Curriculum Embedded Performance Task
Middle School Science

Content Standard 7.2

Feel The Beat

Teacher Manual

Connecticut State Department of Education
Bureau of Curriculum and Instruction

Acknowledgements

The Connecticut State Department of Education is grateful to the many dedicated science educators who contributed to the development of the elementary, middle and high school curriculum-embedded performance tasks and teacher manuals. Beginning with the initial ideas for tasks, through the classroom field testing, to the guidelines for classroom implementation, these inquiry teaching and learning activities are the result of the creativity, experiences and insights of Connecticut's finest science educators. We thank all of you, too numerous to list, who gave your time and energy so generously to this project.

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OVERVIEW OF THE ELEMENTARY AND MIDDLE SCHOOL CURRICULUM-EMBEDDED PERFORMANCE TASK MODEL

The Connecticut State Board of Education approved the Core Science Curriculum Framework in October of 2004. The framework promotes a balanced approach to PK-12 science education that develops student understanding of science content and investigative processes.

WHAT IS A CURRICULUM-EMBEDDED PERFORMANCE TASK?

Curriculum-embedded performance tasks are examples of teaching and learning activities that engage students in using inquiry process skills to deepen their understanding of concepts described in the science framework. Developed by teachers working with the Connecticut State Department of Education, the performance tasks are intended to influence a constructivist approach to teaching and learning science throughout the school year. They will also provide a context for CMT questions assessing students' ability to do scientific inquiry.

The three elementary performance tasks are conceptually related to Content Standards in Grades 3 to 5 and the three middle school performance tasks are related to Content Standards in Grades 6 to 8. The elementary performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 3 to 5 (see Science Framework B.INQ 1-10 skills) to understand science concepts. The middle school performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 6 to 8 (see Science Framework C.INQ 1-10 skills) to understand science concepts.

Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry process skills to deepen understanding of science concepts. Students who regularly practice and receive feedback on problem-solving and critical thinking skills will steadily gain proficiency.

HOW ARE THE PERFORMANCE TASKS STRUCTURED?

Each performance task includes two investigations; one that provides some structure and direction for students, and a second that allows students more opportunity to operate independently. The goal is to gradually increase students' independent questioning, planning and data analysis skills. The elementary performance tasks introduce students to understanding and conducting "fair tests". The middle school performance tasks focus on designing investigations that test cause/effect relationships by manipulating variables.

Mathematics provides a useful "language" for quantifying scientific observations, displaying data and analyzing findings. Each curriculum-embedded performance task offers opportunities for students to apply mathematics processes such as measuring, weighing, averaging or graphing, to answer scientific questions.

Not all science knowledge can be derived from the performance of a hands-on task. Therefore, each curriculum-embedded task gives students opportunities to expand their understanding of concepts through reading, writing, speaking and listening components. These elements foster student collaboration, classroom discourse, and the establishment of a science learning community.

A useful structure for inquiry-based learning units follows a **LEARNING CYCLE** model. One such model, the "5-E Model", engages students in experiences that allow them to observe, question and make tentative explanations before formal instruction and terminology is introduced. Generally, there are five stages in an inquiry learning unit:

- **Engagement:** stimulate students' interest, curiosity and preconceptions;
- **Exploration**: first-hand experiences with concepts without direct instruction;
- **Explanation:** students' explanations followed by introduction of formal terms and clarifications;
- **Elaboration:** applying knowledge to solve a problem. Students frequently develop and complete their own well-designed investigations;
- **Evaluation:** students and teachers reflect on change in conceptual understanding and identify ideas still "under development".

The performance tasks follow the "5-E" learning cycle described above. However, the teacher can decide the role the performance task will play within the larger context of the entire learning unit. Early in a learning unit, the performance task can be used for engagement and exploration; later in a learning unit, the performance task might be used as a formative assessment of specific skills.

<u>HOW ARE PERFORMANCE TASKS USED WITH YOUR CLASS?</u>

Curriculum-embedded performance tasks are designed to be used as part of a learning unit related to a Framework Content Standard. For example, while teaching a unit about human body systems (Content Standard 7.2,) the teacher decides the appropriate time to incorporate the "Feel The Beat" performance task to investigate factors affecting pulse rate. In this way, the natural flow of the planned curriculum is not disrupted by the sudden introduction of an activity sequence unrelated to what students are studying.

