# Spotlight on Science Skills Grade 7

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New Nouveau Brunswick

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## Objective

The Atlantic Provinces' science curriculum is guided by the vision that all students will have an opportunity to develop scientific literacy.

> Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge that students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them. (*Foundation for the Atlantic Canada Science Curriculum*, page 11)

The *Spotlight on Science Skills* series of documents:

- Clusters the existing Atlantic Canada skill outcomes into nine scientific practices (questioning, predicting/hypothesizing, variables, experimental design, collecting data/observations, organizing/displaying data, analyzing data, making conclusions, applying learning).
- Provides educators with an elaboration of the scientific practice including explanations of specialized terminology. It indicates what students have learned in previous grades and what the focus is for learning in the current grade.
- Provides a list of achievement indicators with an accompanying rubric for each scientific practice to further clarify expectations and guide educators in determining whether their students have met the outcome.

## Overview of Outcomes

**GCO: Plan & Perform (PP)** - Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

SCO: PP1 - Propose testable questions
SCO: PP2 - State a prediction and hypothesis
SCO: PP3 - Identify and describe variables
SCO: PP4 - Plan investigations
SCO: PP5 - Conduct investigations

**GCO: Analyze & Explain (AE)** - Interpret findings from investigations using appropriate methods. Work collaboratively to carry out science-related activities, and communicate ideas, procedures and results.

SCO: AE1 - Classify, organize and display data
SCO: AE2 - Analyze data patterns
SCO: AE3 - Draw conclusions
SCO: AE4 - Apply learning

**GCO: Plan & Perform (PP)** Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

**SCO: PP1 - Propose testable questions**

### Scope and Sequence of Outcomes

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 205-8 Identify and use a variety of sources and technologies to gather pertinent information | 209-5 Select and integrate information from various print and electronic sources or from several parts of the same source | 213-7 Select and integrate information from various print and electronic sources or from several parts of the same source |
| 204-1 Propose questions to investigate and practical problems to solve | 208-2 Identify questions to investigate arising from practical problems and issues | 212-1 Identify questions to investigate that arise from practical problems and issues |
| 204-2 Rephrase questions in a testable form | 208-1 Rephrase questions in a testable form and clearly define practical problems | 212-2 Define and delimit problems to facilitate investigations |
| | 208-3 Define and delimit questions and problems to facilitate investigation | |

### Elaboration

**Connection to Communication**
- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means.

***Guiding Questions:***
- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

Previous learning may lead to research, new ideas for innovation, or a new investigation. Before writing a **testable question**, students will pose a general scientific question drawing from this previous learning.

From an initial scientific question, students will then develop a testable question. This type of question is one that can be answered by designing and conducting an investigation. It should be written in an unbiased way.

Testable questions are always about changing one thing to see what the effect is on another thing. In any experiment there can be only one variable to test or change and, at this grade level, only one variable to measure.

The variable that will be changed is called the **independent variable (IV).** The variable that will be measured is called the **dependent variable (DV**). In Grade 6 and beyond, students are expected to be using this terminology.

- Scaffold 1- Does changing __IV__ affect __DV__?
- Scaffold 2 - How does changing __IV__ affect __DV__?
- Scaffold 3 - If we change __IV__ does it affect __DV__?

This chart shows how questions can be changed to a testable format.

| General Scientific Question | Examples of Testable Questions |
|---|---|
| What happens to the sound if I use another tuning fork? | If we use different types of tuning forks (IV), will the sound be the same (DV)? |
| Do different light bulbs use less energy? | Does changing the type of light bulb (IV) affect energy consumption (DV)? |
| Will washing hands mean students will be healthier and miss less school? | If students wash their hands (IV), will the number of days students are absent decrease (DV)? |

Students should understand that precise language is very important to writing a good testable question. A testable question must clearly identify the **specific variable to test** and the **specific variable to measure**. Students should be encouraged to change terms such as "better" and "improve" with a specific measure.

For example:

"If I change the wheels, will it **improve** how the car rolls?"

- is a statement that is only approaching expectations, since the variable to be measured
- is not specific and is open to interpretation.

"If I change the wheels, will it increase the distance travelled?"

- is a statement meeting expectations because it indicates specifically what will be measured.

**Achievement Indicators**

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Write questions using language that suggests an investigation of two variables that are related.
ii. Indicate **specifically** what will be tested and what will be measured.
iii. Develop testable questions that indicate the independent variable (variable to test)
iv. Develop testable questions that indicate the dependent variable (variable to be measured/observed )
v. Use language that is precise and relevant to the question
vi. Use the terminology of **independent, dependent**

## Achievement Rubric

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Testable Question** | Write a scientific question is in a testable form that includes the dependent variable and independent variable uses specific language (**independently and consistently**) | Question is testable and measureable/ observable<br><br>Variables are named using specific language<br><br>Identify the variable to test and the variable to measure | Question is testable and measureable/ observable<br><br>Variables are not specific (may use "better" or "improve") | Unclear as to which variable is being tested and which variable is being measured<br><br>Any other answer |
| | | Use the terminology of independent and dependent variables correctly | | Any other answer |

**GCO: Plan & Perform (PP)** Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

**SCO: PP2 - State a prediction and hypothesis**

**Scope and Sequence of Outcomes**

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 204-3 State a prediction and a hypothesis based on an observed pattern of events | 208-5 State a prediction and a hypothesis based on an observed pattern of events | 212-4 State a prediction and a hypothesis based on available evidence and background information |
| | | 212-5 Identify the theoretical basis of an investigation and develop a prediction and a hypothesis that are consistent with the theoretical basis |

**Elaboration**

***Guiding Questions:***

- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

Students used an "If, then, because" scaffold in the elementary grades for writing predictions with a supporting reason. In Grade 6, the term **hypothesis** was introduced. Hypothesis statements are plausible predictions of a relationship between two variables, supported by information from a student's current understanding. In Grade 7, a hypothesis is more specific or detailed, possibly requiring more factors to be deliberately controlled than in previous grades.

**Connection to Communication**

- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means.

