DESIGNING, PROMOTING, AND IMPLEMENTING A STATISTICS POSTER COMPETITION FOR PRE-COLLEGE STUDENTS

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The American Statistical Association began a national Statistics Poster Competition in the United States in 1990. The competition provides an ideal way to introduce students to the world of statistics. Statistical posters require that students select and define a topic of interest, design a corresponding study, collect data, appropriately present the data, and effectively communicate their findings to a non-statistical audience via graphical and, perhaps, inferential methods. The national competition spawned numerous regional and state competitions throughout the U.S. We provide a brief history of the national statistics poster competition. We describe the experiences of a group of statisticians at Grand Valley State University who began a statewide statistics poster competition in 2000 in the state of Michigan. We provide lessons learned for those hoping to start a competition in their own regions.

A BRIEF HISTORY OF STATISTICS POSTER COMPETITIONS IN THE UNITED STATES

The national statistics poster competition in the United States dates back to the late 1980s when Lorraine Denby, then American Statistical Association (ASA) officer of the Graphics Section, learned about a national statistics poster competition held in Japan. Lorraine suggested that ASA sponsor such a national contest in the United States. At the Joint Statistical Meetings (JSM) in 1989 Jerry Moreno of John Carroll University in Cleveland, Ohio was asked to organize a national competition. With the help of Kathryn Rowe, then Director of the ASA Center for Statistics Education, Jerry formed a committee of five teachers and statisticians from across the country who organized the first national poster competition held in spring 1990. The competition was a joint effort between the ASA Center for Statistics Education (CSE) and the ASA Section on Statistical Graphics. In the mid-1990s the ASA and the National Council of Teachers of Mathematics (NCTM) assumed responsibility for the poster competition through the ASA/NCTM Joint Committee (background from Young, 1998, and Rogness *et al*., 2003).

The national competition spawned numerous regional and statewide competitions through word-of-mouth advertising. Statisticians at Grand Valley State University (GVSU) have organized a competition open to all kindergarten through grade 12 students in the state of Michigan since 2000. In this paper we describe the steps taken to launch the competition, advertise its existence, and successfully build upon a network of participating teachers. Before we go into the details of the Michigan model, we describe the purpose and educational benefits of getting students involved in a statistics poster competition.

EDUCATIONAL GOALS OF A STATISTICS POSTER COMPETITION

The ASA Mission Statement includes the objectives that ASA should "work for the improvement of statistical education at all levels" and that ASA should "promote the proper application of statistics." ASA members are encouraged to use their expertise for "the promotion and development of statistical education for the public and the profession" (http://www.amstat.org/). A Statistics Poster Competition provides practicing statisticians in academics, industry, or government with the opportunity to positively influence the perception that students have about the use of statistics by involving students in the investigation of important social, environmental, and political questions.

Support and encouragement of students and teachers to participate in statistics poster competitions aligns directly with multiple strands of the NCTM Standards that set out a comprehensive vision for mathematics instruction of students from pre-kindergarten (age 4) through grade 12 (age 18) in the United States. Not only is the Data Analysis and Probability Standard addressed through participation in a statistics poster competition, but also the standards for Connections, Communication, and Measurement are directly involved as students conduct research and create statistical posters. For all grades Pre-K through 12 the first point in the Data

Analysis and Probability Standard indicates that students should be able to "formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them" (http://standards.nctm.org/). By creating statistical posters students formulate a question of interest, design an experiment or a sample survey, conduct the experiment or administer the survey, and use graphical representations to create an informative display of their data. High school students often use inferential techniques to generalize conclusions from their sample data to a larger population. Basically, the students engage in the scientific process from beginning (formulating a research question) through the middle (design) to the end (data analysis).

