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13. QUANTITATIVE FORM IN ARGUMENTS¹

Many people argue that too much data about the injustices in our world make us numb to the realities of those situations in people's lives. Wasserman's editorial cartoon about the Israeli occupation of Palestine makes this point²:



However, we do need to know the meaning of the numbers describing our realities in order to deepen our understandings of our world. One of my proudest academic moments was when *The Nation* published an edited version of the following letter I wrote responding to an article by Howard Zinn, in which he argues that the numerical descriptions of the deaths from the US war on Afghanistan can obscure those horrors.

February 11, 2002

To the Editor:

Howard Zinn's article ("The Others," February 11) is a powerful reminder of the horrors that are perpetrated in the world on all the days in addition to 9/11. I, too, cried as I saw the portraits of the 9/11 victims. I, too, was crying not only for them, and not only for the victims of the wars the USA and other powers create, but also for the millions who die every year because of

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economic terrorism – from unsafe working conditions that kill “by accident,” to unjust working conditions that result in death from preventable causes such as hunger.

Binu Mathew reports in *Z* magazine (January, 2002) that at this point in time the original death toll of 8,000 caused by the Bhopal gas leak at Union Carbide’s factory has increased to 20,000, growing every month by 10-15 people succumbing to exposure-related diseases. Union Carbide management delayed sounding the public siren for 15 hours, and continues to obstruct full revelations which would have helped decrease some of this horrific toll. I, too, wondered, if detailed, in-depth TV and newspaper portraits of these victims, and of, say, the 12 million children who die from hunger every year (Moore, 1998), would wake up our collective consciousness.

Zinn makes another important point that I stress with my Quantitative Reasoning classes at the College of Public and Community Service (University of Massachusetts/Boston): statistical data can distance us from a deep empathy and understanding of the conditions of people’s lives. Of course, the data are important because they reveal the institutional structure of those conditions. But, also, quantitatively confident and knowledgeable people can use those data to deepen their connections to humanity. Those 12 million children are dying faster than we can speak their names.

In essence, the quantitative point of my letter is about the form in which we put numerical information.³ Changing the form can help us make sense of quantities whose significance we cannot grasp. Changing the form through basic calculations can allow us to feel the impact of those quantities through better understandings. Further, knowing the most effective form in which to present those quantities in arguing for creating a just world is an important skill in a critical mathematical⁴ literacy curriculum. I suggest that knowing the most meaningful quantitative form in which to express information is necessary to understand what is going on.

CHANGING THE FORM TO UNDERSTAND LARGE QUANTITIES

In 2010, the American Friends Service Committee and the National Priorities Project sponsored a contest for youth to make a short video with the theme “If I had a trillion dollars.” The goal was to have young people who “are affected by the ongoing costs of the wars and our federal budget priorities ... but are often not part of the conversation or the anti-war, pro-peace movement,” present their ideas for spending what at that time had been the estimate of the costs of the wars on Iraq and Afghanistan.⁵

One of the two national contest winners was *AmplifyMe*, a non-profit group that uses “[P]op culture to inspire people to think differently about their power to create change in their lives and the lives of others through civic engagement.” The kinds of projects that the youth wanted to spend this money on included: “a new medical center for people who don’t have access to health insurance or people who just can’t afford it,” “a center for the homeless and underprivileged to reconnect with

Table 13.1. Key domestic programs vs. major military programs fiscal 1998 budget

<i>Domestic Program</i>	<i>Military Program</i>
Home-heating assistance for low-income families (\$1 billion)	Cost of 1 Arleigh Burke destroyer (\$1 billion)
Raise Pell grants to \$3000 (\$1.7 billion)	Cost of 1 B-2 bomber (\$2.1 billion)
Head Start for young children (\$4.3 billion)	Cost for 1 Seawolf attack submarine (\$4.3 billion)
Drug prevention programs (\$2.2 billion)	Request for F-22 fighter program (\$2.2 billion)

(Center for Defense Information, quoted in Herman, 1997, p. 43)

society and also to get food and appropriate clothes,” and “a different type of community center to keep the young teenagers out of the street and prevent gang violence.” Only one youth suggested a project that would use up more than a miniscule fraction of the \$1 trillion: “I would donate the trillion dollars to better our economy to have more jobs available.” This lack of perception is because most of us have no idea of how large \$1 trillion really is; and, although most of us will never personally deal with these sums of money, collectively we are spending these sums of money on our wars, with no concrete idea of how much that war spending is stealing from our human services.

