The Beat Goes On

Description: In middle school a student's body goes through enormous changes. You can take advantage of their natural interest in the human body at this time while practicing scientific inquiry with this activity.

Students will gather data as they check and record the heart rate of their classmates at rest and after physical activity. They will come up with a question to test, form a hypothesis, collect data, record their results in a graph and come to a conclusion. They will work with a partner and each student will write down their data.

Grade level: 6-8

Time: (2) 45 minute class periods

Standards; (Objectives)

As a result of this activity students will develop a greater understanding about scientific inquiry and the ability to do it.

Teachers can reinforce the importance of making healthy decisions by having students measure and record their heart rate during various forms of activity. Graphing and comparing active hearts rates with resting heart rates will give an indication of cardiovascular fitness. (Taken *from the NSTA Pathways To Science Standards, p. 99)*

KEY INQUIRY SKILLS from National Content Standard A:

- Pose investigable questions that may be answered through scientific investigations
- Design and conduct a scientific investigation
- Use simple measurement tools to collect data
- Identify dependent and independent variables and constants
- Present data in an organized format
- Use mathematics to analyze data
- Interpret data to form conclusions
- Apply experimental results to solve problems

UNDERLYING SCIENCE CONCEPTS (KEY IDEAS):

- The heart pumps blood around the body;
- Blood carries oxygen to all of the body's cells;
- The rate at which the heart beats is affected by a variety of factors, such as activity, time of day, age, gender, disease or fitness;
- Each heartbeat produces a palpable surge in the blood vessels; the surge is called a pulse;
- The respiratory and circulatory systems interact with each other.

Materials:

Pencil

Paper or Science Notebook

Stop watch (or use classroom clock if it has a second hand and can be seen by students). Make sure students can count seconds using the second hand)

Graph paper

Computer with internet access

Procedures:

1. ENGAGE:

Ask the following questions:

- You have probably noticed that when you walk or run up the stairs at school to get to a class upstairs, you feel “out of breath” and your heart beats faster.
- Why does this happen?
- What does heart rate have to do with fitness?
- Are there other conditions that cause your heart to beat faster or slower?

This should lead to a lively discussion which should allow you to briefly assess what students already know.

In this activity you and your partner will conduct experiments to explore how hearts beat under different conditions.

2. EXPLORE:

Say to students: “You’re going to find out the heart rate of your partner by using their pulse. There are two ways to do this and you will need to try both ways to see which location is the most comfortable for you to use.” Go over the following with the students.

Methods for Measuring Pulse Rate

There are two methods for measuring pulse. You should sit quietly for several minutes before measuring your "**resting**" pulse rate. You can work with a partner or by yourself to try both ways, and then decide which way works best for you. Try each location at least 3 times and record your pulse rate in your science notebook or on the "resting pulse rate data sheet". Have the partner who is taking the pulse also keep the time. Each partner should record their data for their "resting" heart beat. Explain and demonstrate to the students ways to take their pulse.

Wrist Method: With the palm of your partner's hand facing up, place the tips of your first two fingers on the fleshy part of your partner's thumb. Slide your fingers about 2 inches toward the wrist, stop, and press firmly to feel the pulse of blood which each heart beat sends through the artery. To measure heart rate, count the number of pulses in 30 seconds. Multiply that number by 2, and you will have the number of beats per minute ("bpm"). (You don't use your thumb to take the pulse because it has its own pulse which can be confusing.)

Neck Method: Place the tips of your first two fingers on either side of your windpipe, near the lump, called an Adam's apple, in the middle of your neck. Press gently until you can feel a pulse. To measure heart rate, count the number of pulses in 30 seconds. Multiply that number by 2, and you will have the number of beats per minute ("bpm").

Teacher notes: Give students 10-15 minutes to practice finding a pulse and then counting pulse beats for 30-second intervals. Students should try both methods since they may find their accuracy is better with one method or the other. Once they begin their experiments, however, they should choose one method to use throughout.

