



Lesson Plans

GOAL

Students will be better able to bridge the past and present through stories of people, ideas, and inventions.

OBJECTIVES

By utilizing these lessons, activities, and discussions:

- students will be prepared to see and discuss the machines at the National Museum of Industrial History
- students will understand what America was like prior to the Industrial Revolution
- students will learn about the impact of steam, electric, and gas power on the way people lived and worked
- students will be introduced to America's debut on the World Stage

THEME

Industrialization

S.T.E.A.M. INITIATIVE

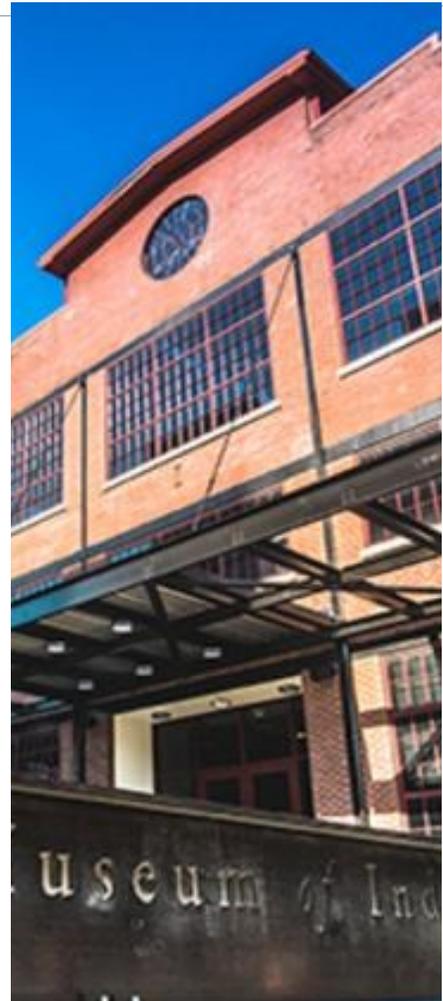
At NMIH we strive to use an interdisciplinary approach to educate our visitors—the general public and school groups alike—about our city's unique history, the region's industrial heritage, and the far-reaching impact of the local innovations, entrepreneurs, and workers.

The following RESOURCES, MATERIAL LIST, ENRICHMENT SECTION, and DISCUSSION GUIDE can be used in any combination to meet the needs of the students and subject being taught in the classroom. It is not necessary to use the pre-lesson prior to your school visit to the National Museum of Industrial History, however, we find that students who are informed about what they will see at the museum are more confident as they interact with the exhibits, have a deeper understanding of the content presented, and are better able to use critical thinking skills to draw conclusions about the machines and objects on display.

AUDIENCE

Bethlehem Area School District 5th graders (2018-2019)

Allentown Area School District 7th graders (2018-2019)



CONTENTS

About the NMIH Lesson Plans...	2
Preindustrial America and the Industrial Revolution	3
Pre Lesson Discussion Guide	5
Pre Lesson Glossary.....	6
Visiting NMIH	7
Post Lesson Activities	9
National and State Standards.....	11





OUR MISSION

The mission of the National Museum of Industrial History, in affiliation with the Smithsonian Institution, is to forge a connection between America's industrial past and the innovations of today by educating the public and inspiring the visionaries of tomorrow.

ABOUT THE NMIH LESSON PLANS

These lessons are designed to introduce students to the American Industrial Revolution, the United States' debut on the world stage in 1876, and the growth of industry in Northeastern Pennsylvania. It is ideal for students studying 5-7th grade American History, regional history, and provides a perfect introduction to the technological, industrial, and cultural changes in American from the mid 19th century to the mid 20th century.

Standards that meet the 5th-12th grade National Educational Guidelines and additional Pennsylvania-specific standards that can be used for secondary and middle-level learners can be found at the end of the lesson.

We created these lessons so that educators can best utilize their time and experience at the museum. At NMIH we strive to use an interdisciplinary approach to educate our visitors, the general public and school groups alike. Our city's unique history, the region's industrial heritage, and the far-reaching impact of the local innovations, entrepreneurs, and workers are all central to our mission.

While the pre and post lessons are optional, we have found that students who have a familiarity with the concepts and artifacts in the exhibits, as well as those who revisit these themes after the visit the museum, gain a greater understanding of the content taught and are more likely to be able to apply what they have learned to future experiences.