- But, by changing the form of numbers, we can get some idea of how large they are. Ask people to guess, without calculating, the answers to the first two questions to get a sense of how little sense we all have about the meaning of large numbers. About how long, at the non-stop rate of one number per second, would it take to count to one billion?⁶
 - About how long, at the non-stop rate of \$1,000 per hour, would it take to spend \$1,000,000,000?⁷
- And, then, of course, to get a sense of the size of 1 trillion, you need to multiply by 1,000.⁸

In terms of what human services \$1 trillion can buy, one of the largest and well-equipped community health centers in the country is currently building an expansion at the cost of \$24 million. So, building one such health center would use up 24 ten-thousandths of one percent (0.0024%) of the \$1 trillion dollars. Or, for \$1 trillion we could build over 40,000 such facilities. To put this number in a more realistic context, as of 2007, there were about 19,500 municipal governments in the country.

The political and real meaning of the dollars we spend on wars is also revealed in various other specific comparisons (Table 13.1)⁹: in 1997, for example, was “a B-2 bomber worth more than twice the \$800 million currently being saved by cutting 150,000 disabled children with ‘insufficiently severe’ disabilities? Is \$248 billion for the military and \$31 billion for education a proper balance in the use of federal funds?” (Herman, 1997, p. 43).

Further, other seemingly large numbers are not so large when placed in context, in a different quantitative form. Without proper context, people’s lack of quantitative understanding results in their voting against their own interests (Baker,

Table 13.2. *What does he mean?*

WHAT DOES HE MEAN?

“Our troops ... will not be asked to fight with one hand tied behind their back.”
 – President Bush, national address, January 16 [, 1991]

Tons of bombs dropped on Vietnam by the U.S.: 4,600,000
 Tonnage dropped on Cambodia and Laos: 2,000,000
 Tonnage dropped by the Allies in World War II: 3,000,000
 Gallons of Agent Orange sprayed: 11,200,000
 Gallons of other herbicides: 8,000,000
 Tons of napalm dropped: 400,000
 Bomb craters: 25,000,000
 South Vietnamese hamlets destroyed by the war: 9,000 (out of 15,000)
 Acres of farmland destroyed: 25,000,000
 Acres of forest destroyed: 12,000,000
 Vietnamese killed: 1,921,000
 Cambodians killed (1969-1975): 200,000
 Laotians killed (1964–1973): 100,000
 Vietnamese, Cambodians & Laotians wounded: 3,200,000
 Total refugees by 1975: 14,305,000
 American troops who served in Vietnam: 2,150,000
 American troops killed: 57,900

Note: From *The Nation* (February 18, 1991)

2005). For example, in the mid-90’s a Kaiser poll found that 40% of people ranked welfare for those with low incomes as one of the two largest items in the federal budget – the overall number was under 4%, even according to the government statistics that mislead in a way that underestimates human services (as compared with 22% for Social Security and 18% for military spending). Baker blames the misperception on the way the numbers for welfare are reported – \$16 billion for a core welfare program sounds gigantic, but in context it is only 0.6% of total federal spending. He feels that when people have such an exaggerated view of current welfare spending, they are unlikely to support increases in programs for those with low incomes.

QUANTITATIVE FORM IN ARGUMENTS

One consideration in understanding, evaluating, and constructing arguments whose claims are supported by quantitative evidence is the form in which this evidence is presented. Is it clear, or is it misleading? Is it powerful, or is it likely to be ignored? In this section of the chapter, I focus on examples in which the latter question is explored.¹⁰ The examples illustrate various ways I ask students to reflect upon how the forms of quantitative data affect the meanings we take from information.

We discuss a table from *The Nation* (Table 13.2), which presents a counter to the first Bush’s claim about our former wars, in particular our war on Vietnam. Is

this numerical formulation powerful? What might be more powerful forms in which to express the numbers supporting this counter-argument?

