The
Statistics
Teacher
Network

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From the Editor.....

This issue of STN is devoted entirely to the American Statistics Project Competition. In 1987, the ASA/NCTM Joint Committee, through the efforts of member Dwayne Cameron, initiated the American Statistics Project Competition. From the project competition web site *(www.amstat.org/education/statproject.html*), a statistics project is "the process of answering a research question using statistical techniques and presenting the work in a written report." Linda Young is the current chair of the competition and has written the following article that describes winning projects, one in each of the three eligible categories: grades 4–6, 7–9, and 10–12. Single entrants or teams of two to six may develop a project. For several years the ASA Nebraska Chapter has been responsible for project judging. Six components are emphasized in the judging: question of interest, research design and data collection, analysis of data, conclusions, reflection on the process, and final presentation. In evaluating the final presentation, the creativity of the project as well as the quality of the written report are considered. Each project is read by at least one teacher and at least one statistician.

I thank Linda for having provided the following descriptions of projects that I trust will encourage participation in the competition by seeing what others have done.

Jerry Moreno, Editor

Project Competition.....

The American Statistics Project Competition

Linda Young, University of Nebraska

ljyoung@unl.edu

Below we first describe a project in each of the three age categories for the American Statistics Project Competition. Each won its respective age category. The statistical methods become more advanced with age category. Yet, in each case, the students selected a question of interest to them, collected data to answer the question, analyzed the data, and then answered the question of interest. We conclude by looking at two other projects that had excellent questions but needed to be strengthened if they were to finish at the top.

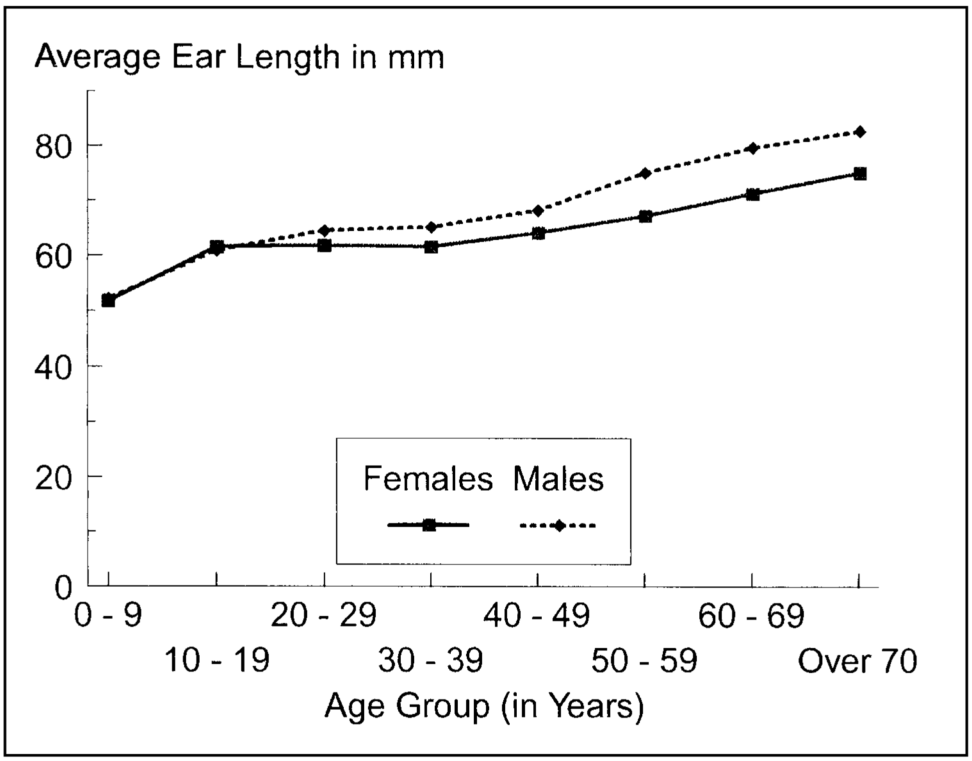
The statistics project is a fun and natural way to meet the increasing educational demands for integrating the curriculum and writing in the content area.

