The Editor's Corner

This issue of the Statistics Teacher Network brings you three interesting articles and some exciting news. First, the articles:

- Jamis Perrett and Di Cook have written a very informative and useful article about student poster presentations for grades K–12.

- Anna Bargagliotti and I have an article comparing the Common Core Standards, NCTM recommendations, and Guidelines for Assessment in Statistics Education at the elementary grade level.

- Angela Walmsley and Sweta Prasad wrote an article that reminds teachers and students we all use probability concepts and terms on a daily basis.

Now, the exciting news! I want to welcome Rebecca Pierce as the Statistics Teacher Network's new editor. Rebecca becomes editor following this issue and has the credentials and experience necessary to ensure the Statistics Teacher Network stays relevant and engaging into the future. Welcome, Rebecca!

I encourage you to send any articles or ideas you have for consideration for publication to me at *dwebb@bemidjistate. edu* or to Rebecca at *rpierce@bsu.edu.*
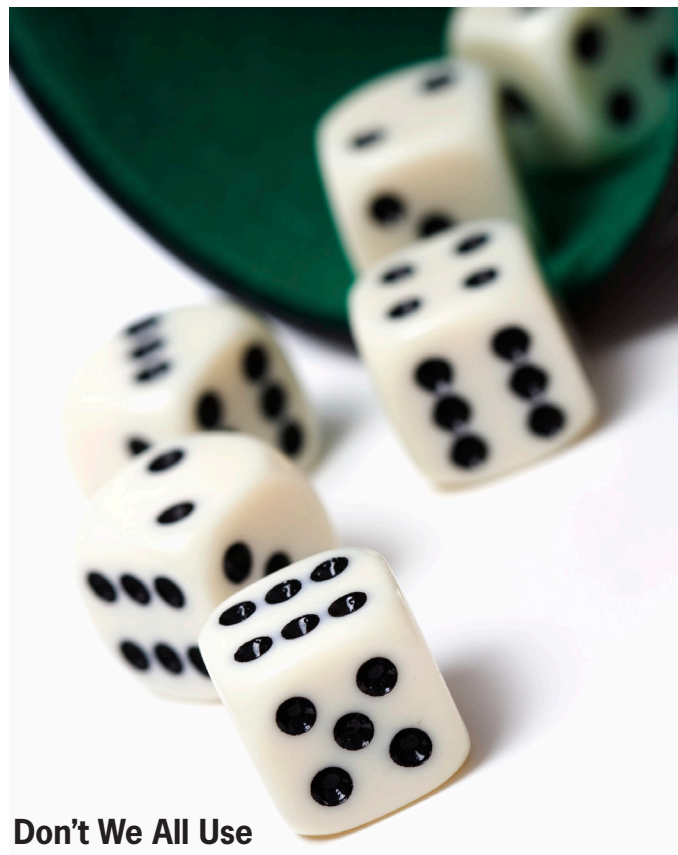
Best Regards,

Derek Webb, Editor
Bemidji State University

Associate Editors

Larry Peterson—
Northridge High School, Layton UT

Rebecca Pierce—
Ball State University

Angela Walmsley—
St. Louis University

**Don't We All Use
Probability Every Day?**
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Also in this issue …

Articles

Student Poster Presentations: K–12

Jamis J. Perrett, Texas A&M University, and Di Cook, Iowa State University

Presenting research is an important part of a student's education. A common approach for presenting research is a poster presentation. Producing poster presentations provides students with the experience of organizing their thoughts into a visual form, in a way that allows a viewer to digest the material at a glance. There are many opportunities for students across the nation to submit statistical posters to competitions. Teachers should consider providing students with opportunities to create and present posters as a part of their education. The purpose of this article is to give insights to teachers on some of the educational opportunities for incorporating statistical posters in education.

Communicating Research Findings

A vital component of science is to communicate research findings. For students, presenting research provides the opportunity to explain their ideas and findings and to receive comments and criticism from peers and mentors. Dissemination of research can take many forms. Students may write reports, present slide presentations, give an oral report, or create a poster.

A statistical poster is simply a display that contains both text and graphics for the purpose of summarizing data and presenting information. That poster may stand alone on display or be accompanied by its presenter to describe the poster information and answer questions.

School Poster Assignments and Sessions

Many high-school teachers are starting to require poster presentations to help students improve their written, visual, and verbal communication skills. Posters also may help students demonstrate knowledge more accurately than research papers and can increase students' courage when engaging in scholarly activities. Student posters allow students to be creative and provide teachers with a break from traditional research papers and class instruction.

Teachers might have students complete poster activities in multiple stages: research a topic, develop a proposal for teacher approval, create a poster, and then present the poster. Feedback from the teacher would be crucial at every stage for students to be successful.

Teachers may consider creating situations for students to display their posters in public: at school; the local shopping mall; a community or civic center; the library; or area, state, and national poster competitions.

Poster activities can be an experience that students remember long after the memory of the topic itself fades.