I also use a letter that Helen Keller wrote in 1911 to a suffragist in England: “You ask for votes for women. What good can votes do when ten-elevenths of the land of Great Britain belongs to 200,000 people and only one-eleventh of the land belongs to the other 40,000,000 people? Have your men with their millions of votes freed themselves from this injustice?” (quoted in Zinn, 1995, p. 337). As part of understanding Helen Keller’s argument, students are asked to discuss how she uses numbers to support her claim, to evaluate whether that support makes her claim convincing, and to reflect on the form of her data – why she sometimes uses fractions, other times uses whole numbers, and whether there are alternative ways of presenting her quantitative evidence that would strengthen her argument.¹¹

Another example of considerations about quantitative form comes from an argument we study about the globalization of workers in the garment trades. As part of that argument the Leslie Fay company’s Honduran workers’ earnings are compared with the company’s sales receipts (Gonzalez, 1995). Specifically, he expresses the quantities as a “grand total of \$300” that all assembly line workers in Honduras cost Leslie Fay for one day (and he includes the information that this comes from 120 workers paid \$2.50 per day), and \$40,000 in retail sales that the company takes from the skirts those workers make in that one day. He does not say how many skirts they each make (another quantity which could reveal a different aspect of the exploitation.)¹² He does not calculate the workers’ yearly pay and compare it to the yearly retail sales of those Leslie Fay skirts.

One of the points brought out on our discussions is that if he had just focused on the average worker’s daily pay and the average amount the company made from selling the skirts she made, he would have compared \$2.50 to \$333. We speculate that he felt the \$333 figure would not appear as outrageous to the reader as the \$40,000, even though the numbers for one worker are in the same proportion as the numbers for 120 workers. Also, most readers can relate to \$40,000 in terms of their yearly income – most would have a yearly income that is somewhere between half and double that figure. Since Leslie Fay is grossing that amount of money in one day, that adds to the outrageousness Gonzalez wants us to feel. If he had calculated the yearly sales – \$14,600,000 – since most readers could not deeply grasp the meaning of such a giant number, its impact would have been less than when readers can think, “Leslie Fay makes more in one day than I make in a year!” And, even minimum-wage workers in the US could think, “In one day, they are paying their workers less than I make in half an hour – could it cost that much less to live decently in Honduras?”

The following is an argument supported by quantitative evidence in the form of a graph, and three forms of similar quantitative information that could have been used to support the claim.¹³ Students are asked to identify the claim, the reasoning and the evidence Sklar (1999) provides in an editorial graph (Fig. 13.1). Then we compare the different forms of the quantitative evidence given in the related arguments. Students reflect on the questions: Which quantitative form provides the most powerful support for the claim? What other kinds of numerical data would

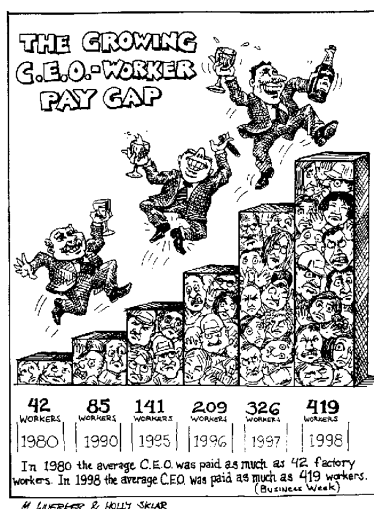


Fig. 13.1 The growing C.E.O.-worker pay gap

further strengthen the claim? What data or reasoning would a counter-argument present?

- The cartoon graph “The growing C.E.O.-worker pay gap” (Fig. 13.1).¹⁴
- Similar quantitative evidence from Jackson (2001): If the minimum wage had risen at the same pace as executive pay since 1990, it would be \$25.50 an hour, not \$5.15; if average pay for production workers had risen at the same level as CEO pay since 1990, the annual salary would be \$120,491, not \$24,668.
- Analysis from *United for a Fair Economy* (Sklar, 1999, p. 63): “If the real 555-foot Washington Monument reflects average 1998 CEO pay, then a scaled-down replica representing average worker pay would be just 16 inches tall – 5 inches shorter than in 1997. Back in 1980, the Workers Monument was over 13 feet tall – reflecting a CEO-worker wage gap of 42 to 1.”¹⁵
- The cartoon “How long does it take to earn \$8,840?” (Fig. 13.2).¹⁶

