

LESSON 5:

Who Should Decide Basic Science Funding?

A Structured Academic Controversy

INTRODUCTION

In this lesson, students participate in a *Structured Academic Controversy* around the question, “Should citizens determine funding for scientific research?” The general public can often see the importance of human research and clinical trials, but they may not be able to see the value of **basic research**, especially when budgets are tight. The National Science Foundation (NSF) distributes funds for basic research, and because the research is not always directly applicable to a health treatment or cure, questions can be raised about its usefulness. There have been debates about the applicability of some of the research funded by the NSF, in which it was implied that these studies were a waste of taxpayer money. This led to a suggestion by a U.S. Representative that American citizens should be able to help decide which research projects get funded by the NSF. Students explore both sides of this issue before examining their own views.

CLASS TIME

One class period of 55 minutes.

KEY CONCEPTS

- The usefulness of basic science research is not always obvious to the general public.
- The amount of taxpayer money spent on basic scientific research can be debated to make sure that it is spent wisely.
- The scientific research community uses peer review to help determine what projects should be funded.

LEARNING OBJECTIVES

Students will know:

- Basic science research can be useful in the future for **translational research** but may not be seen as useful by the general public.
- The amount of money spent on scientific research is not a huge part of the federal budget.
- It is important to be skeptical of information, especially if it has gone through many filters.

Students will be able to:

- Look at two sides of a controversy and decide how money should be spent.

MATERIALS

Materials	Quantity
Student Handout 5.1— <i>Structured Academic Controversy Worksheet</i>	1 per student
Possible Answers to Student Handout 5.1— <i>Structured Academic Controversy</i>	1
Student Handout 5.2a— <i>FOR: Citizens Should Have Input</i>	2 per group
Student Handout 5.2b— <i>AGAINST: Citizens Should NOT Have Input</i>	2 per group
Student Handout 5.3— <i>Homework: Your Own Stand on Science Funding</i>	1 per student
Teacher Resource 5.1— <i>The Federal Budget: How Do We Spend our Money?</i>	1
Computer with PowerPoint and overhead projection	1
<i>Basic Science Funding Slide Set</i> found at http://nwabr.org	1

NOTE TO THE TEACHER

The National Science Foundation (NSF) provides funding for about 20% of the basic scientific research conducted by colleges and universities through grants and awards (NSF, 2010 April). The NSF has a budget of about \$6.9 billion, which may seem like a lot, but is actually only about 0.2% of the total \$37 trillion U.S. budget. The NSF uses an extensive review process, asking at least three experts in the relevant field to help determine which projects should be funded (NSF, 2010 May). This research is also evaluated on its intellectual merit as well as its societal applicability (NSF, 2010 May). NSF primarily funds basic science research, which can be seen by some as useless or frivolous because its benefit to society is not always obvious. This is especially a problem in tough financial times with a huge federal deficit. Some Congressional leaders have questioned certain NSF projects that seem to have limited applicability to society, and have asked that the American people have more direct oversight of funding decisions.

TEACHER PREPARATION

- Make copies of *Student Handouts*.
- For showing the PowerPoint slide set, prepare the computer and projection unit. Download the *Basic Science Funding Slide Set*.

PROCEDURE

Part I: What Do You Think...

1. Write these questions on the board or show the corresponding slide from the *Basic Science Funding Slide Set*:
 - “Who do you think should have a say in what scientific research gets funded in the United States?” (*Examples could include: Expert scientists in the field, the state, or federal government; the researchers themselves; voters; an online survey of random people; a university or research institution; etc.*)
 - “About what percentage of the federal budget do you think the U.S. government spends on basic science research?”

[**Note:** The actual percentage of the federal budget spent on basic research will be revealed to students after the activity. Please **do not** share the number with them now.]

2. Solicit student responses to the questions.
3. Continue with the Structured Academic Controversy as described in **Part II**.

Part II: Structured Academic Controversy

[**Note:** *Structured Academic Controversy* is a text-based, small group deliberation model in which students explore both sides of an issue before examining their own personal views. Active listening is an important part of the process.]

4. Tell students that they will be exploring the following ethical question: **“Should citizens determine funding for scientific research?”** Students will be presenting either FOR or AGAINST viewpoints assigned to them, and not relying on their personal opinions.

