# Lies, Damn Lies, and Statistics: Uncovering the Truth Behind Polling Data

By: P.Holt Wilson and Wayne Journell

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## Abstract:

One of the fundamental tenets of social studies education is preparing students to become knowledgeable and informed citizens. Especially in this era of increased communication and technology, one skill necessary for informed citizenship is the ability to critically understand polling data. Social studies educators, however, rarely provide their students with the mathematical framework required to move beyond face-value analysis of public opinion polls. This article outlines the basic statistical processes behind public opinion polls and provides social studies teachers with activities that encourage students to critically question political data presented in the media.

**Keywords:** Polling | Civics | Statistics | Interdisciplinary | Mathematics | Sampling

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# Interdisciplinary Education

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*Contributing Editor*

## Lies, Damn Lies, and Statistics:

## Uncovering the Truth Behind Polling Data

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Key Words: Polling, Civics, Statistics, Interdisciplinary, Mathematics, Sampling

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*Our lives are governed by numbers. Every high-school graduate should be able to use sound statistical reasoning to intelligently cope with the requirements of citizenship, employment, and family and to be prepared for a healthy, happy, and productive life.*

## Introduction

In the age of the 24-hour news cycle, citizens are constantly bombarded with information about politics and the functions of government. One part of that barrage is the use of public opinion polls. Politicians, pundits, and news media point to opinion polls as the primary measure of the will of the people. Whether assessing the approval ratings of a political figure or gauging opinion of a particular social issue, contemporary media is replete with estimates of groups' characteristics and views. Secondary education must help students develop a critical perspective on political and government issues including the use of data and the claims made from them.

Joseph Kahne and Ellen Middaugh (2008) argue that one aspect of a quality civic education is teachers providing students with opportunities to monitor and discuss current political events with the goal of making informed decisions about public policy. Within that context, an understanding of polling data seems essential for students. While many state curriculum standards, as well as the National Council for the Social Studies (NCSS) and the Center for Civic Education (CCE), place media literacy as essential elements of students' civic and governmental knowledge (CCE, 2009; Journell, 2010; National Council for the Social Studies [NCSS], 2010), teachers are often provided little guidance on how to actually create this type of understanding in their classes.

At the same time, mathematics educators are charged with supporting students in developing an understanding of how data from surveys is used to characterize attributes of populations. In their *Principles and Standards for School Mathematics* (2000), the National Council of Teachers of Mathematics (NCTM) states that all high school students should:

> use simulations to explore the variability of sample statistics from a known population and to construct sampling distributions; understand how sample statistics reflect the values of population parameters and use sampling distributions as the basis for informal inference; and evaluate published reports that are based on data by examining the design of the study, the appropriateness of the data analysis, and the validity of conclusions (NCTM, 2000).

Echoing these recommendations is the American Statistical Association (ASA). In its *Guidelines for Assessment and Instruction in Statistics Education* report, the ASA suggests that students should understand how sampling distributions describe variability among sample statistics and that they should interpret the margin of error when estimating some characteristic of a population (Franklin et al., 2006).

In most secondary schools, these ideas have been taught in courses dedicated to statistics and probability, such as Advanced Placement Statistics. Of course, relatively few students have the opportunity to take Advanced Placement courses, especially students whose schools are located in low-socioeconomic urban or rural areas (Moore & Slate, 2008). Research has shown, however, that most students take at least one semester of civics or government coursework before they graduate (Niemi & Junn, 1998; Niemi & Smith, 2001), making the need to cover the nuances of polling data in these classes even more important.

Moreover, the recent release and subsequent adoption by 40 states of the Common Core State Standards means that in the coming years, all college and career ready students will be expected to "use data from a sample survey to estimate a population mean or proportion" and "develop a margin of error through the use of simulation models for random sampling"

(Council of Chief State School Officers, 2010). The increased expectation of statistical literacy for all students called for by the Common Core State Standards provides an opportunity for interdisciplinary work among secondary teachers, particularly social studies and mathematics teachers.

