Bridgeport Public Schools
Embedded Performance Task

Grade 5

Catch It!

Teacher Manual

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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.

HOW ARE PERFORMANCE TASKS USED WITH YOUR CLASS?

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 "CATCH IT!"

In this performance task, students will explore factors affecting human reaction time. In Investigation #1, students will use a technique for measuring the reaction time of different individuals. They will observe how long it takes group members to catch a falling ruler. Noting that people have different reaction times, students will explore possible factors that might influence reaction time speed in Investigation #2. In both experiments, students will learn about the importance of controlling variables to make a fair test so that results are more reliable.

SAFETY NOTES:

1) Review expectations for appropriate behavior, handling of materials and cooperative group procedures prior to beginning this investigation.
2) Students will be testing various factors that may affect reaction time. Review each group's experimental design to assure that the methods are *accessible* and *safe* for *all* students.
3) 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): *Catch It* relates conceptually to the following content standard. It should be used as one of several experiences during the learning unit that contribute to student understanding of how the sense organs perceive sights, sounds, smells, tastes and physical characteristics. *Catch It* provides a good opportunity for students to learn how the sense organs are connected to the brain and the spinal cord to comprise the nervous system.

5.2 - Perceiving and responding to information about the environment is critical to the survival of organisms.

- The sense organs perceive stimuli from the environment and send signals to the brain through the nervous system.

UNDERLYING SCIENCE CONCEPTS (KEY IDEAS):

- There are different systems within the body and they work independently and together to form a functioning human body;
- The central nervous system is divided into two parts: the brain and the spinal cord.
- The somatic nervous system consists of peripheral nerve fibers that send sensory information to the central nervous system and motor nerve fibers that deliver movement instructions to skeletal muscle
- The sense organs perceive stimuli from the environment and send signals to the brain through the nervous system.

- Some movements controlled by the brain are voluntary, and others are involuntary.
- The time it takes for the information and instruction messages to travel back and forth is a person's reaction time.
- Different areas of your brain deal with planning, carrying out, overseeing and remembering movements.
- Human reaction time is affected by a variety of physiological and environmental factors.

KEY INQUIRY SKILLS:

- Make scientific observations and recognize the difference between an observation and an opinion, a belief, a fact or a name.
- Formulate an investigable question based on observations.
- Identify steps to make a scientifically "fair test".
- Use a metric ruler to collect accurate data.
- Read and interpret a table of statistics.
- Record data in an organized way.
- Seek relevant information in books, magazines and electronic media.
- Use oral and written language to describe observations, ideas, procedures and conclusions.

MATERIALS NEEDED: Listed below are all the materials needed to complete the two investigations in *Catch It*. There is no starter kit for this performance task provided by the Connecticut State Department of Education. All materials are supplied by the school district:

1. A 30-cm metric ruler. Using different types of rulers (different colors, materials, transparent vs. opaque) provides another opportunity for students to investigate factors that may affect reaction time.
2. Calculators (optional)
3. Resources for recording and presenting observations (science notebooks, paper, posters, etc.)
4. Nonfiction reading materials – see "Resources" section

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.
2. Gather a variety of 30-cm rulers. Try to get rulers of different colors and materials (wood, plastic, metal, transparent, etc.) This will provide many variables for students to investigate.
3. Create science notebooks if your students do not already have them.
4. Gather nonfiction reading sources from your library, media specialist, or language arts team.

ESTIMATED COMPLETION TIME AND PACING SUGGESTIONS:

Day 1 – Investigation #1 (with task directions) record observations and wonderings

Day 2 – Investigation #1 reaction time mini-lesson/ discussion of results/ questions for further investigations

Day 3/4 – Research

Day 5 – Students select investigation questions and design procedure

Day 6 – Conduct Investigation #2

Day 7 – Preparing to share results

Day 8/9 – Share and discuss results

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 "**B INQ.3**" indicates an inquiry skill related to designing or conducting a simple investigation.

Catch It!