QUANTITATIVE FORM IN AURAL ARGUMENTS

In addition to various written and graphical forms of quantitative information, sound can also be used to help people grasp data. Business as usual was disrupted as part of a traveling exhibit, *Witness to Violence*, to dramatize the toll of domestic violence. A bell was rung in the Massachusetts State House’s Great Hall every 15 seconds on February 14, 1995. Each ring represented that, on average, another woman had been beaten somewhere in the US during that time interval. I ask my quantitative reasoning students to write a commentary that uses quantitative data to highlight the emotional and political impact of domestic violence. They are given



Fig. 13.2 How long does it take to earn \$8,840? (Wasserman, 1996)

hints about how to elaborate on the numerical data in such a way that it would make sense to as many people as possible and would capture the attention and imagination of most people. We also discuss media coverage of the issue. The results of the studies are what decide how they will be considered (Pozner, 1999). “A small number of faulty studies showing women and men as ‘equal’ batterers get a lot of press coverage and respect. On the other hand, many more carefully researched studies, including those conducted by the U.S. Department of Justice, showing most victims of domestic violence are women, and most perpetrators of this violence, against women and men, are men, are ignored and/or attributed to “feminists” promoting “half-truths based on ideological dogma.”

The Sound of Inequality is another example, a fascinating way to experience, aurally, the concentration of wealth in the US. It is part of *The Working Group on Extreme Inequality*, formed in 2007, connected to the *Institute for Policy Studies*, and believes that the fight against poverty and economic insecurity “has to both ‘raise the floor’ and challenge the concentrated wealth and power that increasingly sit at the top of our economic ladder.”

QUANTITATIVE FORM IN ARTISTS' ARGUMENTS

In addition to various written and graphical forms of quantitative information, the arts present different kinds of opportunities for people to understand and use quantities in arguments. As Toni Morrison states: “Data is not wisdom, is not knowledge” (quoted in Caiani, 1996, p. 3). Caiani goes on to add:

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In contrast to stories told in a living language filled with images taken from the human world, facts, statistics, data and bits of information, valuable as they are, slide in and out of memory without fully engaging sustained, powerful connections to the whole being. Data are important, are necessary, but not all by themselves, not alone. Analysis and facts are not able to give a face, eyes, a body to the suffering, joy, love, anguish of the people ... Art, I am convinced (as indeed have been many scientists like Pascal and Einstein), is at least as necessary as the sciences in grasping reality if we are ever to effect the change we seek in our long struggle to be human. ... Our efforts to make a better world through a narrow, reductive, isolated, scientific method which relies on the accumulation of data and its business-like interpretation, will fail. (p. 3)

The following examples of art encode quantitative information in ways that make us understand – what does this amount mean? The numbers are the data of our world – our wars. The art allows us to understand the quantities in ways we could not understand from the numbers alone.

- “The other Vietnam Memorial” refers to the original famous Vietnam Memorial in Washington, D.C. by artist Maya Lin, which lists the names of 57,939 Americans killed during the Vietnam War. In the “other” Vietnam Memorial, Chris Burden etched 3,000,000 names onto a monumental structure that resembles a Rolodex standing on its end. These names represent the approximate number of Vietnamese people killed during the U.S. involvement in the Vietnam War, many of whom are unknown. Burden reconstructed a symbolic record of their deaths by generating variations of 4000 names taken from Vietnamese telephone books. By using the form of a common desktop object used to organize professional and social contacts, Burden makes a pointed statement about the unrecognized loss of Vietnamese lives. (Notes from the Museum of Contemporary Art in Chicago, IL).
- The work of Chris Jordan gives us a powerful way of visualizing the impact humans are having on our environment. He describes his “Running the Numbers” series as viewing “contemporary American culture through the austere lens of statistics. Each image portrays a specific quantity of something: fifteen million sheets of office paper (five minutes of paper use); 106,000 aluminum cans (thirty seconds of can consumption) and so on. My hope is that images representing these quantities might have a different effect than the raw numbers alone, such as we find daily in articles and books. Statistics can feel abstract and anesthetizing, making it difficult to connect with and make meaning of 3.6 million SUV sales in one year, for example, or 2.3 million Americans in prison, or 32,000 breast augmentation surgeries in the US every month.”
- Artist Alfredo Jaar (born in Chile, works in New York City) went to Rwanda in 1994 to try to understand and represent the slaughter of “possibly a million Tutsis and moderate Hutus” during three months of Prime Minister Jean Kambanda’s term. “Even after 3000 [photographic] images, Jaar considered the

