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The BYU Child and Family Studies Laboratory Program

by Scott Grimshaw, Brigham Young University

Scott Grimshaw, professor at Brigham Young University (grimshaw@byu.edu) describes how preschool children can begin to explore data gathering and other statistical concepts and, in the process, learn many other skills. The BYU Child and Family Studies Laboratory offers two morning and two afternoon classes for children turning five. The lab provides a practicum experience for undergraduate and graduate education students. Professor Grimshaw wishes to give special thanks to Genan T. Anderson, Sterling C. Hilton, Judy Kugath, Andrew and Jacob Grimshaw, and the children who participate in the BYU Child and Family Studies Laboratory program.

The NCTM Standards (2000) expect that all students in pre-kindergarten through second grade should gather data about their environment and represent the data in a visual presentation. It is natural for statistical topics and tools to be taught in early childhood education programs. The BYU Child and Family Studies Laboratory designed its curriculum to support and scaffold the development and learning of young children. Vygotsky (1978) describes how the curriculum supports a child's learning by providing an interim scaffold that can eventually be taken away as the child is able to perform the behavior on his/her own. Just as parents hold the little hands of a child just beginning to walk, their teachers use tools of statistics as the scaffold to support the acquisition of many other skills.

The BYU preschool curriculum is built around the principles that children are naturally curious and their curiosity and interests should direct curriculum content. Consequently, the curriculum is built

around projects that are student-driven. The projects continue as long as the children demonstrate interest. This is in contrast to the unit curriculum found in K-12 that identifies skills that must be mastered before moving to other topics. While the

Also In This Issue...

project approach requires the preschool teachers to be both creative and flexible, it provides a rich learning environment where a child's natural curiosity is fostered and rewarded. We learn from Piaget (1962) that children's learning begins with the known and moves outward to the unknown. When new knowledge is related to what is already known by the child it is assimilated into existing schemas and accommodation occurs to develop a new level of understanding. Allowing the children to choose the context of their learning assures high interest and attention to task while increasing the probability of the new information being assimilated into long-term memory (Bredekamp and Copple,1997).

Surveys are an activity to collect data that are easily mastered by children. Questions are chosen from the topic under study. For example, when studying buses children may ask, "Have you ever ridden a bus?" or before touring the campus flower store ask, "Do you like a sunflower or rose best?" Children are divided into small groups of four or five with a teacher for each group. Each child receives a clipboard, tally sheet, and a pencil to record responses. Initially, the children survey one another and then they take their questions to BYU students. The children stop students walking on campus. Each child stops between one and 20 students depending on the child's enthusiasm and speed in questioning. The survey of university students takes between five and fifteen minutes. When the data collection is complete, children count their tallies and try to write the numeral to match their count. Children make bar charts using graph paper and colored stickers to equal their counts. The teacher encourages the children to use the chart to make comparisons between the responses.

The statistical skills of data collection and presentation are obvious from this exercise. However, while the children's attention and interest are focused on performing the survey, the teacher can guide their development in other areas. For example, socialization and communication are major curriculum goals for the preschool-age child, and surveys create opportunities for children to practice and extend their oral language and their group entry skills. Important skills like staying with the teacher and taking turns are learned and practiced by performing the survey outside the classroom.

Children learn the social skills of stopping someone and politely asking a question in different ways. Children help one another by offering an example to follow or providing encouragement. With encouragement from other children, support from the teacher and kind survey subjects the child gains confidence.

The four-year old perspective is one of "What I'm thinking, you are thinking" (Piaget, 1962) and survey work helps children learn to listen to others. Children notice that people respond differently to the survey question. Within their group, children may ask different questions and when the teacher discusses the surveys in the group, children see "questioning" from different perspectives.

Peer teaching occurs when children instruct one another. Children teach each other how to record survey responses correctly ("Make a straight line here.") and supply missing information ("How do you write eleven?" "It's a one and a one."). Children also help one another to remember or read the question to the survey subject.

Another curriculum goal is to teach children how to represent their knowledge. The survey instruction is to make a mark for each response, but the literacy goal is for children to learn that print has meaning. Sometimes children use a tally, an 'X,' a cross, or write the words 'yes' or 'no.' Sometimes a child chooses to draw the response, such as drawing an ice cream cone or a piece of pie when asking about favorite foods. Early in the year the survey sheet will be written for the child. As the year progresses, chil-

dren choose their own questions and 'write' their question on the survey sheet.