[**Note:** The *Basic Science Funding Slide Set* can be used to show students the steps in the *Structured Academic Controversy*.]
5. Divide the class into groups of four students each for the *Structured Academic Controversy*. Each group should have two students who are FOR and two students who are AGAINST citizens helping decide funding questions. Students may sit down with their groups at desks.
6. Explain the framework of a *Structured Academic Controversy*. The basic framework is:
 - Two students represent the FOR position; two represent the AGAINST position.
 - Each pair reads background for their position and prepares their argument.
 - The FOR pair presents while the AGAINST pair listens.
 - The AGAINST pair paraphrases the FOR pair’s arguments and asks clarifying questions only.
 - The AGAINST pair presents while the FOR pair listens.
 - The FOR pair paraphrases the AGAINST pair’s arguments and asks clarifying questions only.
 - Students drop their assigned roles and discuss their personal positions.
 - Students clarify areas of agreement and disagreement.
7. Remind students of the classroom norms. For example, students should speak one at a time, hear all sides equally, listen well enough to respond, and back up their opinions with clear reasons.
8. Pass out copies of Student Handout 5.1—*Structured Academic Controversy Worksheet*, one per student. Pass out copies of Student Handout 5.2a—*FOR: Citizens Should Have Input* to two members of each group. Pass out copies of Student Handout 5.2b—*AGAINST: Citizens Should NOT Have Input* to the other two members of each group.

9. Tell students that each pair should read the background information supporting their position and fill out the **Relevant Facts** section of the worksheet (see Student Handout 5.1).
10. Challenge each pair to plan a presentation of their position and arguments. Students should focus on the **three most important arguments** that best support their position.
11. **One side presents, the other side listens and repeats.** One side presents their important arguments to the other side. The other side needs to listen carefully, take notes, and then paraphrase the arguments back to be sure that they understand them, asking clarifying questions as necessary. Emphasize that there is no discussion at this point. The presenters should be satisfied that their position has been heard and understood.
12. **The pairs switch** presentation roles and the process is repeated.
13. **Students drop their roles.** Students proceed as their individual selves, using information from their experiences as well as the background readings.
14. Share with students the following prompt: “See if you can clarify areas of agreement and disagreement. Feel free to change your mind.”
15. Help students finish Student Handout 5.1—*Structured Academic Controversy Worksheet*. Students might have difficulty coming up with possible solutions. See Teacher Resource 5.2— *Possible Answers to Structured Academic Controversy Worksheet* if you think they need help finding compromise.
16. Show students the answer to the question: “About what percentage of the federal budget do you think the U.S. government spends on basic science research?”

The budget of the National Science Foundation is about \$7 billion out of \$3.7 trillion, or about 0.2%. The federal budget is 3.7 trillion. Show the math for students:

First, 3.7 trillion = 3,700 billion. Then,

$$\frac{7 \text{ billion}}{3,700 \text{ billion}} = .19\% \sim .2\%$$

17. Using the classroom projection system, display Teacher Resource 5.1—*The Federal Budget: How Do We Spend Our Money?* This image is also included in the *Basic Science Funding Slide Set*. This image displays the federal budget as a pie graph. Note that the top right budget is the entire federal budget of which 37% is **discretionary** spending, which gets debated by Congress every year. The pie graph on the bottom left shows how the discretionary budget is spent.

18. Point out to students that the **entire Science/Environment/Energy** budget is 6% of 37% of the total budget, or about 2.2% of the total budget.

[**Note:** This discussion is **not** intended to be a budget or debt crisis debate. It is just supposed to provide context for the amount of money being debated relative to the total federal budget. The titles on the pie chart are not nuanced enough to convey exactly how money is spent. For example, military spending includes the Pentagon, Department of Defense, wars, veterans’ benefits, health care for soldiers, etc. Education expenditures include higher education and K-12 education. Budget talks can be sensitive and bring up passions, especially at a time of financial uncertainty.]