The performance tasks are NOT intended to be administered as summative tests. Students are not expected to be able to complete all components of the tasks independently. Teachers play an important role in providing guidance and feedback as students work toward a greater level of independence. Performance tasks provide many opportunities for "teachable moments" during which teachers can provide lessons on the skills necessary for students to proceed independently.

There is no single "correct" answer for any of the performance tasks. Students' conclusions, however, should be logical, or "valid" interpretations of data collected in a systematic, or "reliable" way. Variations in students' procedures, data and conclusions provide opportunities for fruitful class discussions about designing "fair tests" and controlling variables. In the scientific community, scientists present their methods, findings and conclusions to their peers for critical review. Similarly, in the science classroom, students' critical thinking skills are developed when they participate in a learning community in which students critique their own work and the work of their peers.

Performance tasks should be *differentiated* to accommodate students' learning needs and prior experiences. The main goal is to give all students opportunities to become curious, pose questions, collect and analyze data, and communicate conclusions. For different learners, these same actions will require different levels of "scaffolding" as they move toward greater levels of independence. For example, if students have had experiences creating their own data tables, the teacher may decide to delete part or all of the data table included in the performance task. Other possible adjustments include (but are not limited to):

- Text readability;
- Allowing students to control all or some of the variables;
- Whether the experimental procedure is provided or student-created;
- Graph labels and scales provided or student-created;
- Expectations for communication of results; or
- Opportunities for student-initiated follow-up investigations.

There are many science investigations that are currently used in schools that provide inquiry learning opportunities similar to those illustrated in the performance tasks. Students need a variety of classroom experiences to deepen their understanding of a science concept and to become proficient in using scientific processes, analysis and communication. **Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry processes and critical thinking skills.**

HOW ARE THE PERFORMANCE TASKS RELATED TO THE CMT?

The new Science CMT for Grades 5 and 8 will assess students' understanding of inquiry and the nature of science through questions framed within the CONTEXT of the curriculum-embedded performance tasks. Students are not expected to recall the SPECIFIC DETAILS OR THE "RIGHT" ANSWER to any performance task. The questions, similar to the examples shown below, will assess students' general understandings of scientific observations, investigable questions, designing "fair tests", making evidence-based conclusions and judging experimental quality.

Here is an example of the type of multiple-choice question that might appear on the Grade 5 Science CMT. The question is related to the "Soggy Paper" performance task:

> Some students did an experiment to find out which type of paper holds the most water. They followed these steps:
>
> 1. Fill a container with 25 milliliters of water.
> 2. Dip pieces of paper towel into the water until all the water is absorbed.
> 3. Count how many pieces of paper towel were used to absorb all the water.
> 4. Repeat with tissues and napkins.
>
> If another group of students wanted to repeat this experiment, which information would be most important for them to know?
>
> a. The size of the water container
> b. The size of the paper pieces *
> c. When the experiment was done
> d. How many students were in the group

Here is an example of the type of constructed-response question that might appear on the Grade 8 Science CMT. The question is related to the "Feel The Beat" performance task:

> Imagine that you want to do a pulse rate experiment to enter in the school science fair. You've decided to investigate whether listening to different kinds of music affects people's pulse rate.
>
> Write a step-by-step procedure you could use to collect reliable data related to your question. Include enough detail so that someone else could conduct the same experiment and get similar results.

NOTE THAT THE CMT QUESTIONS DO NOT ASSESS A CORRECT "OUTCOME" OF A PERFORMANCE TASK OR STUDENTS' RECOLLECTION OF THE DETAILS OF THE PERFORMANCE TASK. Students who have had numerous opportunities to make observations, design experiments, collect data and form evidence-based conclusions are likely to be able to answer the task-related CMT questions correctly, even if they have not done the state-developed performance tasks. However, familiarity with the context referred to in the test question may make it easier for students to answer the question correctly.

INTRODUCTION TO "FEEL THE BEAT"

In this performance task, students will compare the sound of the beating heart to the pulse rate that can be measured. Following their initial explorations, they will identify factors that may affect pulse rate and design an experiment to test their ideas.