The Question of the Day is a one-question survey at the start of each class. The children are the questioners in the survey work, but the Question of the Day reverses the roles with the children as respondents. The children enjoy expressing their opinions and comparing their selections to the rest of the class. Many parents pick up their children from class and ask, "What was the Question of the Day?"

Each child answers the Question of the Day on the same large sheet of paper. During large group time, all the children gather together and the teacher reviews the question. Before the tally of responses, the children try to predict the outcome. Some children are content to estimate the most frequent answer while others estimate the tally for each possible response. At the beginning of the year, the class counts the responses together with the teacher pointing to each child's answer. This reviews the skill of one-to-one correspondence. As the children learn the routine through the year and the children's responses become more connected and legible, one child is chosen to lead the count and record the total. The teacher helps the children compare the tallies and make comparisons of "more," "less" or the "same" between responses.

Since the Question of the Day is answered every time they meet, the children frequently review these basic statistical skills. However, the Question of the Day provides development and frequent review of other skills as well. The primary vehicle for teaching literacy is to provide multiple opportunities for the children to use reading and writing in the natural course of their exploring. The children represent their responses to the Question of the Day with a written representation of their names. With the frequent repetition, many children progress from squiggles, disconnected letters, or a dominant letter to a full representation of their names with all the letters. The children practice under the teacher's guidance, with many using the model of their nametags as they write their names.

At the same time, the children learn to identify clues that unlock the symbols for reading the Question of the Day. To teach reading skills, the Question of the Day is written and complemented with pictures related to the question. For example, pictures of ice cream cones provide clues to help the children read the question, "Do you like ice cream?" Eventually some children will be able to recognize the frequently used words by sight and use beginning letters to help decode new words.

The BYU Child and Family Studies Laboratory has used survey work and the "Question of the Day" to teach preschool age children many skills. These activities certainly teach children statistical and mathematical skills. It may surprise some readers to learn that creative and innovative early childhood specialists foster socialization, literacy, questioning, and representational skills with statistical research principles. However, in a child's world, all learning is intertwined and statistics is naturally one of the key strands that supports other learning. ■

References

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Let Them Roll, Then Show Us Your Data

by Murray H. Siegel

Murray H. Siegel, at the time of this experience, was a full-time professor of mathematics at Sam Houston State University and an associate editor of STN. *He volunteered to teach a fifth grade mathematics class every day at Huntsville Intermediate School. Siegel is now at the Governor's School for Science and Mathematics in Hartsville, SC. He planned curricula that would compliment the following objectives from the state curriculum (Texas Essential Knowledge and Skills)*

The student will be able to compute the mean, median and range of a set of data.

1. *The student will be able to construct and interpret graphical representations of data.*
2. *The student will be able to determine whether specific events are more likely or less likely.*

The following is an overview of his adventures in the fifth grade:

Every nine weeks I assigned a project designed to allow students to apply their mathematical knowledge in an engaging activity. The focus of the project for the first half of the spring semester was data gathering and producing graphical displays to reinforce student understanding regarding measures of tendency, range, and graphical displays of data and probability.

Students were divided into pairs and were given three number cubes (known outside of school as dice). The directions were to have one student roll the three number cubes 25 times while his/her partner recorded the sums. The class was already familiar with finding the sum of the dots on the cubes from an earlier investigation of likelihood. Once a group had completed a set of 25 rolls, the students would reverse roles, thereby alternating turns rolling the cubes and recording the sums. I circulated throughout the room during the activity, ensuring that students were performing the tasks correctly.

Each student had a tally sheet with both the student's name and the partner's name on the sheet. The sums from 3 to 18 were listed and there was a place for tally marks below each sum. Under the area for tally marks was a section for recording the actual counts once a set of 25 rolls had been completed. Each sheet had room for four samples. If a pair of students completed all four samples before the end of class, students received a "bonus" sheet and recorded the results for additional samples. The tally sheets were collected and graded. A correct sheet was awarded 15 points. Extra points were added for bonus data. Points were deducted for errors such as incomplete sets or tallies that did not add up to 25. The same point total was given to both group members. The lowest score was a 12 and the highest score was a 19.

Forty of the 44 samples were selected and a frequency distribution for each of the 40 samples was created. During the next class meeting students were given the frequency distributions for the 40 samples, and each student was provided with a unique definition of a success for his/her investigation. Weaker students received very specific definitions such as "sums of 10, 11, 12 or 13". Stronger students were given definitions such as "11 or more" or "8 or less". The best students were asked to investigate definitions such as "odd sums", "even sums" or "sums that are multiples of 3".

