Issue Date: September 25, 2023

Science Proficiency-Based Graduation Hierarchy

Introduction

The exemplar Proficiency-Based Graduation Requirement (PBGR) Hierarchies support equity by providing a cohesive and coordinated vision of student-centered learning across Vermont schools. The hierarchies serve as a foundation for the implementation of standards adopted by the Vermont State Board of Education, Local Comprehensive Assessment Systems, flexible pathways, and personalized learning plans. The Agency of Education recognizes the considerable time and effort that educators and other stakeholders across the state have already put forth developing proficiency-based learning systems and this work is intended to serve as a resource for SU/SDs to consider as they reflect on the key concepts and skills that students should develop within each content area. It is important to note that while there is a separate hierarchy for each disciplinary content area, the hierarchies work together to support student proficiency in those attributes described in a Vermont Portrait of a Graduate (PoG).

Process

The first step in the process of developing PBGR Hierarchies involved the creation of content area PoGs. The Vermont Agency of Education (AOE) did this by reading the Vermont PoG through a content lens, comparing the PoG indicators with national content standards, and identifying those indicators that could best be addressed within that content area (e.g., A Vermont Portrait of a Graduate through the lens of Social Studies). The AOE integrated these content area PoGs, State board-approved national standards, and other research to define what it means to be literate within each disciplinary content area. Each literacy statement was pared down to its essential elements, resulting in one PBGR for each content area. Once the PBGR was developed, the AOE identified the Critical Proficiencies (CPs) that would support the teaching and learning related to that PBGR. The AOE developed Priority Performance Indicators (PPIs) for each CP, based on national standards, research, and input from the field. While the PPIs will be formally assessed to develop evidence of student proficiency, all standards have a place in the curriculum and in student learning. Throughout this process, attention was also given to how transferable skills could be interwoven throughout each PBGR Hierarchy. The construction of these hierarchies was an iterative process, taking on many different stages with educator feedback and internal review being essential components of that process.

Contact: Lisa Bresler, Student Pathways Division,
lisa.bresler@vermont.gov

Proficiency-Based Graduation Hierarchy Development Process

Vermont adopted the Next Generation Science Standards (NGSS) in 2013. Inherent in the NGSS design is a 3-dimensional structure built on disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). The Science PBGR Hierarchy was developed to integrate these 3 dimensions and uphold the expectations put forth by the Vermont Education Quality Standard 2120.5.

Each school shall enable students to engage annually in rigorous, relevant and comprehensive learning opportunities that allow them to demonstrate proficiency in scientific inquiry and content knowledge (including the concepts of life sciences, physical sciences, earth and space sciences, and engineering design).

The overarching statement of the PBGR reflects the goals for our students as they develop the knowledge and skills to become scientifically literate individuals.

The Critical Proficiencies (CPs) are based on the four crosscutting concepts: Structure and Function, Cause and Effect, Energy and Matter, and Systems and System Models. These four CCCs were chosen as they naturally support and integrate the other crosscutting concepts. They provide a strong bridge to the DCIs and the SEPs deemed most valuable for all students to demonstrate proficiency in before graduation. Additionally, the CPs provide a solid foundation on which to develop a cohesive vertical alignment of curriculum that can be met through specific standards and/or across grade levels.

While all performance expectations published in the NGSS are important, the PPIs in the Science PBGR Hierarchy accentuate foundational knowledge and skills that prepare students for post-secondary education and future careers while instilling in them a sense of social responsibility and the ability to be discerning consumers of science. In today's world, it is particularly important to understand the how and why of everyday phenomena such as climate change, how our bodies work, human impacts on the environment, and the interconnectedness of Earth's systems.

The SEPs should be embedded throughout a science curriculum. While some SEPs are included in the PPIs, the breadth of SEPs is not explicitly addressed. The science and engineering practices foster critical thinking, problem-solving skills, creativity, and interdisciplinary learning. To ensure students attain a thorough comprehension of content and its underlying discovery and development processes, active engagement in scientific and engineering practices is essential. Therefore, the integration of SEPs throughout science courses is expected.

