Teacher Toolbox- Next Generation Science Standards and the Alignment with Service-Learning

Next Generation Science Standards (NGSS) Overview- The National Standards that has been implemented has a different focus and structure than state standards in the past. The goal of these standards it to not only have a commonality for content throughout the United States, but also to give guidance to the process skills of the Scientific Process and the Engineering Design model. If you are well versed in the Next Generation Standards and the *Framework for K-12 Science Education,* from which the NGSS developed, you may want to skip this background information.

Never have we had such a complete resource as this document! It is exciting to see how the Common Core, process skills and content knowledge are integrated into one. In the In next few paragraphs, we will explain the structure of the NGSS so that you will have that knowledge to be able to help students understand what they are going to be learning and how this structure can guide their learning of Scientific Concepts with Investigative processes and Engineer Designing.

The major component of Service-Learning and particularly the EPICS program is the symbiotic relationship between serving the community and the authentic application of content knowledge and learning by students. The Next Generation Science Standards gives a strong framework for this learning and the EPICS Engineering Design Model gives the engineering design structure that helps students move seamlessly through the process.

In the next few paragraphs, we will examine the structure of the NGSS and how service-learning can be embedded with the standards to improve the students' retention of content and application of knowledge.

NGSS Structure-

There are three main components of the Next Generation Science Standards which are also integrated with the Common Core in English Language Arts (ELA) and Mathematics.

Scientific and Engineering Practices- These are process skills or actions that will help students learn content and practice the process of exploring science and creating their own understandings.

Crosscutting Concepts- *These are unifying themes that have applications across science and engineering content that can be commonly applied.*

Disciplinary Core Ideas- *Is the basics of curriculum that structure the core content. There are 4 disciplines which include life sciences, earth and space sciences, physical sciences, and the process standards of engineering, technology and the process concepts of science.*

Scientific and Engineering Practices- This portion of the Standards incorporates the action of how the content knowledge will be delivered and ultimately internalized through the Scientific Process and the Engineering Design Model. Below you will find the eight components of the Scientific Process and Engineering Practices.

Notice the action words in each statement.

1. ***Asking*** questions (for science) and ***defining*** problems (for engineering)
2. ***Developing*** and ***using*** models
3. ***Planning*** and ***carrying out*** investigations
4. ***Analyzing*** and ***interpreting*** data
5. ***Using*** mathematics and computational thinking
6. ***Constructing*** explanations (for science) and ***designing*** solutions (for engineering)
7. ***Engaging in argument*** from evidence
8. ***Obtaining***, ***evaluating***, and ***communicating*** information

Crosscutting Concepts- This portion of the NGSS incorporates the overarching concepts that have application throughout all learning. These concepts are used to help understand natural phenomena in Science that can then be used to help create solutions to problems through the Engineering Design Model.

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Disciplinary Core Ideas- *in the NGSS, this section gives guidance and more specific ideas of how to teach the concepts. Additionally, there are overarching concepts that guide the teaching and structure of the 4 core ideas with specific ideas and the application of these central concepts into concrete applications.*

Life Science	Physical Science
LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity	PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

Exploring the Next Generation Science Standards: *Understanding the Performance Expectations.*

Performance Expectation-

HS.Interdependent Relationships in Ecosystems

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Students who demonstrate understanding can:

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
[Classification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruptions or sea level rise.]

This is the ***Performance Expectation***. This statement combines the **Science and Engineering Practices**, the Scientific Content from the **Disciplinary Core Ideas** and the Crosscutting Concepts into one statement. This is the basis of what is to be assessed in the lesson.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

If you start looking at the ***Performance Expectation Statement***, you can see that this sentence is a combination of the Science and Engineering Practices, Disciplinary Core Ideas, Crosscutting Concepts. To more fully understand how this has been compiled, I have color coded the different elements so you can see how they fit in the statement.

Standard Statement Numbering-
HS- High School
LS- Life Science
2- Ecosystems, Interactions, Energy and Dynamics

Science and Engineering Practices- Through the use of Scientific method and Engineering practices, the students will practice the skills necessary to learn content.

Disciplinary Core Ideas- This part of the performance statement is the science content that is going to be assessed

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
[Classification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruptions or sea level.

Crosscutting Concepts- This is one of the 7 concepts that are examined throughout the science curriculum. In this case it is stability and change.

Clarification Statement- The final part of the Performance expectation statement is a clarifying example to help teachers and students have an example of the application of the statement

