

PROMOTING QUANTITATIVE LITERACY FOR SCHOOL AGE CHILDREN December 2007

Shail Butani, Bureau of Labor Statistics

ABSTRACT

In this paper, I'll describe some of the activities that I have undertaken for the Washington Statistical Society to promote quantitative literacy (QL): (1) Conducted and organized speakers and materials for career days for over 100 math classes each year. I organized a small group of statisticians to develop materials that were available to all the speakers. This action made it much easier to find volunteers since speakers did not have to develop their own materials. Additionally, the group was able to establish a great deal of quality control. (2) Participated and provided consultants for QL workshops conducted by ASA for local teachers. (3) Provided statisticians to assist in developing math curriculum for the Fairfax County Public Schools. About 25 percent of the math curriculum is now statistics and probability. (4) Conducted and provided statisticians for elementary school teachers' workshops. (5) Presented materials at the Female Achieving Mathematics Equity (FAME) project. (6) Provided speakers for Girls Excelling in Math and Science (GEMS) programs. (7) Conducted and provided consultants for Girl Scouts' workshops.

1. INTRODUCTION

AMSTAT NEWS of August 2006 announced the formation of a Special Interest Group (SIG) on Volunteerism within the ASA¹. The formation of this group was initiated at the 2005 Joint Statistical Meetings (JSM) by the then ASA President, Fritz Scheuren. Dr. Scheuren appointed Dr. Roderick Little, Dr. Robert Starbuck, and myself to be the steering committee and Dr. David Banks and Jonathan Kurlander to oversee these efforts.

The purpose of the SIG on volunteerism is to increase the scope of volunteering activities and to increase the exposure of these efforts in order to increase the number of statisticians who will participate in them or in some related activity of their own choice. To date, there are about 80 volunteers in the database who have worked on many different issues such as: using statistics to monitor human rights issues; assisting scientists in various disciplines to collect and analyze data, especially in developing countries; and promoting quantitative literacy.

I chose to work on quantitative literacy since I had led this movement in the mid 1990's for the Washington Statistical Society as a Representative-at-Large.

The layout of the remainder of this paper is as follows: Section 2 states the vision of the SIG on volunteerism; Section 3 lists the various QL activities that I conducted and organized for the Washington Statistical Society's volunteers; Section 4 describes how to go about obtaining required resources; Section 5 states how to get started; Section 6 states how to keep QL going; and finally, Section 7 provides some thoughts for future directions.

2. VISION

The vision of the ASA Special Interest Group of volunteers is to inspire other statisticians to adopt some of these and other activities in their local communities to promote QL efforts.

3. ACTIVITIES

In this section, I'll describe some of the activities that I have undertaken as a Representative-at-Large for the Washington Statistical Society to promote quantitative literacy, and list some specific actions suggested by Professor Jerry Moreno of John Carroll University at the 2007 JSM in Salt Lake City, Utah. Professor Moreno is working very actively with ASA and the National Council of Teachers of Mathematics (NCTM) to further statistical education in the K-12 grades, especially in the 7th and 8th grades. He led the Meeting Within a Meeting (MWM) at the 2007 JSM; this meeting was primarily targeted for 7th and 8th grade teachers in Utah. An abbreviated version of the list he presented at the Roundtable with Coffee—Session 73 is: Become familiar with the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report, A PRE-K-12 CURRICULUM FRAMEWORK*; Become a classroom speaker in your schools; Provide materials to your local school via Adopt a School program; Get your ASA chapter involved in doing activities for K-12; Organize a Statistics Career Day; Organize a local poster or project competition, Judge the national project competition (electronically); Become a science fair judge and give awards for using statistics; Become an AP Statistics Reader; etc.

3.1 Career Days

I conducted and organized speakers and materials for career days for over 100 math classes each year, mostly in

¹ Views expressed in this paper are those of the authors and do not necessarily reflect the views or policies of the Bureau of Labor Statistics, Washington Statistical Society, or American Statistical Association.