Each student was also given a tally sheet to record the number of successes for each of the 40 samples. A second sheet enabled the student to construct a frequency chart for his/her type of success for the 40 samples. Students understood that the sum of the frequencies would have to be 40 since there were 40 samples. While the class worked on the frequency charts, I circulated throughout the classroom, acting as a consultant. The frequency chart, once completed, was submitted for a grade. Any student who did not finish the chart was allowed to complete it for homework. The chart was worth 15 points and most students received the full number of points.

The next component of the project involved the construction of a line plot for the frequency chart using graph paper, an activity that the students had done earlier in the semester. Students were expected to provide a title for the graph and to label and scale the axes. The line plot was worth 20 points. Points were deducted for errors and for sloppy graphs. Two students failed to submit a completed graph.

The final project assignment, which was to be completed at home, required the student to compute the mean, median and range for his/her data set. The class had performed these types of computations on various sets of data prior to the project. Students understood that to receive full credit, they needed to show all of their work. The mean and median were each worth 20 points and the range was worth 10 points. Students who did not have the project completed on time were allowed to submit the project one day late and lose twelve points or two days late and lose 25 points. Individuals, who had been absent for any of the project activities, were given additional time to complete the project. The final project grades ranged from 26 to 97.

To provide an incentive for students to work on the project in addition to an interest in seeing the results, the project grade would replace a student's lowest test grade for the nine-week grading period. If the project grade were lower than the lowest test grade, the project grade would count as an additional test grade. The test average comprised 60% of the student's report card grade. Some students were highly motivated by this opportunity.

For the students who participated diligently in this project, their knowledge of data analysis, likelihood, and graphical representations was enhanced. I would certainly conduct this project again with no substantial change. In fact, for the last report card period of the school year, the students conducted a similar project where the data were counts of the various colors of M&Ms in "fun size" bags. ■

"Real" Statistics in an Elementary School

Dr. Nancy Obuchowski, a biostatistician at The Cleveland Clinic Foundation, shared her statistical background with students at her son's Montessori school as part of its annual parent/grandparent career week to present statistics as a career option. This is her first-hand account of the experience:

The project was designed to help students see data as a tool to answer questions, learn basic survey skills, perform basic data analysis and present results of analysis.

I planned a simple game to play with the children. We would pretend to work for a company that made various foods. I used the name "The Really Yummy Company". The Really Yummy Company has a big problem. The Company has two factories that make different kinds of pudding, crackers, cereal, and peanut butter. One of the two factories must close, and the workers (a.k.a. the students) must decide which factory would be best to close.

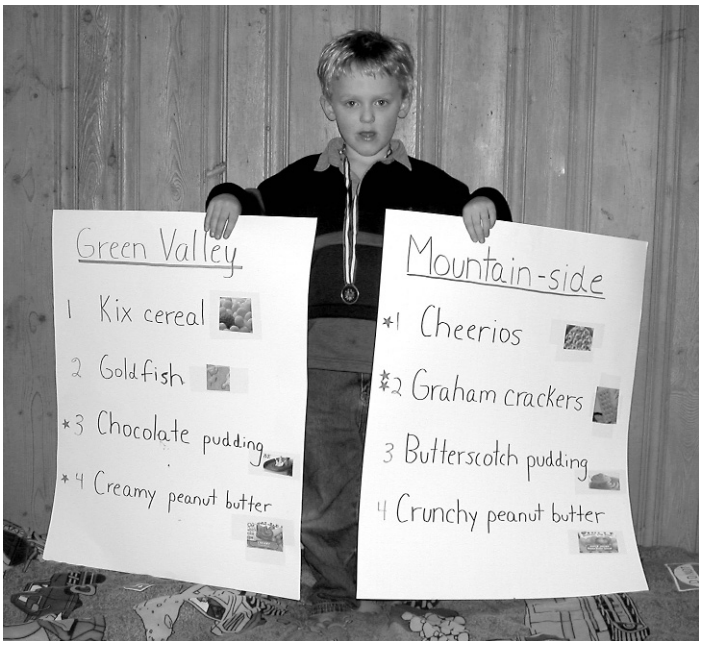
I purchased the following items for the presentation:

