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Science-Informed Arguments in Undergraduates' Opinions About Biofuels

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SCIENCE-INFORMED ARGUMENTS IN UNDERGRADUATES' OPINIONS ABOUT BIOFUELS

University of Nebraska- Lincoln

Olivia Straka & Jenny Dauer

Overview

- Socioscientific issues (SSIs) are complex, multi-faceted issues with components of science as well as components of values requiring evaluation of social, political, and ethical concerns (Nichols & Zeidler, 2009).
- However, many students do not possess a fundamental understanding of the underlying scientific foundations of SSIs (NRC, 1998), or may evaluate issues based on personal relevance as opposed to contemplation of evidence presented (Sadler et al., 2004).
- This study examined how undergraduate students chose to substantiate their opinions on the SSI of using biofuels as a fuel source before and after taking a semester long course, AGRI/NRES 103.
- The AGRI/NRES 103 course is designed to increase students' capacity to use science in their analysis of SSIs facing agriculture and natural resources.
- By helping students understand and use scientific information when reasoning about this issue, we hope to support greater understanding of how science is relevant to an issue, which is a key component of science literacy (Feinstein, 2013).

Methods

Data collection: We gave students in the AGRI/NRES 103 class a questionnaire at the beginning and end of the semester. The questionnaire asked students to state their opinions about burning biofuels for energy.

Data analysis: The answers from both pre- and post-tests were coded for: 1) a pro, con and neutral position towards biofuels and 2) types of arguments present. Types of arguments emerged from the data after multiple iterations of coding with a final inter-rater reliability of 89.5% agreement. We grouped types of arguments based on their level of sophistication following Kuhn, 1997.

- Level 3: Scientific arguments that connect to the functional reasons of why biofuels are in use today.
- Level 2: Non-functional arguments represent some misconceptions about biofuels usage, as well as arguments that do not represent the main function of using biofuels.
- Level 1: Emotive arguments that tend to be based in personal values and experiences.

Graphs

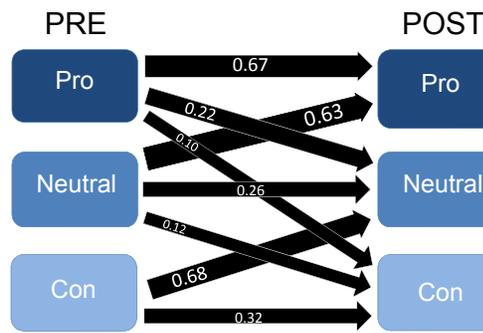
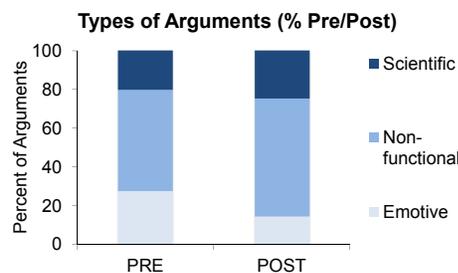
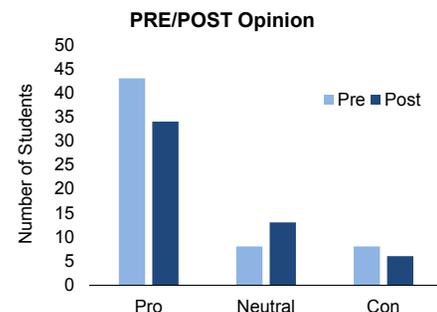
| Types of Arguments Number of Students N=53 | | |
|--|-----|------|
| Coding Criteria | PRE | POST |
| Level 3: Scientific (Functional) | 22 | 24 |
| Helps atmosphere; reduces CO ₂ in the atmosphere/climate change/global warming | 10 | 10 |
| Good renewable source of energy; better than fossil fuels | 7 | 12 |
| Could lead to new technology | 3 | 2 |
| Good domestic source of energy | 2 | 0 |
| Level 2: Non-functional | 57 | 58 |
| Helps rural/state/general economy | 22 | 11 |
| Vaguely better for the environment/earth, reduces pollution, cleaner | 11 | 9 |
| Food vs. fuel isn't a problem | 10 | 16 |
| Other non-functional argument (e.g. biofuels don't deplete natural resources, reusing dead organisms, cheaper utilities, distillers grains byproducts have value, less fuel efficient) | 6 | 10 |
| Should use an alternative technology (e.g. cellulosic, algae, solar panels, corn stover) | 5 | 10 |
| Ethanol is cheaper at the pump | 3 | 2 |
| Level 1: Emotive | 30 | 14 |
| Biofuels are a good idea (generally, vaguely) | 12 | 0 |
| Should use biofuels because there is a lot of corn | 10 | 5 |
| Other sentiment based (ex. it isn't hurting anyone, people don't understand, we should educate people, because I farm and we make money) | 8 | 9 |

Above: Number of types of arguments in Pre and Post written responses across all students.

Right: Percent of arguments given within each level of argument quality, significantly different between Pre and Post (Chi-sq, $P < 0.05$).

Each student gave between 1 and 4 types of arguments. For each student we calculated a mean argument quality score. The overall mean POST argument quality score, 2.10 exceeded the overall mean PRE argument quality score of 1.87 (T-test, $P < 0.05$).

Below: Opinions of students were coded for their overall position Pro, Neutral, and Con biofuels and compared Pre/Post ($n=53$). Some students changed their opinions from the Pre questionnaire. Proportion of students that moved to each opinion are represented in the arrows.



Example Student Responses

Student 191: "I believe that using corn for ethanol energy is a very good idea. The intent behind it has been very positive."
Pre-Level 1

"...I believe that corn ethanol has been a good beginning step to transitioning into using more effective biofuels...it has not done any more harm to the earth than fossil fuels already do."
Post- Level 3

Student 131: "There's plenty of corn being grown, I think biofuels are fine. I'm also not educated on this enough to really understand both sides."
Pre-Level 1

"I think we should continue to use corn ethanol for energy...It is a cheap resource to make fuel, helps farmers and reduces emissions."
Post-Level 2 and Level 3

Student 6: "It keeps the consumer prices down on gas and food."
Pre-Level 2

"We should do it because we will run out of fossil fuels; if we don't find other ways to produce fuels then we will run out of them."
Post-Level 3

Conclusions

Overall, student responses showed improvement in overall mean argument quality, and less emotive arguments. However, students may need more support in developing high-quality, science-informed arguments.

Many students changed their opinions about biofuels, (42% of all the students) which is a sign of deep reasoning and learning about the issue.

Many students' analyses, explanations, and opinions of the usage of biofuels are based in economic, environmental and social dimensions of agriculture and natural resources.

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