the animal body moves around in a circle continuously and that the action or function of the heart is to accomplish this by pumping. This is only reason for the motion and beat of the heart.*" During his experiments Harvey would remove hearts from living organisms and they would still beat. This showed the heart clearly had a pumping function. He was also able to mathematically calculate the **blood volume** which showed blood was not being completely consumed and recreated with each meal.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776239/

Just Keep Pumpin'

"Blood viscosity is the thickness and stickiness of blood. It is a direct measure of the ability of blood to flow through the vessels. It is also a key screening test that measures how much friction the blood causes against the vessels, how hard the heart has to work to pump blood, and how much oxygen is delivered to organs and tissues." An increase in the viscosity of blood means an increase in resistance to blood flow. If there's greater resistance to flow the heart has to work harder to pump the blood and this causes a higher blood pressure.

Think of the high viscosity of blood like a thick milkshake, the straw would be the blood vessel, and your mouth would be like your heart. If you wanted to drink the milkshake through a straw you'd have to inhale very hard on the straw to overcome the resistance of the milkshake, but if you wait and let the milkshake melt it will become more fluid. The viscosity will then decrease and it will be much easier to drink your milkshake.

Think about how tired your mouth would get if you had to constantly drink thick liquids like milkshakes. Your heart gets tired too. Having to pump thicker blood for long periods of time can have a negative impact on your

health. “The largest blood viscosity study ever conducted was part of the Edinburgh Artery Study in the 1990s, which followed a random population of 1,592 middle-aged adults for a mean of 5 years. It showed that blood viscosity, after adjustment for age and gender, was significantly higher in patients experiencing heart attacks and strokes than those who did not ($p = 0.0003$). The 20% of the individuals with the highest viscosity had 55% of the heart attacks and strokes during the 5-year period.” The studies show high blood viscosity has been linked to **hypertension** (prolonged high blood pressure), high cholesterol, Type-II diabetes, obesity, and smoking which increases an individual's risk for **cardiovascular disease**.

http://www.bloodflowonline.com/learn-about-blood-viscosity/blood-viscosity-basics

Blood viscosity can vary largely in part due to the amount of red blood cells in the blood stream. If an individual has an increased red blood cell count then their blood viscosity will increase. The reverse effect will occur if an individual has anemia or reduced blood cell count. “A second important factor that influences blood viscosity is temperature. Just like molasses, when blood gets cold, it gets "thicker" and flows more slowly. Therefore, there is an inverse relationship between temperature and viscosity. Viscosity increases about 2% for each degree centigrade decrease in temperature. Normally, blood temperature does not change much in the body. However, if a person's hand is exposed to a cold environment and the fingers become cold, the blood temperature in the fingers will fall and viscosity increase, which together with sympathetic-mediated vasoconstriction will decrease blood flow in the cooled region. When whole body hypothermia is induced in critical care or surgical situations, this will also lead to an increase in blood viscosity and therefore affect systemic hemodynamics and organ blood flow.”

http://www.cvphysiology.com/Hemodynamics/H011.htm

“blood viscosity can increase because of many factors, such as certain medications, too many red blood cells, high lipid levels, and other conditions, including diabetes and cancer.”

“strategies to improve blood viscosity are not too different from those for general heart health. "Exercise definitely helps the blood flow better by improving the health of the arteries, reducing blood pressure, and reducing cholesterol, among other benefits," says Dr. Padmanabhan. "Quitting smoking goes a long way in improving overall health, reducing the clotting ability of blood and reducing the chance of a heart attack. Reducing fat in our diet, losing weight, keeping cholesterol in check, and keeping blood pressure under tight control all help directly and indirectly in reducing the chance of heart attacks, which is essentially related to blood flow.”

"Sarah Klena, a schoolteacher in Orange County, Fla. Despite living a healthy, active lifestyle, she had a heart attack at age 31. Her doctors suspected blood thickness shouldered part of the blame. "

http://www.everydayhealth.com/heart-health/blood-viscosity-how-thick-is-your-blood.aspx

Vocabulary

Blood Pressure -the force of blood in the circulatory system , often measured for diagnosis since its closely related to the force and rate of the heartbeat and the diameter and elasticity of the arterial walls.

Resistance- The measure of the friction between blood and the vessel wall.

Viscosity- The measure of a fluid's resistance to flow; the internal friction of a moving fluid.

Blood Volume – The total quantity of blood in the body.

Hypertension (high blood pressure/HBP) – A condition in which the force of the blood against the artery walls is high over long periods of time.

Arteriosclerosis – The thickening and hardening of the walls of the arteries, occurring typically in old age.

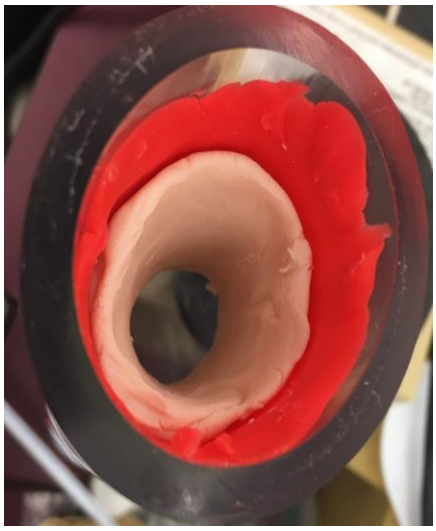
Blood Vessel – a tubular structure carrying blood through the tissues and organs; a vein, artery , or capillary.

Diet – food and drink regularly consumed for nourishment.

Exercise – Activity requiring physical effort to sustain or improve health and fitness .

