Scientists
Middle Level Lesson Plan

Topic Science as a human endeavor

Grade Levels 7-8

Overview

When students are asked to describe a scientist at work, they will often come up with an image of an older white man dressed in a white lab coat, in a lab, working rigorously with some peculiarly bubbling chemicals. This image raises many questions that can be used to help students understand what scientists do and what they are like – for example, What exactly does the work of scientists entail? What types of people choose scientific careers? What attracted these people to the work they do, and what keeps them interested, motivated, and productive? This episode of QUEST, *Scientists*, highlights the work and lives of several contemporary scientists from the northern New England area, shedding light on common stereotypes.

Introduction

The focus this teaching unit is to broaden students' understanding of the work and lives of contemporary scientists.

At the end of this teaching unit, students will be able to:

- Recognize that scientists come from diverse backgrounds, are of various ethnicities and ages, and include both men and women.
- Recognize that the work of a scientist occurs in a variety of ways and in a variety of settings.
- Recognize that scientists have diverse interests, talents, knowledge, skills, and abilities.
- Describe a number of career possibilities in science.
- Recognize several characteristics of scientific work.

Time Allotment

Five to six 45-minute class periods.

Accessing Prior Knowledge

Students in middle school have usually had classroom experiences working as "scientists." They have worked individually, in pairs, and in small collaborative groups to investigate problems, observe phenomena, draw

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Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands, by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming, and Desiree Carlson, M.D.

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conclusions, describe procedures, communicate findings, and critique others' work. In addition, middle school students have often been introduced (through feature films, documentaries, and short biographical stories) to individuals who have made contributions to the world of science. Students at this age should be able to recognize that many people choose science as a career.

Concepts to Clarify

While students are undoubtedly familiar with the work of scientists, they may have conflicting perceptions of the image of a scientist. Research found in Benchmarks for Science Literacy states: "….students portray scientists as brilliant, dedicated, and essential to the world. However, when asked about science as a career, they respond with a negative image of scientific work and scientists." (AAA, 1993) A number of studies have revealed that students of all ages share this stereotypical image of scientists and their work. It is important to be cognizant of this persistent view, but to allow students to "discover" a more diverse population of individuals engaged in scientific careers through the activities in this teaching unit.

Be aware that students may also hold misconceptions about the ways in which scientists work. Students may not realize that scientists often do not follow a specific series of prescribed steps of the "scientific method" as they go about their day-to-day work. This is so because many unpredictable things tend to happen during a scientific investigation. Encourage students to find out how scientists are conducting their work. Do they talk about steps they are following, or perhaps do they follow a "trail" of ideas? Students also may believe that the primary goal of scientists is to invent new things or to solve particular problems. While these goals may in fact be part of what some scientists work for, it is important for students to recognize that some people engage in science simply to learn something new, however small.

Lastly, keep in mind that many students do not consider themselves "eligible" for careers in science. Broadening students' awareness of scientific career possibilities can support and encourage them to pursue such opportunities. Help students make observations about the different types of people involved in the many fields of science and the various work environments these fields entail.

CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
G. History and Nature of Science (5-8) Science as a Human Endeavor 1. Women and men of various social and ethnic backgrounds –	Chapter 1C: The Scientific Enterprise (6-8) 1. Important contributions to the advancement of science, mathematics, and technology have been made by	M. Implications of Science and Technology (5-8) Recognize scientific and technological contributions of diverse people including women,	Science, Technology, and Society 2f.: Curriculum Standard 3 (Grade 6) Describe how science and technology affect career choices and the kinds of work	Roles and Responsibilities (5-8) 7.5.aa.: Analyze the roles and responsibilities of scientists, mathematicians, and technologists in relation to ongoing

CONNECTIONS TO THE STANDARDS cont.