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tragedy to be unrepresentable. He found it necessary to speak with the people, recording their feelings, words and ideas. ... In Jaar's Galerie Lelong installation, a table containing a million slides is the repetition of a single image, *The Eyes of Gutete Emerita*." The text about her reads: "Gutete Emerita, 30 years old, is standing in front of the church. Dressed in modest, worn clothing, her hair is hidden in a faded pink cotton kerchief. She was attending mass in the church when the massacre began. Killed with machetes in front of her eyes were her husband Tito Kahinamura (40), and her two sons Muhoza (10) and Matriigari (7). Somehow, she managed to escape with her daughter Marie-Louise Unumarunga (12), and hid in the swamp for 3 weeks, only coming out at night for food. When she speaks about her lost family, she gestures to corpses on the ground, rotting in the African sun." The art review ends with a comment about the numbers: "The statistical remoteness of the number 1,000,000 acquires an objective presence, and through the eyes of Gutete Emerita, we witness the deaths, one by one, as single personal occurrences" (Rockwell, 1998; for images go to <http://www.alfredojaar.net/> and, under "projects", view Rwanda).

ADDITIONAL CONSIDERATIONS ABOUT QUANTITIES IN ARGUMENTS

There are other kinds of considerations about quantities that are important in understanding, evaluating, and making powerful arguments that challenge the global imperialism that has trickled down into every corner of our world. In addition to the more typical ways of classifying various misleading statistical accounts (like misinterpreting correlation as implying causation), two overarching questions are important to consider: What are the political, as opposed to scientific/mathematical, aspects involved in the data presented? Is the measure chosen the most accurate way of describing or analyzing the situation, or, in other words, is the correct answer being given to the wrong question?

It is important to understand which aspect of quantitative evidence is mathematical fact and which is political, and therefore, subject to debate. Much data are presented as if they were neutral descriptions of reality, masking the political choices that produced the data. For example, once the government determines which categories of workers count as part of the labor force, and which categories of workers count as unemployed, rewriting that information in percent form is a mathematical algorithm for which there is only one answer and about which it does not make sense to argue. The politics about which we can, and should, argue comes in decisions made by the government such as to count part-time workers who want full-time work as fully employed, and to not count workers who have looked for over a year and not found a job as unemployed.¹⁷

It is also important to determine which quantitative measure gives the most accurate picture of a particular issue. For example, the ultra-conservative Heritage Foundation argues that our progressive federal income tax is terribly unfair because of facts such as in 1997 the top 1% income group paid 33.6% of all federal income taxes, while the share of all taxes paid by the bottom 60 percent was only

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5.5%. But a left (and even a liberal) perspective would argue that is the wrong measure by which to judge tax equity. It makes much more sense to look at what happens to the share of total pre-tax and total after-tax income. That picture reveals only a small progressivity: a slight upward shift for the bottom four quintiles, and a slight downward shift for the top income quintile. Ellen Frank (2002) then argues:

If one believes that Ken Lay deserved no less than the \$100 million he collected from Enron last year, while the burger-flippers and office cleaners of America deserve no more than the \$6.50 an hour they collect, then a progressive tax would seem immoral. But if one believes that incomes are determined by race, gender, connections, power, luck and (occasionally) fraud, then redistribution through the tax system is a moral imperative. (p. 44)

Frank goes on to discuss the impact of other kinds of federal taxes, such as Social Security taxes (which are capped at \$90,000), excise taxes and so on which are regressive, as well as state and local regressive levies like sales taxes. She hypothesizes that adding all these taxes together would “almost certainly find that the U.S. tax system, as a whole, is not progressive at all” (p. 44).¹⁸

