The Final Frontier

ABC NEWS CLASSROOM EDITION

TEACHER GUIDE

BACKGROUND

Apollo moon landing exhibit at the National Air and Space Museum, Washington, D.C.

Most of today's students have grown up in an age where space travel is common place. Students take for granted the launches of manned and unmanned missions to the International Space Station and beyond. This was not always the case. As late as the 1950s, space travel occurred only in people's imagination…until Sputnik.

The Soviet Union launched the first successful satellite, Sputnik (a shortened Russian word that means "fellow traveler"), into orbit on October 4, 1957. This satellite demonstrated the high level of Soviet technology. Sputnik created fear and anxiety for many Americans who were living in the Cold War era. The sound of its radio signal served as a constant reminder of Soviet dominance.

Almost immediately, a demand arose in the United States for quick development of missile and satellite programs and more emphasis on mathematics and science education. In January 1958, the United States successfully launched Explorer I into orbit. The space race was on. *The Final Frontier* details the beginnings of space exploration as a competitive race between the United States and the Soviet Union.

The learning materials in this unit are designed to engage students in inquiry about the history of science and technology in the context of space exploration. The materials consist of a teacher guide and student activity sheets containing detailed procedures, instructional strategies, content, pedagogical background, a list of standards addressed, resources, and assessment approaches. During their investigation, students will view videos from *The Final Frontier* video series. This teacher guide uses the videos as resources throughout units of study.

AT A GLANCE

The United States History standards state that students should understand how trends in science influence society. In the "Explore" section, students will have opportunities to compare and contrast the successes and failures of the United States and Soviet space programs and how they influenced society. They will construct two-tiered timelines to chart events in space history and to understand how United States and Soviet involvement has turned from a competition to cooperation. They will also chart the impact of these events on society. Following further research, students will use this information to help determine their views on whether human or robotic missions should be used to explore space. Students will then participate in a silent debate to defend a side of this issue that is not necessarily their own. In the "Extend" section, students will learn how space-age technologies have changed our everyday lives. The "Assess" section presents the students with a hypothetical situation where there is a proposed dramatic cut in space exploration funding. Using everything they have learned in this unit, students will participate in a mock public hearing with students playing the role of legislators so that everyone can voice their view based on a predetermined perspective.

THE BIG QUESTION

Do the benefits of space exploration outweigh the costs and risks that are involved?

SOCIAL STUDIES STANDARDS ADDRESSED[1]

Historical Understanding

Understands and knows how to analyze chronological relationships and patterns

Grades 6-8

- Knows how to construct and interpret multiple tier time lines

Understands the historical perspective

Grades 5-6

- Understands that specific ideas had an impact on history
- Understands that specific decisions and events had an impact on history

Grades 7-8

- Analyzes the influence specific ideas and beliefs had on a period of history.
- Analyzes the effects specific decisions had on history

Grades 9-12

- Analyzes the influences specific ideas and beliefs had on a period of history and specifies how events might have been different in the absence of those ideas and beliefs
- Analyzes the effects specific decisions had on history and studies how things might have been different in the absence of those decisions
- Understands how the past affects our private lives and society in general
- Knows how to perceive past events with historical empathy

United States

Understands the economic boom and social transformation of post-World War II United States

Grades 5-6

- Understands the impact of postwar scientific research on contemporary society (e.g., the work of pioneers in modern scientific research, the significance of research and scientific breakthroughs in promoting the U.S. space program

World History

Understands how post-World War II reconstruction occurred, new international power relations took shape, and colonial empires broke up

Grades 7-8

- Understands post war relations between the Soviet Union, Europe, and the United States (e.g., interconnections between superpower rivalries and the development of new military, nuclear, and space technology)

Understands the search for community, stability, and peace in an interdependent world

Grades 9-12

- Understands how trends in science have influenced society (e.g., interconnections between space exploration and developments since the 1950s in scientific research, agricultural productivity, consumer culture, intelligence gathering, and other aspects of contemporary life; the changing structure and organization of scientific and technological research, including the role of governments, corporations, international agencies, universities, and scientific communities

TECHNOLOGY STANDARD ADDRESSED[1]

Understands the relationships among science, technology, society, and the individual

Grades 6-8

- Knows that technology and science have a reciprocal relationship (e.g., technology drives science, as it provides the means to access outer space and remote locations, collect and treat samples, collect, measure, store and compute data, and communicate information; science drives technology, as it provides principles for better instrumentation and techniques, and the means to address questions that demand more sophisticated instruments)

SCIENCE STANDARDS ADDRESSED[1]

Understands the compostion and structure of the universe and the Earth's place in it

Grades 9-12

- Knows ways in which technology has increased our understanding of the universe (e.g., space probes gather information from distant parts of the Solar System)

[1]Kendall, J.S. & Marzano, R.J. (2000). *Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education.* (3rd ed.). Association for Supervision and Curriculum Development. Reston, VA.