19. Give students a few minutes (or talk as a class) to present the facts in the case (they may be able to pull this out of the readings, but you can also talk about it). Important facts from 2011 are:

- The National Science Foundation Budget is \$6.9 billion.
- This represents about 0.2% of the federal budget.
- The federal deficit (the difference between the budget and revenue) is \$14 trillion.
- The NSF funds 20% of basic research.
- Some people have questioned funding with taxpayer money studies they believed had limited benefit to society.
- Some have called for more citizen oversight of the National Science Foundation and its grant process to reduce this perceived waste.

Closure

20. Gather student attention back from the small groups, and ask for students to share some **common ground** reached in the argument.
21. Solicit student ideas about **how** and **why** funding decisions should be made for basic scientific research.

22. Talk to students about the way basic research is characterized as it goes through different filters—in this case the filters were the NSF grant proposal abstract, a senator and a representative (or their staff) reading those proposals, and the media picking up the study. A further way this information could be disseminated is through blogs and personal websites. How did the message about the nature of the research change as it went through those successive filters?
23. Tell students that this story illustrates the need to be skeptical and think about the possible biases or “context left out” that might be important to consider when they hear information that has been filtered through multiple sources.
24. Have students retrieve their *Unit Graphic Organizer* handouts and add new information to the organizer. Under “Role of Science and Society” they may add:
- Media influences societal views of science.
 - Society funds research and education it values.
25. Finally, look at the last column, “Being a Scientifically Literate Citizen.” Ask students to think about the role that politics plays in science; how does this impact them as members of society, potential taxpayers, and voters? Discuss their responsibility to be scientifically literate in their role as a **taxpayer** and **voter** and add those words to the *Unit Graphic Organizer*.

HOMWORK

Student Handout 5.3—*Homework: Your Own Stand on Science Funding* can be assigned as homework. The handout asks students to reveal their own opinions on science funding.

ADAPTATION

- If the reading level of the article may be an issue for some students, divide the class in half and have a strong reader from the group read the arguments aloud while the others take notes.
- Representative Adrian Smith was the one who called for citizens to be able to oversee NSF funding. You may want to share this video with students who may have difficulty with the article.

Representative Adrian Smith’s YouCut Citizen

Review (1:46 minutes)

<http://www.youtube.com/watch?v=LSYTS-nRt4o>

EXTENSION

- Another subject for a *Structured Academic Controversy* could be the cost of Gleevec (see Lesson Four). Gleevec costs between \$40,000 and \$90,000 a year. The question could be: “Should Novartis be able to charge so much for their medication?”
- There are many news stories that highlight some of the controversial studies. Students could explore these studies in more depth:

A Report from Senator Coburn’s Office on Spending at the National Science Foundation

http://www.coburn.senate.gov/public//index.cfm?a=Files.Serve&File_id=94c088f1-9629-4eaf-adce-e51331fc0601

Robot Folding Laundry

<http://www.wired.com/gadgetlab/2010/04/towel-folding-robot-could-fix-laundry-woes/>

Gender and Babies

<http://www.livescience.com/14323-genderless-baby-gender-anxiety.html>

Shrimp on a Treadmill

<http://www.livescience.com/4221-scientists-put-shrimp-treadmill.html>

Story of a 2013 Bill that Would Replace Peer Review at the NSF with a Set of Funding Criteria Chosen by Congress

<http://news.sciencemag.org/scienceinsider/2013/04/us-lawmaker-proposes-new-criteri-1.html?ref=hp>

GLOSSARY

Discretionary: Available to be used as needed or desired; discretionary spending refers to the fraction of the budget that Congress can spend as it chooses each year.

SOURCES

Cantor, Eric. (n.d.) Eric Cantor Majority Leader You Cut Citizen Review. Retrieved from <http://majorityleader.gov/youcut/review.htm>

Coburn, T. (2011). *The National Science Foundation: Under the microscope*. Washington, DC: U.S. Government Printing Office.

Congressional Budget Office. (2011). *Reducing the deficit: Spending and revenue options*. Washington, DC: U.S. Government Printing Office.