1995 Winning Project—Grades 4–6

"Do People's Ears Grow Throughout Their Lives?"

This project was motivated by a newspaper article reporting the results of a British study that concluded that men's ears do grow throughout life. When the students looked up the published article, they learned that everyone in the British study was at least 30 years old. Further, men and women had their ears measured, but the report did not consider any effect of gender. Therefore, the students decided to build on this study by measuring the ears of all ages, from very young to very old, and by determining whether or not ear growth was the same for both genders.

The students practiced measuring ears using clear plastic rulers until they consistently got the same measurements to within 1 mm. They prepared data sheets to record the age, gender, and ear measurement for each person. Because the British doctors always measured the left ear, they decided they would measure only the left ear. Then they began looking for ears! They measured them at school and at events they attended. One day when they were out of school, they set up a booth at a student union of a local university. To get younger children, they enlisted the help of a local day care center. For confidentiality reasons, the daycare workers had to make these measurements. The students contacted a nursing home in an effort to measure ears of older adults. This was not permitted because of privacy concerns. Instead, they set up an area in the fellowship hall between services at their church where they measured ears of all ages, including many of older adults. In all, they measured 340 ears (compared to 206 in the British study).



Once they had the ear measurements, they entered the data in a spreadsheet. This is when they began wishing they had not measured quite so many ears. They grouped the data into age categories: 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80–89. They made a dot plot of the ear measurements using different colors for each age category. Black dots were placed in the middle of the colored dots to represent males. The students also made a table for male ears and another for female ears, giving the average, minimum and maximum observed ear lengths within each age category. Bar charts helped them consider how many ears they had measured within each age and gender category. Finally, they drew a line plot of the average ear length for each age category, putting the female and male lines on the same plot.

Based on the graphs, the students concluded that ears do grow throughout life. Under the age of 20 males and female ears grow about the same. After the age of 20, ears of both females and males continue to grow, but at a slower rate, and male ears appeared to grow a little faster than female ears. They discovered that male ears tend to be a little larger than female ears after the age of 20.

In reflecting on the process, the students noted that they had enjoyed the project. It allowed them to meet and talk to many different people of all ages and sizes. People enjoyed participating in the project, often laughing. Some would come back with a friend who wanted to participate in the study.

At the day care center, the people who measured the youngest children's ears had only measured to the nearest centimeter. The students did not use these data, and it meant that they had very few children under the age of one in the study. They decided that they should have provided more detailed instructions to the day care workers. The students also found that they had several new questions such as, "Does wearing earrings affect how rapidly a female ear grow?" and "Do other parts of the body grow throughout life?"

The project's text was slightly over four pages. The newspaper article and the journal article describing the British study were included at the end. All of the data sheets were placed in an appendix as well as a page of the typed data after they had been entered on the computer. The four graphs previously described, each on a separate page, were included. Note that only the minimum and maximum values were used to provide a measure of variation. Since these were fifth grade students, that was taken as acceptable. For older students, something more, such as parallel box plots of each age group would have been expected.

2000 Winning Project—Grades 7–9

"Mozart Effect in Children?"

Dr. Frances Rauscher found that spatial-temporal reasoning increased significantly in college students as a result of exposure to classical music. This finding was widely reported in the popular press, which dubbed it the "Mozart Effect." Subsequent studies attempted to expand on this original study by trying different intelligence tests and also exploring the effects of popular music and relaxation methods, but the results were mixed. Although no major study had ever been attempted to explore the Mozart Effect in children, compact disks of classical music were (and are) being marketed as tools to increase the intelligence of children; the governor of Georgia even considered distributing free classical compact disks to mothers of newborn babies. These events led this student to ask, "Does listening to classical or popular music enhance spatial ability in young children (ages 3 to 5)?"