An Investigation of Factors Affecting Human Reaction Time

ENGAGE

The soccer goalie on the cover page sees the ball coming and has to move quickly to reach and catch the ball. In less than a second, he must see where the ball is traveling and know where to move his arms, legs and hands so he can catch the ball before it goes into the goal. How can the goalie make all these decisions so fast?

Teacher notes: The purpose of the introduction is to engage students in the concept of response to stimuli. Based on the needs and interests of your class, use different examples of stimuli and reactions to spark discussion. For example, you might use a video clip of a soccer game to enhance the introduction used above. Also, many students are familiar with the hand-eye coordination associated with video games, and will readily engage in a conversation on the topic. Other ideas include the game "Red Hands" in which a person holds out her hands, palms up, and her opponent places her hands on top, palms down. The first person then tries to quickly touch the backs of her opponents' hands. All are options for engaging students in the concept of response to stimuli.

EXPLORE

In this activity, you will explore how quickly people can react to catch a falling ruler. Then, you will investigate factors that may affect people's reaction times.

Investigation #1: Observing the Reaction Times of Different People

1. Explore by following steps (a) through (f). Record observations ("*Noticings")* and questions *("Wonderings")* as you explore.

Teacher notes: During this exploration there is likely to be a great deal of variation in the way the students are dropping, catching and recording. Allow this variation to occur, as it will create "discrepancies" that will make for rich class conversation when the activity is complete. During the debriefing when students are sharing their "noticings" and "wonderings", ask students to suggest possible causes for different reaction times. Students may note, for example, that "Some of the rulers are plastic and some are wood" or "The researcher held the ruler with a different hand during the second trial". **B INQ.1**

a. The "researcher" holds the ruler vertically (straight up and down). The "subject" opens the fingers of the catching hand and holds them near the bottom of the ruler, right next to the 0 cm line (without actually touching it).

b. Without warning, the starter lets go of the ruler and the subject catches it by quickly pinching the fingers around the falling ruler.

c. The researcher reads the measurement on the ruler at the point where the fingers are holding it. All members record the distance the ruler dropped in a data table. Repeat several times.

Teacher note: ▲ *If your students are experienced data collectors, you may want to increase the challenge in this task by removing all (or parts) of the data table below and requiring students to create their own data table to record important information about their experiment.* **B INQ.4**

Sample:

Subject's Name	*Trial #*	*Distance*	*Time*	*Average Time*

d. In the chart below, find the distance closest to the one recorded for the subject. Then look at the Reaction Time column to find out how much time it took the subject to catch the ruler. If the exact distance is not listed in the chart, estimate the reaction time by using the numbers that are in the chart.

Distance Ruler Dropped (in centimeters)	**Reaction Time (in seconds)**
1	.05
2	.07
3	.08
4	.09
5	0.10
10	0.14
15	0.18
20	0.20
25	0.23
30	0.25

e. RECORD the reaction time data for each trial in the time column of your data table.

f. Switch roles and repeat.

Teacher notes: Students might need extra help understanding the Reaction Time chart. For example, display the chart on an overhead and explain how the columns relate to each other. If students are not familiar with decimals, explain that each time listed is less than a second. Students will need to estimate the reaction time for some measurements. You may want to do a few samples of estimating the time. **BINQ.10**

2. CALCULATE the average time it took for each subject to catch the ruler.

Teacher notes: ▲ *If students are familiar with averaging decimals, they can complete this portion on their own. If not, you may want to provide calculators and/or teach a mini-lesson on the skill. Allow extra time for this step if averages are a new concept.* **B INQ.10**

3. RECORD the average reaction times in your notebook.
4. INTERPRET the data. Which of your subjects had the fastest reaction time? What factors do you think contributed to the different reaction times?

Teacher notes: Students might discuss these prompts first with their partners, or in writing, before engaging in the class discussion. **B INQ.5**

5. SHARE findings with class. Compare findings of different groups.
   a. Did you notice any similarities among the people with the fastest reaction times?

