

Science Matters: The Case of Plastics

Instructor's Manual

Introduction

Science is at the center of the most important policy questions facing our country and our world today. The goal of this program, *Science Matters: The Case of Plastics*, is to help students recognize the role of science in their lives and how scientific knowledge can make them better-informed citizens.

This unit teaches students about the current conflicts surrounding plastics. Omnipresent in our lives and with obvious benefits and pitfalls, plastics engender a great deal of passion and spirited debate among both proponents and detractors. Students will study the historical and scientific context behind these deeply conflicting perspectives and consider ways to reconcile the conflicts.

The role-playing game format allows students to explore many different points of view through their diverse characters, each of whom has a stake in the plastics question. While in character, students will participate in a hypothetical hearing before members of the Environmental Protection Agency (EPA), who are also played by students, to debate how the United States should regulate plastics. Before a final regulation can be accepted, students will have to reach a compromise with other groups.

The emphasis in this debate is on science, and many of the characters are scientists and researchers. But these characters focus on different findings, and their positions often exist in strong opposition to those of other characters. This project emphasizes that while science does help us understand the world, it does not provide easy solutions to all problems.

The game is divided into six main stages:

1. In the **Introduction**, students familiarize themselves with the issues and do research on their individual roles.
2. During the **Hearing Preparation**, students meet in their interest groups to prepare their arguments for the Hearing.
2. In the **Hearing**, each group presents its arguments and answers questions from the EPA Regulators.
3. In the **Intersession**, students are reorganized into three new groups to develop Regulation proposals that represent compromises among the interest groups.
4. In the final **Debate**, students present their proposals and the Regulators select a winner.
6. In the **Reflection**, students discuss the issues and lessons of *The Case of Plastics*, not in character, but from their own points of view.

This manual provides a detailed outline of the game structure and what should occur at each stage. A day-by-day summary follows for easier tracking during game play. Timing recommendations are included for each stage, although they can be adjusted to meet the needs of individual classes. This manual also includes information on student roles, reading assignments, and evaluation suggestions.

Intellectual Framework

This game is designed to help students understand and appreciate multiple viewpoints in a complex argument and to demonstrate the importance of science and history in contemporary issues. The project has four specific learning objectives:

- Students will be able to describe the molecular structure, the physical and chemical properties, and the development of plastics.
- Students will be able to develop coherent arguments regarding issues that affect their daily lives and to relate these arguments to public policy.
- Students will be able to think critically about how the history of science and technology relates to contemporary life and provides perspective in decision making for current policy issues.
- Students will be able to cultivate their ability to question simple narratives and to recognize and consider multiple viewpoints, especially with regard to the history of science and technology.

Assigned readings emphasize the historical context of debates over plastics. By understanding the historical context of their positions, students will be better able to contextualize their arguments, to employ historical examples, and to strengthen their positions.

Game Setting

Congress has determined that the problem of plastic waste needs to be addressed at the federal level. It has charged the Environmental Protection Agency (EPA) with developing a regulation to reduce plastic waste. Once the Regulation has been approved, it will acquire the force of law.

The EPA has chosen to convene a hearing of experts representing all sides of the plastics debate to provide comments, suggestions, and feedback. The EPA Regulators have provided a draft of the proposed Regulation to form a starting point for discussion. The participants have organized themselves into five interest groups in order to strengthen their positions through coalitions. Each group shares common goals and has prepared a list of recommendations for what the Regulation should include.

Students will play the roles of the experts and the EPA Regulators. During the Hearing students in the role of experts will answer questions from the Regulators. Students will subsequently develop formal proposals for the Regulation that they will present in the Debate. At the completion of the second round Regulators will select one of the proposals as the basis of the final Regulation.

Interest Groups and Roles

Health: Concerned with the danger plastics pose to human health, this group includes scientists and activists researching endocrine disruptors in plastics and plasticizers, as well as other potential effects of plastics and additives on human health.

Industry: As representatives of the plastics industry, members of this group argue against regulation. They promote the societal benefits of plastics and believe that industry self-regulation, education campaigns, and recycling programs are more effective than government regulation in limiting plastic waste.

Invention: These scientists who work in polymer development or with polymer technology tout the societal benefits of plastics and propose limiting regulation so as not to stifle innovation.

Sustainability: This group believes that the problems of plastics can be solved through innovation. They do not want to see the amount of plastic reduced; instead, they want the government to support the development of more efficient recycling methods, fuel recovery, bioplastics, and alternative materials.

Waste: These scientists and activists believe the problems of plastics cannot be solved without significant reduction in plastics consumption and the elimination of one-use, disposable plastics. They do not view recycling as an effective solution to the problem of plastic waste.

Regulators: These EPA representatives are responsible for crafting the final Regulation. During the hearings they will listen to the arguments of the other groups and ask questions. At the conclusion of the game they will vote for the Regulation they feel best addresses the issues. One Regulator will serve as the Chair and manage the Debate. If possible, this role should be given to a student with strong leadership and organizational skills.

The outcome of the game is based solely on the persuasiveness of the arguments made during the Debate. Each student will be given victory objectives to shape his/her argument and must work to ensure that those objectives are included in the final Regulation. The Regulators do not have victory objectives and cannot win the game. However, they determine the winner. Instructors may want to assign the roles of Regulator or ask for volunteers. Remaining roles can be randomly or strategically assigned to students as desired.

Students receive 10 points if the Regulators select their group's final Regulation. Regulators also rank the interest groups based on how well the final Regulation reflects their interests. Students receive an additional 1 to 5 points based on their group's ranking. Students therefore win the game by proposing the best compromise Regulation that also successfully advances the agenda of their group.