and with diverse interests, talents, qualities, and motivations – engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others. 2. Science requires different abilities, depending on such factors as the field of study and the type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity – as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.	different kinds of people, in different cultures, at different times. 2. Until recently, women and racial minorities, because of restrictions on their education and employment opportunities, were essentially left out of much of the formal work of the science establishment; the remarkable few who overcame those obstacles were even then likely to have their work disregarded by the science establishment. 3. No matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone in the world. 4. Scientists are employed by colleges and universities, business and industry, hospitals, and many government agencies. Their places of work include offices, classrooms, laboratories, farms, factories, and natural field settings ranging from space to the ocean floor.	different ethnic groups, races, and the physically disabled. Career Preparation A. Preparing for the Future (5-8) Demonstrate an understanding of the relationship among personal interests, skills and abilities, and career research.	people do.	research and discoveries that impact society (e.g., the dangers and benefits of nuclear energy).

Materials Needed

- TV with VCR
- QUEST *Scientists* video
- Computers with Internet access
- 1 sheet of 8-1/2" x 11" drawing paper per student
- Chart paper
- Class set of colored pencils and/or crayons
- Markers
- Class set of glue sticks
- Scrap paper
- 22" x 28" poster board (1 per team)
- Class set of scissors
- Access to research materials for Scavenger Hunt (see Student Handout 3)
- Access to the Internet and e-mail (optional)
- Digital camera (optional)
- Timer (optional)
- One copy per student of each of the following reproducible handouts:
  - Student Handout 1: QUEST *Scientists* Video Viewing Guide
  - Student Handout 2: Portrait of a Local Scientist – Project Guidelines
  - Student Handout 3: *QUEST* at Home – Scientists Scavenger Hunt
  - Teacher Resource 1: Sample Scientist Interview Questions

1. Introducing the Concepts

Through this initial activity, students will discover their own preconceived notions about scientists: where they work, what they look like, what they do, and how they work. Students will discuss where these stereotypes come from, and will begin to think how the work of scientists in general may be different from the work of other professions.

Note: Advance preparation – Before implementing this activity, review the sequence of the entire lesson. Contact and make arrangements with individuals who work in scientific careers in your region. Try to recruit professionals who represent different scientific disciplines, cultural backgrounds, and genders. Universities, medical laboratories, research facilities, private businesses, and state agencies are good places to find such people. If you are unable to locate a research scientist, consider contacting a co-worker or technician who can help explain what and how scientific work is conducted in his or her field. Explain the intent, general format, and timeline of the interview project to the professionals you solicit. Create a handout (or make list on chart paper) of the scientists who are willing to be interviewed; include their specific fields of work.

Predetermine the method students will be using to conduct their interviews. For example, will these be

face-to-face interviews (which may involve parental transportation), e-mail interviews (which require access to e-mail), phone interviews (requiring access to a reliable telephone), or interviews by mail (requiring stamps and envelopes)? Notify parents of your students' projects, being sure to include the project's goals, requirements, format, and timeline.

Activity 1: My Portrait of a Scientist

Step 1

Provide each student with a sheet of drawing paper and colored pencils or crayons. Explain to students that you would like them to create a drawing of what comes to mind when one speaks of a "scientist" at work. Ask students to include as much detail as possible in their drawings--including where the scientist works, what tools or equipment he or she uses, and what the scientist looks like. (You may wish to list these points on the board or on chart paper as a reminder.) Try not to influence students' ideas, however, by giving specific suggestions or too many details. Reassure students who seem hesitant to convey their ideas via a drawing that their artistic abilities are not being judged. Students should work individually on their drawings for approximately 20 minutes.

Step 2

When students have finished their drawings, use chart paper or the board/overhead to create a class tally of the characteristics captured in their work. Begin by asking students, by show of hands, how many of them drew a picture of a male. Record this number in the class tally. Ask how many drew a picture of a female; record this number in the class tally. Continue through the list of characteristics in the list below, keeping the class tally of features as you proceed.