1. adhesive labels (for badges): one per child
2. six poster boards: two large (I used 36inch x 42inch) and four medium (I used 30inch x 30inch)
3. notepads with top page prepared as a survey tally sheet: one per child
4. colored markers for poster boards
5. 4-6 star- or other-shaped stickers
6. inexpensive medallions: one for each child

At home I prepared the two large poster boards (see figure). One had the factory name "Green Valley" on it and the names of four foods that are made there: chocolate pudding, goldfish, Kix cereal, and creamy peanut butter. On the other poster board was the factory name "Mountain-side" and its four foods: butterscotch pudding, graham crackers, Cheerios, and crunchy peanut butter. I saved labels from the containers of each of these foods and glued them beside the corresponding name to illustrate the foods and to aid the beginning readers.

After describing the game to the children, my plan was to let them "decide", with as much direction as needed from me, to collect data to solve the company's problem. I had worked it out with the principal ahead of time that we would let the children interview the kindergarteners who were in a different classroom nearby.

On the first page of each notepad I made a two-column tally sheet. Each child would ask one question, either about a favorite pudding flavor, cracker, cereal, or peanut butter, and record the results in the appropriate column. After the interviews, the children would tally their results. Prior to the presentation, I drew the frames for four vertical barcharts, one on each of the medium-sized poster boards, and labeled



the axes. I planned to have the children complete the barcharts and present their findings to their principal, a.k.a. the president of the Really Yummy Company.

The actual experience followed the script amazingly well. I found the 15 elementary-level children sitting on the floor in a semi-circle, awaiting my arrival. They ranged in age from 6 to 12 years. I first introduced myself as a statistician working at a local hospital; I also mentioned my association with the school (i.e. my kindergarten-aged son). I asked if anyone knew what statistics were. There were no replies; I wasn't too surprised. I gave them a few examples from baseball, weather forecasting, and medicine. We laughed at how unreliable the local weathermen were; I knew then that they already understood something about our statistics, i.e. they understood uncertainty.

I asked the children if they would like to play a game, referring to it as a game about statistics. They were all very enthusiastic and eager. Things were going well; I expected at least a few to say no, as these are "Montessori" children.

I started explaining about the Really Yummy Company. I showed them the poster boards with the foods made by the Green Valley and Mountain-side factories. I pulled out the adhesive labels which already had the Company's name printed on them. I wrote my first name under the Company name and stuck the "badge" onto my shirt. The children eagerly did the same.

I asked the children what we could do to help our company decide which factory to close. Several children started expressing their own (and even their sibling's) preferences for the various foods. Soon all of the students were expressing their personal preferences for one factory over the other. Fortunately, there was no consensus among the students and I pointed this out to them. I also explained that, while their opinions do matter, the opinions of other people who aren't here matter too. I waited for the students to

take the next step, but no one did. Perhaps it was my fault—the fictional problem left unclear the relevant population. So I suggested that we ask the opinions of everyone in the school. They liked this idea.

With the teachers' help, we divided the students into teams of four (one group had three) with a mix of ages on each team. I passed out four notepads per team, one for each of the four food types. Each student took one notepad. I asked the students what we were going to do with these notepads. They had no trouble explaining the purpose of the two columns. Even the youngest students got the basic idea, although there was one six year old who, instead of placing checkmarks in the columns, wrote out the words "chocolate" and "butterscotch" under the appropriate columns.

Before leading the students to the nearby kindergarten classroom, we needed to talk about interview etiquette. There were three concepts I wanted to convey: identification, consent, and unbiasedness. Of course, I didn't want to use those exact words, so I demonstrated several interviewing styles and hoped they would choose the right one. I chose one student to be my interviewee, and humorously displayed opposing interviewer styles: "Hey you with the red shirt, I want to talk to you" versus "Excuse me. My name is Nancy and I am from the "Really Yummy Company". "I'm going to ask you a question and you better answer it" versus "Could I ask you a question." Finally, "You like butterscotch pudding the best, right?" versus "Which flavor pudding do you like best: butterscotch or chocolate?" This approach worked great; the children thought it was funny and easily understood which approach was correct.

Next came the actual interviewing. I assigned one team to interview the teachers, another to interview themselves (i.e. the 15 elementary-level students), and the other two teams to interview the kindergarteners. Some of the teachers at the school are extremely health-conscious and refused to choose a pudding flavor or even a cold cereal. I thought it might confuse the interviewers if their tallies didn't sum to the total number of teachers, but the students were way ahead of me. They just interviewed the more responsive teachers a second time. In fact, many of us were interviewed multiple times by multiple teams!