In this article, we explore the possible synergy between social studies and mathematics in the context of political polling. We suggest that civics and government courses provide a compelling context for students to understand the ways in which mathematics can be used to analyze social phenomena. By deepening their understandings of the science behind polling, students may adopt a more critical view of the claims made from public opinion polls. First, we explore three statistical ideas used to generate polls – sampling, sampling distributions, and the margin of error. Next, we discuss various conceptions students hold related to these mathematical processes and conjecture different ways in which these ideas might affect students' interpretations of polls. Finally, we offer several instructional ideas social studies teachers may use to support both deep understandings of statistical ideas and critical evaluation of public opinion polls.

## The Science Behind Polling

Polls are an application of statistical inference, a process used to estimate population characteristics based on a sample of that population. Legislators, for example, may be interested in the average insurance premium paid by constituents, or policy makers may need to know the proportion of citizens below the poverty line. By knowing these population characteristics, decisions can be made to reform insurance laws, or increase aid for impoverished children. With a small population, one can simply conduct a *census* to exactly define that characteristic. In a census, researchers collect (or try to collect) information from every member of the population. With a census, there is no need to use statistical inference because no estimation is required; the sample is the entire population. Every ten years, for example, the U.S. government seeks to take census of the population by accounting for each individual in America. Though the U.S. Census Bureau samples portions of the population to estimate various factors of the American public such as unemployment and other economic indicators, its task every 10 years is to account for every person living in the U.S. or its territories.

Conducting a census of a population is often extremely expensive, impractical, or even impossible. Consider, for example, the following Rasmussen Reports poll taken after the attempted assassination of Arizona Representative Gabrielle Giffords on January 8, 2011: *"Would stricter gun control laws help prevent shootings like the one in Arizona?"* This question seeks to characterize the degree to which the U.S. adult population believes stricter gun control laws would have prevented the Tucson shooting. Conducting a census to determine Americans' answers to this question would be nearly impossible. Even if the human and financial resources were available, the time it would take to collect these data would render the results invalid because people's opinions change over time, especially in the wake of a major political event. In situations where a census is unfeasible, statisticians seek to *estimate* characteristics of a population using a sample. In the example above, Rasmussen Reports polled 1,000 adults on January 10-11, 2011 with 29% of respondents indicating that they believed that stricter gun control laws would have prevented shootings like the one in Tucson (Rasmussen, 2011).

## Sampling

When using a sample to make inferences about a population, statistical methods are only valid when the sample is *representative* of the population. There are various ways that samples can be taken where *selection bias* can invalidate any inferences about a population. The politics page on FoxNews.com, for example, offers a feature called "You Decide" where viewers can respond to various questions related to political issues of the day. People volunteer to participate, and this type of survey is called a voluntary response survey. In voluntary response, participants choose to include themselves in the sample. Typically, people with strong opinions are more likely to volunteer for these polls and the resulting estimates tend to be biased. This *voluntary response bias* results in a sample that may not be representative of the implied population, and therefore, no meaningful inferences can be made about that population. Another type of selection bias occurs when pollsters take a sample that is easily accessible, called *convenience sampling*. In this procedure, poll workers survey individuals who are easy to find and contact. These individuals may be systematically different in some way from the intended population and result in selection bias.

A method related to convenience sampling is called *quota sampling*. In this method, the population of interest is categorized into subgroups based on some characteristic. A sam-ple is then constructed in such a way that its characteristics reflect those of the entire population. Suppose, for example, that 46% of a population were male. Quota sampling would construct a sample where 46% of the respondents are male. Though at first this method seems to meet the representative criteria, respondents are often selected based on the judgments of the surveyor and thus could be those most convenient to sample. Even though the sample may be representative of the population on the characteristic of gender, it may not match on other factors such as socioeconomic status. One famous use of this sampling procedure was the Washington State Presidential Poll in 1948, which used quota sampling to forecast incorrectly the outcome of the election between Harry Truman and Thomas Dewey.

The key to selecting a representative sample is to ensure that each member of the population has a certain probability of being selected. While sophisticated sampling procedures exist that are used by professional polling organizations to increase precision and reduce costs, they are all grounded in the use of *simple random sampling* in which every sample from the population has an equally likely chance of being selected. Once students understand simple random sampling, they can better understand statistical inference, which can be generalized to the more complex random sampling methods used by large-scale polls.