Based on previous experience and knowledge, students will predict a relationship between two variables. This prior knowledge could come from a variety of sources such as a previous experiment, a demonstration, research, a television program, or what someone has told them is true. During middle school, students will work on the skill of developing hypotheses with the expectation of mastery at high school.

A useful scaffold for writing a **hypotheses** is the "**If**, **then, because**" format.

**If** the __IV*__ is __(describe the change)__
**then** the __DV*__ will __(predict the effect)__
**because** __(state the justification)__

*Independent Variable - (IV) Dependent Variable - (DV)

Hypothesis examples:

- **If** salt concentrations in soil are increased **then** the rate of plant growth will decrease, **because** plants growing near salt water are smaller. (supported by research or observations)

- **If** air temperature is reduced, **then** leaf colour will change, **because** leaves change colour in the fall when it starts to get cooler. (supported by observations)
- **If** the cones of a tree are pink rather than yellow, **then** flies will lay more eggs in them, **because** initial observations seem to show this trend. (supported by observations)
- **If** exposure to UV light is increased **then** more people will get skin cancer, **because** research shows that people in warmer climates get more skin cancer than people in cold climates. (supported by research)

Also introduced in Grade 6 was writing a hypothesis in the passive voice. The passive voice reinforces that scientific work is done as objectively as possible. It clearly expresses descriptions and procedures so they can be compared and reproduced.

The following are examples of appropriate "If, then, because" statements by grade level:

**Grade 5** If I add fertilizer then the grass will grow taller, because it will give the plants more nutrients that have been shown to support growth.

**Grade 6** If the amount of fertilizer is increased then the grass will grow tall faster, because the fertilizer will provide more nutrients that have been shown to support growth.

**Grade 7** If the amount of fertilizer (20-20-20) is increased then the rate of growth (height) of the grass will increase, because it will provide extra nitrogen which the manufacturer has said will increase growth.

**Grade 8** As the amount of fertilizer (20-20-20) is increased there will be a peak in the rate of growth (height) of the grass, because research indicates too much phosphorus inhibits plant growth.

**Supporting a Hypothesis**
A hypothesis is a statement which may or may not be supported by the results of an investigation. It is important to recognize that positive or negative results are equally valuable and valid.

For example:

The hypothesis is: **If** salt concentrations in soil are increased **then** the rate of plant growth will decrease, **because** plants growing near salt water are smaller.

- If plant growth decreases, the hypothesis is supported, suggesting an effect of the independent variable on the dependent variable.
- If plant growth stays the same or increases then salt (at concentrations tested) does not decrease plant growth.

Whether the hypothesis is supported or not, it is always possible that there is another factor, not accounted for and controlled, that is causing the effect.

**Estimation**
Depending on the context, **estimation** is a skill that can enhance the ability to make an accurate scientific prediction. Estimation is a strategy for determining approximate values or quantities, usually by referring to benchmarks or using referents, or for determining the reasonableness of calculated values. Based on the grade level standards (cross-curricular with Math), students should use estimation strategies where appropriate.

## Achievement Indicators

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Write prediction statements that are testable) with variables that are specific enough to measure, suggesting how the two variables are related.
ii. Write hypothesis statements using the **"If, then, because"** format, including a plausible reason (from previous learning and/or research); may use tentative words such as "*evidence suggests"* and "*may".*
iii. Write prediction and hypothesis statements in third person.

## Achievement Rubric

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Prediction and Hypothesis** | Make a prediction and hypothesis statements that are testable with specific variables<br><br>Make a hypothesis using "If, then, because" **strongly supported by previous investigations or research**<br><br>Write hypothesis in third person<br><br>(**independently and consistently**) | Make a hypothesis that is testable and name specific variables<br><br>Make a hypothesis using "If, then, because", relevant to the question that is supported by previous investigations or research<br><br>Write hypothesis in third person | Make a prediction or hypothesis that is not clearly testable<br><br>Make a hypothesis using "If, then, because", relevant to the question, but with a reason that is not clearly expressed<br><br>Write prediction or hypothesis in first person | Make a prediction or hypothesis that not testable<br><br>Make a hypothesis, with a reason that is not clearly expressed, missing, or irrelevant<br><br>• Any other answer Any other answer |

**GCO: Plan & Perform (PP)** Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

**SCO: PP3 - Identify and describe variables**

**Scope and Sequence of Outcomes**

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 204-4 Define objects and events in their investigations | 208-7 Formulate operational definitions of major variables and other aspects of their investigations | 212-7 Formulate operational definitions of major variables |
| 204-5 Identify and control major variables in investigations | 208-6 Design an experiment and identify major variables | 212-3 Design an experiment, identifying and controlling major variables |

**Elaboration**

***Guiding Questions:***

- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

In Grade 6 students learned to identify a variable to test or change (independent variable), a variable to measure or observe (dependent variable), and the major variables that need to be controlled (kept the same). This will allow a **fair test** in which only one variable is changed at a time, and the same procedures will be carried out for all the measurements.

In Grades 7 and 8, this skill evolves from a simple identification of the different types of variables (independent, dependent, controlled) to a requirement to be specific when defining variables.

In previous grades, a dependent variable could be described as "how far a car rolls." In Grade 7, students are expected to be more specific in their explanation (e.g., "the distance travelled by a car along a specific surface")

**Connection to Communication**

- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means.
- Receive, understand, and act on the ideas of others
- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task

**Independent Variable (IV)** - the variable in the experiment that is purposely changed or manipulated, either in quantity or quality, also referred to as the *manipulated variable* or *variable to test.*

**Dependent Variable (DV)** - the variable in an experiment whose response to the changing independent variable is measured and, therefore, is also referred to as the *responding variable* or the *variable to measure*.

**Controlled Variables** - the variables that are kept constant or monitored to minimize any effects on the experiment. Failure to control variables can bias and influence the results. For a test to be deemed fair, it must be done in a way that keeps all procedures and all major variables the

same, except for those being tested or measured. For example, when testing if paper type affects flight of paper airplanes, the force at which it is thrown must be the same every time.