Science PBGR

The scientifically literate individual knows how to ask questions investigate everyday phenomena, and construct explanations. They describe, explain, and make predictions related to phenomena. Scientifically literate individuals engage in social and civic discourse using valid scientific evidence to express positions to inform global, national, and local decisions. They evaluate the quality of scientific information based on its source and the methods used to generate it, and revise thinking based on new information.

Critical Proficiency

Structure and Function

Demonstrate that the way an object or organism is shaped or structured determines many of its properties and functions.

Critical Proficiency

Cause and Effect

Use evidence to identify or predict cause and effect relationships for complex natural and human designed systems.

Critical Proficiency

Energy and Matter

Analyze energy and matter flows within, between, and among systems to understand the systems' behaviors.

Critical Proficiency

Systems and Systems Models

Define the boundaries and initial conditions of a system, analyze inputs and outputs, and describe and predict behavior using models.

Priority Performance Indicators

Structure and Function

Matter and Its Interactions: Structure of Matter

Construct and revise an explanation for the outcome of reactions based on the-structure of atoms and molecules and knowledge of chemical properties (e.g., trends in periodic table). (HS-PS1-2)

Waves and Their Applications: Structure of Waves and Their Applications in Technology

Support a claim regarding the relationships among the frequency, wavelength, and speed of waves travelling in various media. Understand how wave behavior is applied in the development of technological devices used to transmit and capture information and energy. (HS-PS4-1; HS-PS4-5)

From Molecules to Organisms: Structure and Function of Organisms

Explain how an organism's structure relates to its function and how components form interacting systems with specific roles in multicellular organisms. (HS-LS1-1; HS-LS1-2)

Priority Performance Indicators

Cause and Effect

Earth's Systems: Connections Between Physical Earth and Evolution

Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (HS-ESS2-7)

Earth's Systems: Interconnectedness of Earth's Spheres

Make an evidence-based claim that one change to Earth's surface or atmosphere can create feedbacks that cause changes to other Earth's systems. (HS-ESS2-2; HS-ESS3-5)

Ecosystems: Interactions, Energy, and Dynamics—Response to Changes in Environment

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. (HS-LS2-6; *HS-LS2-7)*

Biological Evolution: Unity and Diversity—Response to Environmental Conditions

Construct an explanation based on evidence for how natural selection leads to adaptation of populations and evaluate the claims that changes in the environmental conditions may result in changes in the populations of species. (HS-LS4-4; HS-LS4-5)

Priority Performance Indicators

Energy and Matter

Matter and Its Interactions: Law of Conservation of Matter

Investigate the claim that atoms, and therefore mass, are conserved during a chemical reaction. Compare and contrast the changes in atoms involved in a nuclear reaction to those involved in a chemical reaction. (HS-PS1-7; *HS-PS1-8)*

Energy: First Law of Thermodynamics

Provide evidence through the process of investigation that the transfer of energy between components with different energy amounts in a system leads to a state of balance or equilibrium. (HS-PS3-4; *HS-PS3-1)*

Ecosystems: Interactions, Energy, and Dynamics — Cycling of Matter and Energy in Environment

Support claims for the cycling of matter and flow of energy among organisms and/or environments in an ecosystem, a biome, or spheres of the Earth. (HS-LS2-4; HS-LS2-5)

Earth's Systems: Energy and Climate Change

Demonstrate understanding of how variations in the flow of energy into and out of Earth's systems result in changes in climate. (HS-ESS2-4)

Priority Performance Indicators

Systems and Systems Models

Earth and Human Activity: Impact on Earth's Systems

Use a representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (HS-ESS3-6)

Engineering Design: Devising Solutions To Complex Real-World Problems

Model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints, and how those solutions affect interactions within and between systems. (HS-ETS1-4)

Earth and Human Activity: Climate Change

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. (HS-ESS3-5)

BREAKDOWN OF PBGR BY DISCIPLINE:

Physical Science	7
Life Sciences	8
Earth Science	5
ETS	1

VERMONT
AGENCY OF EDUCATION