Characteristics of K–12 Posters

Posters created by K–12 students will likely differ in appearance from grade to grade. Younger researchers may create posters with hand-drawn graphics and content, rather than computer-generated graphics and content for a variety of reasons, including age-appropriate use of technology and enhanced creativity by doing things "by hand." Younger students also may choose to glue items onto posters that one might consider nontraditional for a statistical poster, such as candy and small toys.
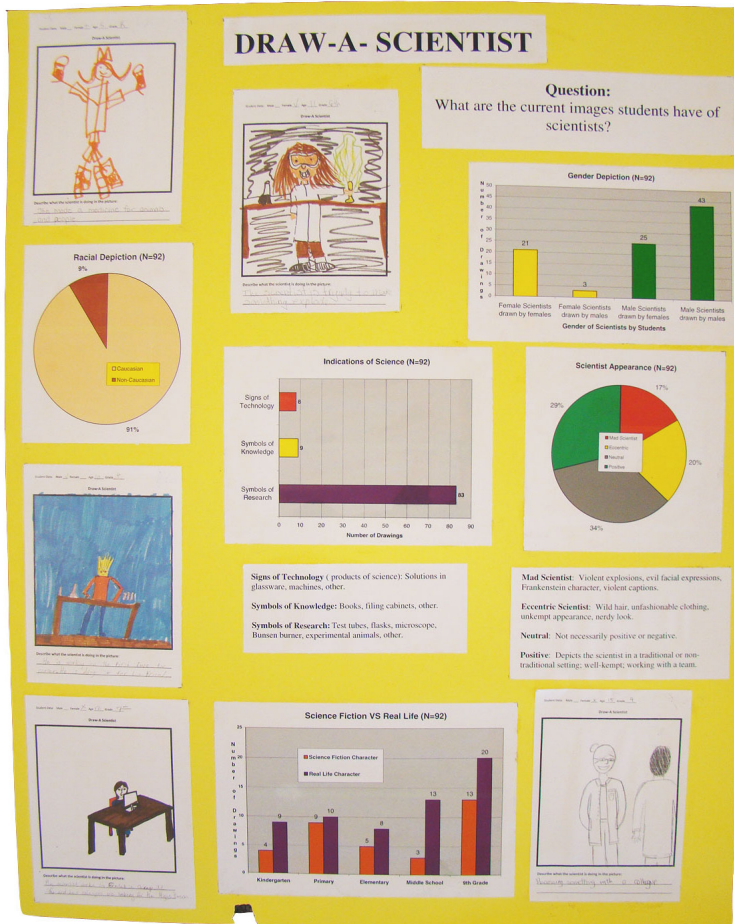
Consider the following three posters selected from among the winners of the 2009 American Statistical Association annual national poster competition. The first is a picture of the poster awarded first place in the Grades K–3 category. Notice that parts were created on a computer, perhaps with the teacher's help, while other parts were hand drawn. All the poster elements were created on smaller pieces of paper and glued onto colored poster board.
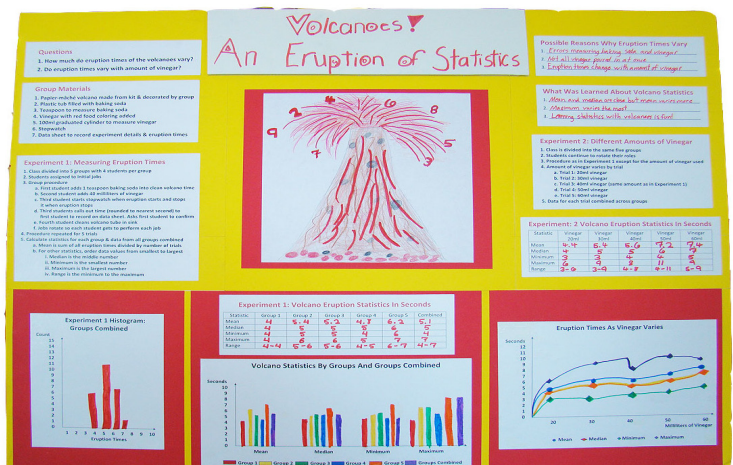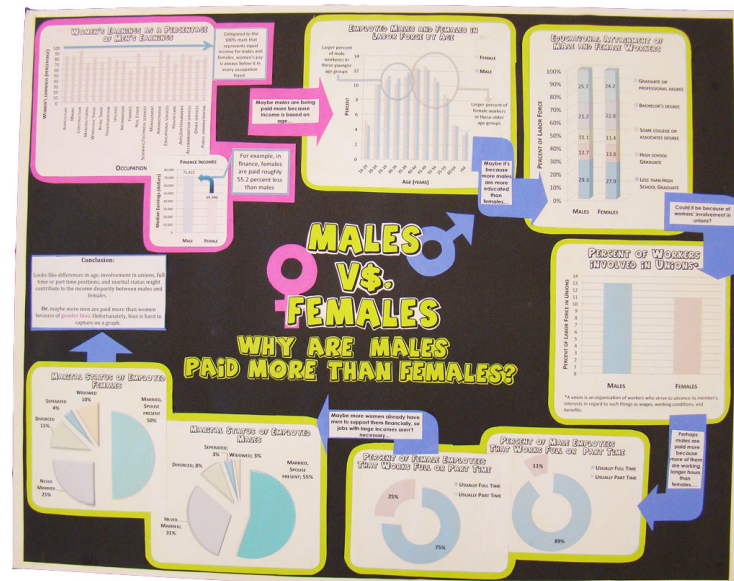

"Volcanoes! An Eruption of Statistics," Mrs. Latimer's third-grade class of 2009, Miramar Ranch Elementary School, San Diego, California, *Amstat News*, September 2009, Issue #386 (p. 39)

Next is a picture of the poster awarded first place in the Grades 4–6 category. As compared to the K–3 poster, the title is printed from a computer, rather than hand drawn, and the statistical graphs appear to have been created in a graphics program such as Microsoft Excel. Though some Grades K–3 students will have computer skills, one would expect students in Grades 4–6 to be more familiar with computers and basic spreadsheet programs that include graphics utilities. Students in Grades 4–6 also may have greater access to computers at home and in school computer labs.

The third is a picture of the poster awarded second place in the Grades 10–12 category. As compared to the Grades 4–6 poster, all poster elements except for the construction paper–colored

"Draw-A-Scientist," Maya Lannen, Caroline Yapp, Lily Krone, and Hannah Lane-Davies, Kazoo School, Kalamazoo, Michigan, *Amstat News*, September 2009, Issue #386 (p. 41)

"Males vs. Females: Why Are Males Paid More Than Females?" Brenna Liponis, Phillips Academy, Andover, Massachusetts, *Amstat News*, September 2009, Issue #386 (p. 44)

arrows appear to be computer generated. One would expect post-elementary school students to use computers to develop poster presentations, use digital cameras to take pictures, and/or download pictures from the Internet, rather than drawing them by hand.

The poster creation and presentation experience can be positive at any grade level if the teachers' expectations are age-appropriate. Teachers also could best determine whether the poster presentations should be created by groups or individually, include one class or several, and be presented over the course of one day or several.

Effective Posters

Teachers may be less concerned with best practices than with creativity and learning enjoyment when it comes to K–12 poster activities. However, if teachers choose to provide general instruction to students for creating effective posters, they might consider the following areas of discussion:

1. Planning and preparation are important. Sketching a mock-up of the poster on scratch paper can save students from wasting a piece of poster board when poster items do not all fit and look as expected.

2. Organization can help deliver a clear message. For the older grades, formal outline items for a poster may include title, introduction, problem statement, method, results, recommendations, and conclusions. Students should keep in mind the message their poster is to present.

3. Materials should be considered. Students need to know what resources they have available to them for creating their posters and what they need to purchase.

4. The size, location, and amount of text, graphics, and other poster elements can enhance the poster's message or conceal it.

5. Providing examples of age-appropriate posters is essential. Students may have no idea what a statistical poster could look like. Showing examples of effective statistical posters can give students ideas and start the creative juices flowing.

Area, State, and National Poster Competitions

The national statistics poster competition for students in grades K–12 has been running since 1990 in a continuing effort to advance the probability and statistics curriculum. The ASA/NCTM Joint Committee on Curriculum in Statistics and Probability for grades K–12 supervises the national poster competition while the American Statistical Association sponsors it. This national poster competition helps achieve the mission statement of the ASA to improve statistical education at all levels and promote the proper application of statistics. It also follows the standards of NCTM to formulate questions, display data to answer such questions, apply mathematics in areas outside of mathematics, and communicate mathematical thinking to others.

The ASA poster competition is divided into four categories: K–3, 4–6, 7–9, and 10–12. Participants can work in groups of up to four people; however, participants of the K–3 group may include an entire class.

Posters in the K–12 poster competition are judged on the basis of overall impact of the display, technical aspects, clarity of the message, appropriateness of the graphics for the data, and creativity. Any area of relative interest is acceptable in the K–12 poster competition.

In addition to this national competition, there are many state and regional statistics poster competitions. In many cases, state and regional statistics poster competitions are precursors to the national competition.

