

Introduction

The *Next Generation Science Standards* (NGSS) represent a seismic shift in K-12 science education in the United States. The standards are the culmination of decades of work by scientists and educators across the country, and are being broadly adopted by states across the nation. As teachers phase in the instruction of the new standards, they are faced with many challenging questions regarding how to interpret the new three-dimensional standards. This interpretation will have an impact on all aspects of science education, including curriculum, assessment, instruction, and evaluation.

The *Institute in Practical Educational Science* (IPES) is a project of the *Association for the Cooperative Advancement of Science and Education* (ACASE). The goal of the Institute is the development of a collaborative community of teachers who have the concepts and skills needed to build practical, useful and reliable assessments that can be applied to enhance decision-making in educational settings. The main focus at present is the Next Generation Science Standards, but the discipline of Practical Educational Science is relevant to any educational or training program irrespective of content or grade level.

Like any science, the outcomes in Practical Educational Science are based on the measurement of well-defined variables. In Practical Educational Science, the dependent variable is the level of student attainment. Systematic techniques are available to iteratively enhance curriculum, assessment, instruction and evaluation in order to effectively realize that attainment. The in-depth, iterative, and scientific approach of IPES has revealed much about the Standards themselves.

Problem

One revelation is the lack of definitions of key terms in the *Framework for Science Education* and in the Standards documents themselves, making defining learning goals difficult. While the terminology of the Disciplinary Core Ideas (DCI's) are often concrete due to their more direct connection with science content, the terminology of the Science and Engineering Practices (SEP's) and Cross-Cutting Concepts (CCC's) often have many different interpretations, or even explicitly different meanings when used in different contexts.

Methods

An analysis was therefore conducted by IPES participants to:

- 1) develop a list of poorly defined, but recurring terms in the Standards,
- 2) identify patterns in their usage, and
- 3) develop working definitions based on these patterns.

Questions posed for each listed term in this analysis included:

- In the Performance Expectations, Foundation Boxes, and Progression Matrices, what other words are typically associated with the word in question?
- What are the accepted definitions of the words in common dictionaries?
- How are the words used in the *Framework for Science Education*?
- How is the word being used in scientific settings such as online classes, college lectures, and scientific papers?

These questions were applied to each of the words listed below.

Strong correlations between words were identified where certain adjectives were exclusively or almost exclusively associated with particular nouns. From this, the definitions and applications of each term in NGSS were inferred.

Resources:
NGSS glossary definition of Performance Expectation
NGSS glossary definition of Foundation Box
Grade Band Progression Matrices: <ul style="list-style-type: none">● Matrix of Science & Engineering Practices in NGSS● Matrix of Crosscutting Concepts in NGSS● Matrix of Connections to the Nature of Science● Matrix of Connections to Engineering, Technology and Applications of Science in NGSS
Framework for Science Education
Dictionaries: <ul style="list-style-type: none">● Merriam-Webster online dictionary● Dictionary.com

Results — The Language of NGSS:

- **Account** – a report or description of an event or experience
- **Analyze** – to examine raw data methodically in order to display meaningful relationships (e.g., organizing data into a table, creating a graph, or applying statistics)
- **Argument** – an approach used to support a claim, explanation, or idea with evidence and reasoning
- **Cause and Effect:**
 - **Cause** – an action or event which produces an outcome (effect)
 - **Effect** – the outcome produced by an action or event (cause)
 - Cause and effect relationships can only be determined when a mechanism is revealed. This requires proof through a controlled experiment.
- **Causality** – the presence of a cause and effect mechanism in a phenomenon
- **Claim** – a statement or assertion that something is the case, typically without providing evidence or proof
 - *Claims can be:*
 - **Valid** – supported by evidence
 - **Relevant** – related to the question being asked
- **Computational Model** – a simple computer program, spreadsheet, or simulation software package
- **Concept** – an abstract idea; a general notion
- **Correlation** – a relationship or pattern between the values of two variables
- **Demonstrate** – to show clearly through exhibition or evidence
- **Designed system** – a system created with purpose and/or intention by humans
- **Design problem** – an attribute regarded as unfit, unwelcome, or harmful and needing to be dealt with and overcome to meet a real or perceived need¹
- **Evaluate** – to consider both merits and limitations of something against a set of criteria