We hope you find value in using these lesson and in your visit to the National Museum of Industrial History!

Kitsa Behringer
NMIH Education and Program Coordinator

PREINDUSTRIAL AMERICA AND THE INDUSTRIAL REVOLUTION

ENRICHMENT

Here you will find a brief introduction to life in America prior to the American Industrial Revolution, become familiar with the people who lived and worked in the major industries of this time period, and receive a basic overview of the 1876 Centennial Exposition.

The purpose of the enrichment section is to present a summary of how life and work changed with the implementation of machine power.

It is helpful for students to be familiar with what life, labor, and society was like in the 19th century and how that compares/contrasts to their daily lives.



Pre-Industrial Revolution: Man-power, Horse-power, Water-power, and Cottage Industries

Before the Industrial Revolution made its way to the American shores, the muscle power of man and animal was used to do the necessary work of survival. People grew their own food, raised their own animals, made their own clothes from raw fibers, built their own homes, furniture and tools, and dipped their own candles to light their homes.

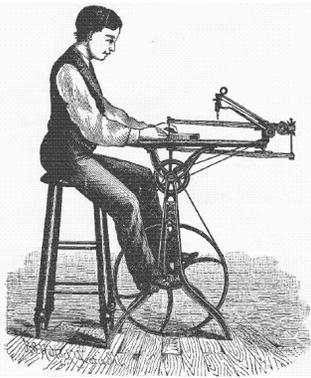
All members of the family were needed to accomplish the work of providing food and goods. When families were fortunate enough to produce more than they required, the excess could be sold or traded for other items. Soon cottage industries were established in which individuals mass produced common household goods—baskets, lace, fabric for clothes—in their homes.

America was an agrarian outpost which meant that most people made their living as farmers or lived in farming communities. Animals—such as horses and oxen—were used to complete the most strenuous, monotonous, or time-consuming jobs. For example, animals were frequently used to plow fields, thresh wheat, and grind grain. Water Mills were also common in areas where flowing water was present.

It was rare for people to travel beyond their own villages, because travel was slow and required covering the distance on foot, horse, or animal-drawn wagon. It is important to remember that for most of human history ideas, information, and people only traveled as fast as a horse!

The Beginning of the Industrial Revolution: Pedal Powered Machines

While treadle powered machines existed for centuries, they were relatively inefficient. Their compact design and hands-free feature were important, but couldn't compare to the rotary motion of pedal powered machines invented in the 1870's. Pedal powered machines were highly effective at transforming human energy into work. The major advantage of pedals was that it used the larger and more powerful leg muscles in a continuous motion.



From 1876 onwards, a system of gears, wheels, belts, and pedals were attached to tools like lathes, saws, grinders, shapers, tool sharpeners and to boring, drilling and cutting machines. These cast iron machines were intended for small workshops and households without electricity or steam power.

Harnessing Power: Engines

Stationary pedal powered machines were used through the turn of the 20th century, but the prevalence of powerful steam engines and the arrival of cheap electricity and fossil fuels led to their decline.

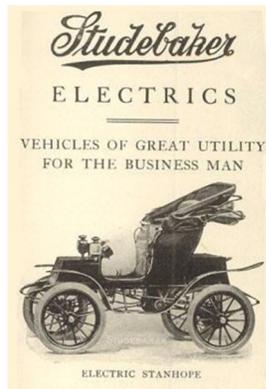
An engine is a machine that converts energy into a mechanical force that can turn pistons and wheels, and its essential purpose is to provide power. In the case of steam engines, the source of the mechanical power is compressed steam. Steam is created when water is heated within a boiler; the ability of the steam engine to perform work is dependent on the steam pressure supplied by the boiler. This is an example of external combustion.

Using steam to produce mechanical motion goes back over 2,000 years, but early devices were not practical for performing sustained work. Thomas Newcomen invented the first true steam engine in 1712 and was used for pumping water out of mines. In 1781 James Watt improved Newcomen's design and patented a steam engine that produced

continued rotary motion and generated 10 horsepower (hp). This enabled a wide range of manufacturing machinery-- such as spinning mules and power looms-- to be powered. These engines, although large for the amount of power they could produce, could be moved and set up anywhere that water and coal or wood fuel could be obtained. In 1876, the Centennial Exposition held in Philadelphia, PA., exhibited the Frick farm engine which carried the "Eclipse" trademark for the first time. The Centennial Commission was impressed with the engine, because of its ability to generate the most power with the least amount of coal and water consumed. It received the highest award in its class. In less than a decade (1883), engines that could provide 10,000 hp (think drag race car) were a reality.