Resources: www. Freedictionary.com; www.mayoclinic.org ; www.merriam-dictionary.com

ADVANCE PREPARATION: This lab requires an extensive amount of teacher preparation in obtaining materials and creating the “blood vessels” that contain the plaque as pictured below:



PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

PART 1: Testing factors that affect blood flow

1. Gather materials: approximately 5 minutes to set up and read over lab
2. Test the variables: approximately 15 minutes
   A) Testing **viscosity**- place each liquid in the opening of the same type of tubing (one at a time and make sure the tubing is clean each time) and use a stopwatch for the time the liquid passes through the tubing. Start the timer as soon as the first drop of liquid enters the tubing and stop the time once the last drop leaves the other end of tubing
   B) Testing **vessel length**- use three different lengths of the same type of tubing and time the rate at which a liquid moves through the tubing. Its recommended to use water or eggnog/buttermilk for the liquid. You must use the SAME liquid for this test. Time the rate using the same method as test A.
   C) Testing **vessel diameter**- use 2-3 different vessel diameters of the same length of tubing and measure the rate of flow using the same liquid that you used in part B. Measure the time the liquid flows through the tubing using the same method as test A and B.
   D) Testing **blood volume**- use the same tubing and test the rate of flow of three different volumes of water. Use the same method to measure the time as the other tests.
3. Record all data in the data table: this is done simultaneously to the testing process

Data

PART 1

Test A (Viscosity)			

	Liquid_____	Liquid_____	Liquid_____
Time/Rate			
Test B (length)	Length_____	Length_____	Length_____
Time/Rate			
Test C (diameter)	Diameter_____	Diameter_____	Diameter_____
Time/Rate			
Test D (Volume)	Volume_____	Volume_____	Volume_____
Time/Rate			

4. Graph the data: approximately 10 minutes
5. Analyze the data & graph: approximately 5 minutes
6. Answer the analysis questions: approximately 15 minutes

- What do you notice about the viscosity of the different fluids? Which fluids have the highest viscosity and lowest viscosity?

- How does the rate of flow compare with the different fluids? Which viscosity has the highest rate of flow? Which viscosity has the lowest rate of flow?

- What do you notice about the different type of tubing? How do they compare in terms of size, length, thickness, diameter (opening for fluid)?

- How does the rate of flow compare with the different length tubing? Which length has the highest rate of flow? Which length has the lowest rate of flow?

- How does the rate of flow compare with the different diameter/thickness of tubing? Which diameter/thickness has the highest rate of flow? Which length has the lowest rate of flow?

PART 2: STEM CHALLENGE

1. Gather materials: each group should be able to select up to 10 materials- approximately 5 minutes

- Each group should also have a tube with red play-doh/clay placed in one section of the tube as if it's the inner epithelium of a blood vessel. Then a yellow lining of play-doh/clay should be placed on top of the red play-doh to represent cholesterol build up/clot as a result of atherosclerosis.

2. Create a device that could remove the "plaque" in the lining of a blood vessel - approximately 20 minutes
3. Students will test their design in front of the class. Teacher will record class data in the table below on a projector or on the dry erase board as each student tests their device for the effectiveness of plaque removal. - approximately 15 minutes

Data

PART 2

Group	Time to remove plaque	Number of materials	Amount of damage to epithelium	Direction	Total score
1					
2					
3					
4					
5					
6					

TEACHER INSTRUCTIONS FOR SCORING STEM CHALLENGE

For each category rank the groups. The top scores are based on the lowest amount of time, number of materials, and damage. The direction category gets the highest score for going out the same direction the device went in the tube. The top score for each category is 5 the lowest score is 0. The group closest to 20 wins the challenge.

4. Analyze the data - approximately 5 minutes as a class discussion:
   - What materials did you use and why?

- How did your group do?
- Which group had the highest score. Why? What techniques and materials were most effective?
- What would you change or fix for a second trial? Why?

5. Answer the conclusion questions- approximately 15 minutes or given as homework:

ASSESSMENT SUGGESTIONS:

Objective 1: Since this is the overarching goal of the entire lesson, this component should be concluded with analysis questions such as the questions below:

1. What would cause a buildup of plaque in the blood vessels? How does diet and exercise affect this? What affect does plaque have on blood flow, resistance, and blood pressure?
2. What would cause blood viscosity to change? How does diet and exercise affect this? What affect does viscosity have on blood flow, resistance, and blood pressure?
3. What would cause hypertension How does diet and exercise affect this?
4. What would cause the blood vessel diameters to increase? What affect does this have on blood flow, resistance, and blood pressure?
5. What would cause the blood vessel diameter to decrease? What affect does this have on blood flow, resistance, and blood pressure?
6. How does age affect the occurrence of cardiovascular disease? What affect does this have on blood flow, resistance, and blood pressure?
7. What would cause blood volume to change? What affect does this have on blood flow, resistance, and blood pressure?
8. Summarize what you have learned about the factors that affect blood flow in at least one paragraph. Include DATA and examples from your experiments and the following terms: *cardiovascular system, blood pressure, resistance, viscosity, blood volume, vessel diameter, vessel length, diet, exercise, hypertension, arteriosclerosis, cardiovascular disease.*

Objective 2: The collaboration component is essential to Team Based Learning. Students should work together to answer questions similar to the following:

1. What materials did you use and why?
2. How did your group do?
3. Which group had the highest score. Why? What techniques and materials were most effective?
4. What would you change or fix for a second trial? Why?

EXTENSIONS:

ACTIVITIES: "The Dangers of Sticky Blood" is an interactive extention:
http://www.cpalms.org/Public/PreviewResourceLesson/Preview/128049

LITERATURE: "Circulation Disease":
http://www.seemyheart.org/echo-and-treatment-of-diseases/circulation-diseases/