Use of Classical Rhetorical Framework for Critical Analysis of Science and Engineering Issues

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Abstract

A unique program at Rowan University has joined a sophomore engineering design lab (Sophomore Clinic I) with the second-semester composition and rhetoric course, for a team-taught class in design and writing. The goals of this collaboration include teaching technical writing formats specific to engineering, strengthening general writing skills, and also making students aware of the epistemological background of thinking like an engineer. In this paper, we will begin with a description of the sophomore engineering clinic, then focus on a particular activity designed to bring a rhetorical awareness to issues that arise in engineering and science. In order to motivate student interest and participation, we decided to work with an issue that has received a significant amount of recent press, the use of genetically modified organisms in products for human consumption. We found that students have strong opinions on this topic, but are often unacquainted with the science behind genetically modified organisms.

The pairing of a faculty member trained in classical rhetoric and analysis of persuasive writing and a faculty member well-versed in the science behind the discussion topic provides complementary perspectives. Through this activity, we show that the effective use of rhetoric can shape public and company policies towards new technologies. We also underline the fact that science and engineering operate within a social context.

In this paper, we detail how we prepared students for class discussion, how the stasis questions of classical rhetoric shaped that discussion, and how we feel this technique can be expanded on.

History and Background

In 1992, Henry M. Rowan donated $100,000,000 to the then Glassboro State College to establish a unique engineering program in southern New Jersey. What is now Rowan University boasts an innovative College of Engineering comprised of four programs: Chemical, Civil and Environmental, Electrical and Computer, and Mechanical. The College graduated its first class in May 2000 and serves 15 to 35 students per year in each of its four programs for a total of 60 to 125 students per year.

The hallmark of the Rowan engineering program is an emphasis on technical communication and integrated, hands-on design and experimentation, which is realized in the multidisciplinary, project-oriented Engineering Clinic sequence. Beginning in the freshman year, all students enroll in Clinics and work with students and faculty from all engineering disciplines on laboratory experiments, real-world design projects, and research projects of increasing complexity. The importance of effective written and oral communication skills, teamwork skills, and technical proficiency is reinforced in the Clinic sequence[1].

In the sophomore year, students from all engineering disciplines work together on semester-long design projects and present results through either written reports (Sophomore Clinic I) or oral presentations (Sophomore Clinic II). Students learn not only the fundamentals of the design process, but also hone their technical communication skills. This paper focuses on Sophomore Clinic I, which is a combined composition and design course team-taught by faculty from the College of Engineering and College of Communication[2-4]. The course is structured so that students meet twice a week in small (~20 students) 75 minute writing sections, and once a week in a 165 minute engineering design lab. For some classes the engineering faculty attend sessions of the writing section, and occasionally the writing faculty attend the engineering section.

The challenge in developing and delivering the course has been in integrating the various educational objectives of both the Engineering and Communications Colleges while maintaining a focus on meeting the students' needs. The goals of Sophomore Clinic I include combining argumentative discourse, rhetorical awareness, technical communication, and engineering design principles. This challenge also presents an opportunity to introduce analysis tools that are complementary to the engineering design process.

One of the advantages we felt this team-taught course provided was to allow an interaction of the different points of view that an engineer and a writing teacher might have, as well as provide an opportunity to draw on different pedagogical approaches. We did not know ahead of time just how such interaction might work, whether there might be a perfunctory cooperation with separate approaches at separate times, or whether this opportunity would allow us to approach the class in ways that would not happen with each instructor independently. Given the critical importance in engineering education of developing the logical thinking of the students, we hoped that an interaction between engineering and writing would do much more than simply improve our ability to teach the forms of engineering writing. We also hoped our team teaching would allow a productive synthesis for the difficult task of moving sophomores toward the type of sharper thinking that we hope to see in practicing engineers (or in the educated citizens of a democracy). At times as we taught this course, we naturally relied on our separate approaches, but we also found at times a satisfying conjunction of effort. What follows is a description of one occasion when the joined engineering/writing instruction provided what we felt was a unique approach in engineering instruction. Moreover, this is a methodology that can be adapted to other engineering classrooms.