Game Play

The game is divided into several sections, and the timing is flexible. The introductory sections of the game should be spread over several weeks and interspersed with other units, allowing students time outside of class to research their positions. Activities discussed in the pregame section give teachers options based on interests, classroom needs, and time.

The Hearing, Intersession, and final Debate stages should be scheduled with as short a break as possible between each section. However, they can be spaced as necessary. The opening Hearing should take about 90 minutes of class time, while the final Debate will last 45 minutes to an hour. The Intersession can last for several days, but some of the work can be done outside of class.

The game is designed to be run mostly by students. The teacher's role is to moderate and ensure that play runs smoothly. You should step in whenever students need clarification or redirection. To avoid disrupting the Debate, adopt the role of an EPA fact checker, which will allow you to interrupt and clarify when students stray from the goals of the game.

All student materials for the game with the exception of the Student Journal are available on the *Case of Plastics* website. Students should be introduced to the website at the same time they are introduced to the project. It will be their main resource for learning about their characters and conducting research. The Student Journal is available only as a teacher resource because each teacher will choose which assignments students must complete.

Stage 1: Introduction

Timing: 1 to 2 weeks

Begin several weeks before conducting the Hearing. This segment contains a number of optional assignments and can involve as little or as much classroom time as available. However, students should have several weeks to complete readings and research outside of class. You can continue with other material during this time.

Classroom Activities

Day 1: Introduce Game

Briefly explain to students what the game is and how it will work. Emphasize that they will be taking on different characters and engaging in a debate to better understand not only plastics but also the importance of chemistry in their daily lives. Explain Assignment 1.

Assignment 1: Over a 24-hour period write down everything you touch that is made of plastic. At the end of that period review your list. Circle 3 things you could live without and 3 that you could not give up. Write down 3 objects you could easily replace with a nonplastic alternative.

Day 2: Review assignment results and discuss with students the importance of plastics in their lives. Assign the readings below to all students to help them prepare for the upcoming debates.

Reading

- Introduction to Game Scenario
- Science of Plastics
- History of Plastics

Additional Assignments (optional)

- *Categorizing Plastics*
 - Ask students to collect an example of a plastic item from 5 of the 7 plastic recycling codes.
 - Using the chart in the Science of Plastics document available on the website, have the students identify and list the polymer, structure, and uses of materials with each code.
 - Discuss with students what types of materials normally have recycling codes, what plastic items are not coded for recycling, and what sorts of challenges the diversity of plastics might pose for the recycling process.
- *Introductory Reflection:* After students complete the initial plastics recording activity, ask them to consider in writing what they already know about plastics and what their opinions are about plastics.
- *Reading Reflection:* Have students write a paragraph or two describing what they learned from either the History of Plastics document or the Science of Plastics document.

Additional Classroom Activities: Science of Plastics (optional)

There are many sources for teacher demonstrations and student activities that involve plastics. Some interesting activities include making rubber balls and rubber latex, making Slime from polyvinyl alcohol, and making Gak from borax and glue. If time permits, these activities can help students better understand the science of plastics and can help them further prepare for the debate.

The following websites provide details on a number of possible activities:

polymerambassadors.org

plastics.americanchemistry.com/teaching-plastics

www.chymist.com

pslc.ws/mactest/maindir.htm

Stage 2: Hearing Preparation

Timing: 1 to 2 weeks

This stage will require more classroom time than the Introduction but can be limited based on need. Students will need some class time to meet in their groups and prepare for the Hearing. If there is time, you may also choose to do mini-lessons on debating and debate preparation depending on student

experience. Again, ensure that students have sufficient time to read and prepare outside of class while continuing with other material in the classroom.

Classroom Activities

Review Game Structure: Provide a concrete explanation about what will happen during the debates. Explain that students will be divided into six groups, each with a different position on plastics. Review the “Introduction to Game Scenario” that was assigned to students during the Introduction period to ensure that all students understand the game setting and what is expected of them.

Each group wants the Regulators to select their proposal for the Regulation. That means each group must work to convince the Regulators that its position makes the most sense and must be adopted. Whatever their personal beliefs, students must argue from the point of view of their character. During the next few weeks they will be preparing for the Hearing and must learn as much as possible about their character, their character’s positions, and the positions of the other groups.

Assign Roles: These assignments may be completely random and done on the spot, or you may choose to group the students strategically in advance of the class meeting.

Roles are listed at the back of this manual along with a ranking system to determine which roles to assign based on numbers of students. There should always be five Regulators, and each Regulator should be assigned an interest group (Health, Industry, Invention, Sustainability, or Waste). Each Regulator will attend the introductory meetings for his or her assigned group and become an expert on that group.

Once students have role assignments, they need to name their character. This task can be done in or out of class but should take place within 24 hours. Encourage students to select props or costumes for their characters and to consider some sort of group prop or symbol to unify their interest group.

Allow students class time to explore the *Case of Plastics* website and specifically the page associated with their group. On this page students will find a more thorough description of their roles along with their victory objectives, writing assignments, and reading assignments.

Hearing Preparation: Students will need several days in class to work with their groups and to prepare their arguments and answers to questions for the Hearing. They will need to determine

- who will present their opening statement/argument;
- responses to each of the questions posed by the Regulators (listed on each group’s web page); and
- how they will respond to the other groups’ main arguments.