As students progress through the grades, it is expected that they will identify more controlled variables and in more detail.

Expected Controlled Variables: Electromagnet Example (less complex task)

| Grade 6 | Grade 7 | Grade 8 |
|---|---|---|
| • Size of nail<br>• Size of battery<br>• Number of times wire is wrapped around nail | • Size of nail<br>• Battery voltage<br>• Number of times wire is wrapped around nail<br>• How tightly wire is wrapped<br>• Material nail is made from | • Size of nail<br>• Battery voltage<br>• Number of times wire is wrapped around nail<br>• How tightly wire is wrapped<br>• Material nail is made from<br>• Temperature in room |

Expected Controlled Variables: A consumer reports company testing winter tires scenario (more complex task)

| Grade 6 | Grade 7 | Grade 8 |
|---|---|---|
| • Speed before braking<br>• Road conditions<br>• Temperature<br>• Same car is used | Students should be able to recognize at least 5 of 6:<br>• Speed before braking<br>• Road conditions<br>• Weather conditions (temperature, sun, etc.)<br>• Same car is used<br>• Same driver<br>• Same pressure is applied to brake each trial | • Speed before braking<br>• Road conditions<br>• Weather conditions (temperature, sun, etc.)<br>• Same car is used (weight of car remains constant as car is re-fueled each time)<br>• Same driver<br>• Same pressure is applied to brake each trial |

If the initial scientific question is, “How effective are plant-based insect repellants?” the possible variables to consider are shown below.

**Independent variable** to test

- Different brands of insect repellants.

Possible **dependent variables** to measure

- total number of insect bites
- size of insect bites (mm)
- colour of insect bites (scale of redness?)
- itchiness of insect bites (scale?)
- length of time each brand provides protection (min)

**Controlled variables**

- same person trying all three brands
- bites from all three brands at the same time
- number of insect bites measured the same for each brand
- same type of insect bite

## Achievement Indicators

***Guiding Questions:***
- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Distinguish between what is tested, what is measured or observed and what is controlled.
ii. Identify specific variables to measure that are related to the variable that is being tested.
iii. Select one **independent** variable, create a list of possible **dependent** variables (and how to measure them), and a list of **controlled** variables.

## Achievement Rubric

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Independent** | Identify all **relevant variables** to control, test, and measure or observe and **describes them in detail** using the terminology of independent and dependent<br><br>(**independently and consistently**) | Identify one independent variable (variable to be tested) that fits the question<br><br>Uses the terminology of independent | Identify one independent variable (variable to be tested) not relevant to the question | Any other answer |
| **Dependent** | | Identify dependent variables (variable to be measured) that fits the question<br><br>Uses the terminology of dependent | Identify one dependent variable (variable to be measured) not relevant to the question | Any other answer |
| **Controlled** | | Identify, <u>control</u>, and <u>describe in detail</u> most or all of the necessary variables, depending on the complexity of the investigation, | Control most or all of the necessary variables, depending on the complexity of the investigation | Control some of the relevant variables<br><br>Control variables that are not relevant to the investigation<br><br>Any other answer |

**GCO: Plan & Perform (PP)** Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

**SCO: PP4 - Plan investigations**

**Scope and Sequence of Outcomes**

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 204-6 Identify various methods for finding answers to given problems, and ultimately select one that is appropriate | 208-4 Propose alternative solutions to a given practical problem, select one, and develop a plan | |
| 204-7 Plan a set of steps to solve a practical problem and carry out a fair test of a science-related idea | 208-6 Design an experiment and identify major variables | 212-3 Design an experiment, identify and control major variables |
| | | 212-6 Design an experiment and identify specific variables |
| 204-8 Identify appropriate tools, instruments, and materials to complete their investigations | 208-8 Select appropriate methods and tools for collecting data for solving problems | 212-9 Develop appropriate sample procedures |

**Elaboration**

***Guiding Questions:***
- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

In the previous outcomes (PP1-PP3), students develop a testable question, determine a prediction and hypothesis, and identify the independent, dependent and controlled variables. This outcome focuses on students designing an investigation and communicating their plan clearly.

For science investigations in Grade 7 students need to: identify needed equipment and materials; name the independent, dependent and controlled variables; plan procedures that are safe and unbiased; control variables; change only the independent variable; measure the dependent variable at given time intervals, and incorporate multiple trials to increase accuracy and/or control groups.

Students also need to communicate their plan, a skill which links directly to the *Grade 6 Language Arts Reading and Writing Standards*
This Language Arts outcome requires students to identify the topic, list materials and explain procedures with key steps, in the correct order and with adequate detail focusing on how and when. The following special features also apply:
- May include headings, illustrations, diagrams or labels;
- Numbered-steps or words showing sequence (first, next, then);
- Point form or full sentences starting with sequence word or verbs;

**Connection to Communication**
- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- Work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
- Receive, understand, and act on the ideas of others
- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task
- Ensure safety of self and others

- Present tense often written as commands;
- Technical language – verbs, adverbs and adjectives (e.g., *whip the cooled cream vigorously)*.

**Multiple Trials**
Where appropriate, multiple trials should be included when planning an investigation. Running multiple trials will allow a student to see how consistent their results are, while recognizing that some variation in results is to be expected. If multiple trials are run, averaging the data values can give a more accurate measure of the true value of the quantity. This links to the Grade 7 Mathematics outcome. SP1 ("demonstrates an understanding of central tendency and range – mean, median, and mode").

Running multiple trials will also highlight data points that are clearly so far different from a pattern that they must be a result of an error of method of equipment. These "outliers" can be removed from the data set. This links to the Grade 7 Mathematics outcome. SP2 ("determine the effect on the mean, median, and mode when an outlier is included in the data").

**Control and Experimental Groups**
In Grade 7, students are introduced to using **control** and **experimental** groups to fairly test their investigation. In some investigations it is appropriate to set up a control group. For this group everything would be exactly the same as for the experimental group, except for the changed variable.

This type of investigation may be seen in medical trials when, to account for any effect other than the medication, subjects are randomly assigned either the medication or a placebo, with no knowledge of which one they have received. The control group would be the group that has received the placebo.