Teacher notes: Provide students the opportunity to informally share their results. Begin your discussion by posting the following questions: Did all your subjects have the same reaction time? Which of your subjects had the fastest reaction time? What factors do you think contributed to the different reaction times? Encourage students to look for any patterns that might exist among those whose reaction times were fastest. **B INQ.6**

   b. Record observations and questions for further investigations.

Teacher notes: Guide a class discussion by charting students' observations and wonderings about what might affect reaction time. Classify the charted questions into those that can be answered by doing a fair test, and those that could be better answered by finding information in a book or on the internet (e.g., "Why are some people faster with their left hand?") Keep a visible record, such as a t-chart, of observations and questions. Examples of investigable questions include "Do the response times change if the subject isn't watching the researcher's hand?", "Can you decrease your response time by repeating the task many times?" or "Do girls react faster than boys?" **B INQ.1**

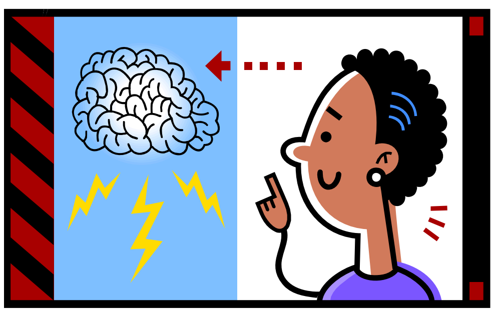
EXPLAIN

Investigate Through Research

Learn more about what's happening inside your body during the reaction test. Do some research on the internet to find out more about how your senses get information to your brain, and how your brain responds.

Write a reflection that explains your understanding of how the brain and senses work together to help you "react" to catch the falling ruler.

Teacher notes: This research can be done in class, in the media center, or as homework. See the "Resources" section of the Teacher Manual for some excellent kid-friendly websites about the nervous system. Students should learn about the major structures and functions of the central nervous system: the brain, spinal cord, and nerves. **B INQ.8**



ELABORATE

Investigation #2: What Affects Reaction Time?

In Investigation #1, you may have noticed that people have different reaction times. What conditions do you think might affect how fast someone can react? In Investigation #2, you will identify a question to explore.

Do your experiment following the steps below:

1. DECIDE on a research question. RECORD the question in your science notebook.

Teacher notes: Encourage students to discuss and write several possible questions of interest to them concerning reaction time. See notes to #5(b). Circulate and listen in on group conversations.

▲ *If needed, inspire students' curiosity by asking open-ended questions, such as: "I wonder what will happen when…?" "What do you know about…" "Show me how you are...." "Tell me more about…" "I'm noticing…" "What else did you notice?" "What else are you wondering?" You may ask students to share their questions with the class and have the group discuss which ones are investigable vs those that are researchable. For example, "Does a person's reaction time improve with practice?" is an investigable question. "Why do some people react faster than others", however, is a question that is better suited for research in books or the internet.* **BINQ.1**

2. DESIGN a plan to conduct your investigation.

Teacher notes: Explain to students that a scientific community critiques and confirms the work of its members in order to assure validity of claims. To do this, scientists must record their procedures in sufficient detail so that anyone could replicate the experiment and obtain similar results. You may want to have students draft their experimental plans, then have the students view each other's plans and provide feedback. This may be a good point to stop and continue the activity during the next science period. **BINQ.3**

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3. CREATE a data table in your science notebook that will help you keep your measurements organized. You will also want to record any unexpected observations and questions.

Teacher notes: You may refer students to the data collection tables they used in the previous investigation. **BINQ.4**

4. CONDUCT your experiment. Collect and record data for each trial in your notebook.

Teacher notes: If your students are inexperienced in conducting fair tests, this may be a good time for a mini-lesson about the importance of repeating a test several times. Facilitate a class discussion to stimulate student thinking about doing multiple trials in order to increase confidence in the data. Multiple trials can highlight "inconsistent" data within a pattern, and can help identify experimental errors. **BINQ.3**

5. CALCULATE the average time it took for each subject to catch the ruler. RECORD the average reaction times for each subject in your data table.