- How many drew a Caucasian or white person? (**Note:** Include a tally for other ethnicities as found in students' drawings.)
- How many scientists in the drawings are wearing lab coats?
- How many scientists are working in a laboratory?
- How many scientists are wearing glasses?
- How many scientists have "wild hair" in the drawings?
- How many scientists are working with chemicals? Other equipment or tools?
- How many scientists are working on "secret" or "dangerous" experiments?

Alternative tallying method: Have students post their drawings where they are visible to all. Then ask students to generate a list of common characteristics based on the group's observations.

Step 3

After the characteristics have been tallied, engage students in a discussion about what these drawings show collectively. What do they tell students about how they perceive scientists and what they do? Ask students if they think this collection of drawings is representative of the work of scientists. Have them consider whether there are "exceptions" to these images. Try to elicit students' ideas about what scientists actually do and how they do it. Ask the class whether they think the work of scientists in general differs from the work of other professionals.

Middle school students are familiar with the concept of stereotypes. Ask the class if they think their ideas of scientists are stereotypical, and, if so, where they think these ideas come from. (Have students think about the images they have seen of scientists in movies, cartoons, the media, books, video games, etc.) Explain to students that their ideas are in line with the image most adults have of scientists and the work they do. Tell them that in the next few activities, they will have a chance to become familiar with the work of a variety of local scientists (people who work and live in Maine, New Hampshire, and Vermont). Their stories may cause students to think about scientists in new and more diverse ways.

2. Exploring the Concepts

In the next activity, students will view the QUEST *Scientists* episode to become familiar with the work and lives of scientists in northern New England. They will use a guide to help them examine and dispel (confront) some of the stereotypical or "traditional" characteristics thought to be prevalent among scientists.

Activity 2: Viewing QUEST *Scientists* Video

Step 1

Engage students by asking them to consider why they think people become scientists or go to work in a scientific field. Ask, "What draws these people into such careers? Do you think scientists in the past studied science for the same reasons and in the same ways?" Briefly discuss students' ideas.

Step 2

Distribute copies of Student Handout 1 (QUEST *Scientists* Video Viewing Guide). Have students familiarize themselves with the handout. Explain that the purpose of this guide is to help students focus on certain aspects of the film – mainly to help them collect data about the apparent characteristics of the people featured in the video. It will also help them capture the reasons why the featured scientists have chosen to do what they do. Explain to students that later they will be interviewing some local scientists and creating "portraits" of these people. The portraits will be on display so that others can learn about the work and lives of these individuals. Point out that there is a place on the viewing guide to jot down ideas for questions that students think are important to ask the individual scientists they will be interviewing.

Step 3

Play the QUEST *Scientists* video. This may require two class periods, depending on the structure of your schedule. Alternatively, you may choose to show only select portions of the video. It may be helpful to pause the film periodically so that all students are able to jot down adequate notes.

Step 4

Divide the class into groups of four students each. Ask each group to share the information they collected on their viewer's guides. Encourage students to make additional notes as they listen to others report out.

Step 5

Reconvene as a large group. Elicit a few summarizing remarks about the video from students. Ask individual students to share the questions they listed as possible interview questions. Record their questions on chart paper, and save them for the next activity.

3. Developing the Concepts

In this lesson, students will develop interview questions and conduct an interview of a local scientist. Students will use the information collected during their interviews to create "portraits" of their chosen interview subjects for public display. The portraits will highlight not only the professional aspects of the subjects' lives, but also the "human" sides of these diverse individuals.

Activity 3: Portrait of a Local Scientist

Step 1

Introduce the details of this project to students. Distribute copies of Student Handout 2 (Portrait of a Local Scientist: Project Guidelines). Review the handout with the class, and answer any questions or concerns students might have. Explain that the source of information for students' work will come primarily through their interviews. Tell students that that they will be interviewing their chosen scientists in teams of two. The interviews can be conducted in person, on the phone, through e-mail, or via regular mail. (**Note:** It may be preferable to have students conduct their interviews individually, depending on the number of scientists recruited.)