Fairfax County, VA. I organized a small group of statisticians to develop materials that were made available to all the speakers. This action made it much easier to find volunteers as speakers did not have to develop their own materials. Additionally, the group was able to establish a great deal of quality control.

The general format of the career day talk was that first the presenter would briefly discuss their own career for about 5 minutes. Next, there was a presentation of the interesting video “*What is Statistics*” (an excerpt taken from the *Annenberg PBS series “Against All Odds”*.) This video is appropriate for middle school students. The presenter watched this video in advance to select two or three places to pause the video for discussion with the students. Most of us selected the famous aspirin experiment that was conducted on males to determine if the aspirin was effective in reducing heart attacks. We’d discuss things like whether the same inference can be drawn for women. Another popular place to pause was the probability of the nose rings malfunctioning in the Challenger Space Shuttle. Still another place to pause was on establishing quality control on potato chips and computer chips. This video was very much enjoyed by the students.

The presenter concluded the session by conducting some hands-on exercises that usually took form of a brief questionnaire. The presenter would hand out four to five pieces of colored paper and ask the students to answer questions. What do you do with your free time? What is your favorite color? How much allowance do you receive per week? How much soda did you drink this past weekend? What is your gender? The presenter then asked the students to form into four to five groups. Each group was asked to organize and analyze one set of data. Generally, the discussion would lead to measurement issues like free time on week days or weekends; one can of soda or a one liter bottle; etc. and the importance of properly designed questionnaire. The discussion would also lead to the concepts of mean, mode, median, range, outliers and true value. This, too, was an enjoyable experience for the students.

In the future, I’m planning to incorporate exercises to stimulate discussion based on Graphs 1 and 2 displayed at the end of the article. These graphs and other related materials can be found on www.bls.gov/spotlight.

3.2 Judges for Local and Regional Science Fairs

Several of us from WSS volunteered to be judges for the science fairs conducted by the school districts; our job was to award prizes in the category of mathematics. The WSS also awarded projects in the category of statistics. We were amazed at the use of statistics by some of the

participants. We enjoyed discussing projects like “Are Random Number Really Random”, and another one pertaining to professional horse races.

Currently, the ASA is seeking volunteers to work with local school officials to expand their use of statistics in order to enhance the quality of the science fair projects. This can be accomplished by showing officials the importance of properly collecting data either through design of experiments or surveys. More information on projects and posters can be found on ASA website <http://www.amstat.org/education>.

3.3 Consultants for Workshops

I participated in and provided consultants for QL workshops conducted by ASA for local middle school teachers. The classes were generally two weeks long and made possible by National Science Foundation grants. An integral part of these workshops called for teachers to work on an independent statistical project developed by them. The Washington Statistical Society volunteers served as consultants to the teachers.

3.4 Math Curriculum

I provided statisticians to assist in developing math curriculum for the Fairfax County Public Schools in Virginia. About 25 percent of the math curriculum is now statistics and probability.

3.5 Elementary School Teachers’ Workshops

The success of the career days in Fairfax County led to a request for conducting workshops for elementary school teachers. Again, a small group of volunteers developed materials for these workshops. I, along with others, conducted these workshops, generally for an afternoon. We started the workshops with an emphasis on why math is important in everyday life. For the most part we used QL exercises developed by ASA. Again, we conducted many hands-on exercises appropriate for elementary school children.

3.6 Special Projects

I presented materials at the Female Achieving Mathematics Equity (FAME) project. I also provided speakers for Girls Excelling in Math and Science (GEMS) programs. These projects are mentioned in the hope that volunteers will offer their services for math nights or similar events that their school organizes.

