

STEM-gineers

TEACHER'S GUIDE

Science, technology, engineering, and mathematics are essential subjects in which students can build skills for success in our always-evolving society. Problem-solving skills, grit, and communication are some of the many skills that students can foster when working on STEM projects. *STEM-gineers* is a unique series that allows students to read about an innovator and their idea, discovery, or invention—then complete a project that helps illustrate and flesh out the concept. Readers will be inspired by the innovators, and are encouraged to make connections across disciplines.

The *STEM-gineers* Teacher's Guide extends on these concepts and encourages students to make connections and build skills. Students will showcase their knowledge of the information in the books by making a class-created informational booklet; make connections between the innovators across the series by exploring character traits; and complete projects while making strong observations and oral presentations. The lessons require students to use strong communication skills—both speaking and listening—and work collaboratively with peers. Students will build on their problem-solving, perseverance, and communication skills by examining STEM concepts and completing STEM projects.

The lessons in this guide are tailored for grades 4 to 6 and encourage exploration and inquiry. They allow students to develop skills working with different materials and media. The lessons in this guide have been created in a sequential order that scaffolds understanding. They can be taught in a sequential order or adapted to teach as single lessons. Reproducible worksheets and assessment tools accompany each lesson.

The titles in *STEM-gineers* include:

Experts in Engineering

Masters of Math

Scholars of Science

Trailblazers of Technology



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PACING CHART AND VOCABULARY

Lesson 1: Innovators and Innovations	1-2 class periods*	adapt battery beam design discovery DNA double helix evolution fractal shapes innovation innovator invention iron lock refract steel suspension bridge tectonic plates
Lesson 2: Character Traits of an Innovator	2-3 class periods	character trait collaborator communication courage creative critical thinker optimist perseverance problem solver self-discipline
Lesson 3: Observation Exploration!	1 class period, approximately 15 minutes on 2 following days, and 1 class period for wrap-up.	data microbe (germ) observation observe vaccination
Lesson 4: Do It Yourself—Culminating Project	3 class periods	Learned vocabulary throughout previous three lessons

* 1 class period = 40-60 minutes

ACCOMMODATION STRATEGIES

Accommodations provide equal access to learning and equal opportunity to demonstrate what is learned. Accommodations allow a student access to the subject or course without any changes to the knowledge and skills the student is expected to demonstrate.

Educators are encouraged to adapt the instructional approach, activities, and assessments included in this guide to best meet the diverse interests, needs, and abilities of their students.

Possible accommodations may include:

Instructional Strategies

- Break tasks into parts with accompanying time lines
- Provide extra time for processing of oral information
- Pair oral instructions with visual ones (writing or symbols)
- Pre-teach new vocabulary and regularly review previously taught vocabulary
- Provide model of completed work
- Frequently check with the student to get him/her started
- Provide oral and visual instructions and examples
- Provide a checklist or tasks for the student

Environmental Strategies

- Proximity to teacher
- Strategic seating
- Flexible or mixed-ability grouping
- Provide an alternative setting for learning that is free from visual and auditory distractions

Assessment Strategies

- Build in extra time to allow students to process questions asked and answers given
- Provide written instructions and rubrics for assignments
- Offer a choice of assessment activities so that the student can choose one suited to their strengths
- Space out or extend assignments to prevent student feeling overwhelmed
- Reduce the number of tasks used to assess skill or concept
- Allow students to use assistive devices or technology

LESSON 1

Innovators and Innovations

Curriculum Correlations

Ontario Language Arts

Grade 4-6 Reading
1.3, 1.4

Grade 4-6 Writing
1.5, 1.6

Common Core State Standards

Reading Informational Text Standards: Grades 4-6
CCSS.ELA-LITERACY.RI.4-6.2
CCSS.ELA-LITERACY.RI.4-6.4

Writing Standards: Grades 4-6
CCSS.ELA-LITERACY.W.4-6.2
CCSS.ELA-LITERACY.W.4-6.2.A
CCSS.ELA-LITERACY.W.4-6.2.B
CCSS.ELA-LITERACY.W.4-6.2.D
CCSS.ELA-LITERACY.W.4-6.4
CCSS.ELA-LITERACY.W.4-6.7

Materials

- *STEM-gineers* titles
- Devices with Internet access
- *Innovator Matching Activity Sheet*
- *Innovator Matching Activity Answer Key*
- *Innovator/innovation slips of paper, cut out*
- *5 W's Booklet Sheet*
- *5 W's Checklist*

Objectives

Students will be able to:

- Identify innovators by the idea, discovery, or innovation that they are known for.
- Write a page in a classroom booklet that identifies key information about one innovator.