**Experimental Bias**
Holding a scientific bias means to unfairly favour one variable over another. In order for a test to be deemed fair, it must be done in a way that ensures one variable does not have an advantage. Procedures must be identical and uniformly performed. For example, to test the effect different types of paper has on the flight of a standard type of paper airplane each of the airplanes must be thrown in the same way, regardless of the type of paper used.

## Achievement Indicators

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Identify equipment and materials for an investigation.
ii. Explain how the investigation will be set up with one independent variable (to test), one dependent variable (to measure), and other major variables controlled.
iii. Describe what will be measured or observed, and how and when it will be recorded.
iv. Plan procedures to minimize experimental bias and ensure safety.
v. Include multiple trials to increase accuracy, if appropriate.
vi. Include a **control group**, if appropriate.
vii. Explain the procedure with enough detail that someone else will know how to do the investigation in the same way.

## Achievement Rubric

| | **Excelling - 4** | **Meeting - 3** | **Approaching - 2** | **Working Below - 1** |
|---|---|---|---|---|
| **Plan an investigation** | Students can perform <u>all</u> of the following **independently and consistently**:<br>• Identify equipment and materials for an investigation<br>• Explain how the investigation will be set up with one variable to test, one variable to measure, and other major variables controlled<br>• Describe what will be measured or observed, and how and when it will be recorded<br>• Plan procedures to minimize experimental bias and ensure safety<br>• Include multiple trials to increase accuracy, if appropriate<br>• Explain the procedure with enough detail that someone else will know how to do the investigation the same way | Students can perform the following:<br>• Identify equipment and materials for an investigation<br>• Explain how the investigation will be set up with one variable to test, one variable to measure, and other major variables controlled<br>• Describe what will be measured or observed, and how and when it will be recorded<br>• Explain the procedure with enough detail that someone else will know how to do the investigation the same way<br><br>Students can perform the following with support:<br>• Plan procedures to minimize experimental bias and ensure safety<br>• Include multiple trials to increase accuracy, if appropriate | Students can perform <u>some</u> of the following:<br>• Identify equipment and materials for an investigation<br>• Explain how the investigation will be set up with one variable to test, one variable to measure, and other major variables controlled<br>• Describe what will be measured or observed, and how and when it will be recorded<br>• Plan procedures to minimize experimental bias and ensure safety.<br>• Include multiple trials to increase accuracy, if appropriate<br>• Explain the procedure with enough detail that someone else will know how to do the investigation the same way | Any other answer |

**GCO: Plan & Perform (PP)** Ask questions, make predictions about objects and events and develop fair tests to investigate those questions. Observe and investigate their environment and record the results

**SCO: PP5 - Conduct investigations**

**Scope and Sequence of Outcomes**

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 205-2/4 Select and use tools in manipulating materials, building models, measuring. | 209-2 Estimate measurements. | 213-3 Use instruments effectively and accurately for collecting data |
| 205-3 Follow a given set of procedures. | 205-3 Follow a given set of procedures. | |
| 205-5 Make observations and collect information relevant to a given question or problem. | 205-5 Make observations and collect information relevant to a given question or problem. | |
| 205-7 Record observations using a single word, notes in point form, sentences, and simple diagrams and charts. | 209-4 Organize data, using a format that is appropriate to the task or experiment. | |
| 205-9 Use tools and apparatus in a manner that ensures personal safety and the safety of others. | 209-3 Use instruments effectively and accurately for collecting data. | |

**Elaboration**

***Guiding Questions:***
- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

By Grade 7, students should be proficient at recording appropriate observations. Students should be able to record all relevant information (quantitative and qualitative data) in an appropriate format based on the specific task. It is expected in this grade that recorded observations are precise and specific to the given task.

**Quantitative Data** is measured as numbers and recorded with units of measurement. Examples include: length, height, area, volume, weight, speed, time, temperature, humidity, sound level, cost, age.

Students should understand that to measure accurately they must use scientific devices and equipment properly. In Grade 7, when the proposed question suggests that variables should be measured, then proper use of an appropriate instrument is critical to the evidence. For example, when measuring the volume of a liquid, students should choose a graduated cylinder rather than a standard beaker. Students also need to use proper units of measurements in their data.

**Connection to Communication**
- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- Receive, understand, and act on the ideas of others
- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task
- Ensure safety of self and others

**Qualitative Data** can be observed but not measured. It usually describes characteristics or qualities. Examples include: colour, odour, texture, appearance, or data that is described by category (e.g., the colour of the sky).

Students should be able to distinguish their observations from making an inference.

**Observations** require the use of one or more of the five senses. Students should be careful to record only their observation when collecting qualitative data, and not to be influenced by prior knowledge. For example, when you see steam rising from a cup of coffee you should only record the observation, and not infer that the coffee is hot.

- "steam is rising from the cup of coffee" (observation)
- "the coffee is hot" (inference based on prior knowledge).

**Inferences** are statements that combine observations with other knowledge.

It is important that students understand that they should suspend judgment during data collection. Both expected and unexpected results are valuable.

**Safety**
Students are also expected to follow and carry out procedures safely (both teacher-directed and student-designed) using appropriate materials and tools effectively (refer to *Science Safety Guidelines* document).

**Achievement Indicators**

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Set up an investigation and follow the procedures as they are described.
ii. Make observations and collect data that is relevant to the question being tested
iii. Collect and record qualitative data objectively (not influenced by prior knowledge).
iv. Collect and record quantitative data accurately including units.
v. Record data in an organized manner and label appropriately.
vi. Follow safety procedures when using materials and equipment.

