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EFFECT OF PROVIDING INFORMATION ON STUDENTS' KNOWLEDGE AND CONCERNS ABOUT HYDRAULIC FRACKING

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Abstract

Governmental agencies, regulators, health professionals, and the public are faced with understanding and responding to new development practices and conditions in their local and regional environment. While hydraulic fracking (fracking) for shale gas has been practiced for over 50 years in some states, it is a relatively recent event in the northeastern United States. Providing environmental health information to the public about fracking requires understanding both the knowledge base and the perceptions of the public. The knowledge, perceptions, and concerns of college students about fracking were examined. Students were interviewed at Rutgers University in New Jersey, a state without any fracking, although fracking occurs in nearby Pennsylvania. Objectives were to determine (1) knowledge about fracking, (2) rating of concerns, (3) trusted information sources, (4) importance of fracking relative to other energy sources, and (5) the effect of a 15-min lecture and discussion on these aspects. On the second survey, students improved on their knowledge (except the components used for fracking), and their ratings changed for some concerns, perceived benefits, and trusted information sources. There was no change in support for further development of natural gas, but support for solar, wind, and wave energy decreased. Data suggest that students' knowledge and perceptions change with exposure to information, but many of these changes were due to students using the Internet to look up information immediately after the initial survey and lecture. Class discussions indicated a general lack of trust for several information sources available on the Web.

Individuals, agencies, and organizations over a wide array are interested in understanding the knowledge base, perceptions, and concerns of people regarding key and emerging environmental issues. Energy availability, energy sources, and energy independence are among the important environmental issues facing the world. Fluctuating energy prices, oil availability, global climate change, and increasing competition for energy sources are

driving public policy makers, governments, and the public toward diversifying energy sources (Sheffield, 1998; IPCC, 2007; Gochfeld, 2011). Increased energy demand may be filled by renewable fuels (Shi, 2010; Jacobson and Delucchi, 2011); other more traditional sources (oil, gas, coal) continue to play an important role in energy production (Focus, 2010). Energy efficiency alone cannot meet the growing energy needs (Zarnikau, 2003), but the recent rise in hydraulic fracturing (fracking) has the promise of increasing production in the United States.

Considerable attention has been devoted to the economic impacts of shale gas development, leading to the conclusion that the short- and long-term impacts for state and local economies require additional, site-specific studies (Barth, 2013). One of the main concerns of shale gas development is potential health impacts, which have often been determined by self-reporting (Steinzor et al., 2013). There is a clear need for research that identifies the links between environmental levels of contaminants or other effects of shale gas development (e.g., noise) and symptoms reported by individuals residing near such facilities (Steinzor et al., 2013; Mitka, 2013), public perceptions, and a need for public policy development (Korfmacher et al., 2013). Environmental degradation in the vicinity of shale gas drilling is another important concern (Slatin and Levenstein, 2013). Ethnographic and medical studies in communities exposed to shale gas drilling are important in elucidating public concerns about health and environmental effects (Perry, 2013; Saberi, 2013), as well as water contamination (Penningroth et al., 2013) and extensive water needs of fracking (Fry et al., 2013; Schmidt, 2013).

Deciding which energy sources to develop and how to develop specific energy sources (e.g. shale gas drilling) is not only a political and societal issue, as well as one of availability of energy resources, but also an issue of public opinion (Owens and Driffill, 2008). Public perceptions and concerns clearly play a significant role in public debate (Slovic, 1987). This study examined the knowledge and concerns of a sample of college students in New Jersey about fracking. Fracking does not occur in New Jersey, but is an important issue in nearby Pennsylvania. Objectives were to determine (1) knowledge about fracking, (2) rating of concerns about fracking, (3) trusted information sources, (4) importance of fracking for natural gas relative to other energy sources, and (5) whether listening to a 15-min lecture about fracking improved students' knowledge base and environmental health concerns. Data serve to inform the health professionals and public policymakers on the types of issues of concern to a college audience, and whether providing a short lecture improves knowledge and changes perceptions of environmental risks. This also addresses the issue of the role of education in affecting knowledge and concerns.

METHODS

A survey was conducted in a class of undergraduates science majors ($n = 60$) at Rutgers University. Students ranged in age from 19 to 21 yr. The class was composed of 44% male students. The sample is not meant to be representative either of students generally, or of New Jersey residents, although there is no reason to assume biases. Rather, the sample is meant to suggest issues for further consideration by health professionals, public policymakers, and the public.