The following is a fairly comprehensive list of statistics poster competitions held in the United States and other resources. These were found through extensive research. Some of the competitions are not held regularly, so the links may not work currently:

- American Statistical Association National Poster Competition, *www.amstat.org/education/posterprojects/index.cfm*
- The Caucus for Women in Statistics Poster Project Competition for Girls in Grades K–12 (held in 2009), *www.science.gmu.edu/~wss/wss0902.shtml*
- Connecticut Chapter of the American Statistical Association Statistical Poster Competition, *www.amstat.org/chapters/Connecticut/home/Poster/poster_index.htm*
- Kansas/Missouri Statistics Poster Contest, *http://faculty.pittstate.edu/~ananda/PosterContest.html*
- Michigan Statistics Poster Competition, *www.gvsu.edu/stat/index.cfm?id=2260FD2C-F9C3-9E3F-18AFB8693484A78E*
- Nevada Chapter of the American Statistical Association K–12 Statistics Poster Competition, *www.nevada.edu/~nvasa/k12postercompetition.html*
- New York City Metropolitan Area Chapter of the American Statistical Association Statistical Poster Competition, *www.nycasa.org/2010PosterCompetition.html*
- Ohio Statistics Poster Competition, *www.bio.ri.ccf.org/ASA/poster.html*
- Washington Statistical Society Poster Competition (submitted through ASA national competition, but DC metro–area posters separately judged), *www.amstat.org/education/posterprojects/index.cfm*

In Conclusion

Poster presentation opportunities benefit students of all ages, and opportunities for statistics poster presentations are available both nationally and in some regions. There is great variety in the way research is presented in poster sessions. Discussing good practices can help students make more effective posters while still allowing for creativity.

Further Reading

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Note: The pictures in this article are courtesy of *Amstat News*.

Elementary School Teachers: Teaching, Understanding, and Using Statistics

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As the world becomes increasingly interested in data and data-driven decisionmaking, it is crucial for us, as educators, to consider how we can prepare a statistically literate population. Statistical literacy refers to the ability to think and reason in the presence of uncertainty. For the purpose of this article, we focus on how to ensure students in the elementary grades gain the skills necessary to become statistically literate as they mature. What statistical content should students learn in the elementary grades? What should elementary teachers know about statistics to be prepared to teach this content?

When thinking about answering questions of this type, many interweaving factors come to mind. For example, we must consider what statistical ideas students need to acquire in elementary school to embark on the pathway towards statistical literacy. We also must take into consideration the guidelines and standards, both at the state and national levels, currently in place that teachers must adhere to, as well as the types of data teachers are regularly presented with and asked to analyze for their jobs.

This article briefly considers each of these factors and offers suggestions for the type of statistical content elementary teachers should know and be prepared to teach.

Student Learning

In 2005, the *Guidelines for Assessment in Statistics Education (GAISE): A Pre-K–12 Curriculum Framework* emerged from the statistics community to provide an overarching outline for statistics education. The document defines a statistically literate person as one who can formulate questions, collect data, analyze data, and interpret results. To characterize the natural advancement of statistical learning within each of these components, the report presents a three-level framework (levels A, B, and C) corresponding to the depth of coverage within each component. The two-dimensional model—component by level—thus highlights differences among the levels by the sophistication of the techniques employed within each component.

Although the GAISE report does not outline statistical learning by grade, it roughly suggests students in the elementary grades should acquire Level A depth, those in middle school should be around Level B, and those in high school should achieve Level C. The following table illustrates the GAISE framework for levels A and B, those that may be pertinent to the elementary grades.

In examining the table, we notice that Level A is, in general, more teacher directed, while Level B shows slight shifts toward being student directed. In Level B, students begin to pose their own statistical questions and to design appropriate data collection strategies to answer their questions. Level A learning is typically contained within the individual classroom environment, while Level B begins to expand past the student's classroom to make assertions about other classrooms or outside the school. Both

Table 1. GAISE Levels A and B	
Level A	**Level B**
Formulate Questions	**Formulate Questions**
Teachers help pose questions Students distinguish between statistical solution and fixed answer	Student begin to pose their own questions Students address questions involving a group larger that their classroom and begin to recognize the distinction among a population, a census, and a sample
Collect Data	**Collect Data**
Students conduct a census of the classroom Students understand individual-to-individual natural variability Students conduct simple experiments with nonrandom assignment of treatments Students understand induced variability attributable to an experimental condition	Students conduct a census of two or more classrooms Students design and conduct nonrandom sample surveys and begin to use random selection Students design and conduct comparative experiments and begin to use random assignment
Analyze Data	**Analyze Data**
Students compare individual to individual Students compare individual to a group Students become aware of group-to-group comparisons Students understand the idea of a distribution Students describe a distribution Students observe association between two variables Student use tools for exploring distributions and association, including: bar graphs, dotplot, stem and leaf plot, scatterplot, tables (using counts), mean, median, mode, range, modal category	Students expand their understanding of a data distribution Students quantify variability within a group Students compare two or more distributions using graphical displays and numerical summaries Student use more sophisticated tools for summarizing and comparing distributions, including: histograms, interquartile range, mean absolute deviation, five-number summaries, and boxplots Students acknowledge sampling error Students quantify the strength of association between two variables, develop simple models for association between two numerical variables, and use expanded tools for exploring association, including: contingency tables for two categorical variables, time series plots, quadrant count ratio as a measure of strength of association, simple lines for modeling association between two numerical variables
Interpret Results	**Interpret Results**
Students infer to the classroom Students acknowledge that results may be different in another class or group Students recognize the limitation of scope of inference to the classroom	Students describe differences between two or more groups with respect to center, spread, and shape Students acknowledge that a sample may not be representative of a larger population Students understand basic interpretations of measures of association Students begin to distinguish between an observational study and a designed experiment Students begin to distinguish between "association" and "cause and effect" Students recognize sampling variability in summary statistics, such as sample mean and the sample proportion

Table 2. NCTM Principles and Standards for School Mathematics Data Analysis and Probability Strand

Standard	Expectations Pre-K-2 In prekindergarten through grade 2 all students should –	Expectations 3-5 In grades 3-5 all students should –
Formulate questions that can be addressed with data; collect, organize, and display relevant data to answer questions	• pose questions and gather data about themselves and their surroundings • sort and classify objects according to their attributes and organize data about the objects • represent data using concrete objects, pictures, and graphs	• design investigations to address a question and consider how data-collection methods affect the nature of the data set • collect data using observations, surveys, and experiments • represent data using tables and graphs such as line plots, bar graphs, and line graphs • recognize the difference in representing categorical and numerical data
Select and use appropriate statistical methods to analyze data	• describe parts of the data and the set of data as a whole to determine what the data show	• describe the shape and important features of a set of data and compare related data sets, with an emphasis on how the data are distributed • use measures of center, focusing on the median, and understand what each does and does not indicate about the data set • compare different representations of the same data and evaluate how well each representation shows important aspects of the data
Develop and evaluate inferences and predictions that are based on data	• discuss events related to students' experiences as likely or unlikely	• propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions
Understand and apply basic concepts of probability		• describe events as likely or unlikely and discuss the degree of likelihood using such words as certain, equally likely, and impossible • predict the probability of outcomes of simple experiments and test the predictions • understand that the measure of the likelihood of an event can be represented by a number from 0 to 1

levels A and B focus on data displays. Level A GAISE guidelines list the use of bar graphs, count tables, dot-plots (also referred to as line plots), and other basic displays, as well as more sophisticated displays such as scatterplots. Presumably, the more complex displays would be covered in the upper-elementary grades.

