

Teacher's Preparatory Guide

Introduction to Nanotechnology Using the Creative Problem-Solving Model

Purpose: Group problem-solving discussion, using the Creative Problem-Solving format, over the pros and cons of the expanded development of nanotechnology.

Time required: Two to three fifty minute class sessions

Level: Middle and High School

Teacher Background: This lesson serves as an introduction to the field of nanotechnology by discussing its real-world implications in light of current economic issues and conditions. The lesson is performed using the Creative Problem-Solving format and serves as a method to encourage debate on current topics.

Teachers regularly want their lessons to be engaging and meaningful. At the same time, much of the current research in science education addresses the importance of real-world applications of concepts to engage student learning. This lesson serves as an introductory activity into the need for promotion of nanotechnology as a science and the real-world benefits that are created through expansion of this research area. Information on the impact of nanotechnology can be found at the National Nanotechnology Initiative (nano.gov).

Materials: Video Introduction into Nanotechnology
- <http://www.kqed.org/quest/television/view/189?gclid=CPufzLnJ06YCFUHS7QodgEJ3HQ>

Internet articles on Pros/Cons of Nanotechnology
- <http://nanogloss.com/nanotechnology/advantages-anddisadvantages-of-nanotechnology/>
- <http://compound-microscope.esciencemedia.com/the-pros-and-cons-of-progress-in-nanotechnology/>

Creative Problem-Solving Grid (attached)

Post-Exercise Question Sheet (attached)

Advance Preparation: Download and copy materials listed in the materials section.

Safety Information: N/A

Directions for the Activity

- I. *Sparking Activity*: Introduce the lesson by having students respond to the following focus question that will guide the Creative Problem-Solving:
“As budget deficits in the U.S. are at record high figures, should our country continue to spend large amounts of money in research fields, such as nanotechnology, where much of the science remains new to exploration yet promising in its results?” Discuss and share answers from a few students in class. Ensure that both sides of the debate are represented.
- II. *Acquiring Information*: As the class begins, show the video clip identified in the materials section that provides an introduction to nanotechnology. Next, read and discuss the articles listed in the materials section (this could be assigned as homework) . The articles describe the pros and cons of the development of nanotechnology as a science. The following questions will be written on the board by the teacher so students may provide input. The teacher will briefly discuss these questions to guide the discussion:
 - a. What are the reasons researchers use to promote the need for increased research in the nanotechnology field? Identify reasons from the students.
 - b. What concerns are raised by critics about the growth of the nanotechnology field?
 - c. How could federal money be spent if it were not used to promote research in nanotechnology?
 - d. How could nanotechnology research benefit the most people in the U.S.?
- III. Divide students into groups of no more than five students each and use the Creative Problem-Solving model to promote discussion and find creative ideas in approaching the problem. The teacher will review the Creative Problem-Solving Technique procedure (Steps 1-6 below), CPS worksheet (attached), and the rubric (attached) for evaluating individual performance with the entire class. The teacher will rotate between the groups and evaluate individual participation on discussion rubric.

Graphic Organizer: Students will use the CPS worksheet to organize their questions and responses. They will use this worksheet to reach a group decision relating to the problem.

Small Group Discussion: Students will work in small groups of no more than five members to discuss the articles read in class, brainstorm solutions, and create answers to questions using the CPS technique.

Step 1: Fact finding and Brainstorming: What are all the problems you see in the government spending money on developing nanotechnology? All answers should be accepted by the group. No one should have their responses criticized. Consider as many categories as possible when considering problems. Is money an issue? Could funds be better used for solving domestic problems? Will the science benefits outweigh the cost of funding this program? How will the science be used? Others?

Step 2: Identify an important underlying problem: Look at all the problems. Is there an important problem or category of problems that could be solved and possibly affect the other problems? (Possible Answer: Do political agendas affect decisions?)

Step 3: Brainstorm solutions: Brainstorm, as done in step 1, to think of as many ideas as possible. Try to think of people who could help with this problem. Use the phrase, “We will get (who) to (do what) in order to (what).”

Step 4: Select criteria to help evaluate the most promising solutions: The criteria must relate to the main problem. The criteria should be worded in a positive way. Example: Which solution will be the best at _____? Which solution will take the least amount of money? Write four or five responses that will help you evaluate your solutions.

Step 5: Evaluate the Solutions: Rank order them according to the established criteria. Your best answer should be your highest number. Do this for each criteria. Your best solution is the one with the highest points.

Step 6: Plan to implement your best solution:

Synthesizing Activity: Each group will complete the Post-Exercise Question Sheet (attached). Write the best solution and tell the class how you would implement it answering the following questions: How would you sell the idea to the public? What obstacles would you face? What groups or people would be involved in carrying out your plan? Why would your solution solve the problem? Next, students will share their results and positions with the class.

IV. *Evaluation/Assessment:* Students will be individually evaluated with the criteria on the rubric for grading group discussion (attached). The maximum points earned is 40.

Assessment and rubrics

Group Discussion Rubric

| ATTRIBUTE (10 pts. Each) | EMERGING | COMPETENT | EXEMPLARY |
|--|--|--|---|
| LISTENING | Accurately recognizes and responds to comments of others | Shows effective uses and practices involved with listening processes. | Continually uses listening processes and effective listening skills throughout discussion |
| NON-VERBAL COMMUNICATION Effectiveness of: Eye contact, gestures, posture, facial expressions, voice/tone. | Understands <u>some</u> information from non-verbal cues given by others. | Interprets accurate conclusions from body language and facial expressions of others. | Can recognize recognize and use own subtle non-verbal communication cues. |
| PARTICIPATION Explains thoughts, rationale, feelings, ideas so others understand. | Rarely talks during the discussion. Comments may be off the subject. Offers few ideas to the discussion. | Shares opinions freely and explains with details and facts. Makes some connections to what others say. | Comments inspire others to connect their ideas. Supports and leads others in discussion. Encourages opinions of others. |

Resources:**Creative Problem Solving:**

<http://www.creativeeducationfoundation.org/our-process/what-is-cps>

To learn more about nanotechnology, here are some web sites with educational resources:

<http://www.nanotech-now.com/>

<http://www.nanowerk.com/>

<http://www.foresight.org/>

<http://www.azonano.com/>

<http://www.nanovip.com/>

<http://nanotechweb.org/>

<http://www.nano.gov/>

http://nanotechwire.com/news_list.asp?ntid=124

<http://nanotechnology.com/>

<http://www.nanotechproject.org/>

National Science Education Standards**Middle School**

Standard F: As a result of activities in grades 5-8, all students should develop understanding of risks and benefits and science and technology in society.

High School

Standard F: As a result of activities in grades 9-12, all students should develop understanding of Science and technology in local, national, and global challenges.