For all grades the Communication Standard specifies that students should be able to (1) organize and consolidate their mathematical thinking through communication, (2) communicate their mathematical thinking coherently and clearly to peers, teachers, and others, and (3) use the language of mathematics to express mathematical ideas precisely (http://standards.nctm.org/). In preparing a clear and coherent poster presentation of their data analysis and results, students exercise these essential communication skills. Winning posters require an accurate display of results such that someone unfamiliar with the specifics of the research question can interpret the findings. This skill is not unlike that required of authors in applied journals who wish to convey the results of a statistical analysis within another discipline (such as Geology or Psychology) to a readership some of whom have a limited knowledge of statistics.

A key element of a high quality statistical poster is the appropriate use of graphical data representations. The Representation Standard requires that students be able to "create and use representations to organize, record, and to communicate mathematical ideas" (http://standards.nctm.org/). Statistical representations of data are among the representations that students should have in their toolkits. These representations form a major component of students' statistical posters.

The Measurement Standard is also addressed in the data collection activities leading up to data analysis and the creation of a statistical poster. This standard involves gaining an understanding of measurable attributes of objects. Often student posters depict the results of experiments or other data collection activities in which the students measured some attribute(s) of a set of individuals. Successful posters require that students analyze what attribute measurements are germane to the research question. The students also must carry out the measurement process accurately and completely.

Beyond the particulars of the NCTM Standards, a statistics poster tells the story of a data set. As academic statisticians, we are constantly impressing upon our students that data is information *within a context*. We emphasize that the proper question for a consulting statistician to ask when presented with a set of numbers is "Where do these numbers come from?" The answer to that question is paramount in the choice of analyses and the interpretation of results. The statistics poster competition requires a student to confront this question throughout the creation of the poster. The student comes to appreciate that statistics is more than calculating numerical summaries given a set of numbers. These numerical summaries have meaning for very specific and very real questions. And, since the question that the student investigates is one of interest to him or her, the connection between the statistics and the question becomes of paramount importance to the student.

ORAGNIZING A STATISTICS POSTER COMPETITION – THE MICHIGAN MODEL

At the 1999 JSM, GVSU statistics' faculty member Neal Rogness attended a presentation given by Tom Short about the Pennsylvania Statistics Poster Competition. Neal became convinced that the poster competition was an event that statisticians at Grand Valley State University (GVSU) could organize and administer. At GVSU, we are fortunate to have a Regional Math and Science Center (RMSC) within the university. The Center is one of 33 scattered throughout the state of Michigan (www.mscenters.org/). The center staff is dedicated to enhancing K-12 education. They have incredible ideas and seemingly endless energy for developing and administering programs that outreach to the K-12 community. When Neal returned from JSM in 1999, he "pitched" the idea of organizing a statistics poster competition to the director of the RMSC at GVSU. She agreed to have the RMSC fund the competition provided

that GVSU statisticians would organize and administer the competition. Neal agreed and we were off and running.

To spread the word about the competition, we wrote a series of articles in the monthly newsletter *Interchange* that is published by the RMSC and sent to over 5700 educators. In the October 1999 issue we announced formation of the competition in the article, "Statistics Poster Competition for K-12 Announced" (Curtiss *et al*., 1999). We explained what makes a good statistics poster. We set out the competition rules and referred readers to the competition website (http://www.gvsu.edu/stat/statposter) for further information.

In the next three issues of the *Interchange* we walked students and teachers through the process of creating a statistics poster. The November 1999 *Interchange* included the article, "Selecting Your Topic for the K-12 Statistics Poster Competition" (Reischman *et al*., 1999). We encouraged teachers to brainstorm topic ideas as a class or small group, critique ideas after all possible topics have been listed, reach consensus on a topic to pursue, decide what questions to answer, and determine the method of data collection. The December 1999/January 2000 *Interchange* included the article, "Statistics Poster Update" (Rogness *et al*., 2000). The article describes how to summarize data graphically and numerically. Emphasis is placed on the different statistical graphical techniques appropriate for categorical data, quantitative data, bivariate data with one categorical variable, bivariate categorical data, and bivariate quantitative data. Finally, the February 2000 issue included the article, "Statistics Poster Competition Update – Putting It All Together" (Gabrosek *et al*., 2000). We discuss approaches that can be taken to organize graphs and results from a statistical investigation into a coherent whole. Particular emphasis is given to being sure that all graphs are correct. These articles remain accessible to participants through the poster competition website (www.gvsu.edu/stat/statposter).