Because the GAISE level A and B guidelines outline the type of statistics content recommended for elementary and middle school students to know and learn, elementary teachers should be made aware of the report and aim to be prepared to teach the content described. The GAISE report also may be used as a teaching resource. It provides several examples of sample questions and problems for each level. A teacher may therefore be able to incorporate the report directly into his/her teaching. A complete copy of the report can be found at *www.amstat.org/ education/gaise*.

Standards

Beginning in 1989, NCTM put forward a series of three influential documents setting mathematics education goals for teachers and policymakers. Those were (1) the *Curriculum and Evaluation Standards for School Mathematics* (1989), (2) the *Professional Standards for Teaching Mathematics* (1991), and (3) the *Assessment Standards for School Mathematics* (1995). As these documents were completed, NCTM appointed the Commission on the Future of the Standards to monitor and update the work.

In 1996, a process for revising and updating the documents was outlined and approved by the NCTM Board of Directors. This process included the formation of both a writing group and an electronic format group made up of teachers, teacher educators, administrators, researchers, and mathematicians (statisticians are

not specifically mentioned) to guide and undertake the upkeep. In 1998, a draft version of the revised standards called *Principles and Standards for School Mathematics* was widely disseminated for review. The writing group reviewed the feedback in the summer of 1999 and reviewed input from a separate committee of experts. In 2000, the updated standards document, *Principles and Standards for School Mathematics*, was published. Simultaneously, NCTM published *Curriculum Focal Points* (2006) as an extension of *Principles and Standards for School Mathematics*. This document provides a more detailed focus of the mathematics curriculum presented in the standards for the elementary and middle grades.

The *Principles and Standards for School Mathematics* organizes K–12 mathematics content into five content standards. Within each strand, the document outlines specific expectations for each grade band. The standard titled Data Analysis and Probability is dedicated to statistical content. As such, NCTM recommends teaching data and probability throughout all grade levels in K–12. The Data Analysis and Probability standards and expectations for the elementary grades are illustrated in Table 2.

As Table 2 shows, the Data Analysis and Probability strand provides four standards that are further decomposed into expectations for a Pre-K–2 and a 3–5 grade band. One of these standards is entirely dedicated to probability. The probability standard has students discuss the likelihood of events and predict the probability of outcomes of simple experiments. As students progress through the elementary grades, the number of expectations given for each standard also increases.

For example, for the first standard, the Pre-K–2 grades have three expectations, while the 3–5 grades have four; the second standard grows from one expectation in the lower grades to three

Table 3. Common Core Measurement and Data Strand

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Organize, represent, and interpret data with up to three categories	Generate measurement data by measuring lengths of several objects or by making repeated measurements of these same objects	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories	Make a line plot to display a data set of measurements in fractions of a unit	Make a line plot to display a data set of measurements in fractions of a unit
Ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another	Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number unit	Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs	Solve problems involving addition and subtraction of fractions by using information presented in line plots	Use operations on fractions for this grade to solve problems involving information presented in line plots
	Draw a picture graph and a bar graph to represent a data set with up to four categories	Generate measurement data by measuring lengths using rules marked with halves and fourths of an inch		
	Solve simple put-together, take-apart, and compare problems using information presented in a bar graph	Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters		

in the upper-elementary grades. As such, students in grades 3–5 are introduced to more concepts.

More specifically, students are asked to compare categorical data to numerical data, differentiate between the measures of center, and make predictions based on "data and design studies." In the lower grades, students are mainly asked to sort, describe, and organize data.

Overall, the NCTM standards set broad general goals for statistics learning in the elementary grades. A complete copy of the standards can be accessed at *www.nctm.org/standards/content.aspx?id=16909.*

More recently, another standards movement has begun to gain momentum. The Common Core Standards, a set of national standards that aim to unify K–12 education across the United States for math and English language arts, were unveiled in 2010. With respect to mathematics, the standards offer grade-by-grade benchmarks for K–8 and a course-by-course outline for high school.

Although, in general, there has been an increased emphasis placed on statistics education throughout the entire K–12 curriculum during the past decade, the Common Core de-emphasize statistics in the elementary grades. In this new document, statistical topics are mostly introduced in middle school and continue through high school.

Since the Common Core has currently been adopted by 41 states, it has the potential to be very influential in affecting mathematics and statistics education in K–12. In light of this, elementary school teachers may be required to teach much less statistics than what is recommended by the GAISE report and NCTM. The way teachers teach statistics also may be different because both the GAISE report and NCTM recommend conceptual and computational instruction, while the Common Core recommends computational instruction.

In the elementary grades, the Common Core contains a strand titled Measurement and Data, under which a few statistical concepts are described. Table 3 outlines the concepts covered within Measurement and Data by grade level.

As seen Table 3, the Common Core focuses the Measurement and Data strand on two central ideas for the elementary grades: generating bar graphs for categorical data and taking measurements of objects and drawing line plots. Grades 1, 2, and 3 have students display data using bar graphs. Using these graphs, students must answer questions related to comparing the categories and total number of data points represented. Grades 4 and 5 shift to drawing line plots. Students are expected to generate data by taking measurements of objects and then represent the data using line plots. Elementary teachers thus must, at the very least, be prepared to teach the content outlined in the Common Core. A complete copy of the standards can be found at *www.corestandards.org.*

In general, the approaches of the GAISE, NCTM, and Common Core are different. As such, elementary school teachers should be made aware of the different approaches and be comfortable switching among them.

When comparing the Common Core to GAISE, we see that the Common Core essentially covers a subset of the concepts outlined by GAISE; however, the difference between the two ultimately lies in the manner in which students are supposed to acquire and be guided through statistical learning. GAISE focuses on a student's overall statistical literacy—this means enabling students to think statistically from the beginning of a problem to the end of a problem. Encompassed in this idea is a student's ability to pose a statistical question and then investigate the answer using appropriate data collection and data analysis methods. On the other hand, the Common Core focuses on ensuring that students can perform specific tasks related to statistics. In the elementary grades, those tasks are focused on making bar graphs, measuring objects, and making line plots.