Have students average the three resting rate trials. Pass out small slips of paper. Have students write their average resting heart rate per minute on their slip and hand it back in. Write the heart rates on the board (without identifying the students) and ask students what might cause any variability in resting heart rates. *(Resting heart rates vary with age, sex, physical shape, and cardiovascular condition. Resting rates can also vary due to emotional changes, caffeine intake, and medication side effects. Athletes generally have lower resting pulse rates than non-athletes.)* As a class, analyze the data set for high, low, average, and median values. (You may want to have students collect data from a similar number of adults for comparison.) (*This may be a good place to stop after day #1.)*

Talk with your students about several actions that might increase pulse rate. Each group of 2 should choose an action that they will investigate. Later, each group will share their results with the rest of the class.

- *Teacher notes: It is interesting to encourage different groups to observe the effects of different actions on pulse rate. Although students frequently think of heavy exercise (e.g., jumping jacks) as the only way to elevate pulse rate, some students may be curious about the effects of other, less strenuous, actions such as reading aloud or holding a stack of books at arm's length. Decide in advance whether or not you will allow students to leave the classroom to perform the investigation. Generate a list of acceptable 'actions' and write them on the board so students may select one. Possibilities might include clapping hands, hopping on one foot, etc.*
- *Many students believe that scientists conduct research only by performing experiments with chemicals. This is a good opportunity to lead a class discussion about the variety of methods scientists use to answer different types of questions. For example, observational research, or field studies, may suggest relationships for further study, but do not isolate a specific cause/effect relationship. This activity offers students the chance to collect observational data about the effect of different actions on pulse rate.*

Conduct Your Experiment: (Write these steps on the board or give each student a copy that they may follow.)

Tell students to keep a detailed and organized record of their experimental design, data collection and analysis in their science notebook.

1. Identify the **question** you will investigate. For example, "What effect does running in place for 3 minutes have on heart rate?"
2. **Predict** the relationship you expect to find. (Hypothesis)
3. Design a **procedure** to collect data to answer your research question. Talk with your partners about how you could test your ideas concerning physical or environmental factors that might increase or decrease pulse rate.
4. Identify the **independent** and **dependent** variables in your experiment. Think about the parts of your experiment that should be kept **constant** so you can collect consistent data.
5. **Write** your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.
6. Get your teacher's approval before you begin your experiment.
7. Create a **data table** to record data related to your experiment.
8. Do your experiment and **record** your findings in your data table. Remember to take a resting pulse count after sitting quietly for 5 minutes.
9. Think about the data you have collected. Does the data for each trial seem generally consistent? If not, do you need to repeat any trials to correct any **errors**?
10. **Analyze** the data.
11. Create a **graph** that will help you make sense of your data.
12. **Interpret** the data. What **conclusions** can you make about the effect of different movements on pulse rate? Did anything surprise you?

Communicate Your Findings:

Scientific research can be communicated in formal and informal ways, including written lab reports, journal articles, poster presentations or round-table discussions. Members of a scientific community review the experiments of others, give comments and ask questions. The teacher will select a method to share the findings and conclusions from your experiment with the rest of the class.

Teacher notes: Review all procedures to be sure they are safe and appropriate. All procedures should include a method for measuring resting pulse rate, a defined activity for a specified amount of time, and a post-activity pulse count (recognizing that the longer the subject rests, the lower the pulse will be). This is a good time to review factors affecting reliability: keeping all variables constant (except for the variable to be measured – pulse rate) and doing multiple trials to engage students in evaluating their own work, you might have groups exchange procedures.

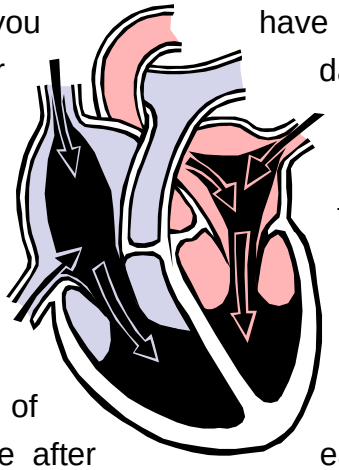
3. EXPLAIN

Teacher asks: What do you think your heart was doing during the activities you have just completed? Why did your pulse rate increase? (*Discuss the results of their experiment*.) When was the pulse rate higher? Why was it higher? Does your blood flow around your body faster or slower when you exercise? Why do your muscles need more blood during exercise? (*they need more oxygen because they're working harder)*