MATERIALS

Videos:

- *ABC News: Classroom Edition*, "The Final Frontier" programs
- "Part 1: The Race to the Moon "
- "Part 2: The Shuttle Era"
- "Part 3: To Mars and Beyond"
- "Part 4: Space Age Technology"
- Student Activity, "Space Age Technology"
- Student Activity, "T-Chart"
- Policy Hearing Role Sheet
- Policy Hearing Preparation Sheet
- Assessment Rubric
- Masking tape
- Construction paper (or craft paper)
- Tape measure
- Scissors
- Markers, colored pencils, or crayons (optional)

PROCEDURE

Explore: Students will create a multiple-tiered timeline to explore the major events in the space race and the effects these events had on society.

1. Provide students with the information in the second paragraph of the "Background" section on page one about the launch of Sputnik. Ask students why Sputnik might have caused fear? (People thought that if the Soviets could launch a satellite into space they could also launch a missile at the United States.) Also ask them "What was the long-term response from the United States? (The United States started emphasizing the subjects of mathematics and science in the nation's schools.)

2. Explain to students that they will be comparing the successes and failures of the space programs of the United States and the Soviet Union by creating a two-tiered timeline. Tell students they will use information from the *ABC News: Classroom Edition* videos as a primary source of information for constructing the first tier of the timeline. Ask students to assemble into groups of four. Two students in the group will be responsible for listing the major events (positive and negative) that were a part of space exploration. The other two students will be responsible for finding indications of how these events affected society.

3. Over the next few days, students should assemble the timeline. Begin by recording the date of the Sputnik 1 launch together as a class, explaining that this will be the first date on everyone's timeline. Each student can construct these draft timelines on a piece of notebook paper by drawing a line and labeling it "1957." Students writing the accomplishments should write a statement above the line about how Sputnik contributed to the space program (e.g., it demonstrated that a spacecraft could be launched into orbit from the Earth). Students writing about the impact on society could write something like "Sputnik created fear and anxiety for many people in the United States during the Cold War era, while people in the Soviet Union were very proud of their accomplishment." Show the video "The Final Frontier Part 1: The Race to the Moon." Students should continue to fill in the two-tiered timeline with other events mentioned in the video. Following the video, groups of students should fill in any missing or additional information by completing library or Internet research. The NASA History office Web site http://history.nasa.gov is a good starting point.

Teacher Tip
Prior to showing the videos in the "Explore", section engage your students in an introductory discussion as suggested in the teacher guide that accompanies each video.

4. Once students have completed individual research, have them come back together in their groups and construct a group timeline with contributions from each member.

5. Tell students to continue their timelines while watching "The Final Frontier Part 2: The Shuttle Era" and "The Final Frontier Part 3: To Mars and Beyond." Have them conduct further research after viewing each video program as in procedure 4 above. Then add to the group timeline as in procedure 5. The finished timeline should minimally contain the following events from the video programs:
   - Sputnik (first satellite)
   - Gemini program (NASA learning to navigate spacecraft)
   - Apollo 1 (launch pad fire with three astronaut fatalities)
   - Apollo 8 (first humans to orbit the moon)
   - Apollo 11 (first humans to set foot on the moon)
   - Apollo-Soyuz Test project (first international cooperative space effort)
   - Sky Lab (first United States space station)
   - The Space Shuttle Columbia (first reusable spacecraft)
   - The Challenger Disaster
   - Space Station Mir (working cooperatively with the Soviet Union)
   - Viking orbiters and landers (explored Mars)
   - Voyager I and II (explored the outer solar system)
   - Mars Pathfinder (explored Mars)
   - Hubble Space Telescope (first Earth-orbiting observatory)
   - The Columbia Disaster

6. Once students have had ample time to construct their timelines, ask students in each group to identify where on the timeline the relationship between the United States and the Soviet Union changed from one of competition to cooperation. Tell them that they should include a rationale and evidence to back up their decision.