When comparing the Common Core and GAISE guidelines to the NCTM standards, one notices that the NCTM standards are much broader and all encompassing. For example, in the first standard, students ask questions, collect data, organize data, and display data. This standard alone encompasses most of the GAISE components. Even when further specifying the standard as expectations, the concepts, thinking, and techniques mentioned are not explicitly parsed out at the level of detail of the GAISE guidelines. Instead, the NCTM standards set large broad goals for statistical learning by listing a general set of tasks. This may be expected since one of the goals of the authors of the GAISE report was to unpack the NCTM statistics standards (personal communication with Chris Franklin, April 22, 2011). Similarly to the GAISE guidelines, however, the NCTM standards allude to having students explore their own statistical thinking process. For example, students are asked to pose their own questions and investigate the answer in an "appropriate manner." In general, the NCTM standards' approach somewhat overlaps with the process approach presented in the GAISE guidelines and somewhat overlaps with the more task-oriented Common Core elementary curriculum.

In light of the differences and similarities found among the way these influential and important documents approach statistics, elementary school teachers must, at the very least, understand all the tasks presented throughout the documents. In addition, teachers must have a general understanding of the process of thinking statistically. We do not advocate one document over the other, but rather recommend teachers understand what is in all three documents so they are best prepared to make informed decisions regarding their particular instructional situation.

On-the-Job Data

In addition to considering student learning and the existing standards and guidelines when making recommendations about elementary teacher statistical knowledge, one must consider the types of data teachers are confronted with on the job. Under the No Child Left Behind Act (NCLB, 2001), all states have to produce an annual yearly progress (AYP) report. Every state, school system, and school is then issued a report card. The report card lists the subjects and assessments included in the evaluation of the specific state.

For example, in the state of Tennessee, the report card includes the Tennessee Value Added Assessment System (TVAAS). The TVAAS provides each teacher confidential information about each of their student's standardized test scores on the Tennessee Comprehensive Assessment Program (TCAP) exam from grades 3–8. Using these performances, a teacher is presented with a predicted score for each student's achievement during the year.

The TVAAS also provides information open to the public. For example, the public can access the System Value Added Report for a school district and school. Figure 1 illustrates such a report for a sample school district in Tennessee.

These reports contain an enormous amount of statistical information. At first glance, one may notice several statistical terms such as standard error, growth standard, three-year average, and normal curve equivalent (NCE). When observing
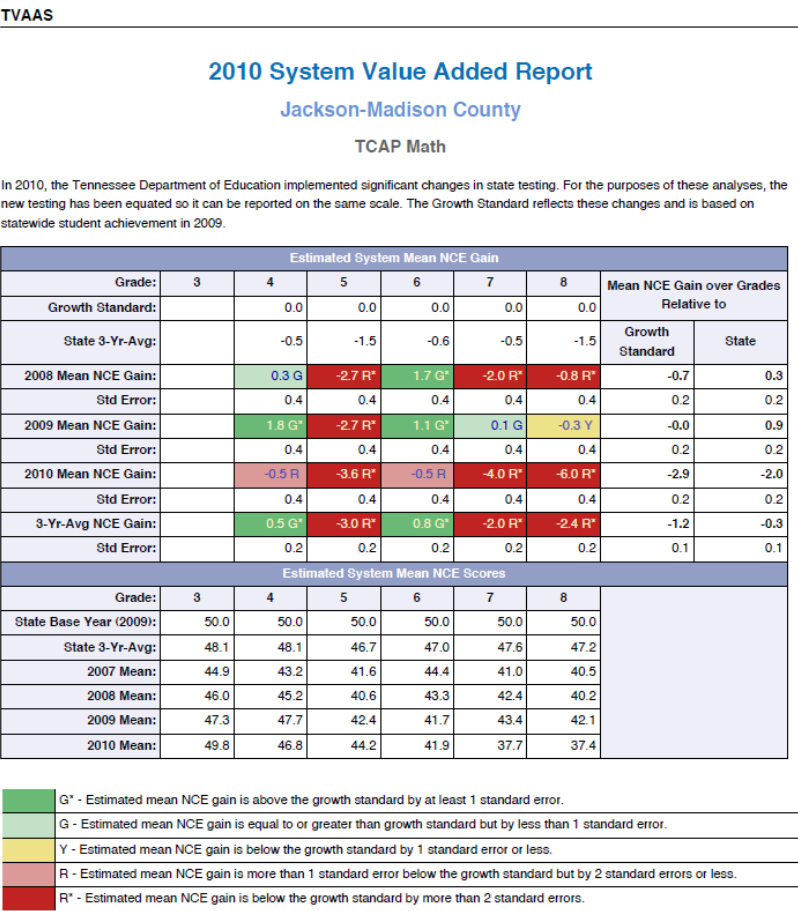
2010 System Value Added Report
Jackson-Madison County
TCAP Math

In 2010, the Tennessee Department of Education implemented significant changes in state testing. For the purposes of these analyses, the new testing has been equated so it can be reported on the same scale. The Growth Standard reflects these changes and is based on statewide student achievement in 2009.

Estimated System Mean NCE Gain								
Grade:	3	4	5	6	7	8	Mean NCE Gain over Grades Relative to	
Growth Standard:		0.0	0.0	0.0	0.0	0.0	Growth Standard	State
State 3-Yr-Avg:		-0.5	-1.5	-0.6	-0.5	-1.5		
2008 Mean NCE Gain:		0.3 G	-2.7 R*	1.7 G*	-2.0 R*	-0.8 R*	-0.7	0.3
Std Error:		0.4	0.4	0.4	0.4	0.4	0.2	0.2
2009 Mean NCE Gain:		1.8 G*	-2.7 R*	1.1 G*	0.1 G	-0.3 Y	-0.0	0.9
Std Error:		0.4	0.4	0.4	0.4	0.4	0.2	0.2
2010 Mean NCE Gain:		-0.5 R	-3.6 R*	-0.5 R	-4.0 R*	-6.0 R*	-2.9	-2.0
Std Error:		0.4	0.4	0.4	0.4	0.4	0.2	0.2
3-Yr-Avg NCE Gain:		0.5 G*	-3.0 R*	0.8 G*	-2.0 R*	-2.4 R*	-1.2	-0.3
Std Error:		0.2	0.2	0.2	0.2	0.2	0.1	0.1
Estimated System Mean NCE Scores								
Grade:	3	4	5	6	7	8		
State Base Year (2009):	50.0	50.0	50.0	50.0	50.0	50.0		
State 3-Yr-Avg:	48.1	48.1	46.7	47.0	47.6	47.2		
2007 Mean:	44.9	43.2	41.6	44.4	41.0	40.5		
2008 Mean:	46.0	45.2	40.6	43.3	42.4	40.2		
2009 Mean:	47.3	47.7	42.4	41.7	43.4	42.1		
2010 Mean:	49.8	46.8	44.2	41.9	37.7	37.4		

G* - Estimated mean NCE gain is above the growth standard by at least 1 standard error.

G - Estimated mean NCE gain is equal to or greater than growth standard but by less than 1 standard error.

Y - Estimated mean NCE gain is below the growth standard by 1 standard error or less.

R - Estimated mean NCE gain is more than 1 standard error below the growth standard but by 2 standard errors or less.

R* - Estimated mean NCE gain is below the growth standard by more than 2 standard errors.

