Heart Rate and Aerobic Exercise

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Modified from PBS Teacher Source Mathline.
In a Heartbeat (Algebra) Middle School Math Project

Grade Level: 8.

Science concepts. The student knows that interdependence occurs among living systems. The student is expected to identify feedback mechanisms that maintain equilibrium of systems such as body temperature, turgor pressure, and chemical reactions;

Mathematics Probability and statistics. The student uses statistical procedures to describe data. The student is expected to: draw conclusions and make predictions by analyzing trends in scatterplots;

Objective

After studying various aspects of scatter-plot diagrams, students will use heart rate monitors to examine the relationship between aerobic exercise and heart rate. Students will extend their findings to a more robust understanding of feedback mechanisms and their importance in maintaining equilibrium in living systems.

Background Information

Scatter plots are graphical displays which demonstrate the relationship between two distinct data sets. When one variable increases as the other decreases, this is known as a negative correlation. When one variable increases as the other increases, this is known as a positive correlation. No correlation exists when points appear randomly on a scatter plot.

Many systems are controlled through a feedback loop. For example, hormones help to maintain normal blood sugar levels. When the pancreas fails to produce sufficient quantities of the hormone insulin, a disease known as diabetes results. In other words the feedback loop which maintain blood sugar levels fails.

Heart rate is controlled via a bio-feedback loop in which special receptors located in the brain known as chemo-receptors monitor blood oxygen levels. As oxygen levels fall, the chemo-receptors sense diminished oxygen levels and the brain sends electrical signals with increasing frequency to the heart. This causes the heart to beat faster as well as produce more vigorous cardiac contractions. As oxygen-rich blood reaches the brain the chemo-receptors sense this restored oxygen level and the rate at which the heart beats slows. In this way, oxygen levels to the brain remain relatively constant and homeostasis is achieved.

Overview of the Lesson

In this lesson, the teacher begins with a discussion of scatter plots. Typical questions which might arise from this discussion are as follows:

-What kind of data is appropriate for a scatter plot?
-What can we learn from scatter plots?
-What is the difference between the dependent and the independent variable?
-What is an ordered pair and what does it represent?

Next, students will be told that they will apply their knowledge of scatter plots to a real world question: **What is the effect of aerobic exercise on heart rate?**

Materials

Computer with Graphical Analysis software
Heart Rate Monitor
If Needed, A Data Collection Interface
Power Point software
Other materials as needed

Procedure

The lesson will begin with a discussion of how variables may be related to each other. Introduce the term "correlation." Many relationships are obvious such as the relationship between the average weight of a defensive line and the number of times they sack the quarterback in any given game.

Next, have students conduct an Internet search of feedback mechanisms. Allow students ample time to do the research and engage in dialogue. Questions to discuss might be: What is a feedback mechanism? How do feedback mechanisms help maintain homeostasis in living systems? What happens when these feedback mechanisms fail?

Begin with the following warm-up. Have students collect height and weight data for the classroom. Next, students will create a scatter plot of this data. Is there a relationship between how tall people are and how much they weigh? Ask students to describe other variables which are correlated.

In this lesson, students will determine the relationship between aerobic exercise and heart rate. Begin by asking the student subject to move to a private place and strap the heart rate monitor snugly around their chests at heart level. They should then apply a saline solution (composed of one tablespoon of salt and approximately 20 ml. of water) to the back of the sensor to insure good contact between the chest wall and the sensor.

In groups of three or four, students should next design and construct experiments which demonstrate the relationship between heart rate and aerobic exercise.

Extension

Ask students what other things might increase heart rate? What types of experiments can be created to test this hypothesis. (For example, a student might believe that caffeine would increase heart rate. An experiment can be created which measures heart rate before and after eating a chocolate candy bar or drinking a caffeinated beverage.)

Have students determine the **line of best fit**. (Graphical Analysis will do this.) What is the line of best fit? What information can be determined from this line?

Evaluation

Groups will present a short Power Point presentation on their findings complete with photos, graphs, and anything else which might help to explain the experiment which they designed.

Included in this presentation each group must demonstrate an understanding of feedback mechanisms in the human system. Students are free to use heart rate monitors, pH sensors, temperature probes, and/or any other probes or equipment which they have access to.

An example might be a group which directs a low intensity light and a high intensity light at the eye of a subject. They then photograph the eye with a digital camera and use image analysis software to measure the diameter of the eye. They would then repeat this procedure on a number of subjects to produce a scatter plot.

Alternatively, students may frame a question which involves the question of body systems which maintain equilibrium and report on this question. For example, the question might be, "How does the body maintain a relatively constant core temperature?" Students might consult Internet resources, visit the library, and/or consult a physiologist at a medical school. Findings would then be organized into a PowerPoint presentation and presented to the class.

Resources

Quantitative Literacy Series: *Exploring Data.* Dale Seymour Publications. (1987) Palo Alto, California.

Web site:
http://www.pbs.org/teachersource/mathline/lessonplans/msmp/heartbeat/heartbeat_mathspeak.shtm