SAFETY NOTES:

- Review expectations for appropriate behavior, handling of materials and cooperative group procedures prior to beginning this investigation. Remind students that the stethoscopes and stopwatches are fragile instruments that require gentle handling and storage in order to avoid breakage.
- BE SURE TO HAVE EACH STUDENT DISINFECT THE STETHOSCOPE EARPIECES using the alcohol wipes provided. Remind students to keep alcohol wipes away from their eyes and mouths.
- Monitor students using the neck method for checking pulse to be sure they are not pressing too hard.
- Check with the nurse or special education staff concerning any students who might have health issues or physical disabilities that would impact the implementation of the activity. Students with all types of physical restrictions can safely raise their pulse rates by doing things such as talking, reading aloud, clapping hands, etc.
- For more comprehensive information on science safety, consult the following guidelines from the American Chemical Society - http://membership.acs.org/c/ccs/pubs/K-6_art_2.pdf and the Council of State Science Supervisors - http://www.csss-science.org/downloads/scisaf_cal.pdf

FRAMEWORK CONTENT STANDARD(S): Feel The Beat is related conceptually to the following learning unit:

7.2 Many organisms, including humans, have specialized organ systems that interact with each other to maintain dynamic internal balance.

- All organisms are composed of one or more cells; each cell carries on life-sustaining functions;
- Multicellular organisms need specialized structures and systems to perform basic life functions.

This is a learning unit about the structures that comprise several human body systems, and how those structures work together to carry out life-sustaining functions. Feel The Beat can provide opportunities for students to explore the interactions between the structures and functions of the circulatory and respiratory systems.

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.

KEY INQUIRY SKILLS:

- Pose investigable questions based on observations;
- 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.

MATERIALS NEEDED:

Listed below are all the materials needed to complete the activities in Feel The Beat. Some materials are supplied in starter kits provided by the Connecticut State Department of Education. These materials are marked with an asterisk (*). The remaining materials are supplied by the school district:

1. Stethoscope (one per group) *
2. Stopwatch (one per group) *
3. Alcohol wipes (rubbing alcohol and cotton balls may be substituted) *
4. Graph paper (optional)
5. Poster paper, markers, crayons, etc.

ADVANCE PREPARATION FOR THE TEACHER:

1. Carefully read through all teacher and student materials. Modify the Student Materials based on the needs of your students. Then print and photocopy Student Materials.
2. Check with the nurse or special education staff concerning any students who might have health issues or physical disabilities that would impact the implementation of the activity.

Students with a variety of physical restrictions can safely raise their pulse rates by doing things such as talking, reading aloud, clapping hands, etc.

MATERIALS DISTRIBUTION:

Get students involved in distributing and returning materials. This saves time for the teacher and also teaches students collaborative skills and self-reliance. One way to distribute materials is through a "cafeteria style" distribution center. All materials are laid out on a table or counter, and each group sends a representative to pick up the required materials. Trays or plastic shoeboxes work well for transporting materials from the center to the lab groups.

ESTIMATED COMPLETION TIME AND PACING SUGGESTIONS:

Experiment #1

Five, 50 minute periods

Experiment #2

Four, 50 minute periods

PEDAGOGY:

Consult the teacher notes accompanying each step of the performance task for suggestions related to classroom implementation, differentiation, assessment and extension strategies. The ▲ symbol is used to indicate a differentiation opportunity. Each Teacher Note is followed by a reference to the Framework inquiry skill featured in that task component. For example, the notation "**C INQ.3"** indicates an inquiry skill related to designing or conducting a simple investigation.

Feel The Beat

A Guided Exploration of the Factors That Affect Pulse Rate

ENGAGE

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? Are there other conditions that cause your heart to beat faster or slower?

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

Gather the following materials:

Materials:

1 stethoscope per lab group	Alcohol wipes
1 stopwatch per lab group	Graph paper, poster paper, markers

EXPLORE

1. Explore the sound of a heart beating using the stethoscope. See if you can detect heartbeats by holding the stethoscope to the neck, back, wrist and ankle. Do the heartbeats sound the same at different places?

Teacher notes: Although not directed to do so, students may begin by placing the stethoscope on their chest. Adolescent girls may feel self-conscious or decline to participate if they are in mixed gender groups. You may decide it is more appropriate to group students by gender. Be aware that students may have difficulty hearing through the stethoscope, encourage the students to keep background noise to a minimum. Be sure that each new user cleans the stethoscope earpieces with the alcohol pads.