Figure 1. System Value Added Report for a school district in Tennessee

the report more closely, however, one quickly notices that the depth of knowledge a teacher must have to adequately understand and make decisions based on the report extends far beyond just knowing statistical terminology.

For instance, the bottom section of the report labeled Estimated System Mean NCE Scores provides the average district test score for each grade as an NCE value. It is stated at the top of the report that the base year is taken as 2009. Thus, the scores in all other years are equated to the 2009 score. If a teacher understood the procedure used to equate test scores, a procedure rich with statistical concepts and not explicitly explained or presented in the report itself, the teacher would have a greater understanding of how to read these data.

The top portion of the report provides the gains with a color and letter-coded key. To see how the average gains are computed, a teacher must realize the figures in the diagonals of the bottom portion of the table are used. For example, the 2008 mean NCE gain in 4th grade is 0.3 G (green) (top portion of the table). This is computed as the 2008 4th-grade average score minus the 2007 3rd grade average score (45.2 - 44.9) from the bottom portion of the table. Following this group of students further into 5th grade, we have a gain of -2.7 R (red) (top portion of the report). This is found by subtracting the 2008 4th-grade average from the 2009 5th-grade average given in the bottom portion of the table (42.4 - 45.2). A cohort of student scores thus can be followed diagonally in the bottom portion of the table, while the top portion of the table presents the gains across rows.

In addition to the need for understanding the meaning of an NCE and how to compute the average gains, a teacher must recognize that not all the data presented in the report can be computed or explained using only the report. For instance, the standard errors and mean NCE gain over Grades Relative to the State given in the top portion of the table cannot be computed from the information shown in this report. The standard errors, however, do provide the key to the color and letter coding of the average gains. Thus, for this report, a teacher must understand how to use the standard errors, but not actually compute them. Presumably, if a teacher understood how to compute the standard errors, they also would have a greater understanding of their meaning.

As we can see by merely looking at a few examples in the report, a teacher must possess a moderate amount of statistical knowledge at the very least. In general, a teacher receiving these reports must be not only able to interpret them, but also use the information to modify and improve their practice. As such, teachers must give meaning to these assessment data (assessment for the sake of assessment is not enough) and be able to use them to generate change. In addition, having teachers thoroughly understand such policy and assessment results can empower them to have the skills to make valuable assessment of their own students, classes, and schools.

Considerations and Conclusions

While taking into consideration the GAISE report, NCTM Standards, Common Core Standards, and district and school data reports, elementary teachers are required to navigate through numerous statistical concepts both in and outside the classroom.

When and how should teachers learn these statistical concepts remains a pressing unanswered question. Currently, most teacher preparation programs do not require teachers to take a separate statistics course. In most cases, the only exposure pre-service elementary teachers receive in statistics is possibly one unit or chapter in their mathematics content courses. However, even this minimal amount of exposure is not guaranteed, since these courses are already packed with material and statistics topics are often the first to be removed from curriculum to make room for other mathematical topics. In addition, because these courses are typically taught in mathematics departments, the courses are seldom taught by statisticians or statistics educators. This means that if pre-service elementary teachers are exposed to statistics, they are mostly being exposed to statistics through a mathematical point of view and not a statistical one. Because mathematical and statistical content conceptually differ, it is important for teachers to be able to make clear distinctions between their thinking. As such, it may be important for teachers to be exposed to statistics through the lens of a statistician or statistics educator.

Because of the increased push for statistical literacy put forth in policy, it is imperative for teacher preparation programs to 'catch up' to this demand. Teachers at all levels must be exposed to statistical thinking and trained accordingly. If this does not happen, how can we expect teachers to properly use student data to influence their practice? How can we expect to have students become statistically literate? Moreover, science classes at the

ANNOUNCEMENTS

ASA 2011 Poster and Project Winners Announced

The American Statistical Association is pleased to announce the winners of the 2011 poster and project competitions. The competitions offer opportunities for students to formulate questions and collect, analyze, and draw conclusions from data. Winners were recognized with plaques, cash prizes, certificates, and calculators, and their names were published in *Amstat News*. To view the winning posters and projects or for more information, visit *www.amstat.org/education/posterprojects*.

2011 ASA "Promoting the Practice and Profession of Statistics" Video Competition Winners Announced

The Public Awareness Group of the American Statistical Association is pleased to announce the winners of the "Promoting the Practice and Profession of Statistics" video competition at *www.amstat. org/youtube*. The competition, which was intended to stimulate public awareness of the many facets of statistics and life as a statistician, includes high-school students among the winners.

STAT Act Reintroduced

The STAT Act was reintroduced in the U.S. House of Representatives by Rep. David Loebsack (D-IA) earlier this year. Known more formally as H.R. 1817, The Statistics Teaching, Aptitude, and Training Act of 2011, the bill promotes K–12 statistics education through professional development and other statistics education programs.

Talking to your congressperson about this bill is a great opportunity to share your enthusiasm for statistics and the value of statistics education. The American Statistical Association (ASA) is asking you to meet with your congressperson in his/her home district office to tell him/her about the importance of statistics education and urge that he/she cosponsor this bill.

For more information or to sign up, go to *www.amstat. org/outreach/statliteracy*. The ASA will prepare you with a training session for how to request meetings, conduct an effective meeting, and make a compelling case for statistics education. You also will learn the broader context for this bill and the ASA's statistical literacy grassroots campaign. If you have questions, contact Steve Pierson (*pierson@amstat.org*) or Rebecca Nichols (*rebecca@amstat.org*).

K–12 level and beyond now require students to possess statistical abilities since much of the curriculum introduces science through experiments and testing—statistics is the quantitative language of the scientific process. This is yet another reason why teachers at all levels must possess knowledge of statistics.

Further Reading

GAISE College Report. 2005. Guidelines for assessment and instruction in statistics education. The American Statistical Association, *www.amstat.org/education/gaise*.

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. 1989. Curriculum and evaluation standards for school mathematics. Reston VA: The Council. *www.nctm.org/standards/content.aspx?id=16909*

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. 1991. Professional standards for teaching mathematics. Reston VA: The Council. *www.nctm.org/standards/content.aspx?id=16909*

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. 1995. Assessment standards for school mathematics. Reston VA: The Council. *www.nctm.org/standards/content.aspx?id=16909*

2012 Poster and Project Competitions

Introduce K–12 students to statistics through the annual poster and project competitions directed by the ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability. The competitions offer opportunities for students to formulate questions and collect, analyze, and draw conclusions from data. Winners will be recognized with plaques, cash prizes, certificates, and calculators, and their names will be published in *Amstat News*. Posters are due every year on April 1. Projects, for all grades, are now due on June 1. For more information, visit *www.amstat.org/education/posterprojects*.

U.S. Census at School Program Seeks Champions

The ASA and Population Association of America (PAA) launched the U.S. version of Census at School (*www.amstat.org/censusatschool*), a free, international classroom project that engages students in grades 4–12 in statistical problemsolving. Students complete an online survey, analyze their class census results, and compare their class with random samples of students in the United States and other participating countries. The project began in the United Kingdom in 2000 and now includes Australia, Canada, New Zealand, South Africa, Ireland, and Japan. The ASA and PAA are seeking champions to expand the U.S. Census at School program nationally. This is a wonderful opportunity for statisticians and statistics educators to perform outreach in their communities. For more information about how you can get involved, email Rebecca Nichols at *rebecca@amstat.org*.