All children who attended a childcare center in the metropolitan area of a medium-sized city were invited to participate in the study. The center had 52 children, aged 3 to 5. The majority of the children came from middle and upper-middle class families of various racial and ethnic backgrounds. Permission slips were distributed to all parents when they picked their children up at the end of the day. An initial low return rate was improved by distributing extra slips and then by the student being present around pick-up time and asking parents to return the slips. A total of 47 consent forms were returned. Some of these children did not participate on one or more days of the study. In the end, 41 students participated on at least one day and 39 participated on at least two days of the three days.

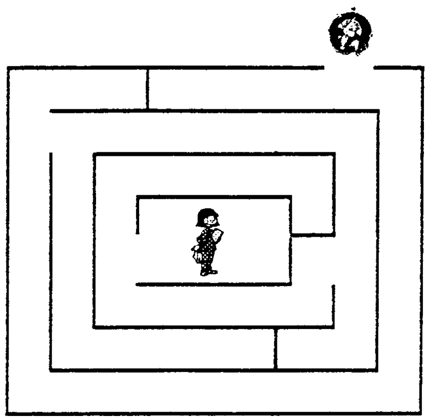
This was a randomized experiment in which each child was exposed to three conditions: Mozart, popular music, and a control, one on each of three days. There were six possible sequences of intervention, two of which received the same intervention each day. The children were randomly assigned to one of the six groups.

	Day 1	Day 2	Day 3
Group 1	Mozart	Popular Music	Silence
Group 2	Mozart	Silence	Popular Music
Group 3	Popular Music	Mozart	Silence
Group 4	Popular Music	Silence	Mozart
Group 5	Silence	Mozart	Popular Music
Group 6	Silence	Popular Music	Mozart

For the *classical* music intervention, the student taped Wolfgang Amadeus Mozart's piano concerto in A major K488 (1^{st} movement). This composition was utilized in Dr. Rauscher's original study and has since been regarded as the standard in testing the Mozart Effect. The student compiled a selection of songs from "songs for the Road" for the *popular* music intervention. The songs were representative of typical children's music, and the tape's running time was the same as that of the classical tape (8 minutes, 20 seconds). For the *control* (*silence*) condition, because it is difficult to keep small children in silence for over 8 minutes, the student played a game of silent "Simon Says" with the subjects as suggested by the director of the childcare center. The game was intended to keep the subjects inactive and silent while waiting to begin the test.

Since Dr. Rauscher had theorized that classical music does not affect all spatial abilities, only those with a temporal component, the student chose a maze test. It is interesting that the student contacted Dr. Rauscher for her advice on suitable interventions and spatial tests. To test the subjects' spatial ability, the student designed and produced a set of similar maze booklets, an example of which was included in the appendix. Since each child was to be tested three times, the student tried to minimize the learning effect by designing a different booklet for each day of testing. In each design, each maze was changed slightly so that they would be unique but of equal difficulty.

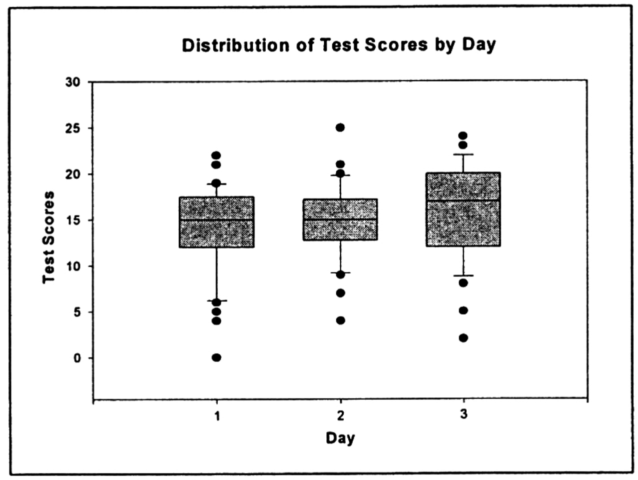
For several days before the actual data maze collection, the student spent time with the children at the childcare center so that they would feel more comfortable when the study began. The help of a friend who had attended the same childcare center was enlisted to help manage the children during the study.