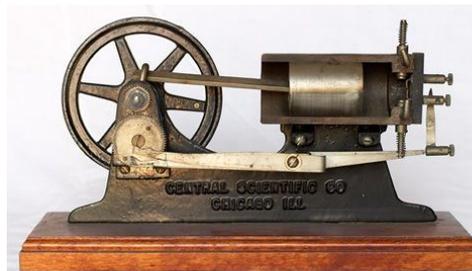
Often overlooked is the development of electric motors and internal combustion engines which were concurrent with the improvements to steam power. Electric



motors have a long history going back to the early 19th century and the internal combustion engine appears as early as the late 18th century.

While steam engines were a driving force behind the American Industrial Revolution, electric motors and internal combustion

engines helped usher in an era of productivity never before seen.



Internal Combustion Model, 1880

The American Industrial Revolution

The Industrial Revolution began in Britain in the mid-18th century, but did not make its way to America until roughly 50 years later. Even then, the transition from an agrarian society to an industrialized nation took more than a century. America lagged behind Europe for a number of reasons: the abundance of wild uncultivated land, the smaller population size, and the limited income for expensive investments in machine production. Nevertheless, once American independence and ingenuity took root productivity, efficiency, and convenience followed.

Samuel Slater is often given credit for bringing the Industrial Revolution to America. With pirated technology, Slater opened the first industrial mill and factory town in 1790. His mill spun cotton thread into yarn faster than ever before.

The economic and social impact of the American Industrial Revolution required several elements; chief among these was organizational strategies to increase productivity. An outgrowth of the small-scale cottage industries was the “outwork system”. This was a method of employing individuals to produce small parts for a larger manufacturing process in their own homes. Over time and out of necessity, the “factory system”—where work is performed on a large scale in a single location—replaced the outwork system.

Despite a higher standard of living and the increased life expectancy due to improved medical treatments, the Industrial Revolution also had an ugly side. Wage labor exploited workers, working conditions often included long days and a dangerous work environment. Workers protested until labor laws were established guaranteeing better pay and safer working conditions.

“The Industrial Revolution was another of those extraordinary jumps forward in the story of civilization.”

-Stephen Gardiner

DISCUSSION GUIDE

The following is a list of prompts to be used in class or as a homework assignment in an effort to engage the students to consider the impact of the American Industrial Revolution on individuals, a society, and the nation.

What did the use of steam powered machines mean to the people of the 1800s? How did it impact their lives? Was the impact all good? All bad? A little of both?

What problems were solved by the Industrial Revolution?

What conflicts were created because of the Industrial Revolution?

How did the Industrial Revolution impact my life?

GLOSSARY

Agrarian society- Agricultural society, any society whose economy is based on producing crops

Cottage industry-a business or manufacturing activity carried out in a person's home

Entrepreneur- a person who organizes and operates a business, taking greater financial risk to do so

Innovation- a new invention or way of doing something

Industrial Revolution- a time of far-reaching-change when the large scale production of goods began

Inventor- the creator of a particular process or device

Manufacture- to make products on a large scale by machine

Mass production- to make a large amount of products of the same quality on an assembly lines