**Achievement Rubric**

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Conduct investigations** | Follow all steps (**independently and consistently**) | Follow all of the steps as described; minimize bias | Follow most of the steps as described | Any other answer |
| | Collect and record relevant data accurately with labels in an organized manner (**independently and consistently**) | Collect and record relevant data accurately with labels in an organized manner | Collect data that is irrelevant or needs support to identify relevancy<br><br>Data may not be labeled or organized | |
| | Collect and record data accurately and records with units (**independently and consistently**) | Collect and record quantitative data accurately and records with units | Record data that is inaccurate and/or missing units | |
| | Collect and record qualitative data objectively (**no inferences**) with additional detail (**independently and consistently**) | Collect and record qualitative data objectively (not influenced by prior knowledge) | Collect and record qualitative data that may include inferences based on what they already know | |
| | Follow safety procedures | | | |

**GCO: Analyze & Explain (AE)** Interpret findings from investigations using appropriate methods. Work collaboratively to carry out science-related activities, and communicate ideas, procedures and results.

**SCO: AE1 - Classify, organize and display data**

**Scope and Sequence of Outcomes**

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 206-1 Classify according to several attributes and create a chart or diagram that shows the method of classification | 210-1 Use or construct a classification key | 214-1 Describe and apply classification systems and nomenclature used in the sciences |
| | | 214-2 Identify limitations of a given classification system and identify alternative ways of classifying and accommodate anomalies |
| 206-2 Compile and display data, by hand or by computer, in a variety of formats including frequency tallies, tables, and bar graphs | 210-2 Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots | 214-3 Compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots |
| | 210-3 Identify strengths and weaknesses of different methods of collecting and displaying data | |

**Elaboration**

***Guiding Questions:***
- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

Once data is collected, it is important to organize the information to help analyze it. As noted previously, there are two types of data: qualitative and quantitative.

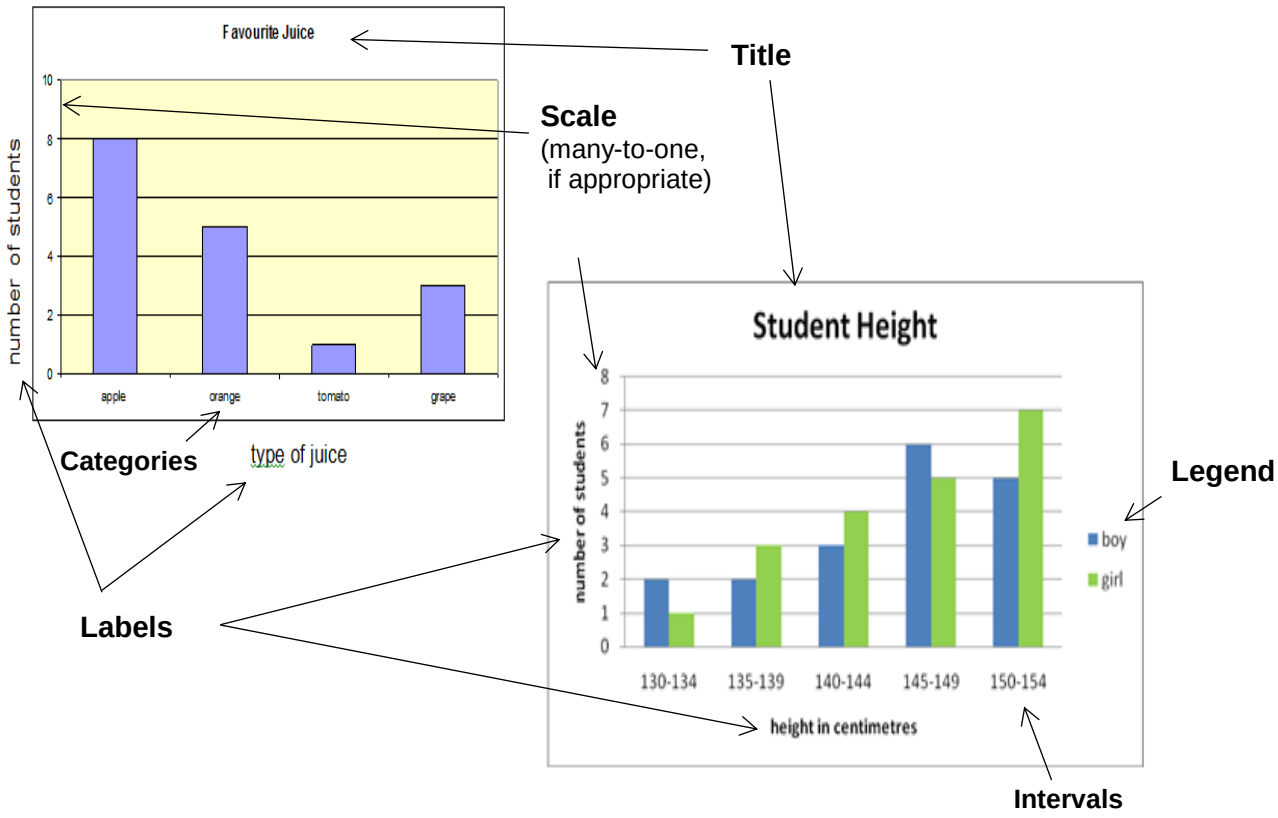
**Organizing qualitative information**:
For qualitative data students will classify according to attributes or characteristics that distinguish or are in common across a variety of items or organisms and display this information as a chart or diagram. Students have also been developing their sorting and displaying skills in mathematics.

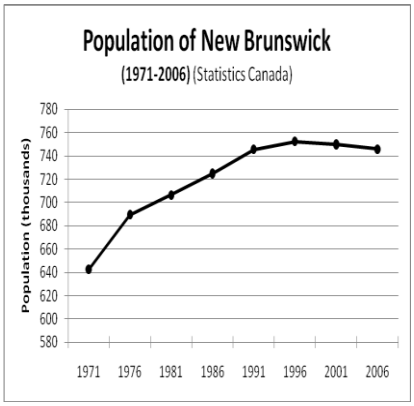
**Connection to Communication**
- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task

In Grade 7, the classification advances past sorting by attributes to the use and/or creation of a classification key. In previous grades, students were asked to look at different objects or organisms and classify them by two attributes. Students now need to apply this understanding to develop a classification key.