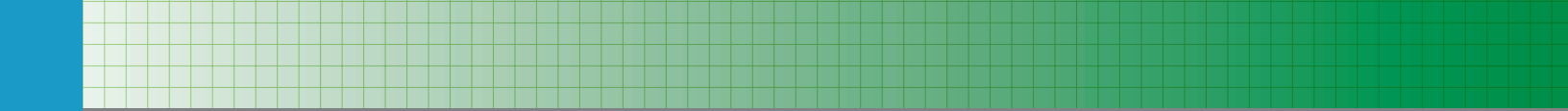
Congressman Adrian Smith launches the first YouCut Citizen Review. Video retrieved from <http://www.youtube.com/watch?v=LSYTS-nRt4o>

National Science Foundation. About the National Science Foundation. *National Science Foundation: Where Discoveries Begin*. Retrieved from <http://www.nsf.gov/about/>

National Science Foundation. How we work. *National Science Foundation: Where Discoveries Begin*. Retrieved from <http://www.nsf.gov/about/how.jsp>

Office of Management and Budget (2011). *Fiscal year budget of the U.S. Government*. Washington, DC: U.S. Government Printing Office.

Pappas, S. (2011, May 26). Scientists cry foul over report criticizing National Science Foundation. *Live Science*. Retrieved from <http://www.livescience.com/14353-coburn-nsf-funding-misleading.html>



STUDENT HANDOUT 5.1

Structured Academic Controversy Worksheet

Name _____ Date _____ Period _____

This Issue: *Should citizens determine funding for scientific research?*

Team Members **FOR**:

Team Members **AGAINST**:

1. _____

1. _____

2. _____

2. _____

Relevant facts:

Questions remaining:

Main argument(s) FOR:

1.

2.

3.

Main argument(s) AGAINST:

1.

2.

3.

List possible solutions (refer to the facts, remaining questions, and main arguments FOR and AGAINST):

Areas of agreement and disagreement:

Circle areas of agreement, above, to highlight common ground reached.

Possible Answers for STUDENT HANDOUT 5.1

Structured Academic Controversy Worksheet

This Issue: *Should citizens determine funding for scientific research?*

Relevant facts:

- *The National Science Foundation (NSF) Budget is \$6.9 billion.*
- *This represents about 0.2% of the federal budget, which is \$37 trillion.*
- *The federal deficit (the difference between the budget and revenue) is \$14 trillion.*
- *The NSF funds 20% of basic research in colleges and universities.*
- *In May 2011, Senator Colburn questioned studies that he believed had limited benefit to society and were therefore a waste of taxpayer money.*
- *Sometimes it may be hard for the average American to understand the relevance of basic research in science.*
- *There has been a call for more citizen oversight of the NSF and its grant process to reduce this perceived waste.*

Main argument(s) FOR:

1. *There is a \$14 trillion dollar budget deficit, which means that we need to be very cautious about funding “scientific” projects (e.g., art projects or studies about avatars) that represent frivolous or silly projects.*
2. *If we avoid funding these projects that have questionable benefit to society, we will be able to provide more funding for more relevant studies, like bar coding, the internet, or cloud computing, that have a clear benefit to society.*
3. *Citizens should be able to flag the questionable studies for further review. This doesn’t mean the studies will stop—it just means there will be further oversight. What are the scientists trying to hide when they don’t want oversight?*
4. *Our tax money helps fund these projects, so we should have a say in how that money is distributed, especially if the government wants to be transparent about how it is spending its money.*
5. *Not even all of the NSF reviewers thought that the work was transformative—they obviously need to be able to speak up more.*

Main argument(s) AGAINST:

1. *The NSF has an extensive review process by experts in the field for every project that is funded. In this review process, the project’s intellectual and societal impacts are evaluated.*
2. *Experts in one particular field are best positioned to evaluate studies, since they know the nuances and ins and outs of that particular study and can see how it will be relevant.*
3. *Much basic science research did not seem relevant at the time (e.g., laser, looking at cells under a microscope) but has proven to benefit society later on. You don’t want to stifle science.*
4. *To remain competitive in the future, we need to continue to fund these projects that have been extensively reviewed, and only represent a fraction of a percent of the federal budget.*
5. *If the people who had criticized the work had actually talked to the researchers, the researchers could have told them the relevance of their projects. There is only so much you can put in an abstract on the NSF site, especially when you are submitting a proposal to experts in the field who understand background that the general public may not have.*

List possible solutions (many solutions are possible here):