¹ Adapted from [Oxford English Dictionary](#) definition

- **Evidence** – information that is used to indicate whether or not a claim is true
 - *Evidence can be:*
 - **Accurate** – the degree to which a measurement or calculation reflects the correct value or a standard
 - **Empirical** – the evidence is based on observation
 - **Precise** – the quality or condition of having consistent measurements
 - **Relevant** – the evidence measures the variables found in the claim
 - **Reliable** – evidence that comes from a credible source
 - The gold standard of reliability is publication in a peer-reviewed journal.
 - There is a broad spectrum of reliability beneath that to consider, and many opinions of sources within that spectrum.
 - **Sufficient** – there is enough evidence to support the claim
 - **Valid** – the extent to which the evidence is logically or factually aligned with the goals of the investigation or the claim that is stated
- **Explain** – to make (an idea, situation, or problem) clear to someone by describing it in detail or revealing relevant facts or ideas
- **Feedback** – a response within a system (e.g., molecule, cell, organism, or population) which influences the continued activity or productivity of that system
- **Function** – the particular way in which something works
- **Identify** – to give a name to something
- **Inference** – a conclusion formed on the basis of evidence and reasoning
- **Interpret** – to restate the relationships or patterns found in data
- **Investigate** – to carry out a systematic or formal inquiry to discover and examine the facts of a phenomenon so as to establish the truth
- **Limitations** – weaknesses, missing components
- **Mathematical Function** – a relationship or expression involving one or more variables (e.g., linear, non-linear, trigonometric)
- **Mechanism** – the components and process by which something occurs, which may be part of a system or include multiple systems
- **Mechanistic Account** – simplified description of how something works by physical parts and processes
- **Merits** – strengths, positives
- **Model** – a physical, mathematical, and/or conceptual representation of a natural phenomenon, system, or process
- **Observe** – to detect with one’s senses
- **Optimal Design Solution** – a solution with the best performance based on a balance of multiple criteria
- **Pattern** – a relationship discovered by human consciousness through observation of more than one occurrence or variation of a phenomenon
- **Phenomenon** – an observable event that occurs in a natural or designed system
- **Prediction** – a proposed possible outcome of a scientific test based on logical reasoning about a particular scientific idea, model, evidence, or scientific principles such as cause and effect
- **Proportion** – the relative relationship in magnitude between one thing and another, or between a part and a whole
- **Qualitative:** interpretation-based, descriptive, and relating to language
- **Quality** – a characteristic that does not involve numbers
- **Quantitative** – numerical, countable, or measurable

- **Quantity** – an amount or number
- **Reasonable** – likely based on evidence, patterns, or cause and effect relationships
 - Reasonable is used in NGSS in connection with predicting outcomes based on patterns such as cause and effect relationships.
 - What would be considered *reasonable* would include a range of possible outcomes based on particular context and evidence. This range must be stipulated in any assessment activity because it is so open-ended.
- **Reasoning** – the use of evidence to support a claim with logic and scientific knowledge
 - *Reasoning can be:*
 - **Logical** – soundly applies logic to connect the evidence and/or scientific knowledge/laws/theories/principles to the claim
 - **Scientific** – includes scientific knowledge principles, theories, or laws
- **Recognize** – to know what something is when you see it
- **Relationship** – the way in which two or more concepts, objects, or people are connected, or the state of being connected
- **Scale** – the magnitude of a phenomenon in relation to the context or system to which it is being compared
 - In NGSS, scale is often thought of in orders of magnitude (e.g., atomic vs. microscopic vs. macroscopic vs. solar system vs. galactic).
- **Scientific Question** – a question which is testable
- **Significance** – the quality of being worthy of attention; importance
 - The significance of a phenomenon is dependent upon its magnitude relative to the system it is part of.
- **Societal Need** – a factor necessary for a society to function and exist
- **Societal Value** – a factor upon which a society places a high level of importance when making decisions
- **Societal Want** – a factor on which a society places value but is not necessary for the society to function and exist
- **System** – a collection of components which work together to support the function(s) of the system as a whole
- **Trend** – a change in a relationship that moves in a general direction; a pattern in data