Setting the Stage

Prior to this lesson, read the four *STEM-gineers* titles as a class, or have students browse the books themselves.

- Can have students browse all four books in groups. Each book can have its own station in the classroom, and students can rotate between the sections. At each section, they browse through the title and read sections or all of it together.

Have a discussion about students' thoughts about the series. Ask students:

- What stands out to you after reading the books in the *STEM-gineers* series?
- Which innovations, designs, discoveries, or ideas had you heard of already? Which do you use every day? Which innovations did you learn about for the first time?
- Which innovators inspired you? Why?

Split students into pairs and hand them the *Innovator Matching Activity Sheet*, and a set of innovator/innovation slips of paper, cut out. Explain that each pair will match the name of the innovator with the innovation, design, discovery, or idea they are known for. They will glue the slips of paper in their proper places on their *Innovator Matching Activity Sheet*.

- Let students know that before they use glue, they should place the slips of paper in the spots they think they should go.

Give students 10 to 15 minutes to complete their worksheets. When they are finished, take up the worksheet as a class. Ensure that the matches are correct.

Create a master table on an anchor chart for students to refer to throughout the lesson and in future lessons.

* In this lesson, 14 innovators were chosen for the relative complexity of their innovations, and for the accessibility of the accompanying project in the *STEM-gineers* series. Teacher can choose 15 innovators that fit class ability and interest, if desired.

Activity

Tell students that together, we will create a class booklet that gives “need to know” information about each innovator and what they are known for.

Place the names of each innovator in a hat. Each innovator will appear in the hat twice, so two students will create their page for each innovator.

Have students pick a name from the hat. Each student will fill in the *5 W's Booklet Sheet* for their innovator. They will use the appropriate *STEM-gineers* book as well as devices for any additional research.

Extensions

- Students can create a time line of their innovator’s life, including at least five events on the time line.
- Create a class time line that places each of the innovators’ inventions or discoveries in chronological order. Examine the progression over time.

Wrap-Up

Have each student hand in their worksheet when they’ve completed it. Scan the worksheets and put them together in a Google doc., on a class blog, or on another platform. This will be a virtual booklet that contains information on all of the innovators. Students can refer to the booklet in future lessons.

Have a class discussion to wrap up information. Ask students to share something that stood out to them about their innovator.

Assessment

Assess the *5 W's Booklet Sheet* using the *5 W's Checklist*.

Name: _____

Date: _____

Innovator Matching Activity Answer Key

Innovator	Known for...
Augustin-Jean Fresnel	Invented a lens that made lighthouse beams four times brighter, so that sailors could see them 19 miles (30 km) away.
Augustin-Jean Fresnel	Designed the Brooklyn Bridge, the first suspension bridge that used strong, steel wires. His bridge is one of the longest roadway bridges in the United States.
Gustave Eiffel	Designed and constructed a lightweight, iron tower that was the tallest in the world at the time it was built—the famous Eiffel Tower.
John Frank Stevens	Designed the Panama Canal with locks and lakes, which let ships safely and easily pass through Central America.
Ibn al-Haytham	Discovered that light travels in straight lines and can refract, or bend, as it passes from air into water.
Palmer Cosslett Putnam	Designed the first wind turbine that was able to generate more than 1 million watts of power.
Charles Darwin	Discovered and developed the ideas of evolution and natural selection. He found that animals adapt to their surroundings over time and pass the strongest traits to their young—causing the animal species to evolve over time.
Edwin Hubble	Used a telescope to discover faraway galaxies that are moving away from us, proving that the universe is getting bigger.
Alfred Wegener	Discovered the tectonic plates that make up Earth's crust and proposed that they were moving, which is what caused the form of Earth's continents today.
Eadweard Muybridge	Produced some of the earliest movies by taking a series of photographs of a moving horse, then playing the photographs in sequence to create a short movie of a horse galloping.
Alessandro Volta	Invented the first battery, which he named a voltaic pile, out of zinc, copper, and cloth soaked in salt water
Ada Lovelace	Wrote the first ever computer program. The program helped a machine make, or compute, calculations—the first computer.
Benoit Mandelbrot	One of the first mathematicians to draw fractal shapes (shapes made up of mathematical formulas) to create beautiful images.
Rosalind Franklin	Made the first breakthrough in the discovery of the structure of DNA by taking an X-ray that showed its double helix form.

