STEM and Politics – Before and After Tuesday, November 8, 2016

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This document has two parts:

- A Model of Polarization and Compromise: How Voters Evaluate Candidates and Options. System thinking, multiple stakeholders, and multiple objectives.
- One classroom-tested example – the Effects of Taxes – illustrating how system thinking and multiple objectives can be infused throughout the undergraduate STEM curriculum.

A Model of Polarization and Compromise

This author believes that the biggest problem infecting American politics is dysfunction caused by an unwillingness to compromise. As educators who must respect divergent opinions and give bias-free grades, we must recognize that this belief is itself controversial. Many Americans are tired of hearing that their views are extreme or uncompromising. Many believe strongly that there should be no compromise on some issues. A Pew Research Center survey[1] conducted September 6-19 2010 yielded the following results:

Admire political leaders who ...	Total	Republican	Democratic	Independent
make compromises	42	33	54	40
stick to their positions	49	62	39	53
don't know	9	5	8	8

Table 1: Is Compromise a Virtue?

Whatever your views on compromise it is important to look at models that can shed some light on how and why voters reach an unwillingness to compromise.

[1] http://www.pewresearch.org/2010/09/20/little-compromise-on-compromising/ Accessed October 4, 2016.

The model we discuss here emphasizes two key ideas:

- Multiple stakeholders and objectives.
- System thinking.

Multiple Stakeholders and Objectives

We use as our example the health care system in the United States. There are many obvious stakeholders and the stakeholder classification does not neatly divide people into distinct non-overlapping groups – for example, patients are taxpayers. Here is a partial list of stakeholders – health care professionals including doctors, nurses, and others, insurance companies, patients, their families, taxpayers, federal, state, and local governments, political parties and individual candidates, big pharmaceutical companies, hospitals, lawyers, employers and many more.

There is also a long and multilayered list of criteria by which a health care system might be judged. The most obvious, of course, is the quality of health care but even this most obvious criterion is complex – preventive care, treatment, end-of-life palliative care, life-saving care and elective care are just broad criteria. In the coming decades we are certain to face questions about measures that enhance human capabilities. Then we have cost – but cost to whom? Many of the stakeholders are driven by their own profits and the cost of drugs is in direct conflict with drug companies' profits. For many people the driving force behind the Affordable Care Act was coverage – providing insurance to the uninsured. But, states have their own interests – how much of the cost falls on them? And then there are voters who don't believe in birth control or in the right to choose.

Many decision-makers and voters recognize this complexity. As a result they are more likely to judge alternatives in a more-nuanced way. Comparing two different proposals they are more likely to see the strengths and shortcomings of each. They are forced to make compromises no matter what. Other decision-makers and voters, however, judge options by a single overriding criterion and are often unwilling to compromise on that criterion.

A narrowed recognition of differing objectives is compounded by a growing tendency of people to get their news from sources with whom they agree. The survey results shown in Figure 1[2] look at media and Cathy O'Neil's book Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy[3] considers the narrowing effects of micro-targeting based on big data.

[2] http://www.journalism.org/2014/10/21/political-polarization-media-habits/10-20-2014-2-31-55-pm/ Accessed October 4, 2016.

[3] https://www.amazon.com/Weapons-Math-Destruction-Increases-Inequality/dp/0553418815/ref=sr_1_1?ie=UTF8&qid=1
1&keywords=cathy+o%27neil Accessed October 4, 2016.