Be very clear about expectations during these meetings, and emphasize the goals above. Depending on student comfort level with debating, this process can be as structured as necessary, but intercede as

needed to ensure that students stay on task and topic. Consider providing a mini-lesson on debate preparation if students seem unsure how to proceed (see [Additional Classroom Activities](#) below).

The goal of the Hearing is for the Regulators to get as much information as possible about each group's position, so having clear answers to each question is important for every group.

REGULATORS: Members of this group will attend the preparation meetings of the interest group to which they were assigned. They will also each draft two questions to ask their group during the Hearing. During the last preparation meeting the Regulators will meet together as a group. During this time they will elect a Chair, who will run the debates, and a Vice Chair, who will handle timekeeping.

Note: You may at any time replace the Chair with the Vice Chair or another Regulator if the Chair is not adequately facilitating the Debate. This change may be accomplished by sending a message that the Chair has been called to another meeting or had to leave owing to a personal emergency. Therefore, someone else must fulfill the role of president.

Reading

- Regulation
- Group Case Study (different for each group)
- Individual Reading (assigned to each role)
- One additional article of the student's choice from Resource List (under the Resources tab on the website)

Assignments: Spaced across the pregame period as effective.

- *Character Name:* Each student will need to name his/her character. This task should be done within 24 hours of character assignments. Encourage students to get into character through the use of props and costumes.
- *Character Reflection/Introduction*
 - Each student will write a brief position paper on plastics from the point of view of his/her character. This paper will outline the character's opinions about plastics and what he/she thinks should be done.
 - Regulators will write a critical review of the interest group to which they have been assigned, considering the strong and weak points in that group's positions.
- *Interest Group Reflection:* Each student will write a paragraph or two that explains how his/her interest group fits into the wider history of plastics.
- *Article Review*
 - Each student should write one or two paragraphs about the article he/she chose from the online Resource List, indicating what the article taught him/her about plastics and how he/she will use that information in the debate to support his/her argument.

- If your students are using note cards for the Hearing, they should transfer the most important information from each article onto cards. These cards should clearly state the source of the information to help students use evidence to support their arguments.
- *Opposition Research:* Students should write a brief reflection that considers one main argument they expect each of the other groups to make. They should then provide a counterargument for each to support their position over the others. They should also reflect on any common ground between their group and the other groups.

Additional Classroom Activities (Optional)

Hearing Preparation: Students will have different comfort levels researching topics and preparing for debates. Spend some classroom time reviewing general debating tips to help them prepare.

- *Use of Evidence:* Arguments must be backed up with evidence.
 - Encourage the use of note cards to record particular points from the articles they read. They can then refer to these note cards during their presentations to back up their arguments.
 - If the use of note cards is unfamiliar to students, model how they would prepare and use note cards.
- *Opposition Research:* Students should be familiar with not only their arguments but also those of the other groups. Emphasize the importance of developing counterarguments as well as the ability to recognize common ground with the other groups.

Character Development: Some students may find it difficult or uncomfortable to take on the role of a character, especially if that character’s opinions do not align with their own.

- If time permits, spend some classroom time engaging students in thinking about their characters—how they dress and talk, how they spend their time, why they hold the positions they do, etc.
- For students who disagree with their character’s position, engage them in an exercise of empathy, understanding someone else’s point of view. Why does their character hold these opinions? What led to them believing these things? What is valuable about these positions?

Stage 3: Public Hearing

Timing: Two 45-minute class periods; or one-and-a-half 60-minute periods

The Hearing can take longer than this if time permits and students are interacting well, but it should be kept within reasonable time constraints to keep students on track.

Classroom Activities

Set-Up: If possible, hold the Debate outside the classroom to help create a new atmosphere for the students. All students should have at least one prop associated with their character. Encourage them to consider dressing as they think their character might at this Hearing.

Students should be seated so they can clearly see and address the Regulators, possibly by arranging the seats in a square or in a conference-room format with a head table facing the other groups. Students should sit with their interest groups, and all students should have a name card that identifies their character and group affiliation.

The Chair opens the first round of debate by briefly reminding everyone why they are there and explaining the way the debate will proceed.

Introductions: Each group will have 3 minutes to briefly introduce its members and present its main positions about plastics and how they should be regulated. These presentations will provide the other groups with a sense of all the positions.

While other groups are presenting and answering questions, students should take notes using the “Tracking Guide” (available in Teacher Resources sent with this manual). This task will ensure that students remain engaged, but it will also help them follow the other arguments and prepare their responses.

Questions: The Regulators will now ask questions, beginning with the questions provided on the website. These questions are intended to foster conversation among the groups. Regulators should encourage dialogue, asking the groups to respond to each other or clarify their positions in relation to other groups’ answers. Each group should be given the opportunity to answer first on one question. As the teacher, you may also intercede to encourage discussion and debate as warranted.

After asking the questions provided to them, the Regulators will proceed with asking the questions they wrote during the Hearing preparation. Each Regulator wrote two questions relating specifically to his/her assigned group. These questions will be directed to that specific group, but the other groups will have a chance to respond after the targeted group has answered.

As many questions as possible should be asked in the time permitted, and each Regulator should have the chance to pose at least one question to his/her assigned group. However, interaction between groups is the goal of this round, so if the discussion is proceeding well, do not force students to stop and ask new questions.

End questioning approximately 10 minutes before the end of the Hearing. The Regulators should then offer comments on what they have heard. They should say which arguments they found persuasive and give their thoughts about the final Regulation. They may also submit a ranking of the interest groups by performance and persuasiveness during the Hearing.