Although random samples avoid selection bias, they still have the potential for bias. When surveyors fail to ensure that all members of the population have a chance to be included in their sample, *undercoverage* occurs and the sample is not representative of the entire population. An historical example of the bias that can result from undercoverage was the 1936 presidential election. *Literary Digest* selected people to survey based on automobile registration lists and telephone directories. From the responses, *Literary Digest* incorrectly forecasted Alf Landon to defeat Franklin Roosevelt when, in fact, Roosevelt won by a wide margin. In the *Literary Digest* poll, citizens who did not have automobiles or telephones were not included in the poll. At the time, automobiles and telephones were items of luxury, and those who had higher incomes were more likely to support Landon's Republican party. Thus, the poll was biased which led to an invalid inference about which candidate would win the election

(Squire, 1988).

Another type of bias that can be present in simple random samples is *response bias.* This can occur when an answer to a survey does not reflect the true beliefs of the respondent, such as when a person who holds a minority opinion but does not indicate that opinion in the response. Some response bias can be attributed to the personal feelings or fears of the respondent, as in the case of the so-called "Bradley Effect" in which White voters tell pollsters they will vote for a minority candidate but then choose not to in the privacy of the voting booth, or when individuals lie to pollsters because their political views lie outside of the mainstream of their respective communities (Finifter, 1974; Noelle-Neumann, 1993; Payne, 2010).

Response bias, however, most often is related to the way in which the survey question is worded. Leading questions, or questions using words that carry strong connotations, can result in a sample that is non-representative. For instance, a poll question about a new government program may show fewer supporters if the question indicates that the program will cost *billions* of dollars. *Non-response bias* occurs when people selected to be in a sample choose to not participate, again resulting in a sample that does not represent the intended population. In all of these cases, the samples are not representative of the population for which they are meant to serve as a basis for inference.

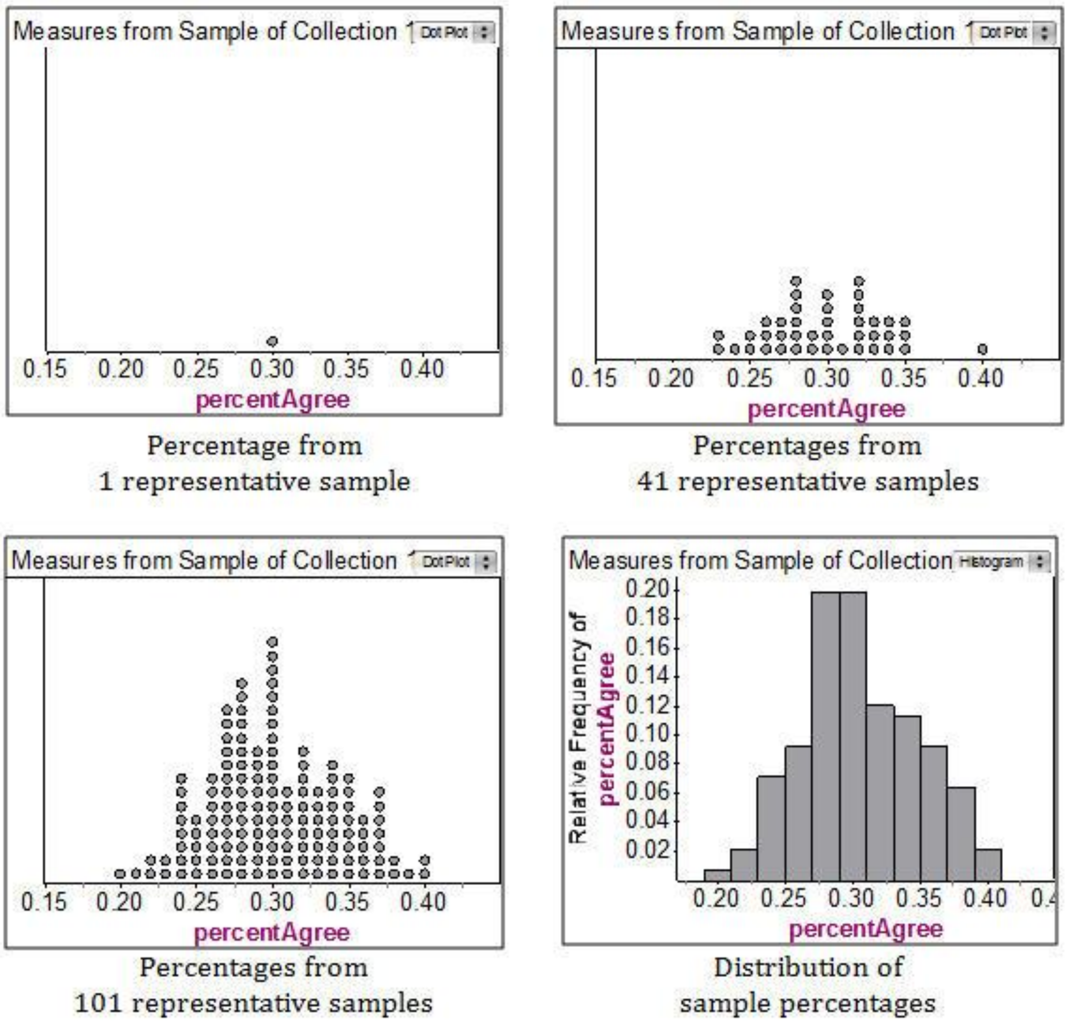
To help students adopt a critical perspective of poll data, social studies teachers can advise students to question the way a sample was selected. Non-representative samples often are used to sensationalize and create political discourse; understanding the sample selection is one way to know whether one should seriously consider a particular poll. Additionally, teachers may pose questions about the representativeness of a sample or the ways in which a question was presented to encourage students to understand both the validity of the estimation as well as question the motives of the poll itself. Teachers may create lessons in which students plan and carry out their own poll of the students at their school to learn the difficulties of obtaining a representative sample.