The survey methodology and questionnaire were approved by the Rutgers University Human Subjects Review Board. The questionnaire was administered using an audience response system with keypads in a classroom situation, where student identity was anonymous. It was administered once; 2 wk later students were given a 15-min lecture on fracking as a follow-up to the questionnaire, and they were told it was for information purposes only and was not part of their classroom work. Three weeks later the questionnaire was administered again.

The questionnaire contained about 60 questions divided into 4 categories: knowledge base, concerns, evaluation of different energy forms, and trusted information sources. Knowledge questions included a few basic questions about the history, geography, and methods of fracking. For some informational questions, the students were given five choices (don't know, no, I think no, I think yes, and yes); in others they were provided five possible answers and required to select the correct answer. The information responses were then analyzed in terms of whether students gave the correct answer or not. Concerns questions involved rating a list of possible concerns, using a Likert scale of 1 (no concern) to 5 (greatest concern), as well as a list of advantages (e.g., reduce emissions, energy cost).

Students were also provided a list of energy sources and were asked to rate whether they should be further developed, using a Likert scale. Trusted information sources were rated on a Likert scale, and included a list of media (TV, radio, Internet), governments, and others (family, friends, researchers).

Statistical Analysis

Data are presented as means (+ standard errors), and differences between males and females were determined with Kruskal–Wallis χ^2 tests (SAS, 2005).

RESULTS

Knowledge-base questions included those related to definitions of fracking, when fracking in the United States started, drilling depths, drilling locations, states where it is possible, states where it is occurring, and the substances/chemicals used in fracking. Except for the last question, a significantly higher percent of students answered the questions correctly the second time compared to the first (Table 1).

The rating of concerns increased significantly between the first and second session for general risks, air pollution, excessive water use, earthquakes, and noise, and decreased for aesthetics. There were no significant differences for the other concerns (Table 2). One clear difference was the change in variance for concern ratings of natural habitat; although the two sessions were not significantly different, variance increased markedly in the second session, and variance was greater than for any other concern. During the first session, concern for natural habitats was rated the highest, while during the second session, general risks and noise were rated the highest, followed by air pollution.

Between the two sessions, the rating for economic benefits of fracking decreased significantly, and lack of support for fracking fell (Table 3). Rating for the effect of fracking

in reducing energy costs increased between the two sessions, as did rating for lowering carbon emissions. There was no marked difference in perceptions that fracking would reduce energy costs.

Their rating of sources students trust for information on fracking differed significantly between the two sessions for every category except the federal government (Table 4). Trust decreased for researchers and family members, and increased for all others. During the initial session students trusted researchers, the Internet, and family, while during the second they trusted the federal government and Internet the most. During the class lecture/discussion, several students were checking the Internet and reporting that they could find a wide array of information, some from companies (mainly researchers, they noted), from blogs, and from conservation/advocacy groups. Individuals noted that they did not find information from university or government researchers.

There were also some significant differences in their rating of which energy sources should be further developed (Table 5). Ratings for solar, wind, and wave decreased, but there were no differences in the ratings for the others.

DISCUSSION

This study found that students (1) increased their knowledge base as a result of a lecture/discussion, (2) changed their ratings of some concerns, benefits, and trusted information sources, and (3) decreased their rating for future development of solar, wind, and wave energy. Each of these is next discussed briefly.

Providing information in a lecture/discussion period improved knowledge, even though students were told it would not be on their exam. Partly this may have been a result of the lecture itself, but it seemed that it was more a result of the class discussion that involved some students using their computers in class to search the Web for information. This form of information seeking was not possible in classrooms 10–20 years ago, and students relied on faculty or textbooks to provide the information. Once one student reported information from a source, others in the class immediately questioned its accuracy and the source, leading other students to search for different sites. Generally they reported that it was better to obtain information from blogs because they could quickly identify the disputed issues, and then seek information from other sources, such as the federal government. Students also noted, in the classroom discussion, that they did not easily find information and data from scientists (or university researchers), but more often found it from “company scientists.” This leads to the suggestion that it was difficult for students to quickly find unbiased information on the Web, except when they searched government sites.