Goods- things for sale

Factory- a place where goods are made

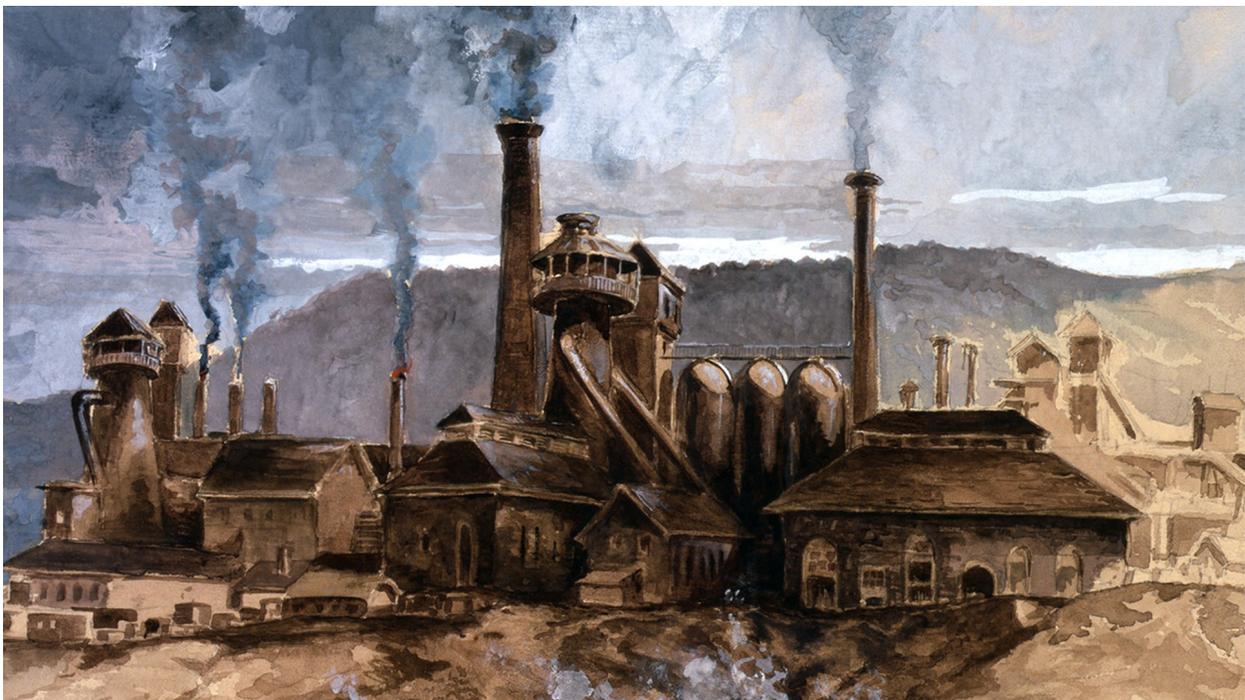
Profit- to make money form business or investments

Rural- in the country

Tenement- a substandard multi-family dwelling in the city center

Urban- in the city

Working Class- people who work in factories and in jobs using their hands

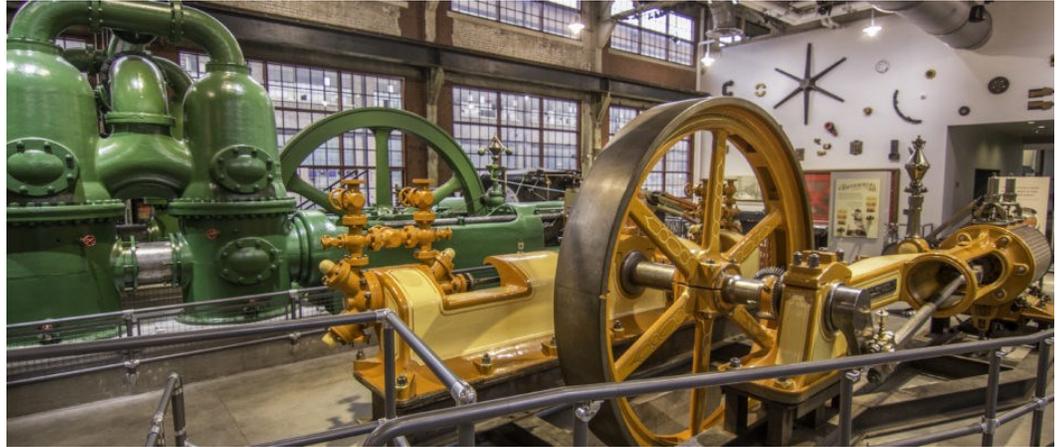


VISITING NMIH: AN OVERVIEW

Centennial Gallery

This first gallery tells the story of American ingenuity on display at the 1876 Centennial

Exposition. It also formally introduces the museum's main themes—innovation, transformation, and scale. The exhibit



areas in the gallery parallel the main impression of visitors to the Centennial as follows:

Power. The innovative machines showcased at the Centennial presented an impressive display of power and potential uses for these new power sources.

Natural Resources. America had vast untapped natural resources, which gave the country an advantage over others whose resources had been largely depleted.

Production Capacity. Mass-production became possible through machines making products initially made through labor and time intensive work, or parts for new machines.

Innovation. New inventions and patents led to technology battles as well as improvements on existing inventions.