Step 2

Share the list of participating scientists with the class. Using pieces of scrap paper, have student pairs indicate their first, second, and third choices of interview subjects. (You may also devise some other fair way to match up scientists and student teams.)

Step 3

Guide students in developing a set of questions that will be used by student pairs as they interview local scientists. See Teacher Resource 1 for a list of sample questions that may be included.

Step 4

Match up student pairs to available scientists. Try to honor teams' first or second choices. Provide teams with contact information and a copy of the compiled interview questions. Be sure to set due dates for the completion of interviews and portrait projects. Discuss proper interview etiquette and attire (if students are conducting face-to-face interviews). Remind students to obtain a photograph or two (preferably digital) of their interview subject to use in their "portrait."

Step 5

When projects have been completed, be sure to have students write thank-you notes to the individuals they interviewed. Also have each student pair include a copy of their completed project in the thank-you note.

Step 6

During the next class period, display students' work in an area accessible to students. (**Note:** Students' projects will be used in the next activity.) If possible, make the display available to other classrooms, parents, and even the public.

Optional Extension: This exercise could be modified to take the form of a job-shadowing opportunity. For information, tips, and templates related to planning a job-shadowing event, see the Groundhog Job Shadow Day Coalition Web site at *http://www.jobshadow.org*.

Optional Portrait Format: The portrait component could easily be modified to utilize available technology. Instead of creating a portrait using poster board, students could create portraits using PowerPoint, iMovie, or Web page programs.

Note: If you have difficulty locating enough scientists to interview for this project, students could instead locate biographies of scientists using the Internet and answer a modified set of "interview" questions.

4. Synthesizing and Applying the Concepts

In this culminating activity, students will review the portrait projects created by their classmates. They will compare their initial ideas about scientists with what they have learned about the work of local science professionals.

Activity 4

(**Note: Advance preparation** – Write the following prompts at the top of separate pieces of chart paper. Post these pieces of paper at different places in the classroom.)

- Prompt 1: What was the most surprising thing you learned from your scientist?
- Prompt 2: Where (in what kind of setting) does your scientist work?
- Prompt 3: What tools and methods did your scientist use?
- Prompt 4: What attributes, or specific characteristics, do all of the scientists interviewed seem to have in common?

Step 1

Make students' initial scientist drawings (from Activity 1) available to them. Ask students to take a few quiet moments individually to look back at these drawings. Encourage them to reflect on what they have learned from doing their scientist interviews. Now have students compare these initial drawings with their complete portrait projects. Direct them to jot down a few notes as they think about the similarities and differences in the images they are comparing.

Step 2

Explain that in a few moments, the class will examine all of the portraits created by their peers. Show students the prompts you have listed on chart paper. Explain that as they view their classmates' projects, they need to focus their attention on gathering information that will answer these prompts.

Step 3

Divide students into four groups. Explain how the following "carousel" activity will work:

1. Students will be given 5-10 minutes to become familiar with the information on the portraits displayed around the room.

2. When directed, students in Group 1 will move to the first prompt on chart paper, Group 2 to Prompt 2, Group 3 to Prompt 3, and Group 4 to Prompt 4. Groups will be given 3-5 minutes to list as many ideas as they can about their particular prompt.
3. When time is called, Group 1 should move to Prompt 2, Group 2 to Prompt 3, and so on. During the next 3-5 minutes, each group should read what the last group has written, then add any new ideas to the list.
4. Continue the carousel for two more rotations, so that all of the groups get to respond to each question.

Step 4

Reconvene as a large group. Discuss the information students compiled during the carousel activity. During this time, you may also wish to revisit the list of stereotypical characteristics listed during Activity 1, as well as the video viewing guide students completed earlier. Have students compare this earlier information with their current knowledge to see if any of the characteristics they first listed were actually present in the scientists students interviewed. (**Note:** There is a dual focus for this closing activity: (1) to reinforce the idea that scientists are diverse people, while (2) there are certain commonalities in the work that scientist do – defining them as "science" professionals.