2. In your science notebook, describe things you observed about the beating heart.

Teacher notes: You may suggest that students list "Noticings" and "Wonderings" in a 2-column chart. Since this is an open-ended observation, the teacher should reserve judgment about content correctness. However, it is a good time to review with students the difference between a scientific observation and a fact, an opinion, a name or an ordinary adjective. **C INQ.1**

Experiment #1: Effect of Movement on Heart Rate

Continue your exploration by investigating how different movements (e.g., walking, climbing steps, lifting weights, or hand-clapping) affect how the heart beats.

You may have found it difficult to accurately count the heartbeats you heard with the stethoscope because of interference from other noises in the room. An easier way to count heartbeats is to feel the pulse caused each time the heart pumps blood.

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:

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").

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. This may be a good place to end Day #1.

COLLECT DATA THROUGH OBSERVATION:

1. Talk with your partners about several actions that might increase pulse rate. Choose an action that your group will investigate and share your ideas 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) is 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. **C INQ.1**

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. **C INQ.3**

2. Write the **question** you will investigate in your science notebook.

Teacher notes: For example, "What is the effect of rapid talking on pulse rate?" **C INQ.3**

3. Write a step-by-step **procedure** to collect data to answer your research question. Be specific and consistent. Get your teacher's approval before you begin your experiment.

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.

4. Create a **data table** to keep track of your results.

Teacher notes: ▲ *For students who need assistance creating their own data tables, you may want to provide part or all of a data table template. For some students, it is enough to give them a blank matrix; others will benefit from having suggested column headings.*

5. Do your experiment and **record** your findings in your data table.

Teacher notes: ▲ *Depending on how much student interaction you wish to foster, you may limit the data collection to the members of each lab group, or you may allow lab groups to collect data from other lab groups as well. Consider how much guidance you want to provide as students are investigating. If your goal is to help students improve their proficiency at designing experiments, you may want to allow them to make experimental errors, and then address those during the post-lab discussion when inconsistent data patterns emerge; or you may visit with groups as they are collecting data and ask them questions such as "Are you allowing time for the activity pulse rate to return to the resting rate?"* **C INQ.5**

6. Analyze the data. Calculate the average activity pulse rate for each person. Compare the activity pulse rate to the resting pulse rate.

Teacher notes: **C INQ.6**

7. Interpret the data. What have you learned from the data in your experiment? Write your conclusions in your science notebook.

Teacher notes: **C INQ.8**

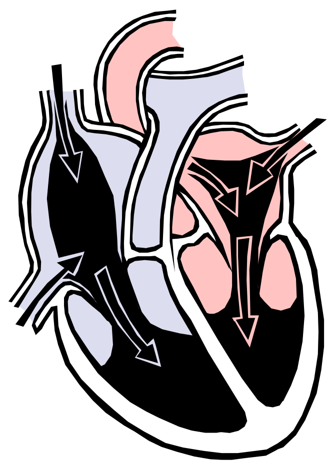
8. Share and compare your findings with others in the class. Which activities increased pulse rate the most? Which activities increased pulse rate the least?

Teacher notes: You may want to ask lab groups to give a 2-3 minute presentation to the class describing their methods and findings. Encourage students to compare their findings to those of others in the class, and to suggest possible explanations for differences in results. **C INQ.8**

EXPLAIN

What do you think your heart was doing during the activities you have just completed? Why did your pulse rate increase? Do some research to find out more about how the structures of the respiratory and circulatory systems work together to keep your body working.

Teacher notes: This information can come from a variety of sources: teacher presentation, textbook readings, or independent research assignments. Students might produce research reports, class presentations, posters, or concept maps. 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.



ELABORATE

1. Think about the observations you have made and recorded in your science notebook. Work with your partners to list questions about pulse rate that you are interested in investigating.

   Teacher notes: Encourage students to review their observations from the stethoscope exploration and the exercise observation. Ask them to consider factors other than exercise that may affect pulse rate.

2. Classify your questions into 3 categories: (1) those that can be answered through a classroom experiment, (2) those that can be turned into an experimental question, and (3) those that require other resources like books, the internet or special equipment not available to you.

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.* **C INQ.1**

Experiment #2 – What Other Factors Affect Pulse Rate?

1. Identify the **question** you will investigate. Record your question in your science notebook.

Teacher notes: This is an opportunity for students to generate their own questions to investigate. 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, time of day, or even the effects of quiet meditation on pulse rate. **C INQ.1**

2. Design a **procedure** to collect data to answer your research question. Talk with your partners about how you could test your idea about a factor that affects pulse rate.