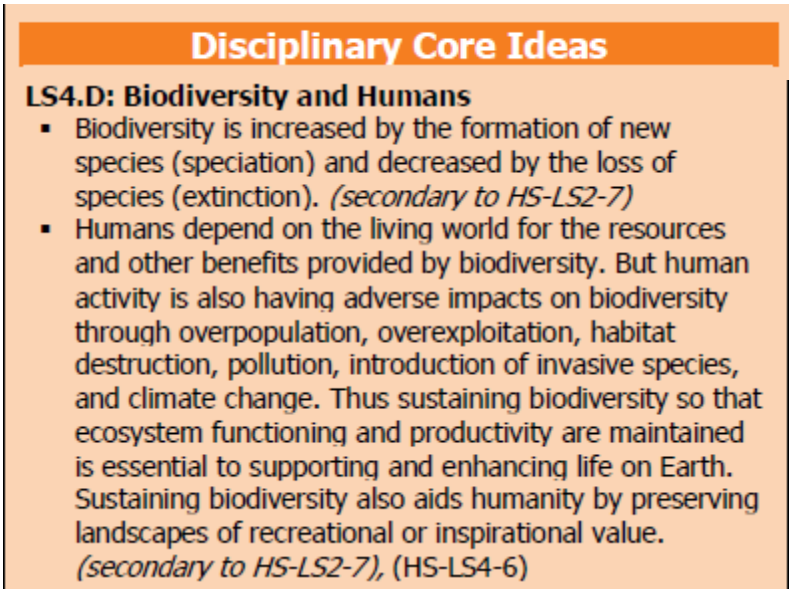
Next Generation Science Standards integrates scientific concepts along with scientific process and engineering principles. Throughout the standards, there are the three categories with descriptions of the possible application of each.

Science and Engineering Practices

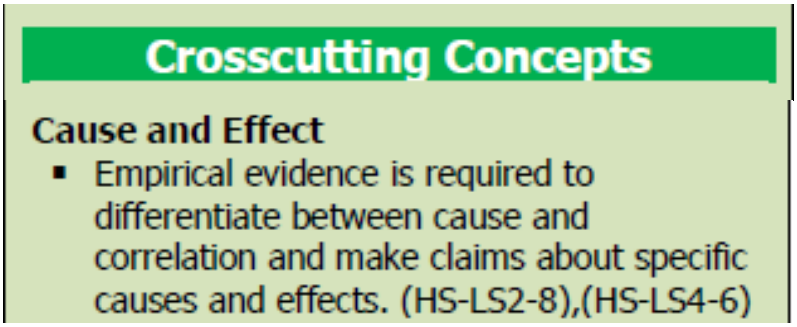
Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)
- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)

This is an example of the Science and Engineering Practices that appear with the Life Science High School content standards. These paragraphs give guidance for the activities in the lesson.



This is an example of the content standard for High School Life Sciences. It gives guidance to what is suggested to be assessed by the learning activity.



This is an example of the cross cutting concept that is associated with the High School Life Science Standard. This statement helps to guide the instructional process as to how this learning activity could be framed.

ELA and Mathematics Common Core Standards Connection:

The last part of the Next Generation Science Standards is the correlation section to the Common Core Standards in English Language Arts and Mathematics. This tool helps Science and Technical Arts Teachers the ease of having the Common Core Standards correlated and listed with the other three parts of the NGSS.

ELA/Literacy-
RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

Example of NGSS related to the EPICS - This is just an example of how the NGSS would relate to one project and one lesson. Each module in the unit would address different standards as the project develops. Of course with the depth of the Next Generation Science Standards, this one Performance indicator would be dissected and would be explored in other lessons throughout the project focusing on different aspects of the standard.

Next Generation Science Standards Components	***EPICS Lesson Application***
Performance Expectation Statement **HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.**	The Performance Expectation is the evaluation statement of the focus of the lesson. We will be using the statement to determine the extent of understanding by the students.
Science and Engineering Practices	***EPICS Lesson Application- Engineering***
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ▪ Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) ▪ Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)	In this lesson the students will be exploring how the EPICS project for the Columbia Park Zoo Otter feeder fulfills the needs of the Otters to have a more naturalistic way of obtaining food in captivity. The students will develop claims, evidence and reasoning why this project will help the Otters live in a more realistic environment.
Disciplinary Core Idea	***EPICS Lesson Application- Life Science***
LS4.D: Biodiversity and Humans ▪ Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) ▪ Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7), (HS-LS4-6)	In this lesson the students will be exploring this standard and how when the otters are in captivity it mimics overpopulation on the species. How does the EPICS project help the otters to function in a more naturalistic way by simulating the predator prey relationship? The students will explore how the new feeder would have to be a natural addition to the exhibit to mimic the natural habitat of the North American River Otter.
Crosscutting Concept	***EPICS Lesson Application- Cause and Effect***
Cause and Effect ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8),(HS-LS4-6)	Students will be exploring how captivity impacts the natural feeding habits of the North American River Otter and how this impact can be minimized by creating a more naturalistic feeding situation within the zoo exhibit.
Common Core ELA with the Technical Subjects	***EPICS Lesson Application to ELA CC***
ELA/Literacy- RST.9-10.8 *Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)*	Because the Common Core ELA and Mathematics have been adopted by most states, it is imperative that these standards also be addressed within the Science and Engineering Curriculum. Because throughout the lesson, the students will be reflecting and defending their understandings with their peers through discussions and artifacts in their notebooks, the student is defending the reasoning why the Otter feeder will positively impact the simulated environment of the exhibit.

In this case, we know that the students will be exploring ecosystems and will need to use higher level thinking skills to evaluate the reasoning and support their findings with evidence.
How does all this fit with Service-Learning and the EPICS program?

Resource:

NSTA Web Seminar- NGSS Crosscutting Concepts: Structure and Function http://learningcenter.nsta.org