CONCLUSION

In “Scenes from the Inferno,” Alexander Cockburn (1989) wrote about some of the realities behind the so-called worldwide triumph of capitalism. One of his illustrations is particularly relevant to understanding how the wrong quantitative measure has real consequences in people’s lives. He relates how in some neighborhoods of Santiago, Chile, “the diet of 77 to 80% of the people does not have sufficient calories and proteins, by internationally established standards, to sustain life.” Under Pinochet, the dictator of Chile during that country’s period of “triumphant capitalism,” malnutrition was measured in relation to a person’s weight and height, in contrast to the usual comparison of weight and age. “So a stunted child is not counted as malnourished, and thus is not eligible for food supplements, because her weight falls within an acceptable range for her height” (p. 510). The overarching goal underlying a critical-mathematical literacy curriculum precisely is to explore the connections between understanding the outrageousness of collecting such statistics, and struggling to change the outrageousness of such conditions.

In this chapter, however, I have focused on the importance of the form in which the measures are actually expressed. I argue for the importance of critical-mathematical literacy curricula also consisting of reflections on questions such as whether it is more powerful to state that “The wealthiest 1 percent of Americans control about 38 percent of America’s wealth.” Part of struggling to change our world in the direction of more justice is knowing how to clearly and powerfully communicate the outrageousness.

NOTES

- ¹ A revised version of Frankenstein, 2007.
- ² Of course, there is more here than just that interpretation. Professor Arthur B. Powell, of Rutgers University, provided many helpful suggestions about this manuscript, reading the cartoon as saying that as time goes on, people tend to lose interest in protesting injustices and as a consequence perpetrators of injustices eventually can act with impunity.
- ³ A similar publication of which I am very proud is an edited version of the following letter responding to an editorial in the *Boston Globe*. To my delight, they titled it “Secretary of Death” and included a drawing of Kissinger, which made the letter the central one on the editorial page. In this case, the focus is on how a particular quantitative form can be correct, but highly misleading.

November 30, 2002

Dear Editor:

I commend the *Globe* for writing an editorial questioning the appointment of Henry Kissinger to lead what is supposed to be an independent commission investigating intelligence failures in the September 11, 2001 attacks.

However, as a teacher of Quantitative Reasoning, I was dismayed to see your misleading presentation of numerical data. You mention Kissinger’s responsibility for “thousands” of civilian deaths in Indochina, Bangladesh, and East Timor. In fact, very clearly documented by Christopher Hitchens’ review of USA government declassified documents detailing Kissinger’s legal crimes (*The Trial of Henry Kissinger*, London and New York: Verso, 2001), Pentagon figures for deaths in Vietnam during the period under which Kissinger’s deceptions and policies prolonged that war, are: 31,205 of our citizens, 86,101 South Vietnamese, and 475,609 Vietnamese “enemy.” The US Senate Subcommittee on Refugees estimated that during that time more than 3 million civilians were killed, injured, or made homeless (p. 41). In Bangladesh, “the eventual civilian death toll has never been placed at less than half a million and has been put as high as 3 million” (p. 46). In East Timor, 200,000 people, approximately one-third of the population, were slaughtered as a direct result of the “green light” then United States Secretary of State Kissinger gave to Indonesian dictator General Suharto. (p.93)

Although your statement that Kissinger’s policies resulted in “thousands” of civilian deaths is technically accurate, clearly it presents a misleading picture. In a conservative tallying from just these three areas of the world, Kissinger is responsible for *more than one million* deaths, *hundreds of thousands* of them civilian deaths.

- ⁴ Broadly speaking, criticalmathematics [one word] defines a pedagogical perspective that connects education in mathematics with critical analyses of social, economic, cultural, and political issues and with movements for social change. Criticalmathematics educators teach for understanding rather than memorization, start with the mathematical knowledge of students, and engage students to reflect critically on both the substance and process of their learning. In agreement with ethnomathematics, this perspective counters Eurocentric historiography of mathematics and considers the interaction of culture and mathematical knowledge. Moreover, criticalmathematics attends to the dynamics of power in society to understand the effects of racism, sexism, ageism, heterosexism, monopoly capitalism, imperialism, and other alienating, totalitarian institutional structures and attitudes. Finally, criticalmathematics educators attempt to develop commitment to build more just structures and attitudes and personal and collective empowerment needed to engage these tasks. For an elaboration on these ideas and the history of the Criticalmathematics Educators Group, see Frankenstein (1983, 1998), and Powell (1995).
- ⁵ At the time, the costs of the wars had been estimated at \$1 trillion. More recent estimates, from Brown University’s Watson Institute for International Studies <http://costsofwar.org/> accessed on July 2, 2011, that include future costs for items such as veterans care (as of Fall, 2010 there were over half a million disability claims submitted to the Veterans Administration) and debt payments

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connected directly to borrowing for the wars, are between \$3.2 and \$4 trillion. The report also emphasizes the direct human costs – conservatively estimating 225,000 dead and 7.8 million war refugees, loss of civil liberties in the USA, and human rights violations abroad.