The Chair will then announce the following:

“Now that all attendees have had the opportunity to share their opinions and recommendations, the Regulators would like to receive formal proposals for the Regulation. However, no one group seems to

have all the answers. Therefore, all participants will be divided into three new groups. Each group must develop and agree to a formal set of recommendations for the Regulation. The panel will then reconvene to hear these proposals and will select one of the three.” **Note:** In large classes it may be necessary to divide students into four or five groups. The announcement should reflect that decision.

Winners: There is no official winner of the first round. However, at the end of the Hearing the Regulators can rank the groups in order of performance and persuasion. This ranking will provide motivation and feedback and help students prepare for the next round.

Stage 4: Intersession

Timing: No more than one week

If possible, the Intersession should occur in class within a few days of the Hearing and be followed closely by the final Debate. This timing will help students maintain momentum.

Classroom Activities

Divide the students into three new groups, with each new group having representation from each of the five original interest groups (excluding the Regulators). This process can be random, or you can strategically distribute the students. The goal is to encourage students to listen to the arguments and positions of other groups and to find common ground. The end result should be a regulation with more moderate provisions than those proposed by the individual groups. **Note:** For large classes you may choose to divide students into four or five groups.

Explain the new assignment to students. The goal has not changed: they still want a Regulation that emphasizes the aims of their interest group and character. But now to get their Regulation chosen (and win the game), they must also compromise. The Regulators want a regulation that incorporates ideas from different groups, so encourage students to compromise with the other members of their groups where possible while still promoting their character’s concerns.

Students must draft a formal proposal for the Regulators. The proposal should consist of a list of recommendations for the Regulation (similar to those given to each interest group at the beginning of the game).

Review the procedures for completing the Regulation before students begin work. The drafting of this proposal can be as structured as necessary depending on the class. Individual members of each group should propose provisions that must be voted on by all members. Only provisions with a majority of “yes” votes can be included. When completed, at least 80% of group members must vote to accept the Regulation before it can be presented to the Regulators.

Students should vote for a version that meets as many of their victory objectives as possible, realizing that they may not be able to achieve everything they wish. Encourage them to think creatively about ways to address the problems of plastics and achieve their character’s goals.

If the development and discussion of the new regulations cannot be completed in the classroom, digital forums may also be used to encourage student interaction. Students may create Facebook groups and discuss changes to the Regulation in that forum. If possible, it may also be helpful to create a wiki for the class or for each group, which would provide the students with another forum for discussion.

REGULATORS: During the Intersession the Regulators will observe the new groups while focusing on the upcoming vote. Allow time for them to sit in on the group meetings but also to meet together and discuss the arguments heard during the first round.

It may be helpful to have the Regulators outline their thoughts on the Debate and the upcoming vote in writing. This task would serve as a counterpoint to the regulation-writing assignment of the other students and would force the Regulators to clarify their positions.

Additional Assignments

- *Writing the new Regulation.*
- *Reflection on the Hearing:* Have students write several paragraphs in which they reflect, in character, on how the Hearing went for them and their group. They should explain where they thought their group made strong points, where they responded well to the other groups, and where their argument was weakest.
- *Intersession:* During the process of rewriting the Regulations, have the students reflect on the other members of their new groups. With which interest groups do they find it easiest to compromise? Which groups have positions that differ most from their own character? How has the arrangement of the group shaped the Regulation they have created?

Stage 5: Debate

Timing: One 45-minute class period

This stage can be extended if the class period is longer or if students are engaged in a productive debate that extends beyond the time. Large classes may also require more time.

Classroom Activities

Set-Up should be the same as for the first round, except students should be arranged in their new groups.

The Chair will once again call the session to order and remind the participants that they are meeting today to present their final versions of the Regulation. At the conclusion of today's session the Regulators will vote.

Each group will have 5 minutes to present its new version of the Regulation. The new regulations should be circulated in advance so students do not need to read them verbatim. Students should highlight areas of compromise and explain how this Regulation effectively addresses the problems of plastics.

Each group will then have 2 minutes to respond to the proposals of the other groups. Responses should be directed to the EPA Regulators but should specifically address the points to which they are referring.

Finally, the Regulators will have several minutes to ask questions of each group. Questions can be addressed to specific groups, but each group should be given the chance to respond to each question and to the responses of the other groups.

Final Vote and Winning the Game

Stop the Debate 15 minutes before the end of class. The Regulators should adjourn to another room to select the final version of the Regulation. If the Debate runs over and there is not enough time in the class period, allow the vote to continue into the next class period.

Each Regulator should have a chance to state which Regulation he/she found the most persuasive and make a case for why it should be accepted.

A vote will be taken on each of the regulations. If there is no clear majority, the Regulation with the fewest votes will be removed and a second vote will be taken.

After selecting the winning proposal, Regulators must determine which interest groups most successfully advanced their goals in the Regulation. They will rank the interest groups in order of effectiveness based on their representation in the final Regulation.

When the vote is finished, the Regulators will return to the class, and the Chair will announce the decision. He/she will also announce the most successful interest group(s).

Regulators should then take the time to explain why they chose the Regulation they did. This step is important because it allows the students who presented arguments to know what the Regulators found persuasive. It is also important that the Regulators reflect on their decision.

Regulators will also explain why they ranked the interest groups as they did, drawing on specific clauses from the Regulation proposal that they feel support each interest group.

Scoring: Students receive 10 points if their Regulation is accepted. Members of the winning interest group each receive 5 points. The second-ranked group will receive 4 points; the third, 3; the fourth, 2; and the lowest-ranked group will receive 1 point.

MVP Awards: In the days after the game the teacher can give MVP awards for student performance during the game. These awards will allow you to recognize students who may not be in the winning group but who did an exceptional job in some aspect of the game.

