A Look at Related NGSS Practices for a Schoolyard Cleanup Project

From Appendix F of the Next Generation Science Standards

As a fully-realized project-based learning opportunity, a schoolyard cleanup may give students experience in the following Science and Engineering Practices, as appropriate for their grade level and teacher constraints. Other aspects of the Practices may be used depending on pre-cleanup lessons and media selected as a part of this project.

Asking Questions and Defining Problems

K-2

- Ask questions based on observations to find more information about the natural and/or designed world.
- Ask and/or identify questions that can be answered by an investigation.
  Question might be, How much litter is on the schoolyard today? What kind of litter is on the schoolyard?

3-5

- Ask questions about what would happen if a variable is changed.
  Variables might be: section of the school grounds, day of the week, time of day...
- Identify scientific (testable) and non-scientific (non-testable) questions.
  Testable question might be, Is there more litter near the lunch tables than outside the principal's office? From what material will the largest quantity of litter made? Non-testable question might be, Is there a lot of litter in the schoolyard?

6-8

- Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument.
- Ask questions that require sufficient and appropriate empirical evidence to answer.
- Ask questions that can be investigated.with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

9-12

- Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
  Question might be, Is more litter found in the area around a trash can or in a similar location where there is no trash can?
- Evaluate a question to determine if it is testable and relevant.
- Ask questions that can be investigated...with available resources and, when appropriate, frame a hypothesis based on a model or theory.
  Question might be, If a No Littering sign is posted, does the quantity of litter change? If students are educated about the impact of their consumer choices, does the quantity of litter change?

Planning and Carrying Out Investigations

K-2

- With guidance, plan and conduct an investigation in collaboration with peers.
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
- Make observations and/or measurements to collect data that can be used to make comparisons.

3-5

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
  What makes a fair test? What if one group is not taking down all of their data, or not picking up the litter? What if some groups have more students than others?
- Evaluate appropriate methods and/or tools for collecting data.
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
  What might it mean if there is more litter in one location than another, or if there is more litter at one time of day than another?
- Make predictions about what would happen if a variable changes.
  How might results change if data collection on the field is done after a soccer game?

6-8

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.
- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

9-12

- Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
  Could the fact that the entire 9th grade was off campus for a field trip on your cleanup day have effected your results? Did you account for the fact that on Fridays the volleyball team sells candy bars during break?
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Analyzing and Interpreting Data

K-2

- Record information (observations, thoughts, and ideas).
- Use and share pictures, drawing, and/or writing of observations.
  Students can document observations of the litter collected and/or the natural elements of the schoolyard with drawings. Students can label drawings and write haikus about what they see and experience in the schoolyard.
- Use observations to describe patterns and/or relationships in the natural and designed world in order to answer scientific questions and solve problems.
- Compare predictions to what occurred.

3-5

- Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) or reveal patterns that indicate relationships.
- Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
- Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
- Use data to evaluate and refine design solutions.
  Repeat cleanup data collection after implementing a solution, such as an additional trash can, No Littering sign, or other educational effort.

6-8

- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
  In addition to the data collected by the students, they have the opportunity to analyze data within the International Coastal Cleanup database at www.coastalcleanupdata.org.
- Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.
- Analyze and interpret data to determine similarities and differences in findings.

9-12

- Analyze data using tools, technologies, and/or models (e.g. computational, mathematical) in order to make valid and reliable scientific claims.
- Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Using Mathematics and Computational Thinking

K-2

- Use counting and numbers to identify and describe patterns in the natural and designed world.
- Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.

3-5

- Organize simple data sets to reveal patterns that suggest relationships.

6-8

- Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.
  In addition to the data collected by the students, they have the opportunity to analyze data within the International Coastal Cleanup database at www.coastalcleanupdata.org.

9-12

- Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Constructing Explanations and Designing Solutions

K-2

- Generate and/or compare multiple solutions to a problem.

3-5

- Construct an explanation of observed relationships.
  Why is there more litter by the lunch area than the playground?
- Use evidence (e.g. measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

6-8

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
  Does the KIND of litter collected depend on the location of its collection? Does the QUANTITY?
- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

9-12

- Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
  Does the KIND or QUANTITY of litter collected change if a trash can or recycling bin is available?
- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Engaging in Argument from Evidence

K-2

- Identify arguments that are supported by evidence.
- Distinguish between opinions and evidence in one's own explanations.
  There's too much litter vs. 100 pieces of litter was collected on the playground.
- Construct an argument with evidence to support a claim.
  Chip bags are the biggest problem, since we collected more chip bags than anything else.

3-5

- Compare and refine arguments based on an evaluation of the evidence presented.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
  We found 20 chip bags and 30 aluminum cans vs. Chip bags are the biggest concern because most of them were found near the storm drains vs. The aluminum cans would get blown to the storm drains if it were windy.
- Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model by citing relevant evidence and posing specific questions.
- Construct and/or support an argument with evidence, data, and/or a model.
  As seen on this graph of litter materials, plastic items are the biggest concern because we found the most of those items.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.
  Emptying this garbage can more often would reduce the litter problem because we found 100 pieces of litter around the base of the overflowing can.

6-8

- Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
  Pencils are the biggest problem because we found the most of them vs. Pencils can be returned to the classroom and reused, so chip bags are actually the biggest problem as the second most frequent item.
- Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

9-12

- Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions.
- Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
- Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Obtaining, Evaluating, and Communicating Information

K-2

- Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

3-5

- Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

6-8

- Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

9-12

- Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).