Name: _____ Date: _____

5 W's Booklet Sheet

After choosing your innovator, answer the following questions using the books from the *STEM-gineers* series.

WHO Who is the innovator in question? Add 2-4 relevant details and/or interesting facts from your research here.	
WHAT What is the innovator's discovery, innovation, idea, breakthrough, etc?	WHEN When did the innovator make the breakthrough? When did others start to acknowledge/appreciate their discovery?
WHERE Where was the innovator born? Where did they make their breakthrough? Where is the idea being used?	WHY Why is this research significant? Why is it relevant in today's world?

Student name: _____

Date: _____

5 W's Checklist

Criteria	YES	NO
Included name of innovator		
Added 2-4 relevant details/interesting facts		
Explained the innovator's breakthrough		
Identified when the breakthrough was developed		
Acknowledged when others acknowledge/appreciate the discovery		
Correctly identified where the innovator was born		
Identified where the breakthrough was made		
Identified where the idea is being used		
Explained the research's significance		
Described how the breakthrough is relevant in today's world		
Writing is clear and appropriate for audience		

Additional comments:

LESSON 2

Character Traits of an Innovator

Curriculum Correlations

Ontario Language Arts

Grades 4-6 Media Literacy

1.2, 1.3, 3.4

Grades 4-6 Writing

1.2, 1.3, 1.4, 3.7

Common Core State Standards

Grades 4-6 Writing

CCSS.ELA-LITERACY.W.4-6.6

CCSS.ELA-LITERACY.W.4-6.2.D

CCSS.ELA-LITERACY.W.4-6.2.B

Materials

- Devices with Internet access
 - Students will create wordles (wordle.net) and a picture web using clipart.
- Poster board
- Question page
- Glue
- Printer
- Projection device for video
- Chart paper
- Markers
- Sticky notes
- White board or chalk board
- *Traits of an Innovator Assessment Page*
- *Traits of an Innovator Poster Assignment Sheet*

Objectives

Students will be able to:

- Identify and describe character traits of innovators.
- Make connections between character traits and innovations.
- Use media to represent the character traits of one innovator.

Setting the Stage

Engage students' interest with a video about innovations and the people who sparked them. This short video shows Walter Isaacson, author of *The Innovators*, speaking about some of the main character traits that he feels are shared by most innovators.

<https://www.businessinsider.com/traits-innovator-walter-isaacson-steve-jobs-2015-3>

Hold class discussion about video and the innovators they read about in the *STEM-gineers* series. Ask students:

- How do people make discoveries and design amazing buildings and structures? Where does it come from?

Explain to students that all innovations begin with an innovator who has what it takes to tackle a problem or challenge. All designers, thinkers, and researchers have character traits in common.

- Ask students to identify some of the character traits that they feel the innovators they have read about share.
 - ▶ Give students sticky notes to brainstorm thoughts. Have them put the notes on the white board to share their answers. Duplicates are welcome and encouraged.
- When each student has placed at least one note on the white board, view the board and look for the most common words that come up. Possible answers can include:
 - ▶ Perseverance
 - ▶ Courage (able to go against the norms of their time)
 - ▶ Communication
 - ▶ Self-discipline
 - ▶ Creative
 - ▶ Problem solver
 - ▶ Optimist
 - ▶ Critical thinker
 - ▶ Collaborator
 - ▶ Big thinker (connecting different ideas across disciplines)

Activity

Come to a class consensus on 5 or 6 main character traits that they feel innovators hold. Write them on the white board.

Lay pieces of chart paper around the classroom—one per trait from the list on the white board. Write the trait at the top of the chart paper and use black marker to split the rest of the paper into 5 or 6 sections.

Split students into groups of 4 or 5. Each group gets a different colored marker and will begin at a different piece of chart paper. They will create their own definition for the character trait on their chart paper and, starting at the bottom section, write the definition in marker on the paper. When they are finished their definition, they need to fold the section up so the next group cannot see their definition. This ensures that each group creates an authentic definition and does not replicate the ideas previous groups wrote.

Rotate around the classroom this way until all groups have written definitions for all of the traits. You now have an anchor chart of student-generated definitions for each character trait.

Post the anchor charts at the front of the classroom and go through the definitions. Invite each group to read their definition (designated by their color marker). Invite discussion by asking students:

- What similarities do you see in the definitions for this character trait?
- Did any definitions bring up something new? Something unexpected or surprising? What was that, and why did it surprise you?

Leave the anchor charts on a wall in the classroom for students to refer to in the second part of the lesson.