Teacher notes: **C INQ.3**

3. 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.

Teacher notes: Review the distinction between independent and dependent variables. In this experiment, all students are investigating the same dependent variable: pulse rate. The independent variables may be age, gender, body position, etc. Remind students to think about the parts of the experiment that should be kept ***constant****.* **C INQ.4**

4. **Predict** the effect you expect your independent variable to have on pulse rate.

Teacher notes: Students' prediction will be based on their prior experiences and readings. The prediction should include a "because" statement. **C INQ.1**

5. **Write** your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.

Teacher notes: **C INQ.3**

6. Create a **data table** to record data related to your experiment.

Teacher notes: See Experiment #1. **C INQ.5**

7. Get your teacher's approval before you begin your experiment.

Teacher notes: Be sure that all experimental designs are safe and appropriate. **C INQ.5**

8. Do your experiment and **record** your findings in your data table. Do the data for each trial seem reasonable? If not, do you need to repeat any trials to correct any **errors**?

Teacher notes: **C INQ.5**

9. **Analyze** the data. Calculate the average change in pulse rate for each individual.
Teacher notes: **C INQ.6**

10. Create a **graph** that will help you make sense of your data.
Teacher notes: ▲ *This is a good opportunity to discuss the selection of appropriate graph types to display different types of data. You may want to do a mini-lesson on the components of a line graph, including title, axis labels, scale and plotting.* **C INQ.6**

11. **Interpret** the data. What **conclusions** can you make about what causes differences in pulse rates? Did anything surprise you? Record your conclusions and new questions in your science notebook.

Teacher notes: **C INQ.8**

12. **Compare** your experimental design and results with others in your class.

Teacher notes: You may want to ask guiding questions such as, "How reliable are your results? What are the similarities and/or differences in the results of your experiments? What might explain these differences? What changes might you make in your experimental design to increase the reliability of your results?" One of the goals of the discussion should be to reinforce the concept of controlling variables in an experiment. As an extension, you might ask students what practical value their conclusions might have and how they might be applied to solve a problem in their daily lives. **C INQ.8, C INQ.10**

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 challenge conclusions. Select a method to share the findings and conclusions from your experiment.

Teacher notes: ▲ *Allowing students to choose their presentation format is another way to differentiate this performance task. You may limit the choice to Options A and B listed below, or you may provide additional formats, such as a Powerpoint presentation or a simulated scientific conference at which each group presents their information. You may also ask students to write a reflection about any changes that might have occurred in their understanding of the key concepts. Find out what questions they still have about these concepts, or what they would like to investigate further.* **C INQ.10**

Option A- Poster Presentation: Work with your partners to prepare a poster that shows:

a) the question you were investigating;
b) the basic procedure you used;
c) the results of the experiment;
d) your interpretation of those results; and
e) possible errors that might have affected the accuracy of your data.

Use your poster to briefly describe your experiment to your class and respond to their questions about your methods and results.

OR

Option B – Formal Lab Report: Work independently to write a formal lab report. Follow the format given to you by your teacher. A lab report usually includes the following:

a) A title;
b) A statement of the question you investigated;
c) A prediction of the results you expected;
d) A detailed description of the procedure you used;
e) A data table that shows all results in an organized way;
f) A graph that shows patterns or relationships in analyzed data;
g) A conclusion that states your interpretation of your data;
h) A statement about possible errors that may have affected the accuracy of your data, including what you would improve if the experiment were repeated.

Teacher Resources

Additional Experiments:

http://www.extremeenvironment.com/2002/resources/downloads/physiology.pdf - a pulse rate experiment similar to Feel The Beat, including methods for measuring cardiovascular fitness.

http://www.standards.dfes.gov.uk/schemes2/science/sci5a/?view=get - a unit for early middle school students that focuses on the effects of diet and exercise on heart health.

http://www.nlm.nih.gov/changingthefaceofmedicine/resources/printable_3_4.html - 3 activities by the National Institutes of Health for learning about the circulatory system.

Websites for student research:

http://www.yucky.com/flash/body/ Very student friendly site appropriate for middle school students.

http://www.medtropolis.com/VBody.asp Has colored diagrams and animated tours of the human heart.

http://kidshealth.org/kid/ A student oriented health site that covers a wide range of topics.