Voices from the Centennial. The Centennial both showcased the growing diversity in America as well as the challenges presented by the prejudices of the era.

Iron and Steel Galleries

The series of galleries collectively tell the story of local iron and steel manufacturing. Iron and steel were essential building blocks of the American Industrial Revolution and the bedrock of modern, industrial America as it rose to become a world power. These galleries feature stories of transporting, defending, and building America. It also provides background context for how the local Lehigh Valley, with its natural resources and its industrial boom, became a national icon for industry.

Major themes include:

Global Reach. This exhibit area features a interactive map that interprets Bethlehem Steel's global reach and influence.

Steel Fabrication. The story of steel fabrication is told through a series of Bethlehem Steel models, a Steam Hammer, a ladle for the molten steel, and an interactive with a series of common steel products.

Transporting. Iron and steel were essential to the transportation of goods, people, and ideas. The Bethlehem Iron Company's rail production, the introduction of the Bessemer process, and the three high rail mill built and improved the rail system in America. It likewise revolutionized the nation's vast transportation network of automobiles, shipping, and aviation.

Building. This portion of the exhibit tells the story of urban construction in America; how the innovation of the wide flanged beams enabled architects to design taller, more stable buildings which led to the city skylines that define urban America.

Voices of Steel. Who worked in the local iron and steel industry? The Lehigh Valley saw a huge demand for laborers when industrial growth accelerated, and when industry grew so did immigration. Working conditions, the role of management, scientists, inventors, and entrepreneurs are told through an interactive audio station.

Defending. The global impact of Bethlehem Steel's massive military production during the major wars of the 19th and 20th century are presented at the conclusion of the exhibit.



Silk Gallery

This gallery tells the story of silk and the hard work behind this extraordinary product, including how it became more broadly available with industrialized production, and how new technologies made it possible for unskilled workers to play an important role. It also answers the question, why and how the silk industry in the Lehigh Valley grew to national importance.

Silk Fabrication. From the natural resource — worms— to the finished woven damask silk, the galleries hands-on learning station allows visitors to discover the process of making silk.

Lehigh Valley Silk. Attracted by the untapped and unskilled labor force provided by the wives and children of the steel workers, the nations silk industry established roots in the Lehigh Valley.



Voices of Silk. This exhibit area tells the story of working conditions and life in the silk mills, including women's and children's significant roles.

Social Reform. Take a picture with kids on strike as you learn about activism and social reform in the silk industry. Change began with women who took a leading role in fighting for the rights and welfare of the working class .

Innovation. This exhibit also tells the story of the innovative Jacquard process, which enabled textile designs to be codified for mass-production.

Uses of silk. The final exhibit area highlights silk's strength and range of uses, including personal and domestic products, as well as military uses, such as parachutes.

INNOVATION YESTERDAY, TODAY, AND TOMORROW

A visit to the National Museum of Industrial History is a great way to expose your students to the humanities research process. In this post-visit lesson, several activities are presented that will invite your students to recall what they learned during the tour, apply that knowledge to a project or assignment, and create a memorable educational opportunity.

Activity 1

Consider designing a project-based assessment in which the students investigate the various industries of the American Industrial Revolution, and determine which industry they believe was the most important to the growth of the United States. If students are hesitant to choose their own industries, the class might be divided into groups, and asked to become the experts on transportation, early iron and steel manufacturing, textile production, changes in communication, etc.

Activity 2

Have students apply old technology in a new way. Begin by reminding students about the power-loom they saw at The National Museum of Industrial History. It was invented by Joseph Marie Jacquard and could be operated with a series of punch cards indicating each line of a pattern. This system was later adapted by IBM for early computing, and continued to be used as late as the 1980's.

Have students brainstorm about potential new uses for the technology in their own life. In what ways might the items they take for granted— phones, cameras, and wireless power— be used for different applications in the near future? Dreaming can be educational too!

Activity 3

Have students review what they learned about the 1876 Centennial Exposition. Remind them that the Exposition was a very large exhibit featuring the creative and the practical inventions of American individuals and businesses.

Have the students make a list of the inventions they recognize/use/appreciate in their own lives. It may be necessary to facilitate a brainstorming session to create a list of the many inventions we use, but take for granted on a daily basis (i.e. toothbrushes, toaster oven, bicycle, etc.)

Invite students to create their own exhibit of modern inventions. What would you include? Why? Provide a floor plan with multiple galleries and have students group their selected inventions by theme or use.