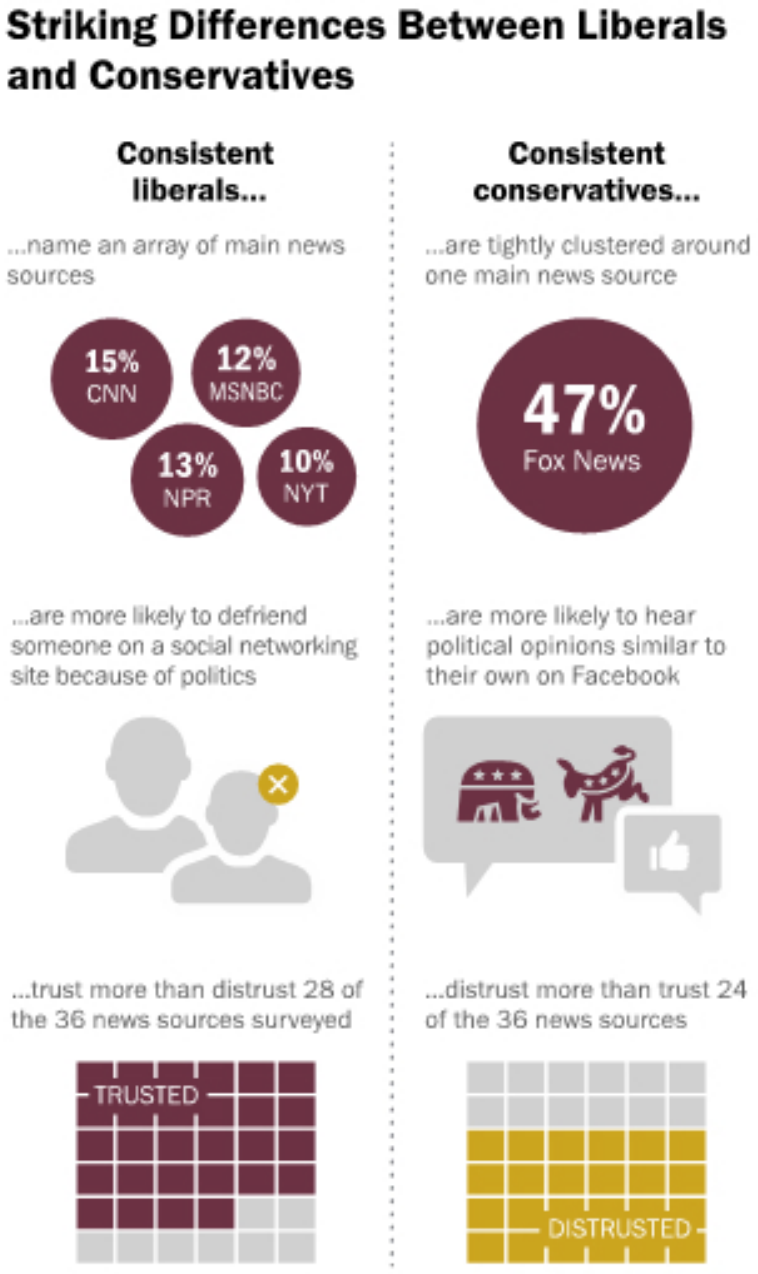

Figure 1: Political Polarization and Media Habits

Thus, our model for how voters choose among alternatives includes the effects of the recognition or lack thereof of the value of multiple objectives on willingness to compromise and acceptance of a broader range of alternatives.

System Thinking

Here again we use the health care system as an example. We start with a simple question an individual might ask – how much will it cost me? Many voters translate this immediately into a single simple isolated question – how much will my taxes rise? But a system thinker recognizes that the even just the dollar cost of healthcare is a complex system. Many Americans, for example, get their health insurance through their jobs. Even though employers pay directly for part of these premiums, employees also pay part both directly and indirectly. This is particularly evident in contract negotiations where trade-offs between salaries and benefits are made very explicitly. So a better question is – how much will my taxes rise and how much will my pay rise if we shift from job-based health insurance to tax-based health insurance? But even this is a small piece of the system. We also need to consider co-pays and deductibles, the impact that treatment of uninsured patients in hospital emergency rooms has on our insurance premiums. Like consideration of multiple objectives, system thinking leads to recognition of complexity and a recognition that no solution is perfect without sometimes negative downstream effects.

Thus, our model for how voters choose among alternatives includes the effects of the system thinking on willingness to compromise and acceptance of a broader range of alternatives. System thinking is harder to work into the curriculum and, especially introductory courses. It is inherently and unavoidably interdisciplinary.

Discussion

> This discussion is meant as a very general example about how a classroom discussion might be built around the ideas of multiple objectives and stakeholders and system thinking. In the second part of this document we look at classroom-tested materials that might be used with some modification in a variety of mathematics classes from high school algebra through upper level undergraduate courses. As written, this example is suitable for high school or college algebra.

One of the most divisive topics in this year's presidential election is whether and how many Syrian refugees the United States should admit. The following paragraphs[4] represent Donald Trump's position.

[4] https://www.theguardian.com/us-news/2016/sep/02/donald-trump-syria-refugees-us-immigration-security-terrorism Accessed October 4, 2016.

As a safeguard, the Republican nominee announced that his administration would suspend immigration from Syria and Libya. Those seeking to enter the US would be subject to an "extreme vetting" process that Trump emphasized would be "so tough."

Before being accepted, applicants would submit to an "ideological certification" that would ensure that those who are admitted "share our values and love our people." Trump said immigrants would face questions about honor killings, their view on "women and gays and minorities" as well as their attitudes on "radical Islam."

"We have no idea who these people are, where they come from," Trump said of Syrian refugees during his speech in Phoenix on Wednesday. "I always say, Trojan horse. Watch what's going to happen, folks. It's not going to be pretty."

The following paragraphs[5] represent Hilary Clinton's position.

Democratic presidential candidate Hillary Clinton said Sunday that the United States should accept 65,000 refugees from Syria to help alleviate the humanitarian crisis created by the war there.

"We're facing the worst refugee crisis since the end of World War II and I think the United States has to do more," the former secretary of state said Sunday on CBS' "Face the Nation." "I would like to see us move from what is a good start with 10,000 to 65,000 and begin immediately to put into place the mechanisms for vetting the people that we would take in."

