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| **Title** | **Social Perceptions of Biofuels** |
| **Introduction** | This activity was created in conjunction with a joint study by North Carolina State University and the Institute of Forest Biotechnology. This study, by Steven Pires, Sudipta Dasmohapatra, Adam Costanza, and Susan McCord, seeks to understand the social perceptions of biofuels and the use of genetically modified (GM) products to create the fuels. This lesson has been divided into two surveys, suitable for a high school classroom that can be used separately or together. The first survey seeks general environmental opinions, and the second survey focuses on GM products and biofuels. Additionally, an activity matrix has been provided with possible activities designed to expand upon the survey results. |
| **Curriculum Alignment** | AP Environmental Science-  Competency Goal 7: The learner will build an understanding of environmental decision making.  Objective 7.02 Analyze cultural and ethical considerations regarding the environment; Environmental worldviews; Sustainable development.  Biology-  Competency Goal 3: The learner will develop an understanding of the continuity of life and the changes of organisms over time.  3.04 Assess the impact of advances in genomics on individuals and society.- Applications of biotechnology. |
| **Learning Outcomes** | Upon completion of this activity, students will be able to   * Identify trends in environmental opinions * Assess application of technology to environmental issues * Understand diverse perspectives of environmental issues |
| **Time Required and Location** | Teacher Prep time- 10-15 minutes for copies  Part 1: General Survey  Complete Survey- 0-10 minutes; Students may do this survey outside of class, or use class time.  Activity- 15 minutes  Part 2: GM and Biofuels  Complete Survey- 0-15 minutes; students may do this survey outside of class, or use class time.  Activity- see Activity Matrix |
| **Materials Needed** | Copies of surveys  Some activities may require additional materials or technology- see Activity Matrix  **TECHNOLOGY RESOURCES:**  Some activities may work well with the use of technology. Some may include Internet Search options, or may integrate technology into statistical analysis. A program such as Microsoft Excel would be useful in this, though not required. |
| **Participant Prior Knowledge** | Survey Part 1 (Awareness of Environmental Issues/ Lifestyle Choices) can be conducted on the first day of a course, as it is looking to gather information based on what students already think.  Survey Part 2 (GM and Biofuels) should be conducted after the following information has been covered in class:   * Critical vocabulary (see section below) * Concept of environmental worldview * Students should also be familiar with basic statistics |
| **Activities** | * Survey Part 1: Awareness of Environmental Issues/ Lifestyle Choices   + Students should take the survey.   + As a class, average the class opinion-1 to 5- for each statement. Students can graph their opinion compared to the class opinion either in class or at home. This will help to strengthen graphing and math skills.   + Student sharing-     - Have students either pair up or group based on their opinion. Students will then share with others in their group. Select 1-3 students to ‘report out’ to the class. Do this for at least 2 or 3 of the statements on each survey part, but do as many as the class time will allow.     - Just a sample of some options-       * Group based on number- homogeneous grouping       * Line up from high to low, and have students on opposite ends grouped up.       * Group students from the extremes with students in the middle.       * (this works if roughly all number groups the same size) form groups with one person each from 1-5       * Form a group with at people from at least three different numbers   + Correct misconceptions- if you see that students seem skewed in one category, or upon discussion discover misconceptions, work to correct these misconceptions. The websites section of this lesson plan has some great options of places to find information.   + OPTION- Conduct this as a course or unit opener. Then go back and complete the survey again after covering material. Students can assess the changes in their opinions or the group changes. * Survey Part 2: GM and Biofuels   + Students should take the survey.   + As a class, discuss results. This can be similar to the graphs created or the student sharing sections associated with Survey Part 1.   + See Activity Matrix for further activities. |