On each day of the study, the student went around to each classroom collecting the subjects in the appropriate testing group. The group was taken into the office of the childcare center. The children were instructed on how to complete a maze test using models and examples. The student then led the children to positions scattered around the room and distributed the pens and tests.

On the first day, the student played the *classical* music tape for the first group. When the music concluded, the children were instructed to begin the maze test. They were given 15 minutes to complete the booklet. During that time, the student wandered around the room to supervise the children. No conversation was allowed. If a child needed assistance, the student helped the subject understand how to complete the test. As children finished, the tests and pens were collected and Oreo cookies were given to the children. When all tests had been collected, the children returned to their classroom. The process was repeated for the *popular* music and the *silence* ("Simon Says") groups. On the second and third days, the process was repeated with the appropriate groups and a new set of mazes. After the experiment was completed, the tests were graded.

The student generated several graphs. The first used boxplots to examine whether there was a learning effect over time. There was a slight improvement from the first to the third days but not enough to worry about especially since the days were counterbalanced across the intervention groups. Several paired t-tests were calculated between each pair of interventions for all children as well as separately per gender. While these paired t-tests are not totally appropriate, students in this age category have no experience (nor should they) with analysis of variance techniques. However, the student did think of a number of ways to look at the data with the tools that were available to him, and recognized that more advanced methods were needed (since testing three separate t-tests increased the overall probability of at least one of them making a type I error).



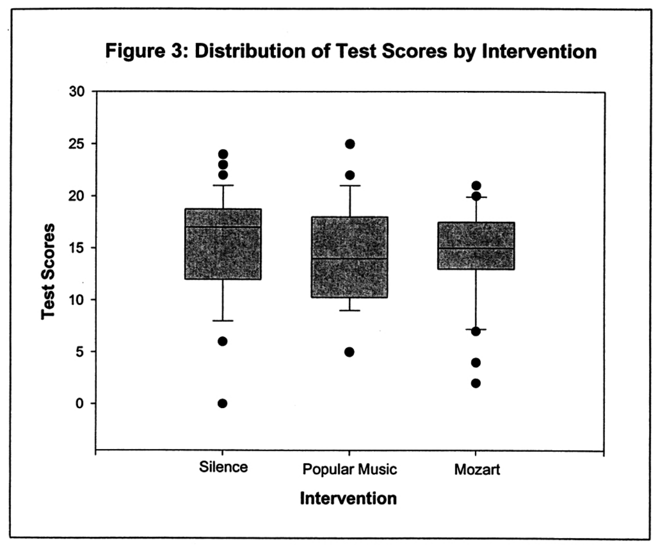


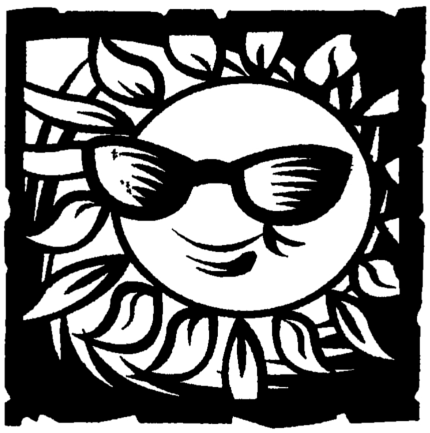
Figure 3: Distribution of Test Scores by Intervention

The results indicated that there was no Mozart effect. The student indicated some possible reasons for the "unexpected results." The concentration of the children was broken by unpredictable disruptions while taking the maze test. The maze tests were intended for one-on-one testing rather than the group testing that had to be conducted in this situation. There were missing data due to sickness, children engaged in classroom activities, or simply children refusing to participate on some days.

The project consisted of a cover page, fourteen pages of text, including several graphs and tables, two pages of extensive bibliography, a page of acknowledgements, and a copy of the parents' consent form.