Activity #2

Explain to students that they will create a poster that represents the character traits held by an innovator of their choice.

Each student must choose an innovator from the *STEM-gineers* series. They can use the booklet created in Lesson 1 to spark ideas, or flip through the books to get ideas. Duplication is okay.

Review the criteria for assessment with students. Ask them to read the Level 3 and Level 4 expectations to themselves. Then, review them as a class. Be clear that their poster should convey a message about the innovator and the traits they possess. Their written answer should be easy to understand, use appropriate vocabulary, and be catered to their audience of peers.

When students have chosen their innovator, they can follow the steps on the *Traits of an Innovator Project Sheet* to create their poster.

Extensions

- Have students write a narrative diary entry from the perspective of the innovator they chose for their poster. Their diary entry should be from the day the innovator made or finished their innovation. The entry needs to clearly display how the innovator used one of their character traits to complete their innovation.

Wrap-Up

Hold a gallery walk in which students view the posters. Give students sticky notes to write feedback to their peers about their posters.

Feedback should address:

- Clarity of the message
- Connections made in the answer
- Visual appeal of the poster.

Provide sentence starters for students to use for their feedback, such as:

- I like how you _____
- I wish you _____
- I was impressed by _____
- _____ caught my eye.

Let students retrieve their posters and read the sticky notes. Have a class discussion in which students reflect on the project.

- What might they change if they were to review their poster?
- What traits do they think are the most useful?
- What traits do they display, or have seen their classmates display?

Assessment

Assess participation in group component of lesson using anecdotal notes. Use the *Traits of an Innovator Assessment Page* to assess both the media components of the poster and the question that addresses their understanding of content. Let students know that they are being assessed on both portions.

Name: _____

Date: _____

Traits of an Innovator Poster Assignment

1. Choose an innovator and read about their innovation, discovery, or idea.
2. Choose 5 or more character traits that describe the innovator. Use the books, the class anchor charts, and the Internet to help you. Create a wordle of the character traits on www.wordle.net
3. Create a picture web using clipart. Find the clipart pictures on Google. The picture in the center represents the innovation. The four other pictures represent the 4 main character traits it took for the innovator to succeed.
4. Answer the question at the bottom of the poster. Write your answer on a separate sheet of paper and glue it to the bottom of your poster.

Arrange your poster so it looks like the one below:

INNOVATOR NAME

WORDLE of character traits

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graph TD; A([Name of Innovation]) --- B([Picture of Character Trait 1]); A --- C([Picture of Character Trait 2]); A --- D([Picture of Character Trait 3]); A --- E([Picture of Character Trait 4]);
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Choose one trait and explain how it helped the innovator to succeed.

Name: _____ Date: _____

Traits of an Innovator Assessment Page

Content				
Criteria	Level 1	Level 2	Level 3	Level 4
Connection between trait and innovation	Connection between trait and innovation unclear.	Connection between trait and innovation can be established, but is somewhat unclear.	Mostly clear connection between trait and innovation is made.	Clear and insightful connection between trait and innovation is made.
Clarity and purpose of writing	Writing is difficult to understand and is not appropriate for purpose and audience.	Writing is somewhat clear and appropriate for purpose and audience.	Writing is clear and mostly appropriate for purpose and audience.	Writing is exceptionally clear and catered for purpose and audience.

Media				
Criteria	Level 1	Level 2	Level 3	Level 4
Media elements included	Uses 1 or no media techniques (wordle, picture map) with limited accuracy and command.	Uses 1 or 2 different media techniques (wordle, picture map) with some accuracy and command.	Correctly uses 2 different media techniques (wordle, picture map) with good command.	Showing exceptional understanding and command, uses 2 different media techniques (wordle, picture map).
Message clearly communicated	Media text does not send a discernable message about character traits and their relationship to innovations.	Media text sends a somewhat clear message, overt or implied, about character traits and their relationship to innovations.	Media text sends a clear message, overt or implied, about character traits and their relationship to innovations.	Media text sends clear messages, both overt and implied, about character traits and their relationship to innovations.

Comments: _____

LESSON 3

Observation Exploration!