DISCUSSION GUIDE

The following is a list of prompts to be used in class or as a homework assignment in an effort to engage the students to consider the impact of inventions/inventors on individuals, a society, and the nation.

In your opinion, what invention (which inventor) made the biggest impact on your life? For your country? In the world?

There is no wrong answer. Explain your choice.

What invention can you not live without? Now imagine life without this invention. What is life like without this invention? What did people use before this invention existed?

Do you think everything that could be invented already has been invented? What would you like to see invented? What problem does it solve? How would this invention change the way we live? Does it have any negative consequences?

Discuss the following concept: *Culture of Innovation*

A culture of innovation is one in which businesses recognize creativity, imagination, and original thinking as valuable resources.

Historical Context:



This is John Fritz. He was an American pioneer of iron and steel technology who has been referred to as the "Father of the U.S. Steel Industry". He was the General Superintendent and Chief Engineer of the Bethlehem Iron Works (which became the Bethlehem Steel) until he was 70 years old.

This photograph is from John Fritz's 80th Birthday Party. In attendance were some of the great inventors, entrepreneurs, and business men of the time. Some of his biggest competitors were also invited. A culture of innovation is one in which great minds seek out the ideas and advice of other great minds to find solutions to common problems. When great minds work together, they can often create solutions that they would not have been discovered on their own. John Fritz and Andrew Carnegie were competitors in the Steel Industry, but they shared "recipes" for making better steel and America benefitted.

NATIONAL STANDARDS

History *and* Social Studies

NSS-USH.5-12.6: The Development of the Industrial United States.

The exhibits at the National Museum of Industrial History are the perfect tools to use when educating students about America's industrial roots. Our hands-on learning stations, exhibit interactives, and machinery collection place history in the room with students.

NSS-WH.5-12.7: Era 7: An Age of Revolutions.

The National Museum of Industrial History acts as a centerpiece in any world history curriculum. Our focus on the men and women who made American industry possible allow students to see the cultural and technological revolutions in the Age of Invention

Arts *and* Communications

NL-ENG.K-12.9: Developing Research Skills.

A visit to the National Museum of Industrial History is an excellent way to introduce students to the research process. Our well-trained and knowledgeable docents can provide a wealth of information beyond the text panels for inquisitive students looking to do independent research.

NA-VA.5-8.6: Making Connections Between Visual Arts and Other Disciplines.

The exhibits at Machinery Hall during the 1876 Centennial Exposition were considered art as much as they were seen as technology. Many famous artists attended and wondered at the machines of tomorrow. The National Museum of Industrial History provides an opportunity for students to do the same while they consider the impact technology has on aesthetics and vice versa.

Math *and* Science

NT.K-12.2: Social, Ethical, and Human Issue of Technology.

The exhibits at the National Museum of Industrial History put the human implications of technology on full display. Here, students get to explore the role of inventors, entrepreneurs, and workers when considering technological advancements that impacted the growth of industry. Understanding the impact of technology on our past is important to when determining how technology will change the future.

NS.5-8.5: Science and Technology.

Students in engineering or physics classrooms have the opportunity to see the principles of basic mechanics in motion. The National Museum of Industrial History provides an opportunity for students to see the impact of the applied sciences in the world around them through machined models and artifacts from the museum's collection.

PENNSYLVANIA STANDARDS

The following is a list of state standards met by utilizing the pre and post lessons as well as participating in a visit to the National Museum of Industrial History.

History

Standard - 8.1.5.A

Identify and explain the influences of economic features on continuity and change over time.

Standard - 8.1.5.B

Classify and analyze fact and opinion from multiple points of view, and secondary sources as related to historical events.

Standard - 8.1.U.A

Evaluate patterns of continuity and change over time, applying context of events.

Arts and Humanities

Standard - 9.1.5.K

Apply traditional and contemporary technology in furthering knowledge and understanding in the humanities.

Business and Communication

Standard - 15.2.5.O

Explain the importance of accepting diverse populations.

Standard - 15.3.5.H

Present information as an individual or in a small group.

Reference English Language Arts CC.1.5.5.A, CC.1.5.5.C, CC.1.5.5.D, CC.1.5.5.E

Standard - 15.7.5.K

Explain how the responsible use of natural resources benefits the individual; the family; and local, national, and global communities.