2002 Winning Project—Grades 10–12

"Blinded by the Suns: Animation and the Learning Process"



Four students submitted this project. They noticed that their local television weather report was filled with floating clouds, falling rain, flashing and radiating suns. The students were curious as to whether or not the animations involved in the "four day forecast," enchanting as they were, actually distracted their ability to concentrate on the report.

They investigated "Does the presence of animation in an informative report inhibit the retention of the presented information, and does it do so independently of the gender of the viewer?" They randomly selected 20 juniors and 20 seniors from their school to participate. A total of 24 students responded. The experiment consisted of presenting slides of trivia about the nation of Uzbekistan. One set of slides was enhanced with pictures, graphics, and unrelated animation and shown to 12 students. A duplicate set was text only and shown to the other 12 students. After the viewings, all students were given the same quiz of eight questions on very specific information presented on the slides. (They were also given brownies after the data were collected as appreciation for their participation.)

Two pie charts were shown that illustrated the breakdown of quiz scores on the two presentations: animated and non-animated. They showed that individuals who viewed the animated presentation received scores of 8 (8%), 9 (25%), 10 (17%), 11 (33%) and 12 (17%), whereas as those who viewed the text only version received scores of 10 (8%), 11 (17%) and 12 (75%).

The design used was a factorial analysis of variance of two factors: gender and presentation (with treatments "animated" and "non-animated"). They used Minitab to find that there was no interaction effect (p-value = .109). The main effect of gender was not significant (p-value = .223) but animation was significant (p-value = .003). So the presence of animation in informative visual presentations affects a student's ability to retain the information presented.

This young group of researchers concluded that "anyone who wants to disseminate information effectively should avoid the temptation to add flashy, colorful and bright animation to their productions, but rather focus on getting the pertinent information across." They also mentioned that if they could do the experiment again, they would take larger samples. They thought that age would be another important factor to consider.

The project consisted of nine pages including a title page, four pages describing the problem with its design and conclusions, two pages of charts illustrating breakdowns of the quiz scores, a page of the analysis of variance output, and a copy of the quiz.

Statistics Project Quiz

Grade: Sub Fr So Jr Sr

Gender: M F

1) The capital of Uzbekistan is

1. Tashkant
2. Tashkent
3. Tashbent
4. Taskent

2) Uzbekistan became an independent nation in:

1. 1991
2. 1982
3. 1966
4. 1999

3) Prior to becoming independent, Uzbekistan was part of

____

4) What happened to many of the old monuments in the capital city of Uzbekistan?

____

____

5) The remaining historical buildings include:

1. a mosque and a palace
2. an ancient shrine
3. a mosque and a mausoleum
4. there are no significant buildings remaining.

6) Name one agricultural problem facing Uzbekistan today.

7) Name one major Uzbekistani export.

8) How many people practice Sunni Islam in Uzbekistan?