In addition, we offered to visit area schools to model the process used to select a topic, determine research questions, collect data, create graphs, and organize the results. We wrote an article about the competition that appeared in the Michigan Council of Teachers of Mathematics (MCTM) newsletter. The organizers of the competition gave presentations about the event at the 1999 MCTM annual conference. Poster competition brochures were included in the package of materials given to conference participants. These efforts were critical to advertising the event statewide. It is imperative that a critical mass of dedicated teachers take the competition to heart in those first few years. Not only do they help sustain the competition in the early years, but also they become the best recruiters for the competition.

In the inaugural 2000 competition we received 300 entries from across the state. The posters were due at the end of February 2000 and judging took place in mid-March. The RMSC funded winners' checks in the amounts of $96, $72, and $48 for first, second, and third place, respectively, in grade level categories K-3, 4-6, 7-9, and 10-12. The RMSC also funded plaques to be given to the winning schools in the names of the winning students. In year two, we had 416 entries. We reached out to the state ASA chapters in an effort to involve them in the competition. We were able to secure judges through the Southwest and Central Michigan chapters, many of whom make an annual pilgrimage to Allendale, Michigan to partake in the Judging Day festivities. In the third year of the competition we received 515 entries. Participation has remained stable with roughly 500 entries per year since 2002.

Rules for the Michigan Statistics Poster Competition are modeled after the national competition and other statewide competitions. A list of the rules as they appear in the brochure sent by the RMSC to schools is given below:

- Posters are to measure between 18 to 24 inches by 24 to 30 inches.
- Any weight paper is permitted. Standard poster board is recommended.
- Be sure that anything attached to the front of the poster is affixed securely. Do not attach perishable items.
- Posters must be the original design and creation of the student.
- In the K-3 category, at least one graph is required. In the 4-12 categories, at least two graphs are required. The two graphs should impart different information (i.e., a bar graph and a pie chart of the same variable does not meet this criteria.)
- Subject matter is the choice of the participants. Data may be original or published.

- A brief description including the method of collection and purpose must be securely attached to the back of the poster. For published data, a reference must be given.
- Posters and the brief description must not contain any marks, names, or information that reveal the identity of the individual, team, school, or location.
- Students may work individually or in teams. For the K-3 category, there is no restriction on the size of the team. (It may be as large as the entire class.) For the other 3 categories, the team may have up to 4 students. For teams with members from different grade levels, the highest grade level determines the category.

After the initial year, the time commitment to run the poster competition is reduced, but only slightly. Advertising the competition is a critical component each year of the competition. Below is the timeline used to administer the Michigan Statistics Poster Competition.

- late August – make changes to the competition brochure and website
- mid September – produce brochure, send competition announcement to *Interchange*
- mid October – send brochures to MCTM for inclusion in the annual conference package
- mid November – send brochures to K-12 math educators throughout the region
- mid January – send reminder of competition deadline to *Interchange*
- beginning of March – deadline for poster submission, log posters into database
- mid March – judge posters
- late March – create database of winners, verify winners' names
- early April – send list of winners to RMSC for cutting checks and for plaques
- mid April – contact winning teachers to set up dates and times for presentations, produce certificates for all winners and honorable mentions, send national qualifying posters on to the national poster competition
- early May – travel to schools for awards' presentations

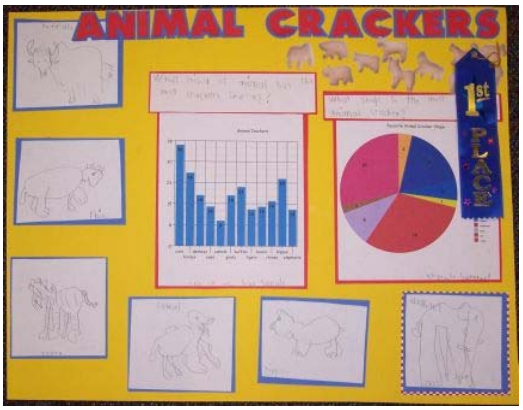
Though the particulars of any specific poster competition depend on the resources available in terms of money and time, there are specific items that we consider to be critical to success for those considering starting a poster competition.