Step 5

Ask students to imagine that the portrait projects they have created are being compiled and published in one book. Working individually, students' task now is to write a one-page introduction to the book. The title of the introduction will be "What Do Scientists Do?" This introduction must describe the content of the book; it must also answer the question, "What do scientists do?" Stress that in their introduction, students must be sure to include the diversity issues addressed in this teaching unit, yet it must also capture the unifying characteristics of most scientific work.

Step 6 (optional)

Wrap up by having students create a revised sketch of a scientist at work. Their sketches should reflect their learning during this series of lessons.

5. Extending the Concepts

In the following take-home activity, students will go on a "scavenger hunt" to become acquainted with the lives, work, and talents of a broad variety of scientists.

Activity 5: *QUEST* at Home – Scientists Scavenger Hunt

Note: Before assigning the scavenger hunt, review the resources available to students in your local library. You may also want to create a list (portal) of suitable Internet sites for students to use during this activity. Be sure to review the questions on the scavenger hunt list, and discard or replace questions that can't be answered with available materials.

Step 1

Distribute copies of Student Handout 3 (Scientists Scavenger Hunt). Read over the directions with students, and introduce the available resources for students to use. Assign a reasonable due date.

Step 2

On the appointed day, have students share their findings with their classmates. Lead a whole-class discussion to go over any questions students were either unable to answer or had varying answers for. Discuss the most interesting findings in the hunt, reiterating the key concepts of this teaching unit.

Alternative procedure: Set out stations that organize the available resources by type. For example, one station could hold biographical material, another could hold encyclopedias, another historical science books, Internet resources, and so on. Students could visit the various stations to complete the activity.

Extension: Encourage students to contribute additional questions or create their own scavenger hunts. Students may want to create scavenger hunt questions for others to use when viewing the class "scientist portrait gallery."

Community Connections

- Start a scientist-in-residence program at your school. Local scientific societies, organizations, universities, museums, research facilities, and businesses may offer outreach programs that bring scientists into schools to work with students on specified topics.
- It is often possible to arrange student tours of local scientific research facilities, museums, businesses, or other related sites of scientific interest. Many have educational programs in place and welcome group visits.

Career Opportunities

- As an extended activity, arrange for a science professional in your community to come to the classroom as a guest speaker.
- Have students do additional research on a specific scientific career of interest. They can discover what educational requirements are involved, the training process, potential salary, and future job outlook for this career. Encourage them to investigate the wide variety of related science careers such as laboratory or hospital technicians, nurses, engineers, environmental lawyers, and so on.

Resources

http://www.madsci.org/FAQs/careers.html
Check out "What is it like to be a scientist?" and other Frequently Asked Questions on Washington University Medical School's MadSciNetwork Web site. It includes descriptions for a number of scientific careers.

http://www.microbe.org/careers/myths.asp
Science is boring and other myths is an engaging, general on-line article written for young people encouraging them to consider scientific careers. Created by the American Society of Microbiology, this site also profiles careers in the field of microbiology.

Profiles of Working Scientists

http://www.astr.ua.edu/4000WS/4000WS.html
This site features 4000 Years of Women in Science.

http://www.princeton.edu/~mcbrown/display/faces.html
The Faces of Science: African Americans in the Sciences is a listing, by scientific discipline, of African Americans who have contributed to the advancement of science and engineering.

http://earthobservatory.nasa.gov/Library/Giants/
From NASA's Earth Observatory library pages, On the Shoulders of Giants profiles a number of geoscientists who have made significant contributions in their field.

http://www.pbs.org/wgbh/aso/databank/bioindex.html
This site offers a listing of companion biographies for the PBS series A Science Odyssey.