a) 90%

b) over 50%

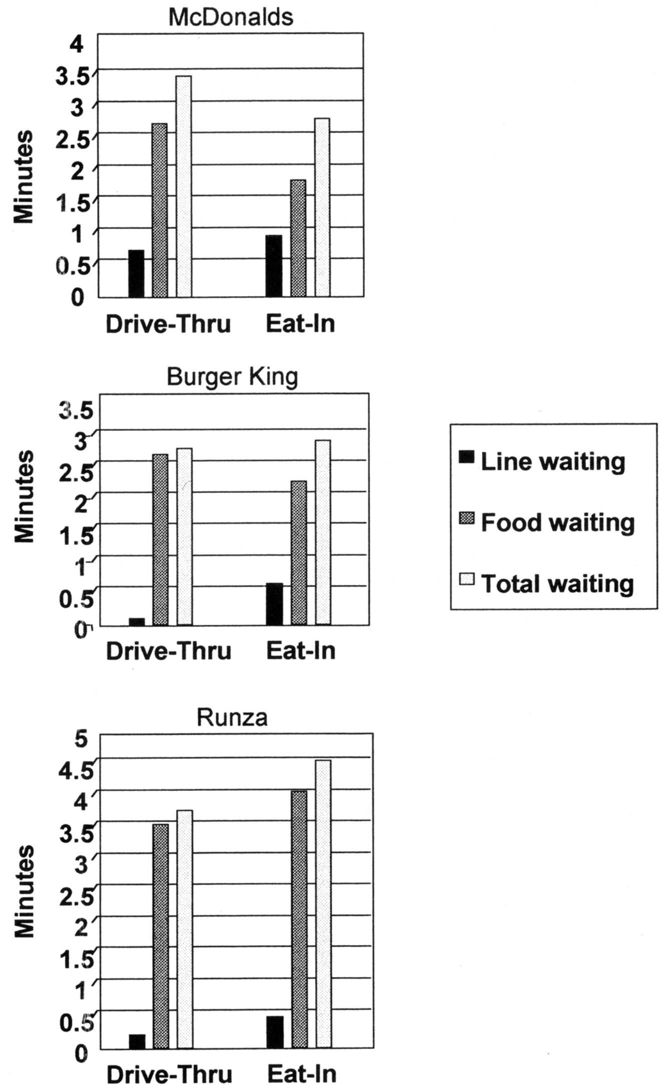
2000 Third Place Project—Grades 7–9

"To Eat In or Drive Through? That is the Question"

This student investigated whether it was faster to eat in or go through the drive-through. She thought that probably it would be faster to drive through since the car line is usually fairly short and if you went inside, the workers "might figure that since you came in you must not be in that big of a hurry, so it might take a little longer for you to get your food."

She included three fast food restaurants in her study: Burger King, McDonalds, and Runza. For each restaurant and for each of drive-through or eat-in, she recorded how long ten people waited in line to order their food and how long it took them to wait for their food after their order was taken. She then totaled the two waiting times and found averages. She presented the averages for the drive-through and for the eat-in waiting times in multiple bar graphs, one for each of the restaurants. The graphs were nicely drawn using the same vertical scale for average minutes and the same color-coding for the various sets of bars. Comparisons were thereby easily seen. She also included pie graphs that indicated the percentage of customers whose total waiting times were under two minutes, from two to three, etc. The pie charts were not as easy to compare from group to group as were the bar graphs, perhaps a reason why statisticians do not use them that often.

In looking over the data, she concluded that "it depended on which restaurant you went to. For instance at McDonalds it would be better to eat inside the restaurant because I found that there was a shorter waiting time inside than going through the drive-through. On the other hand if you went to Burger King you would probably want to drive through. Even though it took longer to wait for the food it did not take very long to wait in line. At Runza you would definitely want to drive through because if you eat inside you would be waiting almost one minute longer. If you wanted to make a general conclusion, it would probably be best to drive through, but it really depends on which restaurant you are going to."



She realized that a source of bias in the data was how much was ordered. Skill of the workers in taking and filling orders was another source of bias. A third source was that she was not able to take the data at the same time of day and on the same day. She would correct these items if she were to do the experiment again.

This was a wonderful question, but a study at the middle school level should have addressed the impact of time of day.

The project consisted of a title page, three pages of text, two pages of graphs, and three pages of data.

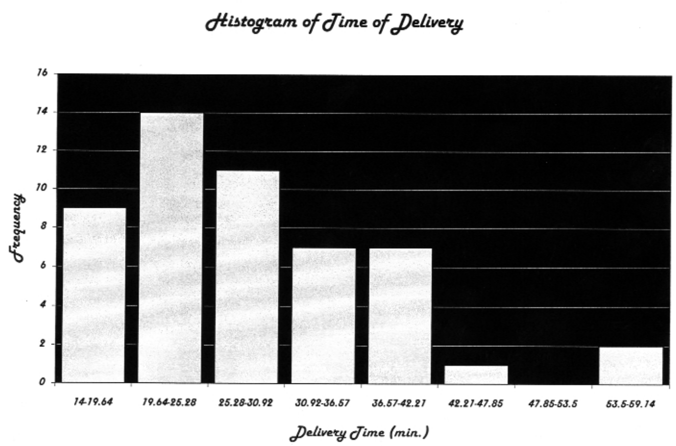
2000 Third Place Project—Grades 10–12

What is the Probability of Getting a Free Pizza?