## Repeated Sampling and Sampling Distributions

Again, consider the Rasmussen Reports poll on the Tucson, Arizona shootings. Assuming that the 1,000 adults surveyed created a representative sample, what if another 1,000 adults were polled? Would 29% of the respondents in the new sample indicate the same belief? Because different people would be selected for the new sample, it is unlikely that the same exact percentage of responses in this sample would be the same as the one reported. In fact, if many samples were taken from the population and we calculated the percentage responding affirmatively for each, there would be considerable variation among them. The fundamental idea behind statistical inference is that though there would be variability among percentages from *repeated sampling*, this variability is predictable using mathematics. To illustrate repeated sampling, samples taken using random sampling can easily be simulated using computer software. Though many software packages used in secondary statistics instruction have limitations related to the size of populations and the type of sampling procedures that can be simulated, simplified scenarios still permit students to develop an understanding of repeated, representative sampling and the resulting variability.

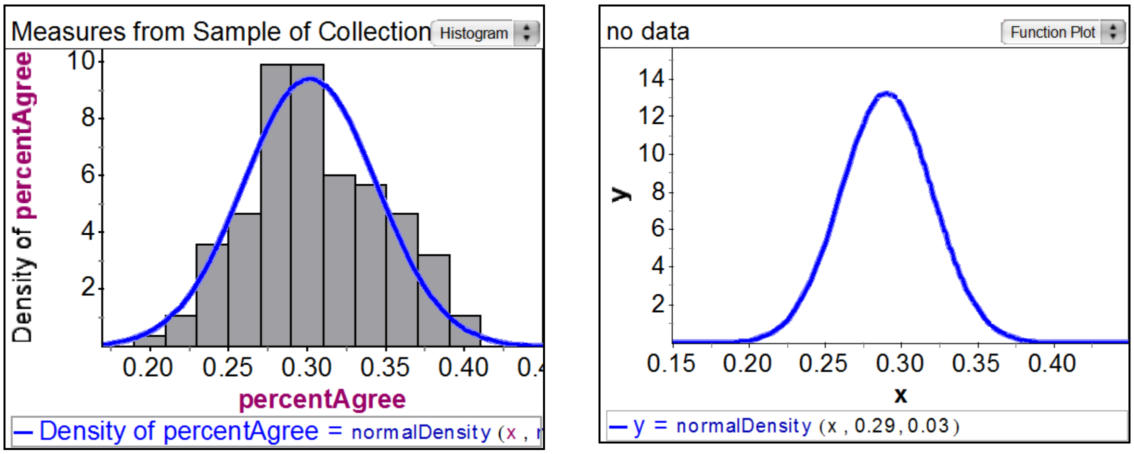
Figure 1 illustrates the concept of repeat-ed sampling. The first graph represents the percentage found by the poll. A simulation can produce other possible samples and the resulting percentage. The second graph shows the original result but also the percentages of affirmative responses from other simulated representative samples. The final graphics show the result of simulating many samples and measuring the percent that believe stricter gun control laws would prevent shooting similar to the one in Tucson. The pattern resulting from simulations such as this tend to have the same type of variability regardless of the population being simulated. Most of the percentages are clumped in the center of the distribution with fewer values occurring further from the center.