1. *Keep the approval process as it is—there are enough checks and balances in the extensive peer review process the NSF undergoes to make sure that only relevant projects are funded.*
2. *Provide an extra step in the NSF review process that allows any citizen or concerned party (for example, a government representative) to review the proposals and vote on/bring up projects that waste taxpayer money. This would be done **before** money is given out.*
3. *Allow citizens to flag studies that concern them after reading the proposals on the NSF site so that they could be further reviewed by specific non-partisan experts if there are too many flags. Funding could be pulled if the research was determined not to be “transformative.”*
4. *Add an additional oversight committee as an extra step in the review process, with a place for concerned citizens, relevant government representatives, and scientists in the field who will further review the projects. It should **not** just be scientists that review these projects. This does not mean that there won’t be funding, it just means that there will be more oversight.*
5. *A group from the NSF, in a transparent process, should develop a document that clearly states their position on transformative science research and lays out more clearly the connections between basic science and societal impacts. This document should be used in the review process by all the reviewers, and should be open to citizen comment.*

Circle areas of agreement, above, to highlight common ground reached.

This depends on student conversations. If they have a hard time, have them think about either extreme (NO oversight to CONSTANT oversight) and then work toward the middle.

STUDENT HANDOUT 5.2a

FOR: Citizens Should Have Input

Name _____ Date _____ Period _____

The United States federal budget is complicated—Congress needs to prioritize spending and keep our government going. In tight budget times, all expenses need to be justified, and waste should be reduced. In April 2011, Senator Coburn of Oklahoma produced a report questioning some National Science Foundation (NSF) spending. NSF is the primary federal entity through which basic science research is funded with taxpayer money. Some people consider basic research to be a misuse of taxpayer funds, especially in tight budget times when we have a \$14 trillion budget deficit.

Senator Coburn is a practicing physician and cancer survivor who has an understanding of and appreciation for the benefits of science research. He says that scientific research can, "...transform and improve our lives, advance our understanding of the world, and create meaningful new jobs" (Coburn, 2011). In his report, he recognizes that America needs to remain a leader in math and science, but expresses concern that some of the money invested in NSF research is wasted or misused.

Although the NSF has made significant contributions to science, a significant amount of money goes to research that many of us would consider wasteful, frivolous, or even fraudulent, according to the report. The NSF could contribute much more if its resources were better managed and if the studies that are chosen and funded were better supervised. This report identifies over \$3 billion in potentially mismanaged funds at NSF, which has a yearly budget of \$6.9 billion. This includes money spent on questionable studies, funds given out for research but not used, unnecessary overspending, and a lack of accountability in communicating study results.

Some of the dubious research questions NSF has funded include: how to ride a bike, whether boys like to play with trucks and girls with dolls, how rumors get started, how much housework a husband creates for his wife, and the best time to buy a ticket to a sold out sporting event. Most people would agree that NSF funds would be better spent on identifying more efficient, renewable fuels or fighting drug-resistant bacteria. NSF already has a peer-review process that checks for quality but this process does not effectively screen for worthwhile studies.

After this report was published, Representative Adrian Smith suggested that citizens who ultimately pay for research should have input into which studies the NSF funds. He proposed that citizens review the database of NSF proposals and flag questionable studies. These would then be investigated to determine whether the study had scientific value using guidelines suggested by Senator Coburn. Majority Leader Eric Cantor has launched a website, The *YouCut* Citizen Review of Government, where citizens can report misspending by government agencies. Citizens can search the NSF and report questionable grants that have been previously awarded. In these tough economic times, everyone is hurting, and we must be even more cautious about what is spent so that we are not funding something at the whim of a researcher. This way there will be more money available to worthwhile studies that will more directly benefit our society. Legitimate scientists should support this proposal since they will have more opportunity to get the funding they might have missed out on when unworthy studies get funded.

STUDENT HANDOUT 5.2b

AGAINST: Citizens Should NOT Have Input

Name _____ Date _____ Period _____

The United States budget is complicated, and we always want to cut waste, but the amount of money spent on science is tiny compared to other areas. For example, the National Science Foundation (NSF) budget is \$6.9 billion, which is much smaller than other departmental budgets including the Department of Homeland Security (\$43.6 billion) and the Transportation Security Agency (\$8.2 billion). Aside from arguments about the total budget of the NSF, citizens are not qualified to see the value of these basic science studies. There are many basic science studies done in the past that would not have seemed valuable to people at the time, but later resulted in amazing advancements. For example, the laser was developed in the 1950s after years of basic science research. When the laser was developed, it had no practical application. Some could argue that it was just physicists “playing with different forms of light,” but without this basic research, we would not have CDs, DVDs, the laser printer, laser surgery, etc. Citizens at the time may not have seen the potential value of the laser, as it did not have any applications at the time.