**Organizing quantitative data:**
For quantitative data students first need to distinguish between continuous and discrete data. They then choose the appropriate chart or graph to display it. In the mathematics curriculum students were introduced to single bar graphs in Grade 3, double bar graphs in Grade 5, and line graphs in Grade 6. In Grade 7, students are introduced to circle graphs. Students need to determine which type of graph is most appropriate for the data collected.

<u>Sample of expectations for bar graphs in Grades 4 and 5</u>



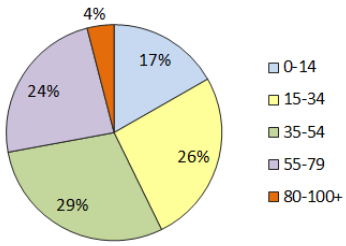



Grade 6 **Line Graph**

*"The purpose of a line graph is to focus on trends implicit in the data… Continuous data includes an infinite number of values between two points and is shown by joining the data points. Discrete data has finite values (i.e., data that can be counted such as the number of pets), and the data between the points have no value. As a result the points in the graph should not be connected and no inferences can be made about values between two data points". (NB Mathematics Grade 6 Curriculum, pg. 94)*

When students create line graphs or plot points of discrete data, they should look for patterns and trends in the data.

**Canadian Population by Age Groups (2011 data)**




Grade 7 **Circle Graph**

*"Circle graphs are used to describe how a whole is distributed into its component parts. Data is partitioned into parts and the circle graph illustrates the ratio of each part to the whole. The sum of the percent of each part will thus always be a whole or 100%." (NB Mathematics Grade 7 Curriculum, pg. 86)*

**Achievement Indicators**

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Develop a **classification key for qualitative data**, according to characteristics that are the same or different.

ii. Differentiate between **discrete and continuous quantitative data** and identify the strengths and weaknesses of different methods of displaying data.

iii. Organize and display qualitative or quantitative data using the appropriate type of chart or graph (e.g., pictograph, bar graph, double bar graph, line graph, circle graph, Venn diagram, Carroll diagram).

iv. Use charts or diagrams.
   - Organize and display data clearly and accurately.
   - Label columns and rows (table, Carroll diagram) or areas (Venn diagram) accurately, and include a chart title.

v. Use graphs.
   - Plot data accurately with independent variable on the x-axis, dependent variable on the y-axis, and the correct scale.
   - Title the graph, label the x- and y-axis including units, and include legend where appropriate.

**Achievement Rubric**

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Classify by characteristics** | Classify according to relevant characteristics **(more than one)** that are the same or different among objects or organisms (**independently and consistently**) | Identify relevant characteristics<br><br>Classify according to relevant characteristics (one or more) that are the same or different among objects or organisms to sequence and sort | Include some characteristics that do not distinguish between the groups<br><br>Classify according to characteristic (one) that is the same or different among objects or organisms (inconsistently or with support) | Any other answer |
| **Compile and display data** | | Distinguish discrete and continuous data<br><br>Use appropriate display of data<br><br>Show patterns and trends in the display of data | Plot data or information correctly, but scale is incorrect<br><br>Omit titles or labels or are incorrect<br><br>Do not use a display of data does that reveals patterns and trends | Use inappropriate display of data<br><br>Use data display that does not reveal patterns or trends<br><br>Any other answer |
| | Plot the IV on the x-axis, and the DV on the y-axis **(independently and consistently)**<br><br>May use multiple displays of data | Plot the IV on the x-axis, and the DV on the y-axis **with support**<br><br>Plot data or information is correctly, with accurate scale<br><br>Use appropriate titles and labels in charts and graphs<br><br>Include a legend in double bar graphs<br><br>Include correct units in labels | | Plot data or information incorrectly<br><br>Use incorrect scale<br><br>Omit titles or labels or are incorrect |

**GCO: Analyze & Explain (AE)** Interpret findings from investigations using appropriate methods. Work collaboratively to carry out science-related activities, and communicate ideas, procedures and results.

**SCO: AE2 - Analyze data patterns**

### Scope and Sequence of Outcomes

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 206-3 Identify and suggest explanations for patterns and discrepancies in data | 210-4 Predict the value of a variable by interpolating and extrapolating from graphical data | 214-6 Apply and assess methods of prediction |
| | 210-9 Calculate theoretical values of a variable | |
| | 210-6 Interpret patterns and trends in data, and infer and explain relationships among the variables | 214-5 Interpret patterns and trends in data, and infer or calculate linear and non-linear relationships among variables |
| | 210-7 Identify and suggest explanations for discrepancies in data | 214-7 Compare theoretical and empirical values and account for discrepancies |
| | 210-10 Identify potential sources and determine the amount of error in measurement | 214-10 Identify and explain sources of error and uncertainty in measurement and express results in a form that acknowledges the degree of uncertainty |
| | | 214-8 Evaluate the relevance, reliability, and adequacy of data and data collection methods |

### Elaboration

***Guiding Questions:***

- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

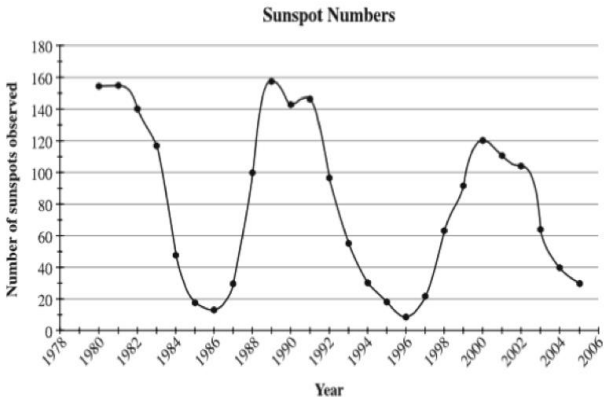
**Connection to Communication**

- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences data tables, graphs, drawings, oral language and other means

Interpreting and analyzing data is a critical-thinking process used by scientific researchers to review the data gathered in the course of an investigation. As part of this process students need to identify and explain **patterns and trends** in data. They should be able to describe the **relationship** and a reasonable explanation(s) for the pattern or trend, noting possible sources of error.

