**Subject area/course**: Science

**Grade level/band**: 9-12

**Task source**: SCALE/New York City DOE; Author: Michal Lomask

**Which Factors Affect Your Reaction Time?**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students will learn how to measure reaction time and then they will explore how various factors affect their individual reaction time as well as the reaction time of other students in class.

This guide provides you with the information you need in order to prepare students for the Grade 9 Living Environment Reaction Time Lab performance assessment. In order for students to participate in this assessment they need to complete the guided and inquiry Reaction Time lab activities during the assessment administration window. The full assessment (4 sessions of approximately 45 minutes each) takes students through four different activities:

1. A **Guided Lab Activity**, during which students learn how to use the lab measurement technique and have the opportunity to perform a simple experiment and collect data.
2. An **Independent Lab Design and Performance** during which students have the opportunity to ask their own questions and use the technique they have learned before to design, conduct and analyze data from their own experiments.
3. **Lab report writing** where students document the experiments they have conducted and analyze the results. This independent lab report will be scored as part of the assessment.
4. **Post Lab constructed response items** where students have to answer several open- ended inquiry items. This test is designed to explore and improve the validity of the inquiry assessment.
5. **Aligned standards:**
6. **Primary Common Core State Standards**

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

1. **NGSS**

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems and provide specific functions to multicellular organisms.

HS-LS1-1 Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

HS-LS1-1 Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

1. **Critical abilities**

**Research**: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

**Analysis of Information:** Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

**Experimentation and Evaluation:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

**Use of Technology:** Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information.

**Interpersonal Interaction and Collaboration:** Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

1. **Time/schedule requirements:**

This task is designed to take place over four 45-minute long sessions, depending on scheduling.

1. **Materials/resources:**
2. 30-cm metric rulers
3. Graph paper (image of graph paper is provided at the end of the lab report)
4. Calculators (optional)
5. Stopwatches (optional)
6. Any additional materials needed for the task designed by students.
7. **Prior knowledge:**

See information below about the potential use of this task as a pre-assessment, as well as related skill development within the broader curriculum.

1. **Connection to curriculum:**

As originally designed, student performance on this assessment is intended to serve as a baseline for measuring student learning of select knowledge, skills, and understandings over the school year. The scores on this pre-assessment combined with other information will aid in the interpretation of student performance on the post-assessment to be administered in the spring. Data from these assessments are intended to inform the selection of measures of student learning to serve as one component in a teacher evaluation system.

* 1. **LAB SKILLS BETTER ASSESSED BY TEACHERS IN THE LAB**
* Follows safety rules in the laboratory
* Selects and uses correct instruments
* Uses graduated cylinders to measure volume
* Uses metric ruler to measure length
* Uses thermometer to measure temperature
* Uses triple-beam or electronic balance to measure mass
* Uses a compound microscope/stereoscope effectively to see specimens clearly, using different magnifications
* Identifies and compares parts of a variety of cells
* Compares relative sizes of cells and organelles
* Prepares wet-mount slides and uses appropriate staining techniques
* Designs and uses dichotomous keys to identify specimens
* Makes observations of biological processes
* Dissects plant and/or animal specimens to expose and identify internal structures
* Follows directions to correctly use and interpret chemical indicators
  1. **INQUIRY SKILLS BETTER ASSESSED BASED ON STUDENT WORK**
* Designs and carries out a controlled, scientific experiment based on biological processes
* States an appropriate hypothesis
* Differentiates between independent and dependent variables
* Identifies the control group and/or controlled variables
* Collects, organizes, and analyzes data, using a computer and/or other laboratory equipment
* Organizes data through the use of data tables and graphs
* Analyzes results from observations/expressed data
* Formulates an appropriate conclusion or generalization from the results of an experiment
* Recognizes assumptions and limitations of the experiment

1. **Teacher instructions:**

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| **Overall Assessment Structure** | |
| Session 1: | Mandatory Lead-in Materials – **Guided Lab**. |
| Session 2: | Mandatory Lead-in Materials – **Inquiry Lab** |
| Session 3: | An assessment based on the Independent Inquiry |
| Session 4: | Post Lab **Inquiry Skills Assessment** test |
| Session Timing | Please note that sessions are meant to last a class period; approximately 45 minutes. If you have block scheduling or a different class schedule, please use the timing recommendations to adjust implementation accordingly. |

Teacher Manual: Guidance for **Session 1** Lead-In Materials

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| Session 1: | Lead-In Materials - **Guided Lab Activity** |
| Purpose | * Performing the Reaction Time Guided Lab * Beginning the design of the Independent Inquiry Lab |
| Materials  (for each group of 3-4 students) | 1. 30-cm metric ruler 2. Graph paper (scanned image of graph paper is provided at the end of the lab report) 3. Calculators (optional) 4. Stopwatches (optional) |
| Total Time | 45 minutes |