| **Assessment** | * See Activity Matrix |
| **Critical Vocabulary** | * Genetically modified organism (GMO)- organism whose genetic makeup has been modified by genetic engineering * Genetic engineering- insertion of an alien gene into an organism to give it a beneficial genetic trait * Biofuel- Fuel such as methane produced from renewable biological resources such as plant biomass and treated municipal and industrial waste. * Organic- foods that have been produced and processed without the use of commercial chemicals such as fertilizers or pesticides or synthetic substances that enhance color or flavor. Organic foods must meet legally regulated production standards in order to use the term organic. * Ethanol- a primary alcohol formed by microbial fermentation of carbohydrates or by synthesis from ethylene. The primary biologically- derived alcohol fuel produced. |
| **Modifications** | The inclusion of an activity matrix allows teachers to select activities that meet the diverse needs of their student populations. These activities are able to fit into a variety of time lengths, materials available and student need. |
| **Alternative Assessments** | The inclusion of the activity matrix allows teachers to select activities and appropriate assessments to meet their student populations. Some activities may offer multiple assessments or assessment extensions. These are included in the matrix and the details. |
| **References** | * Biofuels Center of North Carolina- <http://www.biofuelscenter.org/> * North Carolina Biotechnology Center- <http://www.ncbiotech.org/> * NC Biofuels- <http://ncbiofuels.net/> * North Carolina Biodeisel Association- <http://www.biodieselnc.org/> * Triangle Biofuels Industries, Inc.- <http://www.trianglebiofuels.com/> * Metrolina Biofuels (Charlotte area)- <http://metrolinabiofuels.com/> * Piedmont Biofuels- <http://www.biofuels.coop/> * National Renewable Energy Laboratory- [www.nrel.gov/learning/re\_biouels.html](http://www.nrel.gov/learning/re_biouels.html) * Biofuels Watch- [www.biofuelswatch.com](http://www.biofuelswatch.com) * Biofuels Journal- [www.biofuelsjournal.com](http://www.biofuelsjournal.com) * Bioenergy Feedstock Information Network- <http://bioenergy.ornl.gov/> * You may wish to search for news articles as well- I did not include news articles because they can be outdated easily. A quick Internet search will yield news articles. I recommend [www.dogpile.com-](http://www.dogpile.com-) it searches search engines (using ‘metasearch’) and returns results and tells you where it found them. It’s easy to find and eliminate ads this way. |
| **Supplemental Information** | There is a myriad of information available on the field of biofuels. See the websites section for a list of some websites available where you can find more information.  The researchers who have compiled the survey would like to include your data into further research if you would like. Please email me at [heatherearp@johnston.k12.nc.us](mailto:heatherearp@johnston.k12.nc.us) and I will see that they can get your information for inclusion.   * Handouts and supplemental documents * Survey 1 (two pages)- Awareness of Environmental issues; Lifestyle Choices * Survey 2 (two pages)- Biofuels; Genetically Modified Ingredients in Biofuels * Activity matrix * Activity matrix detail * Sample debate scoring handout |
| **Comments** | These surveys have so many options. I tried to list a few in the activity matrix, but these are by no means the only directions you can go with the surveys. Select activities that fit best with your student population. Within each activity there are also several directions that you can take it- make it work for you. |
| **Author Info** | Heather Earp teaches at West Johnston High School in Benson (Johnston County Schools), where she has been a member of the Science Department since 2003. She has taught numerous science courses including Biology, Honors Biology, Honors Anatomy and Physiology, Earth/ Environmental Science, Environmental Science, Honors Environmental Science, and Advanced Placement Environmental Science. She is a graduate of East Carolina University, where she was a NC Teaching Fellow, and holds a BS degree in Science Education with a concentration in Biology. She holds AP Certification in Environmental Science and K-12 AIG Certification. She has served as a College Board reader for the AP Environmental Science exam. This lesson was developed as part of the Kenan Fellows program through NC State University; Heather is studying Sustainable Forestry and the Use of Botech Trees for Sustainability and Bioenergy. |