In Grade 6, students were introduced to simple line graphs. In Grade 7, they learn to create and analyze circle graphs and describe more complicated relationships and patterns. Students need to be able to describe the trend with sufficient detail (see examples on next page).

Sunspots are associated with solar flares and coronal mass ejections (CMEs). The number of sunspots alternates between periods of high numbers (solar maximum) and periods of low numbers (solar minimum).




**Appropriate description:**
The number of sunspots is at a minimum every 10 years. Overall, between the 10 year minimums the number of sunspots rises and then falls.

**Not acceptable descriptions**:
The number of sunspots goes down to 1986, then it goes up until 1989, then it goes down to 1996. (Describes the line but not the trend)

The number of sunspots goes up and down. (Oversimplification)

The trend forms a wave pattern. (Lacks detail)

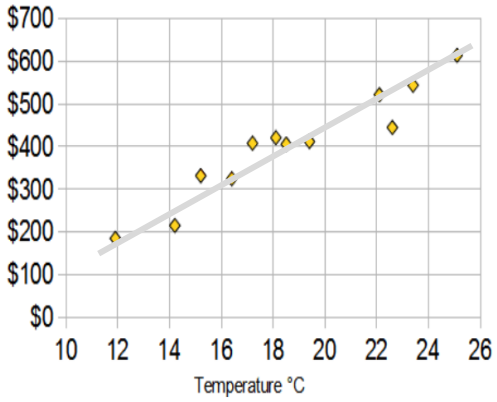
Also in Grade 7, students are introduced to interpolating and extrapolating from graphical data.

**Interpolate** - to estimate a value between two known values.

**Extrapolate** - to estimate (a value of a variable outside a known range) from values within a known range by assuming that the estimated value follows logically from the known values.

Using the example in the graph above, in 2011 the number of sunspots will most likely be between 120 and 160 because the number of sunspots should be at a maximum.

Students can also plot discrete data points (scatter plots) and look for general trends in the data.




For example, the graph to the left shows the relationship between the temperature and the amount of ice cream sales. (https://www.mathsisfun.com/data/scatter-xy-plots.html).

Based on the data, students could **interpolate** that when the temperature is 21°C the amount of money from ice cream sales would be about $450, and could **extrapolate** that at 26°C sales would be about $625.

Students may find it helpful to use a straight edge to interpolate and extrapolate data. They can lay the straight edge to line it up with the points of data to identify trends between and beyond the data points.

When analyzing data it is also important to recognize that sometimes mistakes are made which result in incorrect data. A **discrepancy in data** is when values or observations deviate significantly from the observed pattern or trend. Discrepant data (also called outliers) may be due to measurement error or uncontrolled variables. Discrepant data can be ignored when describing overall patterns or trends.

Inaccurate data can also be collected when there are **sources of error** in methods or equipment. These may be factors such as force or angle of launch of a glider that are difficult to keep consistent from trial to trial. Equipment can help minimize such errors in some situations. For example, using a heart rate monitor is more accurate than using two fingers to determine pulse rate. However, even with specialized equipment, collecting data will never be exact. Even a digital scale has an error of +/- 0.1g in a given temperature range. By doing multiple trials and averaging results, data will approach a more accurate value.

## Achievement Indicators

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Identify and explain in detail patterns and trends in data, and infer and explain relationships.
ii. **Interpolate and extrapolate** from a data pattern or trend.
iii. Recognize that with multiple trials, the data will be averaged for each set of trials.
iv. Identify a discrepancy in data (outlier).
v. Explain possible sources of error in methods or equipment.

## Achievement Rubric

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Analyze data** | Identify and explain multiple or less obvious patterns, trends, and/or relationships (**independently and consistently**)<br><br>Identify a discrepancy and suggest an explanation for it and any possible sources of error<br><br>Suggest **change to experimental design to eliminate the source of error** (**independently and consistently**)<br><br>Identify reasonable values that are consistent with the pattern (Interpolate and extrapolate) (**independently and consistently**) | Identify and explain an appropriate pattern, trend, and/or relationship<br><br>Omit discrepant data (outliers)<br><br>Identify a discrepancy and provide an explanation for it and any possible sources of error<br><br>Identify reasonable values that are consistent with the pattern (Interpolate and extrapolate) | Identify and explain a pattern, trend, and/or relationship, but it is not clear or overly simplistic<br><br>Identify a discrepancy, but is unable to suggest an explanation<br><br>Unable to explain possible sources of error<br><br>Identify values consistent with identified pattern but value is unlikely | Any other answer |

**GCO: Analyze & Explain (AE)** Interpret findings from investigations using appropriate methods. Work collaboratively to carry out science-related activities, and communicate ideas, procedures and results.

**SCO: AE3 - Draw conclusions**

### Scope and Sequence of Outcomes

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 206-5 Draw a conclusion, based on evidence gathered through research and observation, that answers an initial question | 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea | 210-11 Provide a statement that addresses or answers the question investigated in light of the link between data and the conclusion |
| | | 214-12 Explain how data supports or refutes the hypothesis or prediction |
| 206-6 Suggest improvements to a design or constructed object | 210-13 test the design of a constructed device or system | 214-13 Identify and correct practical problems in the way a technological device or systems function |
| | 210-14 Identify and correct practical problems in the way a prototype or constructed device functions | 214-14 Construct and test a prototype of a device or system and troubleshoot problems as they arise |
| 206-7 Evaluate personally constructed devices with respect to safety, reliability, function, appearance, and efficient use of materials | 210-15 Evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials, and impact on the environment | 214-16 Evaluate a personally designed and constructed device on the basis of criteria they have developed themselves |

### Elaboration

***Guiding Questions:***

- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

Student should draw conclusions from prior learning and logical reasoning as it applies to the evidence gained through investigation.

The **conclusion** should refer back to the initial question, and whether the change (independent variable) affected what was measured (dependent variable). As the student looks at the data, they should ask: “Did what I change make a difference?” It should indicate whether the data supports, refutes or is inconclusive about the prediction and what this indicates moving forward. The conclusion may comment on whether the investigation was a fair test and suggest improvements to experimental design.