Figure 1. Building a distribution of sample percentages through repeated sampling.




The pattern apparent in the distribution of sample statistics can be predicted using mathematical functions called probability density functions. A probability density function outlines the shape of the possible values. These functions, called *sampling distributions*, allow us to describe mathematically how likely it is that a statistic, such as a sample percent, will fall within a certain range of values. In Figure 2, the curve over the distribution represents a simplified version of the sampling distribution for sample percentages for the Rasmussen Reports poll. The peak at the center of the curve describes how most sample percentages occur around 29% while the tails show that values larger or smaller are less likely to occur.

Figure 2. A sampling distribution for sample percentages.




Probability density function describing a distribution of sample percentages

A sampling distribution for sample precentages

## The Margin of Error

Sample statistics may vary from the population characteristic. Sampling distributions theoretically describe how much a sample statistic is likely to deviate from the true characteristic of the population. This allows us to predict how far our sample value may differ from the population characteristic, or what statisticians refer to as the *margin of error*. In the Rasmussen Reports poll, for example, the margin of error is plus or minus 3%. This gives an indication of how much sampling variability was present in the procedure that produced the results of the poll, and how the population characteristic may differ from 29%. This margin of error is based purely on the sampling distribution of the statistic and only quantifies that variability. The second graph in Figure 2 shows the sampling distribution that describes how likely the sample percentage observed in the poll would occur based on a representative sampling method. Theoretically, the sample statistic would be within the margin of error of the population characteristic in all but a few of the most unusual samples.

Statisticians also quantify the proportion of samples in which the margin of error "works." This proportion is known as the *confidence level*. For most reports in the popular press, the confidence level is 95%. For the Rasmussen Reports poll, this indicates that the true percentage of people who held this belief would be between 26% and 32% unless this sample happened to be one of the rare 5% of possible samples. This interval that is believed to contain the true parameter is often called the *confidence interval* and is found by simply adding and subtracting the margin of error to the sample statistic.

## Students' Conceptions of Sampling Distributions

Mathematics education researchers have studied the ways that people think about sampling distributions. In this section, we briefly and selectively review the research concerning understandings of sampling, statistical inference, and margin of error. From these understandings of student thinking, we conjecture implications of this type of reasoning in the context of adopting a critical perspective on polling in civics and government classrooms.

Luis Saldanha and Patrick Thompson (2002) suggest that students think of sampling and statistical inference in two ways. In the first, students see a sample only as a subset of the population. Because students base their view of sampling on a mental image of selecting a single subset, this perspective does not support a relational understanding of the sample and the population. Thus, statistical inference is based on a single sample and a procedural calculation of statistical summaries to produce an estimate that is related to the sample only through computations without meaning. The second way Saldanha and Thompson (2002) believe students view samples is as scaled-down versions of the population. Students who fall into this category maintain a strong relationship between the sample and population as a result of seeing a single sample as only one incident of many possible samples. These students have connected understandings among sampling, sampling distributions, and the population. The researchers report that students with this second conception performed better on instructional activities designed to support learning statistical inference than students with the first.

In another study, Pat Thompson and Yan Lui (2005) investigated different understandings of the margin of error. They purport that understanding the margin of error entails coordinating: (1) an image of a sampling distribution based on repeated sampling; (2) the margin of error, as based on the sampling procedure rather than sample statistics; and (3) an understanding of, and the relationship between, confidence levels and margin of error. Their research suggests that the latter two aspects of margin of error are particularly difficult to understand. Additionally, they outline different correct and incorrect understandings of the margin of error they observed in their study. The researchers observed participants who cor-rectly interpreted that a certain percentage of the confidence intervals produced from repeated sampling would include the population characteristic of interest. But, they note that some participants interpreted a confidence interval as always containing the population characteristic of interest, an incorrect interpretation. Another erroneous conception observed included the belief that a confidence interval around the population characteristic created by the margin of error captures a certain percent of the sample statistics if a population were repeatedly sampled.