7. (Optional) In order to demonstrate the international efforts of space exploration, ask students to research current nations that are involved in space exploration (such as those involved with the International Space Station). Students should list the contributions of each nation, including financial involvement and technological expertise.

Apply: Students will apply this information to help determine their views on whether human or robotic missions should be used to explore space. Students will then participate in a silent debate using evidence to defend a side of this issue that is not necessarily their own. The following is a short description of how to conduct a silent debate:

- Divide the class into pairs.
- Assign each student a side of an issue—either for or against.
- Instruct the class that this will be a silent debate. Students will not be allowed to talk, but they must write their argument down on paper.
- Let each student write his or her argument for three minutes.
- Next, instruct students to switch papers and read and respond to the other student's argument. Allow this writing and responding to continue until it appears that the students are running out of arguments to write about. While the activity is going on, have students take brief notes on the main points of the other student's argument.
- After the exercise, have each student summarize the position of the other student in the pair either to that student or to the class. Their notes will be critical for accomplishing this brief summation.
- List the points on both sides of the issue on the chalkboard and engage in a class discussion about what was learned in the exercise.

1. Ask students to refer to their completed timelines from the "Explore" section. Instruct them to identify which events would be classified as human exploration missions (involving human astronauts or cosmonauts) and which would be considered robotic (no humans on the spacecraft).

2. Students should review the impact each of these events had on society in light of this new classification. Show the segments "The Challenger Disaster" and "The Columbia Disaster" from "The Final Frontier Part 2: The Shuttle Era." These clips illustrate the hazards of space flight with the explosion of the Challenger space shuttle (STS 51L) shortly after launch on January 28, 1986, and the demise of the Columbia space shuttle (STS 107) shortly before it was supposed to land on February 1, 2003. After students view these clips, ask them to discuss whether humans on board spacecraft should continue to work in space following disasters like these. Explain that there is no better example of the risk that is present to human life than these tragedies. Next, show students the segments "Blazing a Trail" and "The Red Planet" from "The Final Frontier Part 3: To Mars and Beyond." After viewing these clips, ask students to share their views about human vs. robotic missions. Students may be quick to point out that these clips only show the tragedy of human missions (Challenger and Columbia) and not the triumphs (Apollo 11 First Lunar Landing, Repairing the Hubble Space Telescope). Likewise, they did not consider robotic missions that have been lost (e.g., Mars Observer, Mars Polar Lander, and Contour).

Alternate Strategy Tip

Another option for the silent debate would be to have students argue the issue of having private citizens pay for their travel into space. Show the clip "Space Tourism" from "The Final Frontier Part 4: Space Age Technology." Although this was a dream come true for Dennis Tito, it was a controversial issue between NASA and the Russian Space Agency. Divide the class into pairs and assign each student to be for or against the policy of allowing private citizens to pay for their travel into space. Allow students to complete the silent debate as described above. Then, have students read about the X-Prize (www.xprize.org), an interesting competition that promotes the privatization of space tourism. Ask students to describe how this competition differs from Dennis Tito's experience.

3. Explain to students that they are going to search for evidence to either support the use of robotic-only space missions (eliminating human missions) or the continued use of human and robotic missions. Divide the class into pairs and assign each student to be for or against the use of humans in space exploration. Allow time for students to gather additional evidence that supports their view.

4. Conduct the silent debate as described above. Make sure that each student identifies on paper which arguments reflect his or her effort. By collecting these papers, you will have a snapshot of some persuasive skills that each student was able to demonstrate. Use this information to determine additional experiences necessary for students to build these skills. The ability to use evidence to persuade others is an important part of the "Assess" section of this unit.

Extend: "The Final Frontier Part 4: Space Age Technology" provides examples of the interconnections between space exploration and developments in scientific research in the areas of intelligence gathering (keyhole satellites), communications (new cell phones), medicine (breast cancer research), and the new area of space tourism. In the student activity that accompanies this video, students will make the connection between these space-age technologies and the influence they have on society. This information not only addresses the United States History Standards, but it is also critical in helping students make an informed argument in the assessment activity.

1. Ask students to refer back to their timelines from the "Explore" section. Ask them to consider the second tier in which the impact of society was noted. Have students identify those events that resulted in a tangible benefit to society.

2. Explain to students that one does not have to travel to space to receive benefits from the space program. Have students read the information located at http://www.sti.nasa.gov/tto/ that explains how NASA's missions' technologies are often translated into applications that can be used in everyday life.