The following is from an article from *Live Science*, a scientific news aggregation website and blog:

Although a new report by Senator Coburn identifies major contributions of NSF projects and describes the NSF’s rigorous analysis of grant proposals, it is critical of some of the projects.

Scientists whose work is criticized in the report say that their research was oversimplified or misrepresented. In some cases a small project which is part of a larger research program is looked at in isolation. For example, the report describes one research project as an experiment to determine whether “boys like trucks and girls like dolls.” In fact, Gerianne Alexander, the researcher involved, said the research project is more complicated. This piece of the study is used to evaluate behavior changes resulting from a surge in testosterone levels in infancy. This may potentially help us understand and treat disorders such as autism and ADHD. Another project ridiculed for putting “shrimp on a treadmill” was part of a study on environmental stress in marine animals. In another study, described as teaching robots to fold laundry, the goal was to determine how to make robots that can “interact with complex objects.” This has potential for helping the elderly and disabled live more independent lives.

Researchers who were contacted for this article acknowledge the importance of assessing the value of a scientific study but are not convinced that involving the public is the way to do so. Hibbing, one of the researchers discussed in Senator Coburn’s study, said, “...it was a ‘dangerous’ idea to base research funding decisions on a cursory review of findings given that it can be difficult to tell from the early stages of research which avenues will be important.”

Discovery in science is not always clear. There are a number of studies that may not be easily understood by reading the abstract submitted to the NSF. In NSF’s own words, “in addition to funding research in the traditional academic areas, the agency also supports ‘high-risk, high pay-off’ ideas, novel [original] collaborations, and numerous projects that may seem like science fiction today, but which the public will take for granted tomorrow” (NSF, 2010 April).

Normal citizens, and even scientists who are out of their field, don’t have enough expertise to accurately judge both the intellectual and societal impact of project proposals. Just as you would want a chef judging the work of other chefs, you want an expert in the field judging the scientists’ work.

STUDENT HANDOUT 5.3

Homework: Your Own Stand On Science Funding

Name _____ Date _____ Period _____

1. Were you surprised at the federal budget and how much money the U.S. spends on science research compared to other parts of the budget? Explain.
2. Do you think that the government should fund scientific research at its current levels? Or should spending on research be expanded? Reduced? Explain.
3. Earlier lessons have shown how basic research may eventually lead to studies involving animals and human subjects with the aim of creating a medicine, therapy, or medical device that improves health (the Translational Research Cycle). Think about how you would prioritize each step along the way. Do you think that basic science research, which may or may not even lead to advances in human health, should be more or less a priority than other parts of the Translational Research Cycle? Explain.
4. Who do you think should be deciding how much money should be spent on basic science research? Explain.

5. Do you think that it is important to be skeptical when you hear science stories (or any stories) in the news? Explain how you saw this in the *Activity*.

6. Do you think it is important to look at the original research papers before you make a decision about the strength of science research? Why or why not?