Curriculum Correlations

Ontario Language Arts

Grades 4-6 Writing
2.5, 3.3, 3.5

Next Generation Science Standards

Grade 5: Matter and its Interactions
5-PS1-3
5-PS1-4

Ontario Science and Technology Standards

Grade 5: Understanding Matter and Energy: Properties of and Changes in Matter
2.3, 2.6

Common Core State Standards

Grades 4-6 Writing
CCSS.ELA-LITERACY.W.5.1.B
CCSS.ELA-LITERACY.W.5.1.C
CCSS.ELA-LITERACY.W.5.2.B
CCSS.ELA-LITERACY.W.5.2.D

Materials

- *Observations with Senses Page*
- *Microbe Observation Sheet*
- *Scholars of Science* book (*STEM-gineers*)
- *Observation Exit Card*
- 5 baby food jars
- Boiling water
- Gelatin mix
- String
- White board and markers

Objectives

Students will be able to:

- Define and describe steps of making observations.
- Make clear and accurate observations using words and drawings.
- Describe why making detailed and accurate observations are important.

Setting the Stage

Write the word “observation” on the white board. Offer students markers and have them come to the board and write down words or phrases that they think are related to the word observation. When a word web has been created, ask students to take a minute to read the web and reflect on the ideas that were offered.

Create a student-generated definition of the word “observation.”

- Definition could be something like, “Data recorded during an experiment that was taken in through our senses.”

Discuss that something most innovators have in common is strong observation skills. Making observations is an essential part of discovering how things work and coming to new conclusions

Each student brings an object from home (on previous day, ask students to bring this in) or chooses an object in the classroom. They fill in the *Observations with Senses Page* by making observations about their object. The page does not have a space for them to write the name of the object—it stays a mystery.

- Remind students that they should be imagining the taste of the objects, not actually tasting them. Taste is not always an observation we need to make during an experiment.

When students are finished with the page, they need to hand it in. Then, teacher passes out the pages randomly, so each student has a page that is not their own.

Line up the objects at the front of the classroom. Have students read the observations on the page and make predictions about the object that they think was observed. If the observations were done carefully and with detail, the students should be able to predict the correct object.

When activity is finished, have a class discussion. Ask students:

- Did you find the correct object? If not, what did you find difficult about finding the object? How could the observations have been improved to help you more easily find the object?
- Why are making accurate and detailed observations important?

Take-away concept: Observations are important because they pave the way for breakthroughs and guide future research. All of the innovators we read about were guided by their observations. We too can make observations to see how things work and how we can push ideas further, solve problems, and make breakthroughs ourselves

Activity

Explain to students that they will use their sense of sight to make observations about changes in an experiment with liquid and germs, or microbes.

Review pages 12 and 13 of the *STEM-gineers* title *Scholars of Science*.

- Clarify any unfamiliar concepts and answer any questions by students.
- Encourage students to make text-to-self connections by asking them if they know what a vaccination is, and if they know that they receive regular vaccinations as a child and youth. Ask students why vaccinations are important.

Review Louis Pasteur's breakthrough. Could invite some students to explain the breakthrough in their own words. Ask students:

- Do you think Louis Pasteur made observations that helped him make his discovery?
- Why were observations essential in helping him discover germs?
- What senses did he use to discover germs?

Draw students' attention to the project on page 13 of the book. Review the project and tell students they will be making observations about what they see.

Hand each student the *Microbe Observation Sheet*. Prepare the experiment. (Follow the steps on page 13 of *Scholars of Science*.)

1. Clean the 5 jars in boiling water.
2. Label the jars 1, 2, 3, 4, and "Control"
3. Mix the gelatin with fresh water and place it in the jars, so they are half full.
4. Dip 4 pieces of string in the gelatin mixture and have students collect samples from different locations around the classroom (this can be student-led, based on interest).
5. Put one piece of string in 4 of the jars. Use the numbers on the jars to record which string came from which location (for example, 1-doorknob). The jar without the string is the "Control" jar.

Have students fill in the "Day 1" section of their chart on the *Microbe Observation Sheet*. They will be assigned to one of the numbered jars, so they are not required to make observations about all the jars. Each time, they will compare their numbered jar to the control jar.

Leave the jars for 5 days. Have students make observations and fill in sections of the charts on days 2, 4, and on the final day, 5.

Extensions

- Choose another project, such as the long-term project on page 29 of *Scholars of Science*. Fill in the observation page. Make predictions for what will happen in the project, then reflect on their predictions after the project has finished.
- Have students create their own "Observation" checklists or charts that will help them make clear and concrete observations in other science lessons.

Wrap-Up

When students have made their final observations, place them in groups of 4, made up of students who each observed different jars. Have the students compare the observations. Also allow students to come up and look at all of the jars side by side, for interest.