The lesson we are describing here (which was used in a single period lasting one hour and 15 minutes) originated when the engineering professor, during regular attendance in the writing section of the course, observed a presentation and class exercise in which the students were asked to use a set of questions to examine a number of technical issues. Those questions were adapted from an ancient rhetorical technique, called "stasis". Stasis consists of a small set of questions, which are intended, when answered thoroughly, to clarify the status of an issue. The technique was first developed in the second century BCE by Hermagoras of Temnos, and was adopted as a common technique by Roman professors of rhetoric[5]. The original use of stasis questions (of which there were four) was to provide the speaker or writer with an invention technique for elaborating an issue and helping to generate a fuller discussion of a topic. In its original form, the stasis technique was focused on legal questions: (Fact) What are the signs that X committed an act? (Definition) If X committed an act, was it criminal? (Cause) If X committed a crime, were there extenuating circumstances? (Jurisdiction) If X deserves to be tried for committing a crime, is the trial being held in the right place? Over the centuries, this basic technique of sequential questions has been adapted to other uses. The way we applied the technique in our classroom will be described below. After observing the original class that used stasis for a discussion, the engineering professor suggested that this method would be interesting to apply to a topical issue currently under hot debate, the subject of genetically modified organisms. With a little more discussion between the two instructors, the basis of a future lesson was laid.

Preparation for discussion

In preparation for a lesson on genetically modified organisms (GMOs), a webpage was prepared to present students with information on the topic. Both professors chose web sites to use as background, with a basic goal of choosing sites that both supported and opposed this new technology. Although some students later pointed out that genetic modification can be applied to animals and even humans, the websites we chose limited our discussion to genetic modification of plants and the subsequent benefit to and safety of our food supply. The webpage used for this lesson (at URL [http://users/rowan/edu/~hutto/CE_GMO.html]) served both to reiterate instructions to students on how to prepare for the class, as well as to provide easy access to the chosen websites, with links provided. We did not distribute any paper materials for this assignment. Ultimately, our webpage contained two links for each of four categories, pro-GMO, anti-GMO, more neutral discussion, and American legal attitudes. In addition, there was a link to a separate webpage with a list of the stasis questions being used. The questions were presented in categories as five rhetorical claims:

1) Claim of fact: Did it happen? Does it exist?
2) Claim of definition: What is it? How should we define it?
3) Claim of cause: What caused it? [and/or] What are its effects?
4) Claim of value: Is it good or bad? What criteria do we use to decide?
5) Claim of policy: What should we do?

In order to prepare for class, students were asked to look at the linked websites, exploring them enough to be able to answer the questions on the claims page. Answers to the questions on that page were to be written out and brought to class on the day the discussion was scheduled.

Our use of stasis in this lesson was unlike the classical approach, since our focus was not on using stasis for invention (that is to say, having the students generate their own text). Instead, we applied this technique in a very different way. First, we utilized stasis as a heuristic device for analysis of texts written by other authors. Secondly, we applied it even more broadly as a tool for critical thinking. In creating this lesson, we had three general goals. To begin with, what was done here was in part an experiment, to find a way to apply an ancient rhetorical technique to a contemporary issue. We operated from a position of believing that ancient knowledge and practices can benefit modern society, in this case serving to augment the pedagogy of the classroom. Exactly how to apply the older practices was of course part of our challenge. We tried to meet that challenge by using stasis to address two other goals for this lesson. One of the constant purposes of any college course should be to challenge the students into ways of unfamiliar thinking, to increase their ability to more critically examine the world around them. Whether or not this is even more important for people who physically manipulate the world, such as scientists and engineers, may be an arguable point, but the ability to think critically should be an essential part of an engineering education. Our lesson on GMOs using the stasis technique was thus part of the broad goal of inculcating critical thinking abilities in the students, and we hoped that by doing this we were also giving them a method, a type of mental tool, that they might come back to in the future. A third goal of this lesson involved the particular way we applied the stasis technique. The suggestion of the engineering professor that we use the topic of GMOs was due to her realization that this technology has caused intense and even angry debate. The subject thus served as an obvious intersection of engineering technology with rhetoric, but given the importance of the topic, with the potential of GMOs to impact standards of living as well as human health, we wanted our students to have an opportunity to examine the debate on this issue in some depth. We also hoped that the way we conducted the discussion would serve as an example of how the stasis questions could be applied to topical issues, as well as showing how professors would examine the topic.