⁶ Answer: about 32 years – most people guess way too little or way too big.

⁷ Answer: over one century – 114 years rounded to the nearest year.

⁸ There are also some really interesting ways of getting a sense of the size of finite numbers larger than one billion. For trillions, one of my favorites is: Our blood contains tiny red corpuscles, each like a circular disc somewhat flattened in the center and about 0.007 mm in diameter and 0.002 mm thick. In a drop of blood (1 cubic mm) there are about 5 million of these corpuscles. An average adult has about 3,500,000 cubic mm of blood. If all these corpuscles were strung out in a single chain, about how many times could this chain be wound around the earth's 25,000-mile equator? (Note: 1 mile = 5280 feet; 1000 mm = 1 meter; 1 meter is approximately 3 feet.) (Answer: about 3 times)

A science fiction story whose theme is making sense of super-gigantic finite numbers is *The Universal Library* (Lasswitz, 1951) and “Postscript to ‘The Universal Library’” (Ley, 1958).

⁹ Thad Williamson, in *Dollars and Sense* (July/August 2004, p.12) provided a number of different ways of looking at what the money spent by the USA in the war on Iraq – \$151 billion by the end of 2004 – could have been used for. This money, in his calculations, could have provided in the developing world for two years: food for half of the malnourished people in the world, a comprehensive, global HIV/AIDS treatment/prevention program, clean water and sanitation to all who lack them, and immunizations for all children.

The General Accounting Office found that this bomber deteriorates in rain, heat, and humidity and “must be sheltered or exposed only to the most benign environments.” These special shelters are not available at the very military bases in which the plane was proposed to be located. The plane also needs as much as 124 hours of maintenance time for each hour in the air. In 74% of the trial missions its radar “could not tell a rain cloud from a mountainside.” Further, since the early 1980's its theoretical mission to evade Soviet radar to penetrate to targets in the former Soviet Union, has ended with the end of the “cold war.” Finally, the then-claim of Soviet military superiority, used to justify requests for 21 of these bombers, has been challenged (Herman, 1997).

Herman (1997) points out that the cost per F-22 plane is “five times that of the still quite serviceable F-15, which the F-22 is designed to replace.” Even at the initial unveiling, the media quoted some critics saying “we are in an arms race with ourselves” (p. 42).

¹⁰ Some references to investigate this further are Frankenstein (1994) and Griffiths, Irvine and Miles (1979).

¹¹ When considering this example, I also include information about the politics of knowledge. When Helen Keller became an active socialist, the Brooklyn *Eagle*, a newspaper that had previously treated her as a hero, wrote “her mistakes spring out of the manifest limitations of her development.” Howard Zinn relates that the *Eagle* did not print her reply about the unfairness of attacking her physical challenges and not her ideas: “Oh, ridiculous Brooklyn *Eagle*! What an ungallant bird it is! Socially blind and deaf, it defends an intolerable system a system that is the cause of much of the physical blindness and deafness which we are trying to prevent ... If I ever contribute to the Socialist movement the book that I sometimes dream of, I know what I shall name it: Industrial Blindness and Social Deafness.” (Zinn, 1995, pp. 337–338).

¹² In Las Vegas, for example, in a unionized hotel laundry shop (with much better pay and other conditions than the non-unionized shops), workers count and bundle 1800 washcloths an hour; other workers separate stained and ripped sheets from the total and feed the good sheets, “310 an hour, into a machine that irons and folds them. The pillowcase feeder has to complete 900 an hour; the napkin feeder, 1300” (Wypijewski, 2002). The workers in the “soil sort” need to sort 700 to 1050 pounds of dirty linen an hour. For this they get paid \$9.09 to \$10.45 an hour plus benefits.

