Addressing Educational Standards, Grades 5-8

According to Educational Standards, by grades 5-8, students build upon a foundational understanding of plants and ecosystems through study of adaptations, populations, and interactions between organisms and the environment. Participation in Project BudBurst can provide an engaging, real-world context for learning more about plants, living systems, and environments. It also provides opportunities for students to gain experience with scientific practices such as making observations, collecting data, and contributing to scientific research. These are important knowledge content and skills for middle school students to learn, as defined by today's educational standards.

This document describes how incorporation of Project BudBurst in classroom instruction can help meet various educational standards. Because Project BudBurst is a national program, this document addresses national education standards. District and state requirements of course vary, however many base their standards on 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 5-8 should broaden their understanding of plants and animals learned in earlier grades by studying adaptations, populations, ecosystems and the interactions between organisms and environments. Specific content and inquiry skills defined in NSES for grades 5-8 that may be addressed through use of Project BudBurst are listed on the next page.

Grades 5-8 Topic	Grades 5-8 Content Standards
LS: Regulation and Behavior	All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
LS: Populations and Ecosystems	The number and type of organisms an ecosystem can support depends on resources and abiotic factors (such as range of temperature). A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
LS: Diversity and Adaptations of organisms	Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient for survival.
ES: Earth in the Solar System	The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.
NS: Science as a Human Endeavor	Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity—as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.
NS: Nature of Science	It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Although scientists may disagree about explanations of phenomena, about interpretations of data, or about the value of rival theories, they do agree that questioning, response to criticism, and open communication are integral to the process of science.

Grades 5-8 Inquiry Standards

- *Ask meaningful questions that can be answered through scientific investigations.* Identify changes in natural phenomena over time without manipulating the

phenomena.

- Use appropriate tools and technology, including mathematics, to gather, analyze, and interpret data. *Record data by using appropriate graphic representations and make inferences based on those data.*
- Draw conclusions from scientific evidence.
- Communicate the logical connection among hypothesis, concepts, tests conducted, data collected and conclusions drawn from scientific evidence. *Write a report of an investigation that includes tests, colleting data, examining evidence and drawing conclusions.*

Geography Standards

Because Project BudBurst is a national project, with participants monitoring plants across the continent, students have easy access to data similar to the data they collect in their schoolyard, submitted from locations across the United States. This provides a unique opportunity for students to experience and make meaning of spatial data. Incorporating this type of learning experience into classroom instruction can help teachers address geography standards.

The National Geography Standards provide 18 standards that define what a geographically informed person should know and understand. Below are the particular standards that may be addressed through participation in 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.

Environment and Society:

- **Standard 14:** How human actions modify the physical environment

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 are designed to integrate language skills with other topics through the incorporation of a variety of texts including science-based informational texts. The 7th grade reading standards, for example, state that students should be able to "trace and evaluate the argument and specific claims in an informational text, assessing whether the reasoning is sound and the evidence is relevant and supports the claims." Using Project BudBurst informational texts and resources, students can develop proficiency in reading, writing, speaking/listening, and language skills, while at the same time learn about phenology, ecosystems and climate change. By giving students direct experience with observation and data collection that produces data in a format similar to that reported in scientific texts, students participating in Project BudBurst are also better prepared to read and assess relevant scientific texts. Under the writing standards for 8th grade, students should be able to "conduct short research projects to answer a question drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration." Participation in Project BudBurst can provide a framework for students to explore many questions (including their own) around phenology and climate variability.

Common Core Math Standards in grades 5-8 emphasize helping students understand measurement and data, use measurements in real-world problems, understand the relationship between independent and dependent variables, and understand basic statistical concepts such as distributions, mean, variability, and random sampling to draw inferences about populations. Teachers can use Project BudBurst data to illustrate all of these mathematical concepts. For example, after having students collect phenophase event data on their own plants, teachers may have students graph the distribution of dates of each phenophase event to understand mean and variability.

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. 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 plant studies in their own environment, collecting their own data over time and making connections between observed events and natural phenomena.

A summary of the Framework's practices, concepts and core ideas is listed below, with samples of specific understandings at the grades 5-8 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 their models or scientific investigations."

2) Developing and using models

3) Planning and carrying out investigations

"Students should engage in investigations that range from those structured by the teacher – in order to expose an issue or question that they would be unlikely to explore on their own – to those that emerge from students' own questions."

4) Analyzing and interpreting data

"Students should have opportunities to learn standard techniques for displaying, analyzing, and interpreting data; such techniques include different types of graphs, the identification of outliers in the dataset, and averaging to reduce the effects of measurement error."

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**

8) **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. … by upper elementary grades, students should also begin to analyze patterns in rates of change – e.g., the growth rates of plants under different conditions."

1) **Cause and effect: Mechanism and explanation**

"By upper elementary grades, students should have developed the habit of routinely asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected. The questions should move from 'Why did that happen?' towards 'What conditions were critical for that to happen?'"

2) **Scale, proportion, and quantity**

"As size scales change, so do time scales. Thus, when considering large entities such as mountain ranges [or populations], one typically needs to consider change that occurs over long periods."

3) **Systems and system models**

4) **Energy and matter: Flows, cycles, and conservation**

5) **Structure and function**

6) **Stability and change**

Disciplinary Core Ideas

Life Sciences

- LS1: From molecules to organisms: Structures and processes
- LS2: Ecosystems: interactions, energy and dynamics (in particular C. Ecosystem Dynamics, Functioning, and Resilience)

  What happens to ecosystems when the environment changes?

  "When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die."

  "Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all of its populations."

- 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 minute-by-minute to day-by-day variation of the atmosphere's condition on a local scale. Climate describes the ranges of an area's typical weather conditions and the extent to which those conditions vary over years to centuries."

- ESS3: Earth and human activity (in particular D. Global Climate Change)

  "If Earth's global mean temperature continues to rise, the lives of humans and other organisms will be affected in many different ways."

  "Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming)."