A variety of factors can influence pulse rate, including physical condition, age, weight, heart disease, medications, smoking, and emotional state such as stress. In general, pulse rates will be lower in those who exercise and are in good physical condition. (*For the teacher's information*: *Exercise increases the strength of the heart muscle. A stronger heart muscle pumps more efficiently, i.e., more blood pumped per pulse beat. As a result, the number of beats [pulses] required to move the same amount of blood through the body is decreased. In addition, exercise increases the number of capillaries in muscle. This provides more channels to transport oxygen and carbon dioxide during exercise. The result is that gas exchange in both the lungs and the muscles is faster. This, in turn, reduces demand on the heart to pump faster.) Weight also influences pulse rate. The heart must pump harder to move the blood through more body tissue, in this case mostly fatty tissue. This extra tissue places a demand on the circulatory system for oxygen and nutrients. To compensate, the heart must pump faster increasing*

the pulse rate. Additionally, the amount of blood in the arteries increases, often leading to higher blood pressure.)

4. ELABORATE and CONNECT



Think about the observations you have made and recorded in your science notebook and on your data collection worksheet. Work with your partners to list questions about pulse rate that you are interested in investigating. They may be curious about the effects of the duration of the exercise, or they might explore physiological factors such as age, gender, or height; or they might explore the effects of environmental variables such as different types of music, different body positions, effect of high-caffeine energy drinks, time of day, heart rate change after eating lunch, or even the effects of quiet meditation on pulse rate. Teacher asks: Do the students think the pulse rate would be the same if a very fit athlete did this test?

Do you know that heart disease is the biggest killer in western countries? What can you do to try to keep your heart healthy? (*diet, exercise, and don't smoke*)

There are many other reasons why a person's heart may fail especially as they get older. For that reason many scientists and doctors have become interested in how to prevent heart attacks and to help keep our hearts healthy and prevent heart attacks.

Students should now be motivated to do some research on the www.ScienceHeroes.com web site to find out more about the scientists that have made lifesaving discoveries involving the heart. Have students go to the Science Heroes website and find the section called "Ills and Pills" under the heading "Malady" and pick one of the several scientists that are listed as having worked with a heart related issue. After they select a scientist they may do a class presentation on their scientist telling what the scientist has done to prevent heart failure, a research paper on the contributions of their scientist, a poster or a concept map.

Scientists that students may read about on the Science Heroes website that have had a role in preventing heart disease include:

Aspirin as a Preventative	Lawrence Cravens, Paul Gibson, Charles Hennekens
Statins to Lower Cholesterol	Akira Endo
Originator of the Pacemaker	Wilson Greatbatch
CPR Techniques	Peter Safar, James Elam, James Jude, G.Guy Knickerbocker, and William Kouwenhoven
Treatment for Congenital Heart Defect:	Alfred Blalock, Vivien Thomas
Heart Bypass Surgery:	Vladimir Demikhov, Vasilli Kolesov

While the amount of time devoted to this phase is up to the teacher, it is important that students have opportunities to relate their experimental findings to established scientific knowledge and **connect to the real world.**

5. Evaluate

Encourage students to come up with their own questions to investigate regarding pulse rate. Examples might be: Will there be a difference in the pulse rate between boys and girls? Will age make a difference in pulse rate?

Ask students to think of an experimental question that one of the scientists listed on Science Heroes might have had before they started their research.

Teacher notes: Scientific inquiry is as much about asking good questions as it is about getting good answers. Depending on your students' prior science experiences, you may need to lead a class discussion about how to distinguish questions that are "investigable" from those that are not. Help students to refine and refocus broad or ill-defined questions. Generally, "what happens if" questions are investigable, whereas "why" questions are not.

This is an opportunity for students to generate their own questions to investigate. They may identify the **question** to be investigated and record it in their science notebook.

This lesson plan was written by Catherine Hesseldenz of Lexington, KY. She is a retired science teacher with over 33 years of experience at every grade level ranging from kindergarten to college seniors. Holding a Masters degree, she has also worked as the County Science Resource Teacher for the Fayette County Public Schools (50 schools) for 11 years, including organizing the county science fair and developing teaching materials for middle school programs through the University of KY.

Resting Pulse Rate Data Sheet

Resting Pulse Rate

Fill in your three resting pulse rates. Calculate the average of the three trials.

DATA COLLECTION

Names	Student1	Student 2
Trial 1		
Trial 2		
Trial 3		
Average