- ¹³ It is particularly challenging to analyze visual arguments, which is one reason I include them in my curriculum. The next section on artists' arguments carries this kind of critical visual thinking even further.
- ¹⁴ Reprinted with permission from Matt Wuerker.
- ¹⁵ Recently, I came across a similar presentation in Johnston (2003), an important book revealing the details of how the USA current tax structures transfer money not only from the poor to the wealthy, but even from the upper middle classes to the top 0.1 percent wealthiest. To visualize what he calls the *enormous chasm* in incomes ("just 28,000 men, women and children had as much income in 2000 as the poorest 96 million Americans"), he suggests we "imagine these two groups in geographic terms. The super-rich would occupy just one-third of the seats at Yankee Stadium, while those at the bottom as the equivalent of every American who lives west of Iowa – plus everyone in Iowa" (p. 41).
- ¹⁶ Reprinted with permission from Dan Wasserman.
- ¹⁷ And, of course, there is the Wal-Mart example, where many of their counted-as-employed-in-the-unemployment-statistics full-time workers earn so little that, even under the current stinginess of our government, they are eligible for various kinds of public assistance. The Democratic Staff of the House Committee on Education and the Workforce (2004) estimated that "one 200-person Wal-Mart store may result in a cost to federal taxpayers of \$420,750 per year – about \$2,103 per employee. Specifically, the low wages result in the following additional public costs being passed along to taxpayers: \$36,000 a year for free and reduced lunches for just 50 qualifying Wal-Mart families; \$42,000 a year for Section 8 housing assistance, assuming 3 percent of the store employees qualify for such assistance, at \$6,700 per family; \$125,000 a year for federal tax credits and deductions for low-income families, assuming 50 employees are heads of households with a child and 50 are married with two children; \$100,000 a year for the additional Title 1 expenses, assuming 50 Wal-Mart families qualify with an average of two children; \$108,000 a year for the additional federal health care costs of moving into state children's health insurance programs (S-CHIP), assuming 30 employees with an average of two children qualify; and \$9,750 a year for the additional costs for low income energy assistance" (p. 9). Further kinds of costs that Wal-Mart extracts from taxpayers are detailed in Robert Greenwald's documentary "Wal-Mart: The High Cost of Low Price" (2005). To get current information about the hidden costs of Walmart, see the Walmart Watch website: <http://walmartwatch.org/>
- ¹⁸ Another example that illustrates how to shift the argument by using more appropriate measures involves what Paul Krugman (2005) called the right-wing's "little black lies" about Social Security for African-Americans. Of course, the whole premise of the argument that Social Security privatization would be fairer to Blacks since their life expectancy is shorter than Whites, so they collect fewer benefits, speak volumes about racism in our society! Imagine stating this outrageous fact and then remaining silent about the obvious health-care and other programs which would eliminate that fact! But, in addition to this moral consideration, as Spriggs (2004) argues, there are problems with using the life-expectancy measure to calculate the benefits collected. One key concern he discusses is that since Social Security "also serves families of workers who become disabled or die, a correct measure would take into account all three risk factors – old age, disability, and death. Both survivor benefits and disability benefits, in fact, go disproportionately to African Americans" (p. 18).
- Another example involves the actual creation of a measure to counter the argument that heavily populated countries with many poor people are ruining our environment. Holtzman (1999) relates that Mathis Wackernagel and William Rees, community planners at the university of British Columbia, developed a measure of the impact of each country on the world's resources. "The ecological footprint measures the resources consumed by a community or a nation, whether they come from the community's backyard or from around the globe. ... Wackernagel and Rees ask how many hectares ... are needed per person to support a nation's consumption of food, housing, transportation, consumer goods, and services. They calculate how much fossil energy use, land

degradation, and garden, crop, pasture, and forest space it takes to produce all that consumers buy.” Using this measure, each person in the USA consumes 5.1 hectares, while each person in India only consumes 0.4 hectares. So, even with a population 4 times that of the USA, India has only one-third the impact on our global environment that the USA does. To get current information see the website of the Global Footprint Network: http://www.footprintnetwork.org/en/index.php/GFN/page/at_a_glance/

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