Addressing Educational Standards, Grades K-4

Literacy is a primary emphasis in the K-4 grade band. Current educational standards emphasize an integrated model of literacy – reading, writing, speaking, listening and language – and students' literacy development is shared across subjects. As such, students learn reading and writing through literature and informational texts, and in turn learn content (e.g., social studies, science) through these texts as well.

Early elementary students are typically introduced to simple life science content such as the major structures of plants, plant life cycles, and simple plant/environment interdependencies. Participation in Project BudBurst can help make these topics real for students as they explore first hand how plants change through the seasons. Elementary science and math skills such as making and recording observations through pictures and measurements; keeping a journal; making predictions; collecting and organizing data in tables, charts and graphs, and noting patterns and relationships can all be taught with Project BudBurst.

This document describes how incorporation of Project BudBurst in classroom instruction can help meet various educational standards. Because Project BudBurst is a national citizen science project, we focus on national education standards. District and state requirements of course vary, however many base their standards on these common national standards.

National Science Education Standards

National Science Education Standards (NSES) specify scientific content knowledge and inquiry skills appropriate for multiple grade bands. According to NSES, students in grades K-4 should be introduced to characteristics of organisms, life cycles, and simple plant, animal, ecosystem interdependencies. Specific content and inquiry skills defined in NSES for grades K-4 that may be addressed through use of Project BudBurst are listed on then next page.

Topic	Grades K-4 Content Standards
LS: Characteristics of Organisms	The behavior of individual organisms is influenced by internals cues and by *external cues (such as a change in the environment*). Organisms have senses that help them detect internal and external cues.
LS: Life Cycles of Organisms	*Plants and animals have life cycles* that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.
LS: Organisms and their Environments	*An organism's patterns of behavior are related to the nature of that organism's environment*, including the numbers of other organisms present, and *the physical characteristics of the environment*. When the environment changes, some plants and animals survive and reproduce, and other die or move to new locations.
ES: Changes in the Earth and Sky	*Weather changes from day to day and over the seasons.* Weather can be described by measurable quantities, such as *temperature*, wind direction and speed, and precipitation.
ST: Understanding about Science and Technology	*Science is one way of answering questions and explaining the natural world.* *Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.*
SP: Changes in Environments	*Changes in environments can be natural or influenced by humans.* Some changes are good, some are bad and some are neither. *Some environmental changes occur slowly, and others occur rapidly.* Students should understand the different consequences of changing environments in small increments over long periods as compared with changing environments in large increments over short periods.

Grades K-4 Inquiry Standards

- *Ask a question about objects, organisms, and events in the environment.* This emphasizes students asking questions that they can answer with scientific knowledge, combined with their own observations.
- *Plan and conduct a simple investigation.* In the earliest years, investigations are largely based on systematic observations.
- *Use data to construct a reasonable explanation.* Students should learn what constitutes evidence and judge the merits or strength of data and information that will be used to make explanations.

- *Communicate investigations and explanations.* Students should begin to develop the abilities to communicate, critique, and analyze their work and the work of other students. This may be spoken or drawn as well as written.

Geography Standards

The National Geography Standards provide a set of standards that define what a geographically informed person should know and understand. Geographers ask questions like: *Where* is something? *Why* is it there? and *How* does it interact with other things?

Because Project BudBurst is a national project with participants monitoring plants across the continent, students can see observations of plants similar to theirs but submitted from locations across the United States. Mapping function built into the Project BudBurst Plant pages displays these data spatially and can help young students begin to understand spatial concepts. Incorporating this type of learning experience into classroom instruction can help teachers address geography standards.

Below are the particular standards that may be addressed through use of Project BudBurst.

The World in Spatial Terms:

- **Standard 1:** *How to use maps* and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.
- **Standard 3:** How to analyze the spatial organization of people, places, *and environments on Earth's surface.*

Places and Regions:

- **Standard 4:** The physical and human characteristics of places.

Physical Systems:

- **Standard 8:** The characteristics and spatial distribution of ecosystems on Earth's surface.

Common Core Standards

A majority of states have adopted Common Core Standards for English Language Arts and Mathematics (http://www.corestandards.org/in-the-states). Incorporation of Project BudBurst activities in classroom instruction can help address these standards.

Common Core Standards for Language Arts emphasize integration of language skills with other topics through the use of a variety of texts, including science-based informational texts. *BudBurst Buddies*, a companion program to Project BudBurst that includes a fictional, science-based story to illustrate how kids can participate in citizen science, is designed with this very approach in mind. K-4 teachers may use *BudBurst Buddies* to address *reading* standards in which students learn key ideas and details (e.g., who, what, when, where, how), story structure (e.g., introduction, ending, characters' points of view), and integration of ideas (e.g., after the story, students are invited to collect their own plant observations just as characters in the story did). As students make observations and record/report data, Common Core *writing* standards may also be addressed as students "*conduct short research projects that build knowledge of a topic through investigation*," and "*recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories."*

Common Core Math Standards in grades K-4 emphasize helping students understand measurement and data, and how to represent and interpret data. Students are expected to draw picture and bar graphs to represent data with several categories, and by grade 4, to draw scaled bar graphs using measurement data. They are also expected to solve problems involving measurement and estimation of intervals of time. Teachers can use Project BudBurst data to illustrate all of these mathematical concepts. For example, after having students collect dates of key phenophases, teachers may have students calculate the number of days between events, and create scaled graphs showing the dates for each phenophase.