**Awareness of Environmental Issues** Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Please rank how concerned you are about the following topics (1- not concerned at all; 3- neutral; 5- very concerned)

1. *Never 2- Almost never 3- Sometimes 4- Fairly Often 5- Very Often*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| 1 | Greenhouse gas emissions |  |  |  |  |  |
| 2 | Food availability/ shortage |  |  |  |  |  |
| 3 | The price of energy (e.g., electricity, natural gas, etc) |  |  |  |  |  |
| 4 | Endangered species |  |  |  |  |  |
| 5 | How much energy you are using |  |  |  |  |  |
| 6 | Resource availability for the future generations |  |  |  |  |  |
| 7 | Increasing global population |  |  |  |  |  |
| 8 | Pollutants in the environment |  |  |  |  |  |
| 9 | Drilling more gas and oil wells in the US |  |  |  |  |  |
| 10 | Price of transportation fuels |  |  |  |  |  |
| 11 | US dependence on foreign oil |  |  |  |  |  |
| 12 | Global climate change |  |  |  |  |  |

Below, create a bar graph comparing your response to the class average for each response.

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**Lifestyle Choices**

How often have you participated in the following activities in the past 12 months (1- never, 5- very often)?

1. *Never 2- Almost never 3- Sometimes 4- Fairly Often 5- Very Often*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| 1 | Recycled or used recycled products |  |  |  |  |  |
| 2 | Used biodegradable cleaning products |  |  |  |  |  |
| 3 | Grown my own food |  |  |  |  |  |
| 4 | Someone in family drove hybrid car |  |  |  |  |  |
| 5 | Used biofuels/ biodiesel (as a transportation fuel) |  |  |  |  |  |
| 6 | Volunteered/ donated to an environmental cause |  |  |  |  |  |
| 7 | Eaten food or used beauty products with organic ingredients |  |  |  |  |  |
| 8 | Removed myself (or family) from a junk mailing list (to eliminate junk mail) |  |  |  |  |  |
| 9 | Used Energy Star appliances |  |  |  |  |  |
| 10 | Used energy efficient light bulbs (fluorescent or LED) as opposed to conventional light bulbs |  |  |  |  |  |
| 11 | Purchased or used local products |  |  |  |  |  |
| 12 | Turned off electrical devices with not in use |  |  |  |  |  |

Below, create a bar graph comparing your response to the class average for each response.

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**Biofuels**

Please rate your relative agreement of the following statements considering biofuels (1- strongly disagree to 5- strongly agree).

1. *Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| 1 | I think that the government should subsidize (help pay for) the manufacturing of biofuels. |  |  |  |  |  |
| 2 | I would support the cutting of trees for biofuels if for each tree cut another was replanted. |  |  |  |  |  |
| 3 | Biofuels are not environmentally friendly (they take more energy to make than it is worth). |  |  |  |  |  |
| 4 | I would purchase biofuels even if it is a little more expensive than gasoline. |  |  |  |  |  |
| 5 | I would not purchase biofuels because they might be bad for my car engine. |  |  |  |  |  |
| 6 | Before I would purchase or used biofuels, I would like more information about how they would affect my vehicle. |  |  |  |  |  |
| 7 | I would only purchase biofuels if they were the same price as gasoline. |  |  |  |  |  |
| 8 | Every gallon of gasoline purchased in the United States is blended with ethanol. |  |  |  |  |  |
| 9 | I would only purchase biofuels if they were available at most or all gas stations. |  |  |  |  |  |
| 10 | Biofuels have a lower environmental impact than gasoline. |  |  |  |  |  |
| 11 | Biodeisel has a lower environmental impact than gasoline. |  |  |  |  |  |
| 12 | Some types of biofuels are getter for the environment than others. |  |  |  |  |  |
| 13 | I would like the government to provide me with more information about biofuels. |  |  |  |  |  |

**Genetically Modified Ingredients in Biofuels**

Please read the following statements:

* At least 60% of all food products in US supermarkets contain genetically modified ingredients.
* Most of the ethanol blended into gasoline in the US is derived from genetically modified feedstocks.