3. Show the video "The Final Frontier Part 4: Space Age Technology." Distribute the student activity sheet to each student. For each video segment, students should write down how the space program has benefited and influenced society. Students can then transfer this information to their group timelines.

4. Ask students to conduct research about one of NASA's spin-offs by using the NASA Spin-off Database located at http://www.sti.nasa.gov/tto/spinselect.html. Students can enter subjects into the search function and receive an abstract about that spin-off. Recommend that they search using terms such as surveillance, medicine, agriculture, and consumer. Students should write a short summary of each spin-off they read about and how this spin-off influences society.

5. Print, copy, and distribute the Student Text, "What Goes Around Comes Around," located at http://deepimpact.jpl.nasa.gov/collaborative_ed_module/4clarify/STWhatGoesAround.pdf. This text describes how science drives technology and how technology is essential to science, using the telescope as an example. Have students construct a T-Chart that illustrates the reciprocal nature of science and technology. Instruct students to describe another example of the reciprocal nature of technology and science on the back of the student sheet.

Assess: Present to the students a hypothetical situation where there is a proposed dramatic cut in space exploration funding. Using everything they have learned in this unit, students will participate in a policy hearing where everyone can voice their views based on a predetermined perspective. Students will assume roles of various stakeholders. These stakeholders include scientists, engineers, and the interested public (e.g., environmentalists, politicians, teachers, students, and others). Although

students are encouraged to build the position of the role they are portraying, general guidelines are provided for them to follow. Throughout the delivery of their presentation, students must base the claims they present on evidence and logic. It is important for students to decide what evidence to use when developing their presentation packages. It is also important that they are prepared to defend certain evidence or anomalous data. Students should be able to demonstrate that they have given considerable thought to the manner in which they have chosen to communicate the techniques and methods they used to generate, analyze, and draw conclusions. Each group's views should relate to societal needs, desires, and opinions which are a part of the debate in this activity and a part of the decision-making process in which the students engage in as senators.

1. Tell students they are now going to use the information they gathered to present an argument for or against a proposed major cut in the space program. Explain that they will be assuming roles to present their case to a congressional subcommittee during a hearing in Washington, D.C. Examples of roles students are going to assume may include congressional subcommittee members, outside reviewer, teachers, students, and the media. Read the following scenario to your students.

Proposed Spending Cuts for the Space Program

Due to a number of enormous expenses from unexpected recent events, the United States government has been forced to consider dramatic cuts in funding for the space program. The Vice President has called on a Senate subcommittee to conduct hearings to determine the extent to which these cuts should be implemented and to determine both the short and long-term effects these cuts may have. The subcommittee has asked to hear testimonies from NASA officials, scientists, engineers, and private citizens in order to gain insight and input about the extent to which programs and funding cuts should be made. While all of the Senators have worked on space science committees in the past, this is the first time they have had to consider such dramatic cuts. They have their own opinions about how to make these cuts happen. However, it is in the best interest of the space program (administrators, scientists, and engineers) to convince the subcommittee to minimize the cuts and to at least maintain funding for existing missions and missions that have been planned to occur within the next 10 years. Stakeholders also include individuals who benefit directly from the space program (e.g., industry leaders, teachers, and medical professionals). However, there are a number of outspoken citizens who believe that the space program should be cut entirely or minimally restricted to those programs that have direct benefits. Many of these citizens contend that the recent events are much more important than funding missions to outer space. This hearing will be an important part of determining how the United States Space program will continue.

2. Select five students to play the role of the legislative subcommittee convening the hearing. Distribute the "Policy Hearing Role Sheets" to the other students and ask them to select the role they wish to play (or you may assign that role). If students choose their roles, you may need to ask for volunteers to switch to another role for the day, as it is important to have a fairly equal number of representatives for each role during the presentation. Students should realize that they will play each role at least once, so this should not be an issue.

3. During the presentations of other groups, students will assume various roles in the public forum. One

Teaching Tip

Students often enjoy preparing for roles with character traits and motivations specific to their character. You may wish to allow students to build upon their roles by incorporating a name and/or specific title for their character. This could even lead to research on the various occupations and specialized-careers available to students looking at the possibilities of a future in space science, astronomy, or even NASA. Some students might enjoy dressing the part of their role. Take care, however, to avoid stereotypes in extending the role-playing activity to this point.

representative of each role will be chosen to "officially represent" that role on a panel. Tell students that they must play the role of a panel representative during at least one presentation. They will play each role at least once, therefore, they will need to become familiar with each stakeholder part. Tell students that they will have 10–15 minutes at the start of the period to review the plans and procedures they will follow in their presentation. During that time, other students will work in different groups comprised of those students who will assume a particular role in the audience and the panel representative for that role.