A Framework for K-12 Science Education. Practices, Crosscutting Concepts, and Core Ideas

Building on the NSES, the new Framework for K-12 Science Education emphasizes the integration of scientific practices, crosscutting concepts and core ideas, and sets the expectation that educators incorporate all three dimensions throughout instruction, even in elementary grades. Guiding principles that underlie the structure of the framework include the natural investigative nature of children; the emphasis on a limited set of core ideas to allow for deeper exploration and understanding; and the recognition that science requires both knowledge and practice. The framework also describes learning where students "build progressively more sophisticated explanations of natural phenomena" rather than focusing only on description in early years and leaving explanation for later grades. In general, the new Framework and subsequent standards that will come from this framework stress the importance of giving students experience with authentic scientific practices in the context of important core ideas. Inviting students to become citizen

scientists through Project BubBurst is a natural fit for this type of instruction. Project BudBurst students engage in studies of living plants in their own environment, collect their own data and learn to see patterns in these data.

A summary of the Framework's practices, concepts and core ideas is listed below, with samples of specific understandings at the grades K-4 level included.

Scientific and Engineering Practices

1) Asking questions (for science) and defining problems (for engineering)

"Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from scientific investigations."

2) Developing and using models

"Young people should be encouraged to devise pictorial and simple graphical representations of the findings of their investigations and to use these models in developing their explanations of what occurred."

3) Planning and carrying out investigations

"In elementary years, students' experiences should be structured to help them learn to define the features to be investigated, such as patterns that suggest causal relationships."

4) Analyzing and interpreting data

"At the elementary level, students need support to recognize the need to record observations – whether in drawings, words, or numbers – and to share this with others. As they engage in scientific inquiry more deeply, they should begin to collect categorical or numerical data for presentation in forms that facilitate interpretation, such as tables and graphs."

5) Using mathematics and computational thinking

6) Constructing explanations (for science) and designing solutions (for engineering)

"Students should be encouraged to develop explanations of what they observe when conducting their own investigations and to evaluate their own and others' explanations for consistency with the evidence."

7) Engaging in argument from evidence

9) Obtaining, evaluating, and communicating information

Crosscutting Concepts

1) Patterns

"It is important for students to develop ways to recognize, classify, and record patterns in the phenomena they observe. For example, elementary students can describe and predict the patterns in the seasons of the year. Similarly, they can investigate the characteristics that allow classification of plants (e.g., trees, shrubs, grasses)…"

2) Cause and effect: Mechanism and explanation

"In the earliest grades, as students begin to look for and analyze patterns – whether in their observations of the world or in the relationships between different quantities in data (e.g., the sizes of plants over time) – they can also begin to consider what might be cause these patterns and relationships and design tests that gather more evidence to support or refute their ideas."

3) Scale, proportion, and quantity

"The concept of scale builds from the early grades as an essential element of understanding phenomena. Young children can begin understanding scale with objects, space, and time related to their world and with explicit scale models and maps. They may discuss relative scales – the biggest and smallest, hottest and coolest, fastest and slowest – without reference to particular units of measurement."

4) Systems and system models

5) Energy and matter: Flows, cycles, and conservation

6) Structure and function

7) Stability and change

"Even very young children begin to explore stability and change. The role of instruction in the early grades is to help students to develop some language for these concepts and apply it appropriately across multiple examples, so that they can ask such questions as 'How fast did the plants grow?'"

Disciplinary Core Ideas

Life Sciences

- LS1: From molecules to organisms: Structures and processes

  How do organisms grow and develop?

  "Plants and animals have predictable characteristics at different stages of development…Plants and animals grow and change."

  How do organisms detect, process, and use information about the environment?

  "Plants also respond to some external inputs (e.g., turn leaves toward the sun)."

- LS2: Ecosystems: interactions, energy and dynamics (in particular C. Ecosystem Dynamics, Functioning, and Resilience)

  What happens to ecosystems when the environment changes?

  "The places where plants and animals live often change, sometimes slowly and sometimes rapidly. When animals and plants get too hot or too cold, they may die. If they cannot find enough food, water, or air, they may die."

- LS3: Heredity: Inheritance and variation of traits

- LS4: Biological Evolution: Unity and diversity

Earth and Space Sciences

- ESS1: Earth's place in the universe

- ESS2: Earth's systems (in particular D. Weather and Climate)

  "Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

- ESS3: Earth and human activity