**Connection to Communication**

- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- Defend a given position on an issue or problem on the basis of their findings

To make simple conclusions means that students are able make a statement based upon logic and the evidence available. It means to come to a determination of what is factual about one thing, based upon knowledge, evidence, and/or facts about something different but related. In Grade 7, students should, whenever possible, be using analyzed experimental data as the main support of their argument. It is important to note that the findings are valid and are not considered "wrong" even if the prediction was not supported. Whether the prediction/hypothesis is supported or refuted is not a measure of success or failure since scientific knowledge is advanced by either result.

Where possible students should compare the results of their investigation to those of others, recognize that results may vary, and explain why. Comparison of findings to those of similar investigations can add weight to the conclusion. It can also lead to a reflection on the fairness of the experimental design.

## Achievement Indicators

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. State a conclusion that answers the initial question.
ii. Indicate whether the data supports, refutes or is inconclusive about the initial prediction.
iii. Justify the conclusion by providing evidence from data collected.
iv. Compare the results of an investigation to those of others and explain why results may vary.
v. Discuss fairness of experimental design and suggest improvements for a follow-up investigation.
vi. Design, adjust and evaluate a device or system.

**Achievement Rubric**

| | Excelling - 4 | Meeting - 3 | Approaching - 2 | Working Below - 1 |
|---|---|---|---|---|
| **Draw conclusions** | State a **more detailed** logical conclusion that answers the initial question<br><br>Justify the conclusion by providing **detailed** evidence<br><br>Compare findings with **several** other similar investigations<br><br>Provide **higher level** explanation for the variation in results and suggestions to improve investigation and device or system with a **rationale**<br><br>Discuss fairness of experimental the design and **improvements** | State a logical conclusion that answers the initial question.<br><br>Indicate whether the data supports, refutes or is inconclusive about the initial hypothesis<br><br>Justify the conclusion by providing evidence from data collected<br><br>Compare the results of an investigation to those of others and explain why results may vary<br><br>Design, adjust and evaluate a device or system<br><br>Discuss fairness of experimental design and suggest improvements for a follow-up investigation. | State a conclusion that is not clear or logical<br><br>Restate only the recorded results and observations in the conclusion or is a result of flawed reasoning | Any other answer |

**GCO: Analyze & Explain (AE)** Interpret findings from investigations using appropriate methods. Work collaboratively to carry out science-related activities, and communicate ideas, procedures and results.

**SCO: AE4 - Apply learning**

### Scope and Sequence of Outcomes

| Grades 4-6 | Grades 7-9 | Grades 10-12 |
|---|---|---|
| 206-4 Evaluate the usefulness of different information sources in answering a given question | 210-8 Apply given criteria for evaluating evidence and sources of information | 214-9 Identify and apply criteria including the presence of bias, for evaluating evidence and sources of information |
| 206-8 identify potential applications of findings | 210-12 Identify and evaluate potential applications of findings | 214-18 Identify and evaluate potential applications of findings |
| | | 214-15 Propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each and select on a the basis for a plan |
| 206-9 Identify new questions or problems that arise from what was learned | 210-16 Identify new questions and problems that arise from what was learned | 214-17 Identify new questions or problems that arise from what was learned |

### Elaboration

***Guiding Questions:***

- *What do I want my students to learn?*
- *What do I want my students to understand and be able to do?*

To apply their learning, students need to engage in **higher order thinking (critical thinking skills)**, including evaluating information and conceptualizing new questions or problems to investigate.
Students will:

- *Evaluate sources of information, fairness of an experimental design, usefulness of a constructed design, their own/other's thinking*
- *Apply conclusions reached to real world scenarios.*
- *Extend initial ideas by creating new questions to test*

**Connection to Communication**

- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task
- Defend a given position on an issue or problem on the basis of their findings

Students need to be provided with opportunities to **discuss and reflect** to help synthesize what they have learned. This will allow them to explore other perspectives and evaluate their own and other's thinking and explanations in terms of plausibility and scientific evidence. Students should explore what they need for their own learning and how to self-monitor. This requires skills in **metacognition** which is, put simply, thinking about one's thinking.

To help develop skills in metacognition, students should be given opportunities to:

- connect new knowledge to prior knowledge;
- self-assess by, for example, explaining their thinking to others through discussions or journal writing;
- test their ideas by, for example, designing follow-up investigations or solutions to a problem.

Question prompts such as the following can help start discussions:

- What would happen if….?
- Based on what you know, how would you explain…?
- Can you think of another way…?
- How could you change and improve….?
- What do you think of…?
- How would you justify…?
- Why was it better that…?
- Do you agree with…?

**Achievement Indicators**

***Guiding Questions:***

- *What evidence will I look for to know that learning occurred?*
- *What should students demonstrate to show their understanding of the Scientific Process Skill?*

Use the following set of indicators as a guide to determine whether students have met the corresponding specific outcome.

i. Apply what has been learned to situations beyond the classroom.
ii. Evaluate results in relation to other scientific investigations and knowledge.
iii. Do research and evaluate the sources of information for relevancy and reliability.
iv. Extend what has been learned to develop new questions and address new problems.

**Achievement Rubric:**

<table>
<tr><th></th><th>Excelling - 4</th><th>Meeting - 3</th><th>Approaching - 2</th><th>Working Below - 1</th></tr>
<tr><td rowspan="5">Apply Learning</td><td>Demonstrate evidence of critical thinking beyond the expectations for this grade level based on the criteria below (independently and consistently)</td><td>Demonstrate evidence of critical thinking appropriate for this grade level based on the criteria below</td><td>Demonstrates evidence of critical thinking slightly below this grade level based on the criteria below</td><td rowspan="5">Any other answer</td></tr>
<tr><td colspan="3">Apply what has been learned to other situations beyond the classroom</td></tr>
<tr><td colspan="3">Evaluates results in relation to other scientific investigations and knowledge</td></tr>
<tr><td colspan="3">Do research and evaluate sources of information for relevancy and reliability</td></tr>
<tr><td colspan="3">Extend learning to develop new questions and problems to investigate</td></tr>
</table>