Three students at a boarding school were interested in how often their peers were able to take advantage of the local “Pizzaville” delivery policy of “forty minutes or it’s free.” They were motivated to do this study for a number of reasons: for its interest and help to their hungry fellow students, to see if the delivery policy was just a hoax designed to attract business when in reality late pizzas are so rare that it is not worth the trouble, and to see if it would be more cost efficient to order a pizza from elsewhere.

They collected times for 51 pizza deliveries from “Pizzaville” to the school. Some of the data were taken from the pizza store directly from bills on which the time of order and delivery were recorded.

A histogram of the time of delivery follows.



The students determined that the mean delivery time was 28.09 minutes, median 36.5 minutes, and standard deviation 9.02 minutes. They constructed a normal probability plot that indicated that for the most part, the data were normally distributed. Using the distribution of times they collected, the students calculated that a normal distribution centered at 28.09 minutes with a standard deviation of 9.02 minutes yields probability equal to .0934 of a random time taken from it being at least 40 minutes. They concluded that nearly one out of every ten pizzas ordered from “Pizzaville” by a student at their boarding school will be delivered in more than 40 minutes and therefore will be free of charge.

The students also wanted to know “in terms of price, where is the best place to buy a pizza from?” Actually, there was only one main competitor, “Pizza Pizza” that advertises a large pepperoni pizza for $11.50 including tax. The comparable charge at “Pizzaville” is $12.86. The students commented that for “someone who doesn’t buy pizza often, “Pizza Pizza” is the better price. However, for someone who orders pizza on a regular basis, it is possible to take advantage of the probability that one in ten of the pizzas that you order from “Pizzaville” will be free of charge. They calculated the expected “Pizzaville” charge is ($12.86)(.9066) + ($0)(.0934) = $11.65. So, in the long run, the price would be about the same on average for a regular buyer if he would order from “Pizzaville.”

The students noted that they wish that they had had the resources to have been able to collect more data, that they could have obtained data from the pizza shops to places other than their boarding school, and that “the majority of our data is collected around dinner time causing the under-coverage of deliveries from the remaining hours of the day.” Also they would have liked to have conducted “a more in-depth study on what the ‘Pizzaville’s’ time limit for a free pizza would have to be in order to defeat its rival’s expected value of $11.50.”

This project consisted of ten pages including a cover page, five pages of text, and four pages of graphs.

2003 Poster & Project Competitions

The time has come again to submit entries for the American Statistical Association Poster Competition and Project Competition. The competitions, now in their 14th and 17th years, respectively, offer opportunities for students to formulate questions and plan how to gather and display statistical data while drawing conclusions from the data. Posters are judged in four grade-level categories (K-3, 4-6, 7-9, and 10-12). Projects are judged in three categories (4-6, 7-9 and 10-12). The deadline for each competition is April 15, 2003.

Trophies will be awarded for the competitions along with the established pattern of cash awards, certificates, ribbons, and calculators donated by Texas Instruments. ASA members or representatives will personally present the prizes to the winners at their schools.

Additional information and entry forms for the 2003 Poster Competition and 2003 Project Competition can be accessed online at *www.amstat.org/education/poster1.html*

Keep Us Informed ...

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Send articles by email to the Editor:

Editor - Jerry L. Moreno
Dept. of Mathematics and Computer Science
John Carroll University
University Hts. OH 44118
moreno@jcu.edu • fax: 216-397-3033

Send mailing address corrections and additions to: Madge Haven: *madge@amstat.org*

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Statistics Teacher Network
c/o American Statistical Association
1429 Duke Street
Alexandria, VA 22314-3415
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