It is with the FAME project that I got my foot in the door of the Fairfax County School system. The participants in the FAME project were girls entering 7th and 8th grades;

these females were identified as having high potential in math and science but lacking motivation. I was invited as a role model. A colleague of mine from Vietnam and I went to talk to these girls. Together, we discussed our experiences very informally. We emphasized the importance of setting high goals and sticking to them in spite of the obstacles that life may present. We discussed the hardships we had overcome due to cultural differences and barriers, the major one being language. We learned that even in the mid 1990's these girls were anxious about excelling in math and science because of the fear of not being liked by their male counterparts. We all had fun.

We found the ASA pamphlets "*Minorities: Looking for a Challenging Career? What about Statistics?*" and "*Statistics as a Career: Women at Work*" to be very popular. For budgetary reasons, this program has been cut. What a place to cut!

3.7 Girl Scouts Workshops

I conducted and provided consultants for Girl Scouts' workshops. A group of us selected QL exercises developed by ASA for K-12 for brownies, juniors, and cadets. We prepared a tip sheet for conducting workshops for Girl Scouts. It included general instructions like the workshop is to be fun for the presenter and the Girl Scouts.

For the tip sheet instructed the presenter to take all the necessary supplies and to go through all the steps of conducting these exercises. Presenters should mention the usefulness of math in daily life and mention that graphs are like pictures. Most importantly, the presenter should engage Girl Scouts in as much discussion as possible and provide feedback to me on what worked and did not work so that the materials for future workshops could be modified accordingly.

The program was a huge success as more than 500 girls participated. We learned that exercises in which the participants could eat data were a big hit. These workshops got a substantial write-up in the *GIRL Scouts Newsletter of Winter 1997* (see appendix.)

4. RESOURCES

Many different sources of materials are available today on the Internet. The materials the WSS volunteers used were mainly QL exercises for K-12 developed by ASA. The exercise with M&Ms and the capture and recapture with Pepperidge Farm goldfish were very popular. As mentioned earlier, we found the video "*What is Statistics*", an excerpt from the *Annenberg PBS Series "Against All Odds"*, to be very popular with middle school students.

Newspapers, especially USA TODAY, are always a good source of materials for graphs pertaining to current events.

As far as human resources are concerned, I've found colleagues at work and at the local ASA chapter to be a valuable resource. Whenever I got a request for conducting career days or for developing math curriculum, I'd send out e-mail to the local area network group "community of statisticians" at work and someone would always volunteer. Most people enjoy doing pro bono work for a few hours and their supervisors were agreeable as well.

5. HOW TO GET STARTED

A good place to start is with your children's math and science class teachers. You can offer to participate in career days; talk on proper collection of data for science projects; do hands-on math or probability exercises at math nights, etc. These teachers can then spread the word to the other teachers in the school and school districts.

Another place to start is by contacting local school officials. Again, you can offer activities similar to the ones listed above or some other activities. You may find it easier to start by contacting Girl or Boy Scouts since they do not have the same time constraints that teachers have these days -- especially with Standard of Learning Tests imposed by the States under the No Child Left Behind Act.

The key to success in getting started is persistence. The hardest part of promoting QL efforts in K-12 is getting a foot in the door. Don't be surprised if you are turned down at first. Keep trying different avenues--eventually a door will open.

6. HOW TO KEEP QL GOING

We found that a single success opens many doors. Once volunteers got into a school system, the number of requests increased every year simply by word of mouth. That is, the domino effect was in operation. This increase is contingent on the volunteers doing a good job in the first place.

What does it take to have success? First, engage in lots of hands-on exercises. The ASA has developed and tested QL exercises for K-12, which are posted on their Web site. Select a few age-appropriate exercises that you think the students will like. Our experience is the popular ones are those in which the students get to eat the data. Imagine someone eating the data before the measurement has taken place. What a wonderful way to start discussion about missing observations. The two most

popular exercises are variations of the M&Ms experiment and capture/recapture (goldfish exercise). Another favorite of mine that I developed has to do with exponential growth. Ask the students whether they would rather take a job that pays \$ 5,000 per week or one that pays one cent the first day and double the previous day's amount the next day for 30 days. I tell them to round down when they go over a dollar. The students are totally blown away when they find out how much they would get paid on the 30th day. When I visit the class again, some of the students tell me they tried the same experiment on their parents.