Prior to reading the above statements, were you aware that the majority of the gasoline sold in the US is blended with ethanol from genetically modified (GM) feedstocks?

□Yes □No

Please rate your relative agreement of the following statements about genetic modifications (1- strongly disagree to 5- strongly agree):

*1- Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 |
| 1 | I would support genetically modified trees if they were used for species restoration, or to restrict disease (such as American Chestnut) |  |  |  |  |  |
| 2 | Genetically modified crops are harmful to us. |  |  |  |  |  |
| 3 | Growing genetically modified trees is unethical. |  |  |  |  |  |
| 4 | I would support genetically modified trees/crops if only non-food source feedstocks were used for biofuel production. |  |  |  |  |  |
| 5 | Genetic modifications of trees/crops will be required to meet the natural resource demands of the future. |  |  |  |  |  |
| 6 | Genetically modified trees will alter the characteristics of natural trees. |  |  |  |  |  |
| 7 | I would support genetically modified trees/crops if it allowed the biofuel industry to lower their environmental impact. |  |  |  |  |  |
| 8 | I would support genetically modified trees used for biofuels (as a transportation fuel) if it meant that we didn’t have to import oil from overseas. |  |  |  |  |  |
| 9 | Genetically modified trees/crops have the ability to provide an adequate supply of biomass to create biofuel. |  |  |  |  |  |
| 10 | I would support genetically modified trees/crops only if they had the ability to produce at least 2-3 times the yield as conventional crops. |  |  |  |  |  |

**Social Perceptions of Biofuels- Activity Matrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Activity** | **Time Needed**  **(in minutes)** | **Materials Needed** | **Additional Handouts?** | **Assessment** |
| 1 | students survey their parents and assess generational data differences | 20-30 to analyze data; 20 for discussion | Surveys | No | Students will submit statistical data and analysis. Discussion of reasons for generational differences.  *Extension option* |
| 2 | students take 2-3 parameters and seek correlations | 30 to create correlations; may do research in class (optional); 15 to present (extension) | Surveys, calculators, computers for research (optional) | No | Students correlate 2 or 3 parameters; students turn in correlations and explanations  *Extension option* |
| 3 | the class can choose one topic and debate a related issue | 20 (debate prep); 30-40 for debate  (different days) | Surveys | Yes- debate scoring | Students will assist in debate scoring (comprised of teacher, group members, and audience) |
| 4 | select two topics you know the least about and research- select one to create a small poster to hang in the class | No additional class time needed *(optional- presentations)* | Surveys; poster supplies (optional) | No | Posters can be scored by classmates, by teacher, etc. This can be done individually or in groups. Size of groups can vary based on class size. |
| 5 | select one topic that you hold a strong opinion and write a persuasive article for the opposing side | 45 in class if this is to be in in-class assignment (great for 10th grade) | Surveys | No | Score based on content as well as writing conventions; an English teacher may be able to help you formulate a rubric that includes school focus areas |
| 6 | take survey pt 1 and survey part 2 and seek correlations between any components | 30- 45 | Surveys | No | Students present their correlations and allow the class to give feedback on validity |
| 7 | research biofuels and create a similar survey of 10 questions as a class related to GM industry and biofuels- give survey to other students and analyze results | 30-90 (over several days) | Surveys | Students will create one | Have students analyze other student groups’ surveys; or analyze surveys between classes of students |

Detail from Activity Matrix

1. Students go home and survey their parents. This can be adapted to include more data by surveying multiple adults in their lives. An additional extension might be to survey grandparents as well to get a third generation’s perspective. Create graphs to show averages for the different questions, and then look at where there are significant differences. Discuss reasons for the differences in opinions between generations.

*Assessment Extension option: students can take one parameter and write a response for their specific family and why they differ on a particular issue.*

2. Students select 2 or 3 parameters from survey 2, or a combination of survey 1 and 2. They look for a correlation between the two parameters surveyed. They can analyze the statistics and research a potential cause for the correlation.