Stage 6: Reflection

Timing: Immediately following the completion of the game.

The final classroom discussion and reflection assignment allow students the opportunity to reflect on what they have learned. The discussion should happen within a few days of the Debate.

Classroom Activity

Classroom Discussion: Encourage students to discuss what they learned, share how their ideas about plastics have changed, and listen to the opinions of their classmates. Questions for consideration include

- What did you learn over the course of this project?
- How did your character influence the way you thought about the issues?
- Has your view or understanding of plastics changed?
- What do you think of the result of the game? Do you think the best regulation was selected? What would you change?
- Do you think the United States needs to make policy changes related to plastics?
- Do you think there are things you can do as an individual or a class to help address concerns related to plastics?

One possible way to begin the postgame discussion is to ask the Regulators why they selected the version of the Regulation they did. What made it the best choice? Did any of them prefer a different version? Why?

Assignments

Written Reflection: All students should write a one- to two-page reflection on their experiences with this project. A possible written format for this assignment appears on the final page of the “Student Journal,” but this assignment does not have to be a paper. It can take whatever form you find most effective. The assignment should answer the following questions:

- How did the final regulation you and your group wrote fit the goals of your character?
- In what areas were you unable to achieve your character’s goals?
- What did you find most challenging about the compromise process? The most rewarding?

Community Program

You may choose to expand *The Case of Plastics* outside the classroom and into the community in a number of ways. A community program can serve as an opportunity for students to share what they

learned with their families, other students, and interested community members. By addressing a community forum, sending letters to elected officials, or finding other ways to engage the plastics debate outside the classroom, students will begin to see how science and their classroom experiences can have real-world implications.

A community event or action can take any form. Students may present the program as part of a larger event already scheduled to bring parents and community members into the school, or a separate event or events can be organized either at the school or another local venue to share the program with parents and community members. Students can present their regulation proposals to the audience and answer questions before audience members vote for their favorite regulation.

Game Play Outline

Timing for *The Case of Plastics* is flexible, and the timeline below is merely a suggestion to help guide implementation of the game.

Week	Day	Classroom Activities	Assignments
1	1	Introduce game to students	Plastic in Our Lives
	2	<ul style="list-style-type: none"> Review “Plastic in Our Lives” assignment Explain game in more detail Assign Introductory Readings 	
	3–5	Students read materials/complete assignments out of class	<ul style="list-style-type: none"> Categorizing Plastics Plastic Associations History and Science
2	1–5	Continue from week 1	Continue from week 1
3	1	Review game structure and rules; assign roles	Name characters
	2–5	<ul style="list-style-type: none"> Students research their character and positions Students meets in groups to prepare for Hearing Regulators research and meet with assigned group Optional: Lesson on Debate Preparation 	<ul style="list-style-type: none"> Introducing your Character Understanding your Interest Group Article Review Opposition Research
4	1–5	<ul style="list-style-type: none"> Students meet in groups to prepare for Hearing Regulators meet as a group to prepare for Hearing, write questions about their assigned group Optional: Lesson on Character Development 	Continue from week 3
5	1	Public Hearing	
	2	Public Hearing	
	3	Intersession Explain new assignment to students; organize new groups	Round 1: The Hearing Reflection
	4	Intersession Students meet in new groups to prepare Regulation proposal	
	5	Intersession Students meet in new groups to prepare Regulation proposal	Intersession Reflection
6	1	Final Debate	
	2	Final Debate/Vote	Round 2: The Debate Reflection
	3	Reflection, Conclusion, and Classroom Discussion	Final Reflection

Student Roles

The Case of Plastics is designed to be played with 20 to 33 students. Brief descriptions of the 33 distinct roles, grouped into 6 interest groups, are found below along with priority ranking that explains which roles to assign based on the number of students in your class.

Roles marked with an (*) are required roles that should always be included. Numbers next to the roles indicate the order these roles should be included after the first 20 are assigned. For example, if you have 26 students, you will assign the first 20 roles and then the roles labeled 21 to 26, ending with the Recycling Reformer in the Waste group.

Regulator Group

*** Assistant Administrator, Office of Solid Waste and Emergency Response (Waste Expert)**

The person responsible for the EPA's hazardous-waste and solid-waste programs, the highest-ranking official at this hearing.

Reading Assignment: "The World's Largest Dump: The Great Pacific Garbage Patch," by Thomas M. Kostigen, *Discover Magazine*, July 10, 2008.

*** Director, Resource Conservation and Recovery Division (Invention Expert)**

The person responsible for all programs relating to hazardous waste, municipal solid waste, and sustainable-materials management, including extended producer responsibility.

Reading Assignment: "Plastic Man," by Monte Burke, *Forbes*, December 23, 2002.

*** Director, Materials Recovery and Waste Management Division (Industry Expert)**

An individual responsible for the recovery of solid waste, including plastics.

Reading Assignment: "Benefits of Plastics," by SPI: The Plastics Industry Trade Association.

*** Director, Resource Conservation and Sustainability Division (Sustainability Expert)**

An individual responsible for the sustainable use of resources, emphasizing recycling, recovery, and reuse.

Reading Assignment: "Reshaping Oil from Discarded Plastic," by Michael Kanellos, *New York Times*, "Green Blog," September 29, 2011.

*** Director, Science Coordination and Policy Division (Health Expert)**

The person who oversees the EPA's Endocrine Disruptor Screening Program.

Reading Assignment: "Chemical Safety Bill Has Diverse Support," by Maureen Swanson and Rebecca Roberts, *Philadelphia Inquirer*, May 5, 2012.