Free Statistics Education Webinars

The American Statistical Association offers free webinars on K–12 statistics education topics at *www.amstat.org/education/webinars*. This series was developed as part of the follow-up activities for the Meeting Within a Meeting (MWM) Statistics Workshop. The Consortium for the Advancement of Undergraduate Statistics Education also offers free webinars on undergraduate statistics education topics at *www.causeweb.org*.

Don't We All Use Probability Every Day?

Angela L. E. Walmsley and Sweta Prasad, Saint Louis University

Basic concepts of probability are generally considered to be foundational in a post-secondary probability and statistics course, but many students actually encounter the concepts of probability in elementary, middle, and high school. Sentences such as "90% of my answers were correct;" "There is a 50% chance that I will get a bike this Christmas;" "There is a high chance that I will go to Jack's house tonight;" and "Either of them can win this match" are used daily. The focus of this article is to help educators use everyday life examples promoting the use of probability understanding in students.

Statistics and probability have become an important part of the school curriculum in all grade levels over the past 15 years. Efforts led by the National Council of Teachers of Mathematics (NCTM) in 1989 and 2000 regarded data analysis as a major focus for all grade levels. Because students already know and use many probability concepts in their daily lives, teachers can use this knowledge to explain and build on probability foundations.

The concepts of probability can be explored in the classroom with basic examples, and this can further lead to good discussions from which students can learn and understand the concepts in concrete practical ways. The examples mentioned in this article are meant to improve math-related self-efficacy in students since they link mathematics to their daily lives. According to Albert Bandura's social cognitive theory in *Social Foundations of Thought and Action: A Social Cognitive Theory*, self-efficacy is directly related to the choices made by students and efforts they put into learning. If a student can foresee the usefulness of probability and statistics, it is more likely he or she will put more effort into learning, therefore improving his or her probability-related self-efficacy.

A study by Frank Pajares and M. David Miller indicates that math self-efficacy influences problemsolving more than factors such as math self-concept, perceived usefulness of mathematics, prior experience, or sex of the student. Hence, with improved math-related self-efficacy, students can easily implement the concepts in problemsolving situations. Building a student's natural understanding of probability into higher-level thinking is a step toward higher math self-efficacy.

One of the most important aspects that can be brought directly into the classroom is the use of many probability situations experienced by students in real life. Once students understand the everyday language of probability, they can transfer their learning to formal probability concepts expressed using words such as chances, odds, likely, and unlikely. For example, the concept of probability is employed when someone says, "There is an 80% chance of rain today." The interesting fact is that our minds can quickly process an 80% chance of rain to also mean there is a 20% chance of no rain, even though a 20% chance of no rain is not said explicitly.
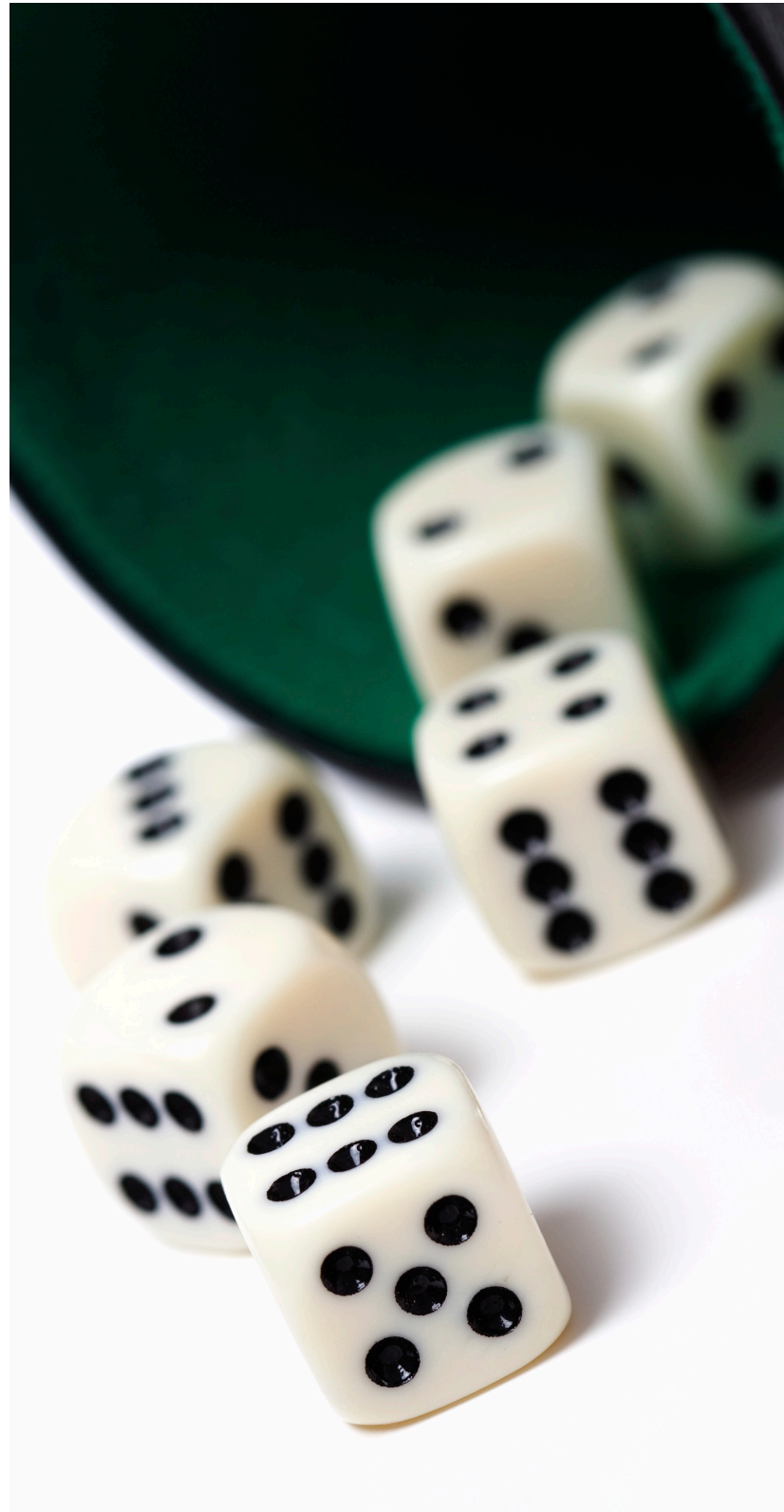
Consider another example: "The probability of getting a purple card from a bag is 2/3. What is the probability of not getting a purple card?" It is less likely students will correctly answer this second example than the first. Why? One reason is that students generally cannot correlate the latter example with a real-life situation as easily. Therefore, they cannot perceive the possible applications as easily. The main challenge is to explain the usefulness of concepts with examples that are more easily visualized through life experiences and then move to more abstract examples.