She said there should be a focus on admitting the most vulnerable, like persecuted religious minorities, or those who had been brutalized, like the Yazidi women.

Clinton also said, "I want the United States to lead the world," and said the United Nations Secretary General should call for a meeting at the upcoming U.N. General Assembly meeting in which countries make specific commitments about to provide money and aid.

Please address the following three questions:

- Who are the stakeholders in this debate? What criteria are useful for evaluating different courses of action?

[5] http://www.cbsnews.com/news/hillary-clinton-u-s-should-take-65000-syrian-refugees/ Accessed Ocober 4, 2016.

- What does system thinking contribute to this debate? What are the downstream effects of different courses-of-action?

- How will Trump supporters react to this analysis? How will Clinton supporters react to this analysis? Does this framing of the issue, by itself, favor one or the other side of the debate?

A Classroom-Tested Example

The United States and state tax systems are often used in the pursuit of public policy goals. For example, cigarettes are heavily taxed in an effort to discourage smoking, sugar taxes have been proposed in an effort to improve public health, and carbon taxes have been proposed to drive down carbon dioxide emissions and lesson its greenhouse gas effects. Gasoline is heavily taxed in many countries to drive down carbon dioxide emissions and air pollution. Economists often argue that these taxes are necessary so that free market price-setting mechanisms takes into account the true costs of, for example, carbon dioxide emissions.

In this module we apply some simple mathematics to answer questions about the multiple stakeholders and criteria involved in these decisions and to look at the downstream effects predicted by system thinking. Because this module is designed for use in a high school or college algebra course, we use a "toy model." Nonetheless this "toy model" shows how STEM and mathematics can illuminate complex and contentious issues.

This module is designed to be used when students study simple linear functions and solve simple linear equations. It can easily be modified for more advanced classes. As one example, it provides a good application in calculus modeling situations where producers are able to maximize profits.

We look at a product whose production cost is \$2.00 per unit. This cost includes materials, labor, and taxes. The current tax is \$0.50 per unit. If the product is sold at a price of p dollars per unit then the unit profit is $p - 2$. In our model there are many independent producers for the product and it is easy to move in and out of production. The supply produced by the producers is a function of its price. We use the function

$$S(p) = 100,000(p - 2),$$

in units per day. Notice that if the selling price is equal to the production cost there is no profit to be made and no incentive for the producers to produce the product. In fact, it would be better to write the supply function as

$$S(p) = \begin{cases} 0, & \text{if } p \leq \$2.00; \\ 10,000(p-2) & \text{otherwise.} \end{cases}$$

We also assume that there are many independent consumers for this product and that the demand for this product is given by the function

$$D(p) = 100,000(10-p).$$

This leads to a standard high school or college algebra problem – find the equilibrium price, the price where supply and demand are equal. In a free market economy we expect the price to settle down at thus equilibrium. If the price was above the equilibrium then supply would exceed demand and the price would have to fall to clear inventory. If the price was below equilibrium then excess demand would drive the price upward.

In most high schools or college algebra courses the problem stops here. But, we want to use this problem to examine a public policy alternative – suppose we impose an additional tax of \$1.00 per unit. Now the supply function is

$$S(p) = \begin{cases} 0, & \text{if } p \leq \$3.00; \\ 10,000(p-3) & \text{otherwise.} \end{cases}$$

and we ask the following questions:

- Who are the stakeholders as we consider this new tax?
- What criteria should we use to judge the effects of this new tax?
- Using this "toy model," provide quantitative answers for the criteria you identified above.
- Identify and quantify the downstream effects of this new tax.

These kinds of questions can engage and motivate students in STEM courses and at the same time help inform the debate about complex, contentious, and consequential topics like adopting a carbon tax. We have used this problem often with great success. Here are some of the answers we expect for the last bullet.

- Before the new tax the equilibrium price was \$9.2727. At this price the total number of units produced and sold each day was 72,727.3. The unit profit was \$7.2727 and the total profit each day is \$528,926.

- After the new tax the equilibrium price is $9.36364. At this price the total number of units produced and sold each day is 63,636.4. The unit profit is $6.36364 and the total profit each day is $404,959.
- Since the equilibrium price rose by $0.11, from $9.27 to $9.36 the producers effectively paid most of the tax.
- For the industry as a whole total profits dropped by 11%.
- The total number of units produced and sold each day dropped by 12.5%. This is good if you are trying to reduce the number of units produced and sold but for the producers and workers it translates into lower profits and job losses.
- Productivity in terms of profits per unit dropped.
- Before the new tax the government collected $36,363.60 in taxes per day. After the new tax tax collections rose to $95,454.50 per day. This money could be used to lower other taxes or to fund other government services.
- The total amount consumers spent per day on this product dropped from $674,380 to $595,868. This money can be spent on other products.