- The event needs someone to champion it. In Michigan, that person was Neal Rogness the first year of the competition (2000) and John Gabrosek the past six years. If that person is at an academic institution, then it certainly helps for the institution to value the commitment the person is making to K-12 education in contract renewal, tenure, and promotion decisions.
- The event needs a stable, committed, long-term funding source. In Michigan, that source is the Regional Math and Science Center at Grand Valley State University.
- The event needs to be advertised through mailings, conference presentations, articles, etc…
- The event needs a website. It doesn't have to be fancy, but it should have a downloadable entry form and a description of the event.
- Teachers that participate need to be kept informed of the competition and thanked for their efforts. We want to encourage as much repeat business as possible.

CONCLUSION

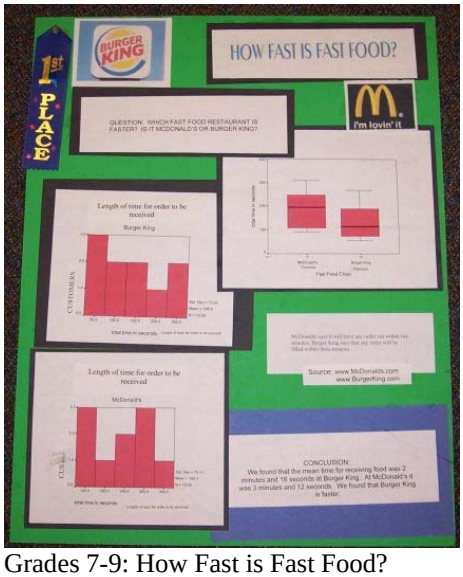
Organizing, administering, advertising, and conducting a statistics poster competition is a major undertaking – there is no doubt about that. Anyone considering starting a regional or larger competition needs to be aware that there will be a substantial initial investment of time to secure funding and get necessary forms completed. After the initial year the time commitment lessens, but remains significant.

Fortunately, the rewards of hosting a competition are numerous. The organizers of the Michigan competition consider the Judging Day, when we get to interact with colleagues from three or four other Michigan universities in a relaxed environment, and the days spent making award presentations at schools to be highlights of the academic year. As the competition matures, we remain impressed and awed at the quality of work that we receive from pre-college students. We close the article with a few examples of winning posters from the 2005 Michigan Statistics Poster Competition.

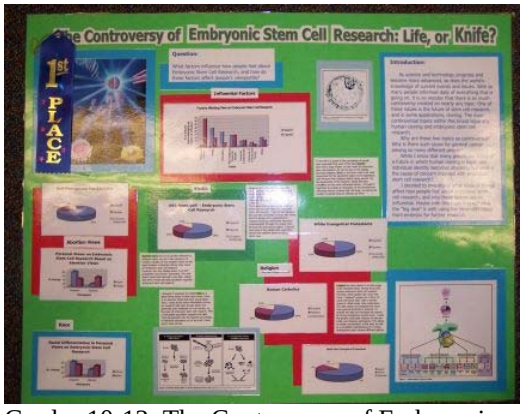


Grades K-3: Animal Crackers,
B. Walsh and J. Walsh

Grades 4-6: Greatest Inventions of the Past 20 Years, L. Bedenis



Grades 7-9: How Fast is Fast Food?
by B. Beadling, S. Harper, C. Carson



Grades 10-12: The Controversy of Embryonic Stem Cell Research: Life or Knife? by M. Goll

Figure 1: Winning Posters 2005 Michigan Statistics Poster Competition

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