Out of curiosity, on the day we conducted this class, we began by asking how many students felt on the whole positively disposed toward GMOs, and how many felt generally negative toward them. The great majority regarded GMOs positively, which probably indicates the basic faith these students have in science in and in engineering. One student even articulated this rather graphically (if overstated for most of the students) by saying "If it wasn't a good idea they wouldn't have thought of it." As faculty interested in improving the students' critical thinking, this also told us in a very clear way that we have some work to do. The first part of the class drew on the students' written preparation, as we went through each claim and discussed what could be said about it, looking at alternative ways of seeing each question. While examining the stasis questions, student opinions were constantly elicited, and we then tried to add to what the students had said, to bring in points of view that had not been mentioned.

In-class discussion of rhetorical claims

On the rhetorical claim of fact, there was no question as to whether or not genetically modified organisms already exist, by any definition that is used. Other types of claims, however, could still be examined for whether or not the things claimed were true. All students in written comments started from the point of view that GMOs exist, but the real claims of fact concern benefit or harm. Most students did not approach the argument at first by considering the existence of benefit or harm to be the real question. In the written preparation for class, one student typified this when he wrote, "Genetically engineered foods do exist today. Many food-processing companies enhance their product to make their product a higher quality." From the websites we looked at, many claims were made about the amazing benefits of genetic modification (reduced use of pesticides, increased nutritional value, foods that can vaccinate against diseases, increased shelf life of food), as well as equally vivid claims about the harm caused by genetically altering plants in the food supply (transfer of genes to create superweeds, destruction of desirable insects like butterflies, harming the health of some people, causing some deaths). Some students did focus their discussion of the claim of fact on these questions of harm. One wrote, "The problem at hand is whether or not genetically modified organisms are a 'threat' to the environment and society. It has been proven that some GMOs cause problems in animals that eat the altered plants. However, not all GMOs are proven to be a danger." Another possible approach to the claim of fact is whether or not human beings are likely to encounter these altered plants in our foods. The existence of GMOs, even if they are proven harmful, is not the same thing as having them unavoidably in the food supply. One student articulated this well, writing, "GM foods do exist in the marketplace today. Actually most of the food we eat has been altered in some way or another. The controversy over the foods first arose when Europe restricted or banned the foods after an incident with Monsanto over a mixing of GM and unaltered soya beans. So the problem does exist."

The rhetorical claim of definition raised some particularly interesting ideas from the rhetorical point of view. For a discussion to rationally take place, people must be discussing the same thing, yet from looking at the GMO debate, we found a problem in that sometimes the disputants only appear to be in a dialogue with one another. In fact they are sometimes talking about different subjects even when using the same word to refer to them. Definition of terms can be critical. The phrase "genetically modified organisms" concerns a sophisticated process of cutting and moving genetic material from one organism to another. In theory genes from any organism can be moved to any other organism, say from a redwood tree to a mouse, assuming any reason can be thought of for doing so. This remarkable choice of genetic manipulation has only existed for a few years, and it can only be done in a laboratory. The purpose of the process is usually to alter either plants or animals so as to have new characteristics that are desirable for some reason.

A narrow definition of the process just described might attempt to capture the artificial laboratory nature of the technology, as well as its beneficial intention. In practice, however, we found both proponents and opponents stretching the definition far beyond this limit. Some proponents of GMOs see the alteration of plants as a natural extension of a process begun thousands of years ago when humans first began to replant the seeds of plants with preferred qualities. The term "biotechnology" can be used to cover the entire range of manipulation, including both selection of desirable seeds and current gene splicing. One student caught this idea when writing, "A genetically modified organism is nothing more than an extension of what has been done since man first settled in one place. Since then 15 major crops that provide 90% of the world's agriculture has been continuously changed to increase efficiency." Another student expressed the same idea in saying, "Technically, we have been genetically engineering crops for hundreds of years. Monks growing pea pods in Britain would produce 'hybrids', a combination of two species of pea pods." These definitions of GMOs are those used by Monsanto, one of the companies producing GMOs, but of course such definitions completely ignore the fact that gene splicing can produce combinations of genes that were not possible for thousands of years, as we are no longer limited by natural sexual reproduction to carry the genes. One student moved toward this subtlety in the definition, writing, "A genetically modified organism is any organism which its DNA has been spliced or parts have been added in from another organism in order to alter insect control, herbicide resistance, or the value of the food. According to the USDA, there is no inherent difference between a genetically modified organism and a regular one. However, mother nature is showing a difference..." This student saw a contrast between an "official" definition and what nature itself will allow. Because our engineering students were so strongly inclined toward GMOs, none of them took the extreme definition used by opponents, which often sees this process as technology gone amuck (typified by the references to genetically modified foods as "Frankenstein foods"). The opponent definition sees scientists as playing with dangerous unknown processes with unknown and potentially terrible consequences. Between the definition of GMOs on the one hand as a natural extension of what we have always done, and on the other hand as a step toward technological horror, dialogue becomes very difficult. This extreme dichotomy was one of the things our class found in looking at the GMO debate.