Have a class discussion about what they found:

- Which area of the classroom had the most germs? How do you know?
- Did the number of microbes in each jar differ? By how much?
- What surprised you about the observations you made?
- Were there any unexpected changes to the liquid, outside of the microbes? Did it change in color, texture, etc.?
- How did the microbe jars compare to the control jar?

Hand students the *Observation Exit Card*. Have them complete the questions, then hand it in for assessment.

Assessment

Use the checklist at the bottom of the *Observation Exit Card* to assess the exit card. Check for understanding of observations and their significance. Address any confusion as needed.

Name: _____

Date: _____

Observations with Senses

Choose a distinctive object. Be sure that it is something unique so your classmates have to think hard in order to guess what you have described!

Use the space below to describe your object using 2-3 adjectives for each of the five senses. Be sure you are choosing juicy words to describe your object! Once you have completed the five senses, cut along the dotted line of your page and hand it in to your teacher. Do not fill in the prediction section.

Taste: _____

Sight: _____

Smell: _____

Touch: _____

Sound: _____

Prediction #1	Prediction #2
<hr/> <hr/>	<hr/> <hr/>
Drawing	Drawing

Name: _____ Date: _____

Microbe Observational Sheet

Jar: _____ compared to control jar

Schedule	I see: _____	Drawing: _____	I see - Control Jar	Drawing: Control Jar
Observation 1 – Monday A.M.	Color: Shape: Size: Texture:		Color: Shape: Size: Texture:	
Observation 2 – Tuesday P.M.	Color: Shape: Size: Texture:		Color: Shape: Size: Texture:	
Observation 3 – Thursday A.M.	Color: Shape: Size: Texture:		Color: Shape: Size: Texture:	
Observation 4 – Friday P.M.	Color: Shape: Size: Texture:		Color: Shape: Size: Texture:	

Name: _____ Date: _____

Observation Exit Card

In your own words, explain why observations were crucial for Louis Pasteur to discover germs.

Why is making observations an essential step in innovating?

Criteria	No	Somewhat	Yes
Student's answer is explained using knowledge learned in class about the innovator, Louis Pasteur, and his discovery			
Student develops answer using detail.			
Student incorporates understanding of observations and their significance.			

Comments: _____

LESSON 4

Do It Yourself—Culminating Project

Curriculum Correlations

Ontario Language Arts

Grades 4–6 Oral Communication

1.2, 1.4, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 3.2

Grades 4–6 Media Literacy

3.4

Common Core State Standards

Grades 4–6 Speaking and Listening

CCSS.ELA-LITERACY.SL.5.2

CCSS.ELA-LITERACY.SL.5.4

CCSS.ELA-LITERACY.SL.5.5

Grade 6 Science and Technical Subjects

CCSS.ELA-LITERACY.RST.6–8.3

Supports select science standards, based on projects.

Teacher can choose to assess students on their knowledge of these curriculum concepts as they complete and explain projects.

Next Generation Science Standards

4-PS3-2.

3-5-ETS1-3.

4-PS4-2

4-PS3-2

5-ESS3-1.

5-PS1-3

4-LS1-1.

Ontario Science and Technology

Grade 4: Understanding Life Systems: Habitats and Communities

3.7

Grade 4: Understanding Matter: Light and Sound

2.2, 3.3

Grade 5: Understanding Structures and Mechanisms: Forces Acting on Structures and Mechanisms

2.4, 3.2, 3.3, 3.4

Grade 5: Understanding Earth and Space Systems:

Conservation of Energy and Resources

2.3, 3.1, 3.2, 3.3

Grade 6: Understanding Earth and Space Systems: Space

3.1

Objectives

Students will be able to:

- Complete a step-by-step project or experiment that illustrates one science, engineering, math, or technology concept from the *STEM-gineers* series.
- Create a short presentation, using words and photographs, that explains their project or experiment and the concept it illustrates.
- Reflect on their skills as innovators, speakers, and listeners.

Setting the Stage

Review the class booklet created in lesson 1. Can invite students to read the booklets together in small groups, or invite students to read-aloud in a class review of the booklet.

Explain to students that the *STEM-gineers* series includes a project that illustrates the concept that each innovator discovered or created. Tell students that they will follow the steps in the *STEM-gineers* books to create the projects that illustrate the booklet innovators' concepts.

In small groups, students will create the projects for one innovator from the class booklet.

To create the groups, follow these steps:

1. Have each student make a list of the top three innovators they are interested in. They must pick from the class booklet.
2. End the first class period here.
3. Review the lists from students prior to the next class period. Create groups of 3 or 4 students based on common interests.
4. Write the groups on a document with member names and the innovator being focused on, and display it at the beginning of the next lesson.