QUEST *Scientists* Video
Viewing Guide

Directions: Use the focus question in each box below to help you organize the information you gather while watching the video.

What attracted these scientists to their respective fields of study?	"Scientists Stereotype Busters"
What do scientists do? List some general qualities/commonalities found in the work habits of scientists featured in this program.	Possible Interview Questions for a Local Scientist:

Portrait of a Local Scientist
Project Guidelines

Project Checklist and Timeline:

Name of Scientist: ______________________________ Interview scheduled for: ______________

Contact Information: ____________________________ Interview completed by: ______________

____ Project completed by: ______________

____ Digital picture: __________________

Project Requirements:

Create a 22" x 28" poster board "portrait" of the scientist you interviewed. Your poster should include the following elements, presented in a pleasing, polished way:

- General biographical information
- A description of the individual's role in a field of science (what this person does for work, how he or she does the work, the tools involved, description of typical day, etc.
- Insight into what keeps this person interested, motivated, informed, and productive in his or her chosen field
- Picture of the person (ideally at work), and/or a graphic related to the work he or she does

Sample Layout:

Person's Name

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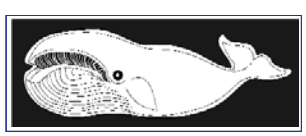

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Scientists Scavenger Hunt

You're on a Quest!

Directions: Use the library and/or other available sources of information to answer the following questions. Include the references for the information you note here.

1. What presently working octogenarian grandmother and accomplished meteorologist discovered what fuels hurricanes?

2. What group of people invented gunpowder and used it first in the battlefield?

3. Of what nationality was the 1970 Nobel Prize winner in chemistry? What was his work in?

4. Who was the first African-American astronaut?

5. Nineteenth-century astronomer Maria Mitchell is known for what contributions in her field?

6. What Serbian astrophysicist studied seasonal and latitudinal variations of solar radiation received by Earth? Hint: the theory shares his name.

7. What famous book did Rachel Carson write in 1962? What was the book about?

8. What African American, nicknamed the Black Edison, had over 50 patented inventions – including equipment that helped prevent train accidents through the use of telegraphic messages?

9. What female scientist is known for her work in radioactivity and was the recipient of two Nobel prizes?

10. Who was the first woman in space, and what country was she from?

11. Who was the famous left-handed, Jewish scientist who moved to the United States from Germany to escape Nazi persecution?

12. What major contribution did Ellen Swallow Richards make to the field of ecology?

13. What African-American physician and surgeon is famous for developing the blood bank system?

14. What 1965 Cambridge University graduate has devoted her life to studying animal behavior – in particular chimpanzees – in the jungles of Africa?

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Sample Scientist Interview Questions

I. General Biographical Background Information

- Where were you born?
- Where did you grow up?
- What is your heritage or ethnicity?
- Where did you go to school? What did you study?
- What did you like to do growing up?
- What kinds of activities were you involved in?
- What early experiences or opportunities do you think contributed to your professional interests today?
- Do you have any special interests or hobbies?

II. Science Profession

- Describe your work. Where do you work? What is a typical day like? What tools do you use? What are your responsibilities?
- Is there a particular process or method you follow when doing your work?
- What scientific knowledge, skills, or special talents are required to work in this field? What kind of special training did you receive?
- To which discipline does your field belong? (life science, physical science, earth science, or interdisciplinary, i.e., involving one or more of the above)
- Are there any special accomplishments, honors, and/or awards you would like your audience to know about?
- What work are you most proud of?
- Why do you feel your work is important?

III. Scientist as a Person

- When you were growing up, what experiences got you interested in becoming a scientist, or influenced your chosen career pathway?
- Where did you (or do you) receive your encouragement, support, or inspiration to do this work?
- What is, or was, the greatest obstacle for you to overcome?
- What advice would you give to others who want to work in your field?

IV. Other

Allow time for the person you are interviewing to add any final comments.