One implication of this research for social studies teachers is the importance of understanding that valid polls rest on a robust notion of sampling. Procedures for statistical inference are based on representative, repeated sampling, an idea research suggests is difficult for students. If students do not have a well-developed understanding of sampling, sampling distributions, and their relationships to the population as described by Saldanha and Thompson (2002), they may view polls as a deterministic, exact characterization of a population rather than with a probabilistic, qualified view.

Most importantly, the research of Thompson & Lui (2005) suggests students believe the margin of error "covers all manners of sins." By encouraging students to think about repeated, representative sampling and its relationship to the population of interest, teachers can support students in interpreting confidence intervals and margins of error in ways that acknowledge the inherent uncertainty of estimation while simultaneously quantifying that uncertainty with the interval's confidence level. Teachers also may point out that other biases such as question wording or undercoverage are not accounted for by the margin of error. Consider the Rasmussen Reports poll one final time. The research findings discussed in this section suggest that some students may interpret this poll in a way that the actual percentage of Americans who believe that stricter gun control laws will prevent similar incidents is exactly 29%. Others may assume that the margin of error would account for biases such as question wording. Through a detailed discussion of the science behind polling, teachers can help students to understand that the margin of error only accounts for the random variability innate in sampling.

## Developing a Critical View of Polling

By focusing on ideas of repeated sampling, sampling distributions, and an understanding of the margin of error, teachers can provide opportunities for students to develop a critical stance on polls. To assist students in thinking about the importance of sampling, teachers can have them locate and compare a voluntary response poll on an issue to a similar poll from a reputable organization. Students may, for example, visit CNN.com, MSNBC.com, or FoxNews.com and view the results of a "quick vote" that polls page visitors on whether they approve of Congress. Then, students may compare these results to similar polls from the Gallup Organization or Pew Research (for a list of websites that contain public opinion polls, see the Appendix). In classroom discussion, teachers can guide students toward understanding the importance of the sampling procedure, the influences of the wording of a question, and potential biases present in the sample and how those factors affect the outcome of the poll.

Another activity would be to have students locate and explain the results of several polls suggesting different findings. An NBC/WSJ poll (2011), for example, conducted January 13 - 17, 2011 found that 46% of respondents were opposed to the repeal of the 2010 Health Care Reform bill with a margin of error of 3.1%. A Quinnipiac University Polling Institute poll (2011) found 43% opposed on January 4-11 with a margin of error of 2.4%. Assuming that the sampling procedures were the same, teachers can engage students in discussions about the sampling distribution and how likely these disparate findings are to occur under repeated sampling. If students were to repeat this exercise over time, they would probably be able to find patterns among the various polling agencies with more liberal and conservative outlets consistently reporting data that fall outside that which is reported in more "neutral" outlets. After a pattern is established, students could begin to probe further by examining the language used in each poll and discussing possible sampling and response biases that may have occurred.

Another way to help students understand how polling data is used politically would be to provide a class with a particular topic, such as the 2010 Health Care Reform bill. Then, in small groups, students must adopt a particular political stance and devise survey questions they believe could possibly influence a respondent to answer a certain way. One group of students, for example, may create a survey taking a supportive position and create leading questions such as, "Are you in favor of insurance companies not being able to deny you coverage if you have a preexisting condition?" Students taking an opposing position may create questions such as, "Do you believe that Americans should be forced to buy Obamacare?" A third group of students may try to write non-leading, neutral questions for the survey. The activity would illustrate both the ease by which polls can be manipulated to support partisan agendas and the difficulty associated with making "good", non-leading surveys. Also, the resulting classroom discussions may help teachers assist students in understanding the relationships among polling, its purposes, and the importance of adopting a critical perspective when consuming polling data.

## Conclusion

In a nation increasingly being defined by political disinterest and ambivalence (Hibbing & Theiss-Morse, 2002), it is imperative that teachers place greater emphasis on current events and public policy in their classrooms. Research has shown that most secondary students, in fact, express interest about political issues, but their enthusiasm is often tempered by feelings that they do not know enough about politics to truly understand the political debates being waged around them (Hahn, 1998; Journell, in press). Understanding the nuances of polling data is essential to improving students' political knowledge simply because so much of American public policy is implemented in response to public opinion polls. If students can become critical consumers of polling data, it is plausible that this critical analysis may transfer to other aspects of politics, such as television and newspaper coverage of political issues and events.