Their ratings of concerns and benefits about fracking, however, also changed somewhat on the second session. Their concern level increased for general risks, contaminants in water, air pollution, excessive use of water, earthquakes, and noise. Except for general risks, the others were topics discussed in the lecture/discussion. Many students said they were not aware that water or contaminants were even used, that earthquakes could result, or that there was any noise involved. This suggests that students have heard of “fracking,” as many said,

but they did not actually know what the process was, what it involved, or what equipment was used. Similarly, information on the effect of fracking for natural gas on carbon emissions was a subject on which they professed a lack of knowledge, which showed in their increased rating during the second session.

Except for the researchers and family members, most information sources were trusted more after the second session. The decrease in trust for researchers may have been a result of the class discussion where several students noted that they only found information (all positive) from company researchers, and did not find any from university scientists, advocacy or conservation organizations, or community groups on the Web. Even so, the rating for fracking companies also went up, perhaps due to the abundance of information from these companies and the general feeling that companies would report facts correctly (e.g., where they were fracking, how many trucks or other vehicles were involved, how deep the wells were).

The changes in ratings for different information sources, coupled with the class discussion, suggests that future questions regarding information sources need to be combined with the type of information being sought. That is, students should be asked who they trust for specific types of information, perhaps about health, ecological, and physical information.

Finally, there were decreases in ratings for future development of solar, wind, and wave energy, but no changes for the other types. That is, students appeared to have firm views on whether they thought natural gas, nuclear, and coal need to be further developed, and these did not change with a lecture/discussion or time. However, they did decrease their ratings for the renewable energy forms of solar, wind, and wave.

In conclusions, results from this study indicate that students increase their knowledge base, and as a result of a lecture/discussion they shift their ratings of concerns, benefits, trusted information sources, and which energy sources to further develop. These changes occurred even though there were several weeks between the first session, lecture/discussion, and second session. While the lecture presumably improved the knowledge base, the discussion that followed both the first survey and the lecture/discussion appeared to have a greater effect in that students talked about the issues, went immediately to the Web, and reported information to the class, which generated further discussion about the information, who you could trust, and what types of information were easily available. The student use of blogs as a way to quickly identify the major issues was interesting and bears further examination. The increase in rating for general risks bears further examination.

Finally, changes in rating of trusted information sources, along with ratings of issues of concern, suggest that future work needs to examine these two together. An attempt needs to be made to determine where students and others go for information about specific concerns, whether they are environmental, ecological, or human health issues.

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TABLE 1

Results of Questions Related to Knowledge of Fracking, as Percent of Students Who Responded With the Correct Answer

Question	Response	Session 1 results	Session 2 results	χ^2
Fracking is a method of extracting coal from earth?	No	32%	86%	35.3 (<.0001)
Fracking is a method of extracting gas from earth?	Yes	24%	81%	36.0 (<.0001)
Fracking only involves digging in a well vertically in the earth	No	19%	81%	45.5 (<.0001)
Fracking only involves digging in a well vertically in the earth and then horizontally	Yes	20%	76%	36.1 (<.0001)
Shale gas drilling or fracking has been done in the US for	over 30 years	39%	47%	1.0 (NS)
Fracking can involve drilling as far as	> 1000s ft	39%	67%	8.4 (.004)
Fracking uses the following to obtain gas	Water, sand, chemicals, and oxygen	24%	20%	0.2 (NS)

TABLE 2

Importance of Different Concerns Relative to Fracking of New Jersey College Students, as Means $\pm$ SE of Students Who Responded Using 1= Unsure, 2= No Concern, 3= Somewhat Concerned 4= Concerned, 5=Very Concerned