Teacher notes: Students might need extra help understanding the Reaction Time chart. For example, display the chart on an overhead and explain how the columns relate to each other. If students are not familiar with decimals, explain that each time listed is less than a second. Students will need to estimate the reaction time for some distances. You may want to do a few samples of estimating the time.

This is a good opportunity for students to understand the practical application of "average" in order to eliminate extreme highs and lows in a data pattern. If students are familiar with averaging decimals, they can complete this portion on their own. If not, you may want to provide calculators and/or do a mini-lesson on the skill. Allow extra time for this step if averages are a new concept. **B INQ.10**

6. DRAW a bar graph that compares the average reaction times of your subjects for the factor you tested.

Teacher notes: ▲ *If students are familiar with bar graphs, they can complete this portion on their own. If not, you may want to provide a mini-lesson on some of the elements of constructing a bar graph. You may differentiate this step by providing some or all of the graph components. For example, provide students with unlabeled axes and expect them* *to draw and label the axes correctly. Or, you can use this as a mini-lesson on scaling a graph. Allow extra time for this step if bar graphs are a new concept.* **B INQ.10**

7. INTERPRET the data. What conclusions can you draw based on the graph? Did the factor you investigated have an effect on the reaction times of your subjects?

Teacher notes: Students might independently reflect in writing, before engaging in the class discussion. While facilitating, assess for students' ability to formulate a logical conclusion based on data. Help students understand that in science, data is interpreted as evidence that either supports or does not support an assumption. It is not bad when the evidence does not support the original assumption because new understanding comes to light. There is no "correct" answer for this investigation since the outcomes depend largely on carefully controlling the variables in the experiment. Students should be guided to consider how reliable their data are. For example, was the ruler dropped the same way each time? Was the measurement taken in the same way each time? Encourage students to develop a respect for data, even when it supports a conclusion that was unexpected. Unexpected results lead to new questions, which have led to most of mankind's advances in scientific understanding! **B INQ.5**

Present Your Findings:

Work with your partners to make a poster that summarizes your investigation. Use the poster to make a presentation to your class to share the results of your investigation. They will want to hear what you found out in Investigation #2. Some of them may have done a similar investigation, and you will want to know if their findings were similar to yours.

Your poster should include:

- The question you were investigating;
- A brief description of how you did your experiment;
- A bar graph showing your findings; and
- The conclusion that is supported by your data.

Be prepared to tell your class about any data you collected that might not be accurate because of unexpected things that happened during your experiment.

Teacher notes: Each group should present for a short amount of time. You may have the rest of the class take notes, such as suggestions for ways the investigation could be modified or improved, or things that were interesting or innovative about the investigation. You may also allow a brief period for questions after each presentation. If possible, highlight questions or ideas that may relate to the nonfiction research project. **B INQ.6**

Teaching Resources

Human Body Systems:

http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=11&DocID=385 – Student misconceptions about systems in general, and specifically human body systems. A sample lesson to develop conceptual understanding of interactions among parts of a system.

Brain and Senses Info for Teachers:

http://www.hhmi.org/senses/a110.html

Further Brain Explorations for Students:

http://www.dls.ym.edu.tw/neuroscience/bex/bex.html - Brain Explorers: an inquiry-based neuroscience learning unit created by Baylor College of Medicine for upper elementary grades.

http://www.dls.ym.edu.tw/neuroscience/interr.html - a collection of internet-based activities and info for students.

http://42explore.com/brain.htm - an amazing collection of websites with abundant information and activities for adults and students related to brain science.

Learning About Brain and Senses for Students:

http://faculty.washington.edu/chudler/introb.html#bb

http://faculty.washington.edu/chudler/bookse.html

http://www.sciencemuseum.org.uk/exhibitions/brain/index.asp

Nonfiction Text Resources:

Kids Discover: Brain

The Brain and Nervous System. Parker, Steve. Raintree, Chicago, Illinois. 2004.

The Brain. Simon, Seymour. Harper Trophy, 1999.

The Great Brain Book : An Inside Look At The Inside Of Your Head**.** Newquist, H.P. Scholastic Nonfiction, 2005.