Why this discussion on GMOs is even taking place relates to the rhetorical claim of cause. In other words, why do GMOs exist, what is their purpose? One student wrote, "GMOs came into existence mainly because of the people's concern of increasing population versus the production of food items. There is scarcity of food in most developing countries causing unhealthy conditions for people." During class discussion many students cited this altruistic reason as a motivator for the production of genetically modified food. Another student saw a more abstract reason, saying, "The cause for research and development of GMOs is simply the need for the human race to advance. Since the beginning of time we have been trying to advance everything that we do from day to day...These days the technology exists to enhance the production of our fields on genetic level, and the prospects are simply irresistible." We thus have a reason to cut and splice genes not only because we can create new plant characteristics that help people, but we do it just because we can. With modern science we have continually expanded our control of the world, and this is one more way to control it. This reason seemed to be the one another student was giving, but then yet a third reason was added. "What caused it is probably the human need to control the environment to suit our needs. For some, it might have been the need to increase the food production to help with the hunger problems around the world. But most likely it was a way for companies to increase production with less input, which would in turn increase their profits." This third cause of GMOs, making money, has no hint of the altruism that students first named in class discussion, though once it was pointed out, they recognized that making money was also probably a motivation. As one student expressed it in his written comments, "The cause for plant biotechnology lies not only in society's need for constant technological advancement, but also in the inherent need for prosperous members of society to make efforts to help the less privileged...The need for some successful members of society to use the weakness of the less successful to become even more prosperous has perhaps become an even stronger force in this matter."

The rhetorical claim of value can illustrate some of the great gaps between supporters and opponents of GMOs. Both sides might claim to support the same basic values, yet those values will be cited in support of opposite points of view. Those who favor GMOs in food will cite the value of human life and health, and thus the benefit of this technology to increase nutritional yield, to put vaccines and vitamins into food, or to increase output per acre. Opponent will also argue in favor of human life and health, and then claim that GMOs cause illness in some people and have in some cases resulted in death. The value of a clean, healthy environment is also supported by both sides, but again with opposite claims as to the effects of GMOs. Supporters claim that fewer pesticides will need to be used in the environment with the careful breeding of resistance qualities in plants. Opponents say that genetic damage will spread randomly into the environment from the process itself. Which of the claims are correct is of course the gist of the argument. One student left the question open, writing, "In my opinion, GMOs are neither good nor bad yet. Until their effects can be completely determined, I do not have enough information to form a definite opinion on them. The criteria we should use to decide include their effects on humans' health, and also their effects on world hunger." Several students presented criteria for judging value, that is, the goodness or badness of genetic modification. One wrote, "My criteria to decide whether it's good or bad is to consider the benefits to society this can bring measured against the disadvantages this could have on society. I believe the advantages outweigh the disadvantages..." Another student proposed criteria different from those just cited, writing, "My personal decision is that we must use the basis of whether or not GMOs help or hinder the environment. If we consider only this, then we can have a definite line of yes or no..." While having criteria to judge GMOs by is necessary, it will not be a final solution, as both of these students are using different criteria, and in both cases their criteria use large undefined terms like "effects" and "help or hinder".

The final rhetorical claim is claim of policy, what we should actually do based on preceding discussion. Most students wanted to continue research into GMOs, and most wanted more investigation as to their safety. In regards to growing and testing, one student wrote, "More studies should be done on the already in use GMOs and the effects that they are having on the environment. Before changing any more organisms, a set of criteria should be created to decide if it's ethical and effective. The long-term environmental effects should be researched more thoroughly." A similar desire to continue testing was described by another student, writing, "It seems that the anti-GMO groups would want to promote policies that would ban GMOs altogether, rather than examine them in greater detail. I do not think this is the answer, since it doesn't allow for consideration of the benefits of GMOs. I believe that GMOs should still be created, although they should be constantly tested in order to determine what types of problems might arise in them." Although these opinions seem reasonable, we pointed out that testing for safety will not answer all the critics, because in order to investigate safety, genetically modified plants will need to be grown. For many opponents, however, growing them at all is the problem, as there can be no guarantee that pollen from these plants will not blow away on the wind or fly away on insects to affect other plants nearby. In addition to growing and testing GMOs as most of our students suggested, other policy options include banning such research altogether and destroying those plants that already exist, continuing to have genetically altered plants in the food supply but with clear labeling, or to simply proceed with changing our food and not worry about it. We tried to make students aware of the variety of options that might be followed, options that some people do want to follow.