Health Group

*** Researcher and Antitoxicity Advocate**

An expert on environmental toxins and environmental law, with a particular interest in the effect of chemical toxins on children.

Reading Assignment: “The Environmental Toll of Plastics,” by Jessica A. Knoblauch, *Environmental Health News*, July 2, 2009.

*** Researcher of Endocrine Disruptors**

A research scientist concerned about the poorly understood but potentially devastating effects of endocrine disruptors on human and animal populations.

Reading Assignment: “Endocrine Disruptors,” by the National Resources Defense Council.

*** Academic Researcher**

A professor and scientist who studies the intersection between molecular science and public policy and harbors deep concerns about the potential toxic effects of plastics.

Reading Assignment: “Surrounded by Plastic, NICU Infants Tested for Risk,” by Jon Hamilton, National Public Radio, May 19, 2009.

25. Senatorial Aide

A legislative aide to a Senator who is a strong proponent of the “Non-Toxic Child Act” and is interested in seeing elements of that law in the new regulations.

Reading Assignment: “Chemical Safety Bill Has Diverse Support,” by Maureen Swanson and Rebecca Roberts, *Philadelphia Inquirer*, May 5, 2012.

28. Antitoxicity Activist

A marine biologist and director of NOAA’s Marine Debris Program, who is concerned about the toxic effects of plastic trash in the oceans.

Reading Assignment: “Plastic Breaks Down in Ocean, After All—and Fast,” by Carolyn Barry, *National Geographic News*, August 20, 2009.

Industry Group

*** Pro-Plastic Bag Advocate**

A lawyer who has supported many environmental causes, fought many difficult battles, and firmly believes plastic bags cause less harm than their alternatives.

Reading Assignment: “Plastic Bag Bans Are Bad for the Environment,” by Angela Logomasini, Competitive Enterprise Institute, November 8, 2011.

*** Representative of Plastics Manufacturers**

A chemist who began by developing new applications for polymers, then moved into sales and marketing before assuming a corporate position to promote the plastics industry.

Reading Assignment: “EU REACH and U.S. Regulation of Chemicals and Chemical Users,” by the National Electrical Manufacturers Association (NEMA).

*** Toxicologist**

A scientist who studies endocrine disruption in human and animal populations and who finds weak scientific evidence that endocrine disruptors have adversely affected human populations.

Reading Assignment: “Is It Time to End Concerns over the Estrogenic Effects of Bisphenol A?” by Richard M. Sharpe, *Toxicological Sciences*, December 7, 2009.

21. American Chemistry Council Representative

A lobbyist combining a love of science with years of experience in corporate law to protect the legal interests of the plastics industry.

Reading Assignment: “Phthalates: Oral Statement of the American Chemistry Council,” June 12, 2008.

27. Representative of Coca-Cola

The head of marketing and communication for Coca-Cola’s sustainability initiatives who is proud of the changes these initiatives have brought about.

Reading Assignment: “Interview with the General Manager of Coca-Cola PlantBottle Packaging,” by interbrand.com.

31. Society for the Plastics Industry Lobbyist

A chemist and a lawyer with the Society for the Plastics Industry who has a long history working to protect the rights of the industry.

Reading Assignment: “Recycling Plastic Bottles,” by Amanda Wills, *Earth 911*, June 8, 2009.

Invention Group

*** Polymer Scientist**

An accomplished scientist whose achievements in polymers made cell phones and other electronic devices possible.

Reading Assignment: “Plastic Electronics,” video, www.youtube.com/watch?v=Pr9s2of80xU.

*** Inventor of New Polymers**

An inventor whose polymer developments have applications in medicine, space exploration, textiles, and electronics.

Reading Assignment: “Green Chemistry Discovery Could Lead to Safer Plastics,” by Brian Clark Howard, *Atlantic*, March 15, 2011.

*** Polymer Scientist—Medical Applications**

The cofounder of a successful research company that develops polymers for medical applications.

Reading Assignment: “Plastic Man,” by Monte Burke, *Forbes*, December 23, 2002.

23. Polymer Scientist interested in Innovation

A scientist who works in research and development for a chemical company to improve the use of polymers in new technologies.

Reading Assignment: "Plastic Logic: From Innovation to Impact," University of Cambridge Research Features, August 1, 2009.

29. Plastic Bridge Developer

A structural engineer who has designed and built plastic bridges for government clients and who wants to promote the wider adoption of plastic bridges.

Reading Assignment: "McLaren Engineering Recognized for High-Load 'Plastic' Bridge," by McLaren Engineering, October 18, 2011.

33. Inventor of Medical Equipment

An entrepreneur who has helped advance medical treatment through inventions and who credits success to the availability and versatility of polymers.

Reading Assignment: "Plastic Man," by Monte Burke, *Forbes*, December 23, 2002.

Sustainability Group

*** Plastic-to-Oil Recycling Pioneer**

An engineer who developed technology to return plastic to its constituent parts, allowing for fuel recovery.

Reading Assignment: "Reaping Oil from Discarded Plastic," by Michael Kanellos, *New York Times*, "Green Blog," September 29, 2011.

*** Plastic Recycling Reformer**

An engineer who developed a new recycling method that is more efficient and sustainable than traditional recycling.

Reading Assignment: "Plastic Recycling Is a Work in Progress," by Claudia H. Deutsch, *New York Times*, March 30, 2002.

*** Corn-Based Bioplastic Executive**

A corporate leader who runs a highly successful company producing corn-based plastics for the rapidly expanding sustainable-materials market.