What to do when you get many requests? Delegate, delegate, and delegate to your colleagues at work or to members of your local ASA chapter. It becomes easier to find volunteers if standardized materials are developed in advance simply because it removes a lot of apprehension and commitment of time on part of volunteers. It makes their task easier and more fun. The standardization process also establishes a built-in quality control that is an absolute must for a successful QL effort.

Finally, develop a feedback process from the volunteers to you so that materials for future presentations can be continuously improved.

7. FUTURE DIRECTIONS

After 10 years or so, I'm again trying to start QL efforts. In addition to the above ideas, this time I'm also going to explore process improvement surveys, especially with Fairfax County school officials. The emphasis will be on improving the process rather than identifying what is wrong.

As a parent, I see several areas at the classroom, school, and county levels where I'd like to see some improvements. Being a survey statistician, I thought : "Let's survey three different groups—students, teachers, and parents—to find out what each group thinks is working well, what could be working better, what new approaches or ideas to try."

The surveying of three different groups could be a very resource intensive activity. To accomplish this activity, I thought of using local chapter statisticians and advanced placement (AP) students in statistics to conduct surveys and to analyze data. With help from the local chapter statisticians, the AP students can obtain the real world experience of creating a frame, handling non-response, and ensuring confidentiality of responses. To address the confidentiality issue, students in advance placements statistics courses will not handle data from their own school or nearby schools.

ACKNOWLEDGEMENTS

It is my great pleasure to acknowledge all the Washington Statistical Society volunteers that helped me in the mid 1990's with the various QL activities mentioned above. My particular thanks go to Terry O'Conner, who was at that time with the National Agriculture Statistical Service (NASS) and is currently with the National Science Foundation.

My special thanks also go to Professor Jerry Moreno of John Carroll University.

REFERENCES

American Statistical Association, Minorities Looking for a Challenging Career? What about Statistics?

American Statistical Association, QL exercises for K-12, at www.amstat.org/education.

American Statistical Association, Statistics as a Career: Women at Work.

Bureau of Labor Statistics, Spotlight on Back-to-School Theme at www.bls.gov/spotlight

Butani, Shail, Little, Rod, Starbuck, Robert, New Special Interest Group Forms on Volunteerism, AMSTATNEWS, August 2006.

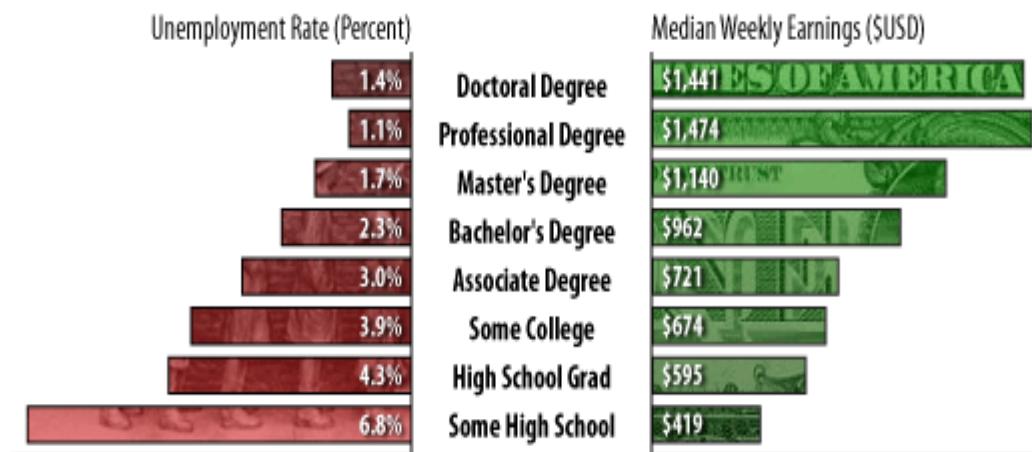
Annenberg PBS Series, "Against All Odds", video "What is Statistics."