Materials

- *Project Information Sheet*
- *Project Rubric*
- *Project Reflection Questions*
- Devices with Internet access to create photo slideshow
- Camera or devices that can take photos
- Class booklet of innovators (created in Lesson 1)
- *STEM-gineers* books and materials for projects (15 innovators chosen in Lesson 1)
 - ▶ *Trailblazers of Technology*
 - Alessandro Volta page 7
 - ◆ Ice cube tray, 5 galvanized nails, 5 pieces of copper wire, distilled vinegar, LED
 - Eadweard Muybridge page 18
 - ◆ Sticky notepad, marker
 - ▶ *Scholars of Science*
 - Ibn al-Haytham page 7
 - ◆ Empty cereal box and its empty inner bag, tape, a pin, scissors, light source such as light bulb
 - Charles Darwin page 11
 - ◆ Group of peers
 - Edwin Hubble page 21
 - ◆ Balloon, marker, ruler
 - Alfred Wegener page 25
 - ◆ Cardboard, map of tectonic plates, 1 cup salt, 2 cups flour, $\frac{3}{4}$ cup water, spatula, 2 bowls, red and brown food coloring
 - Rosalind Franklin page 27
 - ◆ Computer with Internet access
 - ▶ *Masters of Math*
 - Ada Lovelace page 21
 - ◆ Hole punch, 12 pieces of cardboard
 - Benoit Mandelbrot page 29
 - ◆ Ruler, piece of paper, pen
 - ▶ *Experts in Engineering*
 - Augustin-Jean Fresnel page 11
 - ◆ Flashlight, books, paper, measuring tape, calculator, tape
 - John Roebing page 15
 - ◆ Two paper cups, coins, three index cards
 - Gustave Eiffel page 17
 - ◆ Paper, scissors, tape, cookies or other weighted objects
 - John Frank Stevens page 19
 - ◆ Large plastic container, sand, craft sticks, small stones, water
 - Palmer Cosslett Putnam page 25
 - ◆ Piece of paper, ruler, pencil, scissors, skewer, hair dryer or other device that blows air

Activity

Have students get into their groups. Explain that they will follow the steps on the appropriate *STEM-gineers* page to recreate the project. Each project shows the innovator's idea or discovery in action. They will document their process in photos as they complete the project, explaining their observations at each stage in captions. Then, they will present their projects and photos, explaining to their peers how the project helped them understand the innovator's idea or discovery.

Hand groups *Project Information Sheet*. Review criteria with students.

- Follow the steps to complete the project.
- Take at least five pictures as they complete the project.
 - ▶ 1 picture at the beginning
 - ▶ 1 picture in the middle
 - ▶ 1 picture at the end
 - ▶ 1 or more challenges they faced or problems they overcame
 - ▶ 1 or more "proud of" moments
- Compile pictures into Google slide, PowerPoint, or other presentation tool.
- Write a caption for each picture.
 - ▶ Each caption should explain what they observed at that point.
- Oral presentation 2-4 minutes long:
 - ▶ Show photos and captions
 - ▶ Explain the project they did
 - ▶ Explain how the project helped them understand the idea, discovery, or innovation.

Have students read over Levels 3 and 4 of the rubric. Then, review those levels as a class. Talk about what elements would make a Level 4 project.

Give students 2 class periods to complete their projects and prepare their short presentations.

Allocate another class period for the presentations.

Wrap-Up

Hand students *Project Reflection Questions*. Have them complete and hand in for assessment.

Discuss projects together. Ask students:

- What surprised you the most about your project? About a classmate's project?
- How did taking pictures help you reflect on your process?

Assessment

- Invite students to write a reflection about STEM innovations, character traits, and experiment strategies they learned about. Assess them on writing skills.
- Have students prepare mini-lessons in which they teach their peers about a concept (either the concept they explored, or a new one) from the *STEM-gineers* book.

Assessment

Assess oral presentation and reflection page using the *Project Rubric*.

Project Information Sheet

Time for you to **Do It Yourself!** Take on the role of an innovator and explore a science, math, engineering, or technology concept.



Follow the steps to complete your project.