*Assessment Extension option*: students can present the survey correlations to the class. This is also an option for peer scoring, if the class is experienced in peer scoring. Students can provide feedback on their classmates’ correlation evidence.

3. Students can choose any related topic to debate. It is suggested to have two different debates in the class, and have half of the class watch each debate. Some suggestions are: *1) Should genetically modified foods be required to carry labels? 2) Should GM products be used to make biofuels? 3) Should biofuels be required to be held to the same environmental standards as conventional gasoline? Stricter? More lenient?* I usually have students help with debate scoring. Their debate scores comes from me (30%- based on what they actually say during the debate), their group members (average together scores for 40%- based on how they helped their group prepare and get their point across), and the group that watched their debate (score each side- 30%- based on how well the group presented its argument).

4. Students will look over surveys and either individually or in groups select a parameter discussed to research. This should be something they feel they know the least about. They can create small posters (I recommend computer paper- standard 8.5 x 11- so that more can fit in the room as needed. This does not need any additional class time, but if you have the time, you may allow groups to work together and work on this in groups. If time is given in class, students should have internet access to conduct internet searches. See the websites list for some great sites to check out for research.

5. Students can be instructed to look at their list and select one statement that they either scored a 1 or a 5. Have the students ‘lock in’ to their selection before proceeding further. ☺ Then, once they have turned in/ signed up/ etc. instruct them that they are to write a persuasive article in support of the opposite opinion. The rationale behind this is that in order to support their own topic, they need to know the opposing point of view to be able to refute it. If they can write something in support of the other side, and be able to back it up, then they know their own topic. One component of scoring should be that the article is ‘believable’- would someone reading it believe what they are saying? This works great for 10th grade, as they are preparing for a timed writing test in March. You may want to employ the assistance of English teachers to help with the scoring (don’t ask them to score your papers, but you may wish to ask them for how they would break down points, what they would look for, etc- if you have 10th grade students especially)

6. Students can select survey parameters or be given a set of parameters to find correlations between the components. This is a great chance to have students present for their peers for feedback. One option is to have the students prepare their correlations, take them up, and pass them out to other groups to present. I have found that students are more likely to be honest and critical if they are not speaking directly to the group that is presenting. This way, only the group presenting knows who originally came up with a specific correlation.

7. Either in class groups or as a class, students can create a survey and administer it to an audience. This has a lot of options; you may select groups of 4-6 students and give them each a different audience (students, teachers, parents, business owners, farmers, grandparents, etc) for their survey. You may have them administer a class-made survey to different groups and have the class guess which audience yielded specific results. This is a great option for advanced students- this involves them taking information and expanding it to create their own survey based on their own interests; they will determine what questions to ask, how to analyze, their audience for the survey, and their audience for the results.

**Debate Scoring Sample**

*Each student will get the form below filled out for him/her*:

Student Final Scores Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Group score: (given by jury based on preparedness)- 1-15 \_\_\_\_\_\_

Individual Score: (given by group members) avg- 1-10 (x 2) \_\_\_\_\_\_

Teacher score: (given by teacher based on personal preparedness) 1-15 \_\_\_\_\_\_

Total of Scores: \_\_\_\_\_\_/50 = \_\_\_\_\_%

*Each debate group will rate the effectiveness of each group for the debate that they watched.*

Rate the effectiveness of each side of the debate that you watched on a scale of 1-15. This must be a group consensus score. Please explain your reasons for scoring in this way. Your score will be averaged with the other side for your debate.

Debate: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Side/Argument: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score: \_\_\_\_\_\_\_

*Each student will fill this form out based on their debate group.*

Debate:

Rank the effectiveness and preparations of each of the following members of your group. The average of this score will be multiplied by 2 to give the score for this part of the debate grade. Include yourself in this score, but do not put your name on this paper. Please use back of this page to justify your scores.

|  |  |
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| Name | Score 1-10 |
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