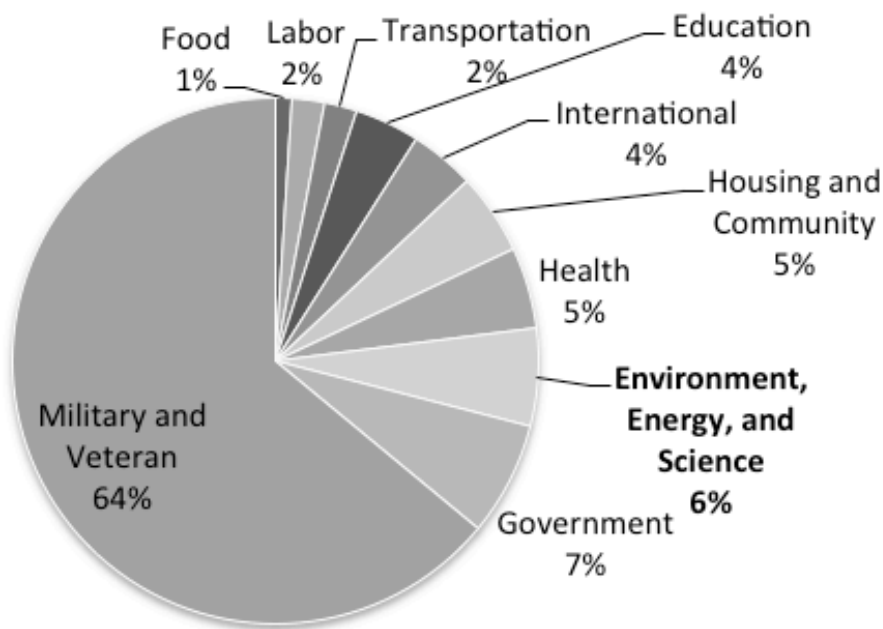
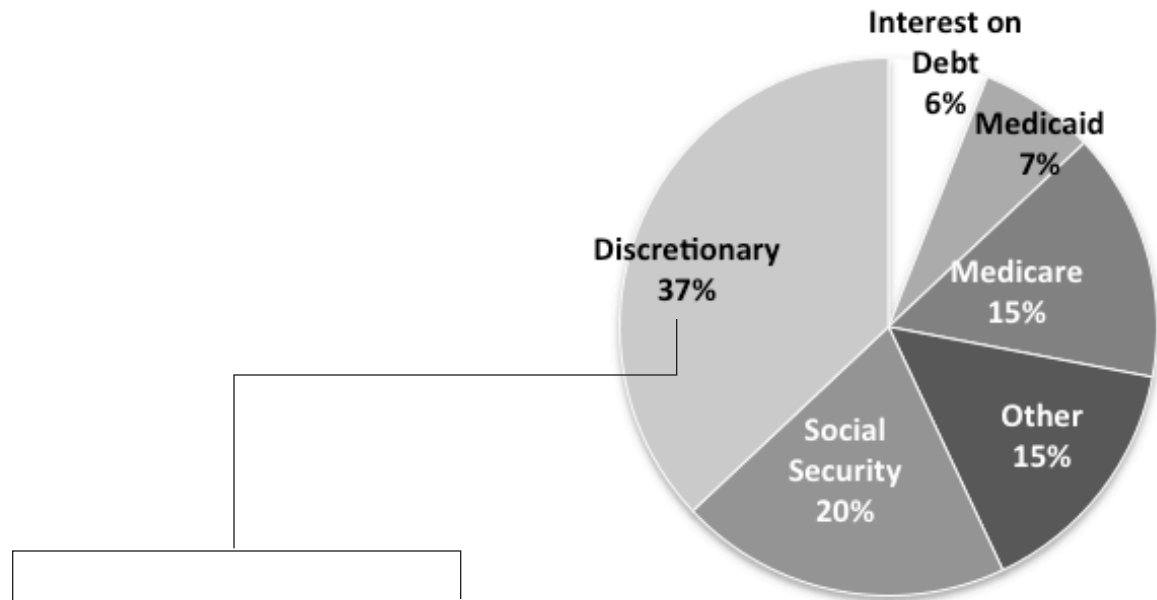
7. What sort of action can you take on this issue personally, especially when you are talking with friends or family and you hear stories in the news or read articles on blogs or websites?

TEACHER RESOURCE 5.1

The Federal Budget: How Do We Spend Our Money?

The \$6.9 billion that the federal government uses to fund the National Science Foundation (NSF) seems like a lot of money, but how does it compare to the rest of the federal budget? To compare expenditures, the relative amounts of money spent also need to be compared. The federal budget is around \$3.7 trillion. The budget is broken up into mandatory spending, which is about 2/3 of the total budget, and discretionary spending, which Congress reviews every year and can increase or decrease depending on national priorities.

United States Federal Budget



U.S. Discretionary Spending

Source: Congressional Budget Office. (2011). *Reducing the deficit: Spending and revenue options*. Washington, DC: U.S. Government Printing Office.