1. Read about your innovator and their innovation, discovery, or idea in the *STEM-gineers* book and online.
2. Follow the steps in the book to complete the mini project that helps you understand your innovator's idea.
3. As you complete the mini project, take at least **five** pictures:
 - a One picture of the beginning of your project
 - b One picture of the middle of your project
 - c One picture of the end of your project
 - d One or more pictures of challenges you faced or problems you solved
 - e One or more pictures of "proud of" moments
4. Prepare an oral and media presentation. Your presentation must:
 - a Be 2-4 minutes long.
 - b Include a slide show that shows your pictures. Each picture must have a **caption**.
 - c Identify your innovator.
 - d Identify and briefly explain the innovation, discovery, or idea.
 - e Explain the project you completed. Use the pictures to explain your process.
 - f Explain how the project helped you understand the innovator's idea, discovery, or innovation.

You are being assessed on your oral presentation and your media element.

You are expected to contribute equally in your group work.

You and your group members are required to speak equal amounts of time during your oral presentation.

As you work, check the rubric to make sure you are meeting the criteria.

Name: _____

Date: _____

Project Reflection Questions

Think back on your project and answer the following reflection questions.

Your answers will be assessed. Please check the rubric to make sure you are meeting criteria.

1. Reflect on your oral presentation. What speaking skill did you showcase? What speaking skill could you work on in your next oral presentation?

Something I did well	Something I can work on

2. Reflect on one other group's presentation.

The group I am reflecting on is _____

a. Summarize the group's presentation in 2 sentences.

b. How did the group's presentation help you understand a new concept?

c. What listening skills did you use when listening to the presentation?

3. How did your project help you understand the idea, discovery, or innovation?

**4. Think back on the character traits of an innovator. Name one trait that you used during this project.
How did it help you take on the role of an innovator?**

Student name: _____

Date: _____

Project Rubric

Oral Communication				
Speaking: Presentation skills appropriate for audience	Displayed limited speaking skills that were not appropriate for audience. Did not contribute to speaking equally.	Displayed some speaking skills that were somewhat appropriate for audience. Took over speaking for group or did not contribute enough.	Showed appropriate speaking skills (tone, pace, volume, nonverbal cues) for audience. Took an equal role in speaking.	Showed exceptional speaking skills (tone, pace, volume, nonverbal cues) for audience. Took an equal role in speaking.
Speaking: Clarity and coherence	Speaking parts were unclear. Concepts were not communicated in an understandable way.	Speaking parts were somewhat clear. Some difficulty understanding concepts.	Speaking parts were clear and understandable. Concepts were communicated well.	Speaking parts were exceptionally clear and easy to understand. Concepts communicated with insight.
Listening: Appropriate behavior	Displayed limited listening skills. Respect for classmates lacking. Missing reflection and questions.	Displayed some listening skills. Some insight when reflecting. Questions were not asked.	Displayed appropriate listening skills by showing respect, asking questions, and reflecting.	Displayed exceptional listening skills by showing respect, asking insightful questions, and reflecting.
Media				
Visual aids: photograph gallery with captions	Less than 3 photographs with some missing captions included in presentation	3-5 photographs with somewhat clear captions prepared and incorporated into presentation.	5 photographs with clear captions prepared and incorporated into presentation.	5 or more photographs with clear, insightful captions prepared and incorporated smoothly into presentation.
Reflection				
Speaking: Reflected on skills and things to work on as a speaker	Showed limited reflection when identifying a skill that was a strength or one to work on.	Showed some reflection in identifying a skill that was a strength, and one to work on.	Showing good reflection skills, identified one skill that was a strength, and one to work on.	Showing insight and strong reflection, identified one skill that was a strength, and one to work on.
Listening: Showed listening skills by reflecting on and summarizing other group's presentation	Summary of other group's presentation was incomplete or unclear. Showed limited reflection on listening skills and what they learned.	Summary of other group's presentation was somewhat clear. Some reflection on listening skills and what they learned was shown.	Summary of other group's presentation was clear. Strong reflection on listening skills and what they learned.	Created strong, clear summary of other group's presentation. Showed exceptional insight when reflecting on listening skills and what they learned from the other group.
Content: Reflected on character trait of an innovator	Identified one character trait, but description on how they used the trait to succeed in the project is unclear or limited.	Identified one character trait and described, with limited clarity or connections made, how they used the trait to succeed in the project.	Identified one character trait and described how they used the trait to succeed in the project.	Identified one character trait and made insightful connections to describe how they used the trait to succeed in the project.
Content: Described how project helped them understand concept	Description of how the project helped them understand the concept is limited or unclear.	Description of how project helped them understand the concept is somewhat clear, with some detail missing.	Clearly described how the project helped them understand the concept.	Showed insight and made new connections in description of how project helped them understand the concept.

Additional comments: _____