	Session 1 responses	Session 2 responses	χ^2
Natural habitat	3.7 $\pm$ 0.2	2.8 $\pm$ 1.1	14.6 (.0001)
Habitat destruction	3.6 $\pm$ 0.2	3 $\pm$ 0.1	11.7 (.0006)
General risks	3.6 $\pm$ 0.1	3.9 $\pm$ 0.1	1.2 (NS)
Health issues	3.5 $\pm$ 0.2	3.7 $\pm$ 0.2	0.4 (NS)
Contaminants in water	3.3 $\pm$ 0.2	3.3 $\pm$ 0.2	0.10 (NS)
Farms being broken up	3.2 $\pm$ 0.2	3.5 $\pm$ 0.2	1.9 (NS)
Air pollution	3.2 $\pm$ 0.2	3.8 $\pm$ 0.1	4.0 (.05)
Gas pollution	3.1 $\pm$ 0.2	3 $\pm$ 0.1	0.3 (NS)
Excessive water use	2.9 $\pm$ 0.2	3.5 $\pm$ 0.1	4.4 (.04)
Earthquakes	2.7 $\pm$ 0.2	3.7 $\pm$ 0.1	18.1 (<.001)
Aesthetics	2.7 $\pm$ 0.2	2.1 $\pm$ 0.1	7.4 (.007)
Noise	2.6 $\pm$ 0.1	3.9 $\pm$ 0.1	33.1 (<.0001)

TABLE 3

Evaluation of Importance of Fracking, Given as Means $\pm$ SE of Students Who Responded Using 1 = No, Not at All, 2 = Not Sure, 3 = Somewhat, 4 = Yes, 5 = Yes, a Lot

I support fracking because I believe it will:	Session 1 responses	Session 2 responses	χ^2
Have economic benefits	2.2 $\pm$ 0.1	1.9 $\pm$ 0.1	3.7 (.05)
Reduce energy costs	2.1 $\pm$ 0.1	2.5 $\pm$ 0.1	4.2 (.04)
Promote energy independence	2.1 $\pm$ 0.1	2.3 $\pm$ 0.1	1.4 (<i>NS</i>)
I DO NOT support fracking because I believe it will have no benefits	2.1 $\pm$ 0.1	1.7 $\pm$ 0.1	8.3 (.004)
Reduce carbon emission	1.8 $\pm$ 0.1	2.6 $\pm$ 0.1	17.5 (<.0001)

TABLE 4

Rating of Information Sources That Students Trust, Given as Means $\pm$ SE of Students Who Responded Using
 1 = No, Not at All, 2 = Not Sure, 3 = Somewhat, 4 = Yes, 5=Yes, a Lot

I trust the following ___ for information about fracking	Session 1 responses	Session 2 responses	χ^2
Researchers	3.6 $\pm$ 0.1	2 $\pm$ 0.1	54.4 (<.0001)
Internet	2.7 $\pm$ 0.1	3.5 $\pm$ 0.2	14.1 (.0002)
Family members	2.6 $\pm$ 0.2	1.7 $\pm$ 0.1	17.6 (<.0001)
Federal government	1.9 $\pm$ 0.1	3.9 $\pm$ 0.2	48.9 (<.0001)
State government	1.7 $\pm$ 0.1	2.8 $\pm$ 0.1	30.1 (<.0001)
Radio	1.7 $\pm$ 0.1	2 $\pm$ 0.1	1.4 (NS)
Neighbors	1.6 $\pm$ 0.1	2.4 $\pm$ 0.2	15.1 (.0001)
Fracking companies	1.5 $\pm$ 0.1	2.4 $\pm$ 0.1	20.9 (<.0001)
TV news	1.4 $\pm$ 0.1	2.1 $\pm$ 0.1	17.9 (<.0001)

TABLE 5

Evaluation of Which Energy Sources Should Be Developed Further by the United States, Given as Means $\pm$ SE of Students Who Responded Using 1 = No, Not at All, 2 = Not Sure, 3 = Somewhat, 4 = Yes, 5 = Yes, a Lot

	Session 1 responses	Session 2 responses	χ^2
Solar	4.1 $\pm$ 0.13	3.54 $\pm$ 0.17	4.9 (.02)
Wind	3.63 $\pm$ 0.16	2.27 $\pm$ 0.17	27.6 (<.0001)
Wave	3.45 $\pm$ 0.13	3.34 $\pm$ 0.16	0.1 (NS)
Hydrothermal	3.28 $\pm$ 0.15	3.34 $\pm$ 0.16	1.0 (NS)
Natural gas	2.44 $\pm$ 0.17	1.78 $\pm$ 0.14	9.9 (.002)
Nuclear power	2.44 $\pm$ 0.18	2.27 $\pm$ 0.17	0.1 (NS)
Coal power	1.89 $\pm$ 0.14	2.12 $\pm$ 0.16	1.0 (NS)