Reading Assignment: "I Have Just One Word for You: Bioplastics," by Mara Der Hovanesian, *Business Week*, August 13, 2008.

22. Bioplastics Innovator

An inventor of a bioplastic made by the action of microbes on plant material that, if the process can be conducted on a large scale, would lead to true sustainability.

Reading Assignment: "In the Fight against Plastics, Mushrooms Become an Unlikely Weapon," by Bernhard Warner, *Business Week*, January 14, 2013.

30. Scientist Investigating Biodegradability

A scientist who is working on the development of microorganisms that break down plastics in an effort to reinvent the plastic-disposal landscape.

Reading Assignment: “Case Study: Breaking Down Plastics,” by the Georgia Tech Research Institute.

Waste Group

*** Great Pacific Garbage Patch Activist**

An environmentalist who first brought public awareness to the pollution in the Pacific Gyre and who continues to conduct research and promote the awareness of marine pollution.

Reading Assignment: “The World’s Largest Dump: The Great Pacific Garbage Patch,” by Thomas M. Kostigen, *Discover Magazine*, July 10, 2008.

*** Anti-Waste Activist and Blogger**

An individual who writes about efforts to eliminate plastics from daily life and who encourages others to do the same.

Reading Assignment: “Plastic Bags Are Killing Us,” by Katharine Mieszkoski, *Salon*, August 10, 2007.

*** Representative of Plastics Pollution Coalition**

A marine biologist deeply concerned about the danger plastic trash poses to marine animals and ecosystems.

Reading Assignment: “Companies Pick Up Used Packaging, and Recycling’s Cost,” by Stephanie Strom, *New York Times*, March 23, 2012.

24. Artist and Anti-Waste Activist

An artist who uses plastic trash to create art as a form of advocacy against waste.

Reading Assignment: “The Fatal Shore, Awash in Plastic,” by Mark McDonald, *New York Times*, August 23, 2012.

26. Recycling Reformer

A lobbyist who promotes the passage of new recycling legislation at local and state levels.

Reading Assignment: “Seven Common Misperceptions about Plastic,” by the Berkeley Plastics Task Force, April 8, 1996.

32. Expert on Plastic-to-Oil Recycling

A scientist who is deeply concerned about the problems of plastic waste in the environment and who sees innovative recycling as the most viable solution.

Reading Assignment: “Plastics and Energy Recovery,” by Jennifer Killinger, American Chemistry Council, March 1, 2011.

Student Readings

Student readings should be assigned in stages as the game is introduced. Students should first read introductory materials assigned to all participants before they receive their interest group and character-specific reading assignments. Though limited class time may be spent on the game during this introductory period, it is important that students have adequate time to read and reflect on all materials and research their role.

All student reading materials are available on *The Case of Plastics* website. Background materials that all students must read are listed on the website home page and each group page. The group pages also contain all information students need to learn about their group and their role, including a list of group goals and detailed role sheets for each character. Assigned readings, video, and audio files specific to each group and individual character can also be found on the group pages.

A substantial list of articles, videos, audio files, and other sources can also be found in the online Resource List. Students will need to read at least one source from the list and should explore others in order to learn as much as possible about their position and those of the other groups. Students are encouraged to do independent research outside the required readings, and the bibliography is an excellent place to begin.

Evaluation and Assessment

Students should be evaluated throughout the game process on their performance. Suggestions for assignments and evaluation opportunities are provided throughout the Instruction Manual as a guide to assessment. Sample rubrics also are provided below for three different areas of evaluation: game play, debate, and writing. The writing rubric can be used with any of the proposed writing assignments throughout the exercise, and the combined rubrics can serve as a starting point for developing an evaluation system for the project.

WRITING

	Excellent	Good	Fair	Inadequate
1. Content	Demonstrates a superior understanding of topic. Responds effectively to all aspects of the assignment. Exceptional use of sources and evidence where applicable.	Responds adequately to all aspects of the assignment. Demonstrates strong understanding of topic. Uses evidence as appropriate.	Responds to appropriate question/topic but shows limited understanding of topic. Limited use of supporting evidence.	Demonstrates little understanding of or misreads the assignment. Offers little or no analysis or evaluation of topic.
2. Organization and Argument	Connections between and among ideas are made. Independent thinking and creativity are evident. Claims and ideas consistently supported with evidence as necessary.	Good sense of flow and connection between ideas. Claims and ideas clearly stated and mostly supported with evidence when appropriate.	Examples used to support some points but not consistently. More description and personal opinion than critical thinking. Evidence may at times be used inappropriately.	Very little or very weak attempt to relate evidence to argument; may be no identifiable argument or no evidence to relate it to.
3. Quality of Writing	Sentence form and word choice are varied and appropriate. Punctuation, grammar, spelling, and mechanics are appropriate. Readability enhanced by facility in language use.	Clearly readable. Occasional errors in grammar, sentence structure, or spelling.	Generally readable but with consistent errors in grammar, sentence structure, or spelling. Little evidence of editing. Reading may be occasionally hampered by unclear language.	Writing is unedited or contains numerous errors. Readability seriously hampered by awkward or unclear language.