Some students automatically perceive probability at the high-school level as memorizing and applying mathematical formulas. They sometimes fail to understand they have been using the concept of probability without realizing it their whole lives. In a simple everyday sense, probability can be considered a concept based on the chances of occurrence of any event. However, the events taught in a probability class in high school are often focused on getting an even number on a die or flipping a fair coin. Giving examples modeled after real-life situations can make a probability class more interesting and allow for further understanding of concepts. The following situation is one example that involves the concept of probability in real life that can be used in the middle-school or high-school classroom.

During a national election, the probability of a candidate winning is stated in terms of chances, initiating student discussion. For instance, teachers can ask students to bring news articles based on elections and ask them what they understand and interpret from the numbers and percentages related to the different candidates. This type of discussion encourages mathematical communication and provides an example of how statistics is present in real life.

For example, in the last election, people frequently discussed the chances of President Barack Obama winning the election. The chances were usually expressed in terms of percentages. The general public understood what 33%, 66%, or 50% meant, but probably never gave a second thought to how those numbers were obtained.

A similar "election" situation can be created in a class in the following way. The teacher can bring posters of three musicians such as Lady Gaga, Justin Bieber, and Taylor Swift. The class can then vote for their favorite musician and count all the votes after the poll. The next step would be to express data in terms of percentage, odds, and chances. Students can be motivated to express their ideas about who they think will be the winner of the favorite musician election. The following questions can be asked:

1. What is the probability that Taylor Swift will be chosen as the best musician? 1/3

2. What is the probability that Justin Bieber will lose the election of best musician? 2/3

3. What are the chances of a female artist winning the election? 2/3

4. If the teacher finds that there was a tie between two musicians, what are the possible distributions of votes given that there are 15 students in the class? This question can promote a good class discussion about permutation and combination.

Probability cannot be properly explained without the concept of randomness, combination, and permutation. This is essential for learning the concept of sample space and how to create one. According to the NCTM's *Principles and Standards for School Mathematics,* high-school students should be able to create a sample space for simple events. With the following example, such concepts can be introduced at a much earlier stage without students even realizing they are actually discussing sample space concepts.

The teacher informs students in the class that she saw nine birds sitting on a tree outside her window. Two out of nine birds were big, and all others were small, but she can't remember how many of them were sitting on the top branch, how many on the bottom branch, and their order. She asks each student to give his/her opinion about it. The following table gives the responses of all students.

Student	Top Branch	Bottom Branch
Jason	1	8
Mary	2	7
Jose	0	9
Wanda	9	0
Phil	3	6
LaToya	6	3
Steven	4	5
Emily	5	4
Pam	7	2
Jack	8	1

The example definitely introduces the concept of combinations and permutations because students can see clearly how many ways {(1,8), (2,7), (0,9), (9,0), (3,6), (6,3), (4,5), (5,4), (7,2), (8,1)} birds sitting on two branches are possible. This allows for an understanding of all possible outcomes in a given sample space.

These few examples demonstrate the ways in which teachers can use everyday life to facilitate probability understanding. If students realize they have been discussing and understanding probability in "real life" situations, they are more likely to be confident in applying probability at a higher, more formal level in addition to raising their mathematical self-efficacy.

Further Reading

Bandura, A. 1986. *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Pajares, F., and M. D. Miller. 1994. Role of self-efficacy and self-concept beliefs in mathematical problem-solving: A path analysis. *Journal of Educational Psychology* 86(2):193–203.

Principles and Standards for School Mathematics. 2000. National Council of Teachers of Mathematics. Reston, VA: NCTM.

YOU ARE INVITED TO HELP THE AMERICAN STATISTICAL ASSOCIATION PARTICIPATE in the

ILLUSTRATIVE MATHEMATICS PROJECT
for the COMMON CORE

The Illustrative Mathematics Project (IMP) will provide guidance to states, assessment consortia, testing companies, and curriculum developers by illustrating the range and types of mathematical work students will experience in a faithful implementation of the Common Core State Standards. The IMP website, upon completion, will display the standards in multiple views and provide easy access to tasks associated with individual standards and higher-order structures in the standards.

Please join us in writing data analysis, statistics, and probability tasks of many formats. The ASA/NCTM Joint Committee on Curriculum in Statistics and Probability for grades K–12 has formed an ad hoc committee, chaired by Jerry Moreno (*moreno@jcu.edu*), to write tasks to submit to IMP. If you are interested in helping, please contact Jerry or Rebecca Nichols (ASA acting director of education/K–16 education manager) at *rebecca@amstat.org*.

THE COMMON CORE NEEDS YOUR EXPERTISE.

PLEASE HELP. THANK YOU!

MAKING SENSE OF STATISTICAL STUDIES
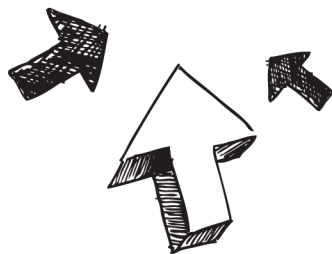
Making Sense of Statistical Studies consists of student and teacher modules containing 15 hands-on investigations that provide students with valuable experience in designing and analyzing statistical studies. It is written for an upper middle-school or high-school audience having some background in exploratory data analysis and basic probability.

www.amstat.org/education/msss

CENS*US* at ✓SCHOOL

FREE international classroom project to engage students in statistical problemsolving

Teach statistical concepts, statistical problemsolving, measurement, graphing, and data analysis using your students' own data and data from their peers in the United States and other countries.

Complete a brief online survey (classroom census)

13 questions common to international students, plus additional U.S. questions

15–20-minute computer session

Analyze your class results

Use teacher password to gain immediate access to class data.

Formulate questions of interest that can be answered with Census at School data, collect/select appropriate data, analyze the data—including appropriate graphs and numerical summaries for the corresponding variables of interest—interpret the results, and make appropriate conclusions in context relating to the original questions.

Compare your class census with samples from the United States and other countries

Download a random sample of Census at School data from United States students.

Download a random sample of Census at School data from international students (Australia, Canada, New Zealand, South Africa, and the United Kingdom).

International lesson plans are available, along with instructional webinars and other free resources.

www.amstat.org/censusatschool

For more information about how you can get involved, email Rebecca Nichols at *rebecca@amstat.org*.

STatistics Education Web

The new editor of Statistics Education Web (STEW), Mary Richardson of Grand Valley State University, is accepting submissions of lesson plans for an online bank of peer-reviewed lesson plans for K–12 teachers of mathematics and science. Lesson plans will showcase the use of statistical methods and ideas in science and mathematics based on the framework and levels in the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K–12 Curriculum Framework* (*www.amstat.org/education/gaise*). Please consider submitting several of your favorite lesson plans according to the STEW template to *steweditor@amstat.org*. For more information, visit *www.amstat.org/education/STEW*.

Statistics Education Web (STEW) in Search of Lesson Plans

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