Franklin, Christine, et. al., *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report, A PRE-K-12 CURRICULUM FRAMEWORK*, Endorsed by the American Statistical Association, August 2005.

Girl Scouts Eating Up Statistical Analysis, Girl Scouts Newsletter of Winter 1997

Graph 1**Education & Training Pays, 2006**

Unemployment & earnings for workers 25 & older by educational attainment; earnings for full-time wage and salary workers



Source: U.S. Bureau of Labor Statistics

www.bls.gov

Graph 2**Above Average Wages & High Projected Growth Occupations**

Occupations that typically require at least a bachelor's degree

	Projected change in employment, 2004-2014	Average annual earnings, 2006
Postsecondary teachers	524,000	\$64,610
General and operations managers	308,000	\$99,280
Elementary school teachers, except special education	265,000	\$48,700
Accountants and auditors	264,000	\$60,670
Computer software engineers, applications	222,000	\$82,000
Computer systems analysts	153,000	\$72,230
Secondary school teachers, except special and vocational education	148,000	\$51,150
Computer software engineers, systems software	146,000	\$87,250
Physicians and surgeons	136,000	\$142,220
Network systems and data communications analysts	126,000	\$67,460

Source: U.S. Bureau of Labor Statistics

www.bls.gov

Girl Scouts Eating Up Statistical Analysis

So you think the hallmarks of Girl Scouting are camping and selling cookies? Think again. Today's Girl Scout program offers learning experiences in topics ranging from peaceful conflict resolution to physics, from etiquette to one of this fall's newest offerings—statistical analysis.

While girls learning probability by constructing and interpreting a box plot, discovering quartiles, and plotting data on a bar graph may seem a far cry from planning how the troop will handle its cookie sale, it's not. The same principles—tackling new challenges, working as a team, and applying new skills to cope with life's lessons—are at work.

In collaboration with the Washington Statistical Society, GSCNC added "Exploring Data" to its fall line-up of math, science, and technology offerings believing that girls could enjoy learning basic statistical concepts if they were presented in an entertaining and informative way. With a volunteer team of statisticians from the Society as instructors, workshops were developed to meet the different needs of Brownies (elementary school age), Juniors (middle school), and Cadettes and Seniors. During the age-specific two-hour workshops, the girls collect, organize, and display data; make and check predictions; and experiment with concepts of chance. In the process, they learn how to combine quantitative and communication skills to make practical decisions in their life.

Response to the program has been good, with nearly 500 girls boosting their understanding of statistics and how they can be used. Noted coordinator Shail J. Butani, Chief of Statistical Methods Division of the Office of Employment and Unemployment Statistics of the U.S. Bureau of Labor Statistics: "The girls are having fun. In fact, I couldn't get one



To see a huge majority of girls working on a business program, you need look no further than the annual Girl Scout cookie sale. This major program activity sees the girls setting individual and troop sales goals, determining their marketing strategy, and working to meet their established goal. The girls already are team-building and brainstorming how the troop will use its cookie sale proceeds as they prepare for the first stage—order taking, which begins January 3. Booth sales begin the first of March and continue throughout the month. ■

group of Brownies to go home—they loved what they were learning! We've also found that the girls particularly like the probability experiments, which center around Girl Scout cookies or candy, as these are projects where they can eat the data."

Butani and her team of 40 volunteers have taken workshops to 10 locations in our jurisdiction so far. In between workshops, they fax and e-mail tips and suggestions to one another, and constantly seek ways to make the program even more appealing. Butani said, "Our goal is to create role models who can encourage girls to enjoy math and statistics. We're not expecting everybody to major in math, but we do want them to understand that being able to read, use, and understand numbers is vital to any profession."

Another series of "Exploring Data" workshops will be offered January through April of 1997. ■