GAME PLAY

	Excellent	Good	Fair	Inadequate
1. Engagement	<p>Brings memorable flair to playing the role. Inspires other students to engage more fully. Vocal and active in deliberations.</p>	<p>Vocal and active in deliberations. Remains in character and stays focused on goals of character and group.</p>	<p>Attentive to deliberations and debates. Remains generally focused on goals of character and group.</p>	<p>Reluctant or resistant to the exercise. Limited participation in classroom activities.</p>
2. Interpersonal	<p>Demonstrates leadership and suggests strategy during game play. Able to respectfully challenge ideas presented by other students and work effectively toward compromise.</p>	<p>Strong presence in group discussions with good ideas but not necessarily a group leader. Willing to challenge the ideas of other students, although not always in a polite manner. Sometimes willing to compromise.</p>	<p>Adequate level of engagement with group. Not consistently respectful of other players. Defensive or diffident when criticized. Active in the game, but more of a follower than a leader.</p>	<p>Does not effectively engage with other players. Either arrogant and dismissive of suggestions or diffident and silent. Unwilling to engage in conversations.</p>
3. Intellectual	<p>Strong grasp of the complexities of the issues involved. Understands points of view beyond that of the student's own character or group. Demonstrates willingness to understand and empathize with multiple viewpoints.</p>	<p>Good understanding of issues. May struggle with compromise but generally displays efforts to understand multiple viewpoints.</p>	<p>Basic understanding of issues being debated. May miss some important points. Good knowledge of student's own issues, but lacks comprehensive grasp of the big picture.</p>	<p>Little to no evidence of understanding even of student's own perspective.</p>

DEBATE

	Excellent	Good	Average	Inadequate
1. Content	Demonstrates full knowledge of the topic. Makes accurate assertions and supports them with appropriate evidence. Shows mastery of and effectively counters opposition arguments. Comfortably answers questions.	Demonstrates strong knowledge of topic and makes accurate assertions, usually backed up with evidence. Shows passing familiarity with opposition arguments. Able to comfortably answer most questions.	Information is generally correct, although rarely supported with evidence. Some errors and/or omissions demonstrate less than full mastery of the issues. May struggle to answer questions and shows little knowledge of opposition arguments.	Presentation is vague and nonspecific with little or no factual support. Student makes factual errors or omits important points of information. Student is unable to respond to questions.
2. Organization and Argumentation	Presentation is clearly organized with effective introduction and conclusion with clear evidence of planning. Evidence introduced with a clear purpose.	Presentation has discernible organization with introduction and conclusion. Evidence and statements generally support the main arguments.	Presentation demonstrates some grasp of organization, with a discernible theme and use of supporting details.	Presentation lacks focus or rambles, with main theme and supporting details presented in a disorganized way. Details are introduced without purpose.
3. Presentation	Delivery is engaging and dynamic. Language choices, rhetoric promote engagement. Excellent voice control, eye contact, and physical demeanor.	Delivery is smooth and effective with clear evidence of preparation. Good voice control, eye contact, and demeanor.	Speaker appears proficient with language and vocal and physical expression but may reveal a lack of sufficient preparation.	Speaker appears unpracticed and uses many vocal crutches. Problems with voice control, eye contact, or posture. May use inappropriate language for forum.

Standards

Science Matters: The Case of Plastics correlates with the Common Core State Standards for English Language Arts and Literacy and the Next Generation Science Standards. The connections are outlined below. For the Next Generation Science Standards, each relevant topic is identified as are the performance expectations, science and engineering practices, disciplinary core ideas, and crosscutting concepts within each topic addressed by this game.

Please note that these standards correlations may or may not be relevant depending on exactly how you implement the game in your classroom and what additional lessons you choose to include. We strongly recommend that you evaluate each suggested standard below for its applicability to your experience.

Common Core State Standards for English Language Arts/Literacy

- **Reading: Science and Technical Subjects**
 - RST.11-12.1 Cite specific textual evidence to support analysis of science and technical text, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
 - RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words.
 - RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.
 - RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
 - RST.11-12.8 Evaluate the hypothesis, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
 - RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- **Writing: History/Social Studies and Science and Technical Subjects**
 - WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
 - WHST.9-12.7 Conduct short as well as more sustained research products to answer a question (including self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding on the subject under investigation.
 - WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

- WHST 9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
- **Speaking and Listening**
 - SL 11-12.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
 - SL.11-12.5 Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Next Generation Science Standards

Topic: HS Structure and Properties of Matter

- **Performance Expectations**
 - HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
- **Disciplinary Core Ideas**
 - PS1.A: Structure and Properties of Matter
 - PS2.B: Types of Interactions
- **Crosscutting Concepts**
 - Patterns
 - Structure and Function

Topic: HS Engineering Design Standards

- **Performance Expectations**
 - HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
 - HS-ETS1-3 Evaluate a solution to a complex real-world problem, based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- **Science and Engineering Practices**
 - Asking Questions and Defining Problems
 - Constructing Explanations and Designing Solutions
- **Disciplinary Core Ideas**
 - ETS1.A: Defining and Delimiting Engineering Problems
 - ETS1.B: Developing Possible Solutions
 - ETS1.C: Optimizing the Design Solution
- **Crosscutting Concepts**
 - Systems and System Models
- **Connections to Engineering, Technology and Applications of Science:**
 - Influence of Engineering, Technology, and Science on Society and the Natural World

Topic: HS Human Sustainability

- **Science and Engineering Practices**
 - Constructing Explanations and Designing Solutions
 - Engaging in Argument from Evidence
- **Disciplinary Core Ideas**
 - ESS3.A: Natural Resources
 - ESS3.C: Human Impacts on Earth Systems
 - ETS1.B: Developing Possible Solutions
- **Crosscutting Concepts**
 - Cause and Effect
 - Stability and Change
- **Connections to Nature of Science**
 - Science is a Human Endeavor
 - Science Addresses Questions about the Natural and Material World