By incorporating basic statistical understanding into civics and government classrooms, social studies teachers can engage in interdisciplinary learning that broadens the type of skills students need in order to succeed in class. Too often, the students who perform poorly in social studies courses are the same ones who excel in mathematics and science; thus, this type of activity would allow those students who may not regularly take leadership roles in their civics and government classes to demonstrate positive academic behavior. Conversely, the students who may struggle with this type of activity may benefit from having an opportunity to practice their mathematics skills in an environment with which they are familiar.

Finally, while we have limited our discussion to activities social studies teachers could do in their own classrooms, we believe an analysis of polling data offers a unique opportunity for secondary social studies and mathematics teachers to collaborate. It is easy to imagine a high school mathematics teacher having his or her students create a survey, implement it in the school or local community, and then have the social studies teacher analyze the results with his or her class based on current political events and national polling data that may be available. As state and national curriculum standards continue to tout the importance of language arts and mathematics, it is essential that social studies educators at all levels of instruction seek ways to incorporate these disciplines into their classrooms.

Understanding the nuances of polling data is essential to improving students' political knowledge simply because so much of American public policy is implemented in response to public opinion polls."

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**Web-Based Resources**

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Council of Chief State School Officers. (2010). Common Core State Standards. Available http://www.corestandards.org

National Council for the Social Studies Standards. (2010). Available http://www.socialstudies.org/standards/strands

NBC/Wall Street Journal. (2011). NBC/WSJ poll: Public divided on health law and repeal. Available http://firstread.msnbc.msn.com/_news/2011/01/19/5877937

Quinnipiac University Polling Institute. (2011). Most American voters see economy improving, Quinnipiac University national poll finds; almost half want health care repeal. Available http://www.quinnipiac.edu/x1295.xml?ReleaseID=1549

Rasmussen Reports. (2011). Most say stricter gun laws would not help prevent shootings. Available http://www.rasmussenreports.com/public_content/politics/current_events/gun_control/most_say_stricter_gun_laws_would_not_help_prevent_shootings

# Appendix

## Resources for Polling Data

ABC News Polling Unit. Available http://abcnews.go.com/PollingUnit/

Canadian Opinion Research Archive. Available http://www.queensu.ca/cora/

CBS News Polls. Available http://www.cbsnews.com/sections/opinion/polls/main500160.shtml

CISER Data Archive. Available http://ciser.cornell.edu/info/about.shtml

Fox News Polls. Available http://www.foxnews.com/topics/fox-news-polls.htm

Gallup Polls. Available http://www.gallup.com/home.aspx

Harris Interactive. Available http://www.harrisinteractive.com/

Inter-University Consortium for Political and Social Research. Available http://www.icpsr.umich.edu/icpsrweb/ICPSR/

Latin American Public Opinion Project. Available http://www.vanderbilt.edu/lapop/

National Opinion Research Center. Available http://www.norc.uchicago.edu/homepage.htm

*New York Times* Polls. Available http://topics.nytimes.com/top/reference/timestopics/subjects/n/newyorktimes-poll-watch/index.html

NPR/Kaiser/Kennedy School Polls. Available http://www.npr.org/programs/specials/poll/

Pew Research Center. Available http://people-press.org/

PollingReport.com. Available http://www.pollingreport.com/

Public Agenda. Available http://www.publicagenda.org/

Public Opinion Poll Question Database. Available http://www.irss.unc.edu/odum/jsp/content_node.jsp?nodeid=7

Quinnipiac University Polling Institute. Available http://www.quinnipiac.edu/x271.xml

Roper Center. Available http://www.ropercenter.uconn.edu/

Survey Research Center of the University of Michigan. Available http://www.src.isr.umich.edu/

UK Social Survey. Available http://surveynet.ac.uk/sqb/

*Wall Street Journal*/NBC Polls. Available http://topics.wsj.com/subject/W/wall-street-journal/nbc-news-polls/6052

*Washington Post* Poll. Available http://voices.washingtonpost.com/politics/polling.html

World Public Opinion. Available http://www.worldpublicopinion.org/

UK Social Survey. Available http://surveynet.ac.uk/sqb/

Zogby International. Available http://www.zogby.com/