## Session 1

**(30-35 minutes) Activity 1:**

1. Engage students in the science content – a short discussion of the stimulus-response loop and its connections to the neuron-muscular systems. Also ask students to describe every day activities that require a quick reaction (e.g., driving, playing sports, etc).
2. Inform students about the goal of the lab activity – learning how to measure and calculate reaction time using the “dropped ruler” technique.
3. Let students work in small groups of 3-4 on the guided lab activity. Make sure students record multiple measures for each student in the team and calculate the average distance (in cm) the ruler dropped for each one.
4. Guide students on how to use the distance/time conversion table to convert the average distance to average reaction time (in seconds).
5. Bring all students back together and let them talk about their findings

## (10-15 minutes) Activity 2:

1. Ask students to work in small groups to identify a testable question that they are interested to explore about what factors might affect the reaction time. Factors may be intrinsic (e.g., gender, age, fitness level, left or right handed, etc.) or extrinsic (e.g., auditory vs. visual cues, multi-tasking, impact of practice, etc).
2. Ask students to design and write down a procedure for an appropriate experiment to find an answer to their specific question. As you circle around and read students’ experimental design, note any additional materials that students will need and ensure they have a plan for gathering them in time for Session 2.

Teacher Manual: Guidance for **Session 2** Lead-In Materials

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| **Session 2:** | **Lead-In Materials for Inquiry Lab** |
| Purpose | * Complete the Independent Reaction Time Inquiry Lab * Share and discuss students’ investigations |
| Materials | 1. 30-cm metric rulers 2. Graph paper (image of graph paper is provided at the end of the lab report) 3. Calculators (optional) 4. Stopwatches (optional) 5. Any additional materials needed for the task designed by students. |
| Total Time | 45 minutes |

## Session 2

**(30-35 minutes) Activity 1:**

1. Let students work in their groups to conduct the labs they have designed in session 1.
2. During the performance of the experiment, all students in each group have to record the experimental procedures and the results of the experiment in their notebooks or in the provided student lead-in booklet.

## (10-15 minutes) Activity 2:

1. After students complete their investigation (and if time permits), let one person from each group present the investigation to the class. Provide feedback on the quality of the investigation, as appropriate (You can use the provided Performance and Scoring rubrics as a basis for your feedback).
2. **Student support:**

When implementing the performance tasks with English Language Learners (ELLs) and Students with Disabilities (SWD), teachers should consider the following instructional supports.

**Vocabulary Building**

ELLs:

* Provide student-friendly definitions, examples, synonyms, antonyms, multiple meanings, roots, affixes, pictures, diagrams, and translations prior to reading.
* Advise ELLs when words are cognates as cognate recognition is not always automatic when students are not proficient in both languages.
* Teach academic language and create purposeful opportunities for students to practice using the words and phrases.

SWDs:

* Provide student-friendly definitions, examples, synonyms, antonyms, multiple meanings, roots, affixes, pictures, diagrams, and regalia prior to reading.
* Provide visual representations prior to teaching and reading of content area material.
* Explicitly teach word origins, roots, prefixes, and suffixes.
* Teach academic language and create purposeful opportunities for students to practice using the words and phrases.

**Reading Comprehension**

ELLs:

* Elicit prior knowledge and build background knowledge to access content in reading.
* Have students complete graphic organizers constructed with prompts that guide them to paraphrase what they are reading and cite supporting evidence.
* Construct prompts so that students are able to make the connection between what they are reading and how the content can be used in developing their writing response(s).

SWDs:

* Utilize various ways of students being able to hear text as they read it including software and other technology-based options that are available for text-to-speech purposes.
* Elicit prior knowledge and build background knowledge to access content in reading.
* Have students complete graphic organizers constructed with prompts that guide them to paraphrase what they are reading and cite supporting evidence.
* Construct prompts so that students are able to make the connection between what they are reading and how the content can be used in developing their writing response(s).

**Writing**

ELLs:

* Provide writing frames and sentence starters.
* Explicitly teach the academic language associated with the writing genre being taught.
* Note that cultural differences in writing discourse may influence ELLs’ approaches to writing in English. For example, the order of ideas and arguments within an argument essay in English may be significantly different than that which is in the ELLs’ native languages. This can be taken into account when scaffolding writing instruction and providing feedback to student writing.

SWDs:

* Present alternate ways of communicating ideas other than traditional writing which can include dictating, using speech-to-text software, and allowing a student with grapho-motor, fine motor, and/or visual perception challenges to use a computer instead of writing the essay by hand.
* Explicitly teach how to use information from a graphic organizer to create an essay.
* Provide writing frames and sentence starters.
* Explicitly teach the academic language associated with the writing genre being taught.

**Native Language Support for ELLs:** The strategic use of the native language can be incorporated into English instruction as a support structure to clarify, build prior knowledge, extend comprehension, and bridge prior learning and experiences. This can be integrated into a teacher’s instructional practice through the following: technology, human resources (e.g., paraprofessionals, peers, and parents), native language materials, and flexible grouping.

1. **Extensions or variations:**

**Related content concepts:**

* + 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.

**On-line resources (partial list):**

Online test of reaction time <http://www.topendsports.com/testing/reactiontest.htm>

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/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/introb.html) <http://faculty.washington.edu/chudler/bookse.html> <http://www.sciencemuseum.org.uk/exhibitions/brain/index.asp>

1. **Scoring:**

Student work can be scored using the Scientific Inquiry/Process Skills rubric.