4. Provide some in-class time to prepare for this hearing. Students should use all of the materials (timelines, video notes, etc.) from this unit to support their stance. Students should also conduct additional research to gather specific information that will make for a convincing argument during the hearing. The "Policy Hearing Preparation Sheet" should be given to students who need additional guidance in preparing for their role.

5. Ask students who are to present to move into their groups and go over their presentation quietly. Make sure they have all presentation aids, illustrations, data, notes, note cards, etc. ready and know the sequence in which they will present. They may be allowed to prepare the front of the classroom for their presentation. This could include posting any signage they wish (e.g., information that supports their viewpoint, data or evidence charts, graphs), preparing an overhead projector and screen, organizing transparencies, making sure computer and projector connections work, and so forth.

6. Students will assess each group presentation using an assessment rubric. Distribute a copy of the "Assessment Rubric." Explain what each category of the guide means, that the scores within each category represent a continuum, and that they should use the guide to assess on the continuum how each group did as they made their presentation. Students should note that some categories provided deal specifically with the evidence and other information that supports or does not support their argument. Other categories deal with delivery and presentation technique, preparedness, quality of visual aids, and so forth. Tell them you will also use a similar guide to assess each group. Note that the rubric contains space for you to add criteria of your own, if you choose to do so. You may even wish to design additional scoring criteria together with your students. Students should realize the importance of their responsiveness and participation in representing a particular audience and/or panel role. Now is also a good time to post the forum rules or distribute copies for students to review.

Teaching Tip

It is difficult for students to effectively critique their classmates, but the critique is an essential part of the learning they derive from this stage of the cycle. To help prepare them to accomplish this task effectively, you may use a short video of a group or individual making a presentation that is intended to be persuasive. Ask them to evaluate the presentation using a modified version of the critique guide. It is not necessary for the presentation to specifically deal with observation strategies. Students should compare and discuss the reasons why they assigned a particular score. You may even use a particular presentation from your own class if you see the need after the presentations have begun. Remember to acquire written permission from students prior to filming or using video or pictures of them for any purposes.

7. Ask a student group to conduct its presentation. Inform audience members to adhere to their roles during the presentation. Tell students to complete their critique of the group's performance and quality of its "case." Conduct your own assessment of the group as well. Allow at least five minutes at the end of the presentation for completing the critique.

8. Finally, the students playing the roles of the legislative subcommittee members should convene in front of the class, vote on the recommendation, and assemble a rationale that they will take back to their committee. This is the policy recommendation that will then be brought before the United States Senate for a vote.

RESOURCES

Burrough, B. (2000). *Dragonfly: NASA and the Crisis Aboard Mir*. New York: Harper Perennial.

Lovell J. & Kluger J. (1996). *Apollo 13.* Boston, New York: Pocket Books.

Slayton, D.K. Cassutt, M. (1995). *Deke!: U.S. Manned Space: From Mercury to the Shuttle*. Forge.

Vaughan, D. (1996). *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at Nasa.* University of Chicago Press (Trd).

Zimmerman, R. (1998). *Genesis: The Story of Apollo 8: The First Manned Flight to Another World*. New York: Dell Publishing Company.

URLs

http://deepimpact.jpl.nasa.gov/collaborative_ed_module/4clarify/STWhatGoesAround.pdf
Student text about the reciprocal nature of science and technology

http://voyager.jpl.nasa.gov/
Information about the planetary voyage of Voyager 1 and 2 from 1977-1989

http://www.hq.nasa.gov/office/pao/History/on-line.html
NASA History Online

http://www.nasm.edu/apollo
The Apollo program from NASA and the National Air and Space Museum's Center for Earth and Planetary Studies collection

http://www-pao.ksc.nasa.gov/kscpao/chron/chrontoc.htm
Space Shuttle Mission Chronology from NASA Kennedy Space Center

http://www.spacelink.nasa.gov/NASA.Overview/.index.html
An overview of the National Aeronautics and Space Administration

http://www.sti.nasa.gov/tto/
NASA Spin-off Online

http://www.xprize.org
The X PRIZE is a $10,000,000 prize to jumpstart the space tourism industry through competition between the most talented entrepreneurs and rocket experts in the world