In-class examination of rhetoric

In addition to our discussion of rhetorical stasis claims, we supplemented the stasis discussion by trying to draw the students' attention to several ways language was being used in the GMO debate. We first did this by giving them an excerpt from a website that was strongly anti-GMO and asking them to make notes while looking for both metaphors and emotional language. The example used in this case was heavily emotional, with much of the emotion being produced by extreme metaphors, such as comparing genetic modification of plants to a shotgun blast, to rape, and to the invasion of a country. We pointed out that in a case such as the one we were looking at, even a writer who is correct or has something valid to say has a very low credibility because the linguistic techniques being used are so extreme as to push critical readers away. This example was followed up with two further examples from websites that both supported and opposed GMOs. We put these examples onto overhead transparencies for projection on a screen. We first showed a resolution passed by the European Parliament banning genetically modified maize. One part of the resolution stated regret that economics had become part of the discussion and declared that safety should be the only real concern. We then showed the students that in giving reasons for passage of the resolution, the same document indicated as a partial reason the anger of consumers over mad cow disease (and thus a political reason for the ban was given, as the Parliament needed to look like it was doing something, even though mad cow disease is completely unrelated to GMOs). In another area the same document stated that European farmers are at an economic disadvantage because of GMO food (and thus an economic reason for the ban was given). After pointing out the inconsistencies in the resolution of the European Parliament, we showed excerpts from a pro-GMO site, from Monsanto, which produces genetically modified plants. On a page explaining what genetic modification is, Monsanto referred to DNA as "simply a code", and used other language on the page to create the impression that the issue is not as complicated as people have thought, stating for instance that all DNA is made up of "the same material". This oversimplification seemed to say that moving genes from one organism to another is of little consequence, since it is all from "the same material." Another example from Monsanto that we used was a question and answer page, in which the question "Can I avoid GMOs?" was supposedly answered with an entry on a separate page. When we read the page carefully and talked about it, we found that in fact the question only had an implied answer at the end of a long paragraph, and the implication was basically "No, you probably can't". The idea that the question was going to be answered, after having been raised on the Monsanto page, seemed somewhat dishonest in the way that it was actually presented. With these examples of the rhetoric surrounding this issue, all of the examples taken from websites, we wanted to show the students that both sides of the argument on this issue are guilty of illogical or misleading language, and even of illogical thought. In discussing each example, we also wanted to give practical demonstration of how to read closely, how to examine both the language being used and what it means, and how to look for ideas behind the writing and for what is not being said.

Conclusions

Assessment of complex long-term goals from one lesson is probably not possible. Thus the effect of these exercises on critical thinking cannot be judged. Nevertheless, the challenge was illustrated for us at the end of the class, when one student, after learning more about genetically modified organisms, exclaimed, "This is even cooler than I thought!" In the long run, will any of these students use this question technique again to look at an issue? At this point we can only guess and say that it's possible. If nothing else, we tried to illustrate for them a systematic approach that considered both positive and negative sides of an issue, and that tried to look at reasons behind those positives and negatives. As part of this examination, we also tried to draw the students' attention to specific instances of language, to increase their consciousness of how the language in a debate affects the ideas.

Regarding the more specific goal of this lesson to critically examine a particular topical issue, that goal was achieved, but at the same time we cannot claim that it had an immediate dramatic effect on student thinking. At the end of the class we again asked who felt generally positive or negative toward GMOs, and we found no real difference from the beginning of the class. From the liveliness of class discussion, however, it is clear that students were very engaged in the topic, even making comments to one another in addition to the general discussion. Getting students intensely involved in talking about an issue we feel was a worthwhile benefit to this class, even if we cannot yet judge long-term effects.

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Biographical Sketches

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