twig SCIENCE

A Deep Dive into 3-D Learning

Want to transform your science instruction but don't know where to start?

Well, we've got you covered. Keep reading and we'll guide you through each of the three dimensions of 3-D learning and take a look at how the principles of 3-D learning are applied to Twig Science's Volcano Hunters module which was awarded the High Quality NGSS Design Badge by NextGenScience at WestEd.



The New Way to Teach Science

The fundamental aim of the introduction of 3-D science standards, such as NGSS, was to change science teaching as we knew it. It's a more creative, student-focused, and equitable approach that focuses on teaching students how to engage with scientific concepts through inquiry and investigation — but applying it can be confusing.

The Three Dimensions of the 3-D Science Standards

What are they?

3-D science standards fill in a demand in education that had previously been left unaddressed, prioritizing methodology and blending content with practice. The 3-D science standards focus on developing the habits and skills that scientists and engineers use in everyday life. Rather than simply learning about science — with a focus on rote memorization — students become scientists and engineers, with teachers there to guide them to draw their own conclusions based on evidence and reasoning. The standards provide students with the space and encouragement to question, investigate, and draw their own inferences based on evidence.

The standards center around three overlapping dimensions: **Science and Engineering Practices** (SEPs), **Crosscutting Concepts** (CCCs), and **Disciplinary Core Ideas** (DCIs). SEPs and CCCs are designed to be taught in context, while a focus on a small number of DCIs help students gain a thorough understanding of science disciplines.

Using these three dimensions, students make sense of phenomena and solve problems.



Crosscutting Concepts (CCCs)

CCCs are themes that apply across all science disciplines and can be thought of as the resources that students use to analyze, interpret, and make sense of phenomena.



Patterns
Recognizing patterns is important for many scientific tasks, like classification or analyzing and interpreting data.

Cause and Effect
Understanding connections and finding out why one event might lead to another can help identify the underlying cause of phenomena.

Scale, Proportion, and Quantity
A big part of investigating phenomena involves comparing them using relative scales and describing them using units.

Systems and Systems Models
To make the world easier to investigate, scientists often study smaller units of investigations, or "systems."

Energy and Matter
Observing and modeling flows and cycles — like the flow of water in Earth's atmosphere — helps to understand a system's behavior.

Structure and Function
Identifying the relationships between the shape and properties of natural or human-made systems helps engineers create effective designs and scientists make sense of phenomena.

Stability and Change
Understanding how change occurs in any system helps scientists and engineers describe how that system functions — and how technology can be used to control the changes.

Science & Engineering Practices (SEPs)

SEPs are the core practices that all scientists and engineers use to make sense of phenomena and solve engineering problems. Simply put, they are the things that almost all scientists and engineers do as part of their daily work.

Asking Questions and Defining Problems
Asking questions helps to understand and explain phenomena, and in engineering, to define problems and design solutions.

Developing and Using Models
Models of systems help to explain phenomena that would otherwise be difficult to study, and in engineering, models are used to test designs.

Planning and Carrying out Investigations
Investigations help to understand phenomena and test theories and engineering designs.

Analyzing and Interpreting Data
Analyzing and interpreting data reveals trends, patterns, and relationships.

Using Mathematics and Computational Thinking
Mathematics and computational thinking allow scientists and engineers to present and compare findings or improve designs.



Constructing Explanations and Designing Solutions
Scientific explanations help scientists and engineers describe and predict phenomena and come up with solutions to engineering problems.

Engaging in Argument from Evidence
Scientific argumentation — supported by evidence — is a tool used in science to agree on the best explanation for phenomena and in engineering, to find the best solution to a design problem.

Obtaining, Evaluating, and Communicating Information
Scientists and engineers must be able to communicate — and critique — findings clearly and professionally.

Disciplinary Core Ideas (DCIs)

DCIs represent the four big ideas in STEM and form the foundational knowledge of each discipline and are the dimension most reminiscent of "traditional" science instruction. They are the big ideas that students need to know to be able to understand the world around them.

Life Science
Examine living organisms as part of whole systems and understand how they interact in the biosphere with their environments and other organisms.

Physical Science
Every system and process on Earth is dependent on physical and chemical sub-processes.

Earth and Space Science
The structure, composition, and history of the Universe — as well as Earth's place within it.

Engineering, Technology, and the Application of Science
Engineering design can be used to create new technology in response to problems or to explore new applications of science.



How Does 3-D Science Happen in the Classroom?

Let's take a look at the Twig Science Middle School module Volcano Hunters — awarded the prestigious NGSS Design Badge — to see some of the ways that 3-D science happens in the classroom.

Anchor Phenomenon

In Kathmandu, Bougainville Island, Auckland, and Yogyakarta, people live in the shadow of hills and mountains. Three of these four locations are near the ocean, and three are in similarly rocky areas. Some of the places have experienced devastating volcanic eruptions in the past, while others have managed to find ways to protect themselves.

How can students make sense of this phenomenon using the three dimensions?

Lesson 1 | Session 3 Volcano Life Cycle

In lesson 1, session 3, students **model** a **growing volcano** using a digital interactive — how exciting! They can change the lava viscosity and increase or reduce the amount of **eruptions** to see how that affects the **volcano's** height and width.



It isn't feasible for students to observe real volcanic **changes**, but they can explore these phenomena by using a **model**. They're also hitting NGSS Performance Expectation "**Develop a model** (SEP-2) to describe **the cycling** (CCC-7) of Earth's materials and **the flow of energy that drives the process** (CCC-2).

Lesson 2 | Session 5 In the Path of Mount St. Helens

In lesson 2, session 5, students observe a real **volcano eruption**. By watching a video depicting the changes on Mount St. Helens in the months leading up to its 1980 eruption, they observe how **volcanoes change** before erupting. They then compare and contrast which parts of the mountain changed and think about whether this information can help predict changes in other **volcanoes** before they erupt. They're making observations and asking great questions, but they're also hitting NGSS Performance Expectation "**Analyze and interpret** (SEP-4) **data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects** (CCC-2)."



Lesson 3 | Session 5 A Monitoring Plan

In lesson 3, session 5, students put everything they've learned to the test and become volcanologists! In teams, **they work together** to identify **patterns** in **data** to **assess** which **volcanoes** are high priority and design a volcano monitoring plan to **present to the class**. They give reasoning behind their scores and evaluate other teams' plans. They're taking on the role of real scientists and they're hitting NGSS Performance Expectation "**Analyze and interpret** (SEP-4) **data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects** (CCC-2)."



These are just 3 examples of how easy it can be to bring 3-D science into the classroom. Sometimes, integrating 3-D science can be as simple as encouraging students to generate their own questions about a phenomena or make claims based on something they observed during class — just like how scientists and engineers approach real-world problems.



For an even deeper dive into 3-D Learning, including **podcasts and video guides, visit edu.imaginelearning.com/twig-science-3d-learning**

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