Within 15 minutes we returned to the elementary-level classroom and each student counted the votes in each column of their tally sheets. One boy, probably 7 years old, approached me with a look of concern on his face. He showed me that the numbers of checkmarks in his two columns were not equal and said that he needed to interview some more students to make the numbers the same. I explained how this was an important observation, the kind of information we needed in order to chose between the two factories. He said he understood, and I hoped that by the end of the presentation he truly would understand.

I regrouped the children according to the question they had asked. For each question one of the older children summed the counts of all the interviewers. On the four medium-sized poster boards I showed them how to create bar charts, one for each question. The children constructed the appropriate heights of the bars and labeled them. Three of the four groups finished their barcharts in just a few minutes. I regretted having constructed the frame and labeled the axes for them. They would have enjoyed doing the entire chart themselves. The fourth group had difficulty summing the counts across interviewers. Their solution was to construct rectangles of various lengths for each interviewer's data. If the rectangles had touched one another, this would have worked, but there were large gaps between the rectangles. One of the teachers eventually went to help this group with its addition.

When the four groups were finished illustrating their data, I asked each group to explain their barchart. As they did, I placed one or two stars beside the preferred food on the large factory poster boards: one to the winner of a very close contest, and two if there was a clear favorite. Without prompting, the students excitedly counted the number of stars for each factory and a winning factory soon became apparent to them.

The teachers and I applauded the students' excellent work, and I presented each child with a medallion with the word "STATS" written on the back to display his or her statistical accomplishments.

The overall experience was quite positive for the students, the teachers, and myself. The students clearly enjoyed the exercise and wanted to keep their tally sheets (and notepads) to show their parents. The medallions, although inexpensive, were worn with pride. The teachers (and principal) were impressed by their students' enthusiasm for statistics. They seemed inspired by the entire experience and, as I was leaving, they were discussing how they might adapt the exercise for future lessons. It was a rewarding experience for me as well. The students seemed to really enjoy learning about and using statistics.

I think the presentation could have been improved in a couple of ways. First, the "Really Yummy Company" needs to serve a defined population so that the students could see the logic of gathering others' opinions. Perhaps the population could be defined by age so that students would be motivated to give their own opinions, as well as elicit the opinions of people both younger and older. Second, I should have discussed with each team the sampling frame prior to the interviews. This hopefully would have avoided the duplicate voting and led to a more valid result. Third, next time I will bring an example vertical bar chart for illustration and four blank poster boards and I'll let the students fully enjoy illustrating their data. ■

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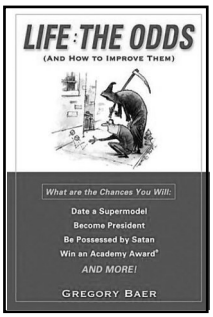
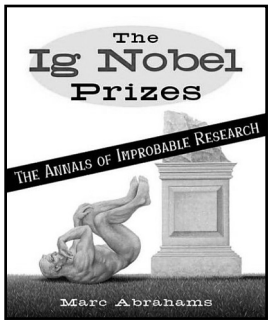
Book Reviews

Baer, Greg, *Life: The Odds (and How to Improve Them)*, Gotham Books (Penguin Group), New York, 2003. ($20)



Life: The Odds is a humor-filled volume about the odds of various things happening in your life. You have probably always wanted to know your odds of becoming President of the USA (10,000,000 to 1) or shooting a hole-in-one (2491 to one, but who's counting) or striking it rich on "Antiques Roadshow" (60,000 to one). This is NOT a book that is useful on a daily basis, but for true statistics groupies, it is a lot of fun to read.

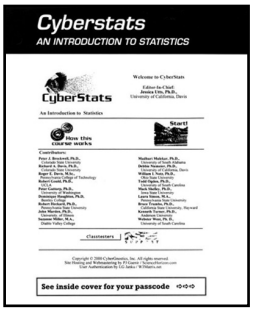


Abrahams, Marc, *The Ig Nobel Prizes*, Dutton (Penguin Group), New York, 2002. ($18.95)

The Ig Nobel Prizes are real prizes awarded at Massachusetts Institute of Technology for research that, perhaps, need not have been done. These are REAL research studies and the people behind them actually show up to receive their awards, sometimes from actual Nobel prize winners. For those who explore research and do experimental designs in classrooms, this short book can be a great way to involve students in developing appropriate research topics.

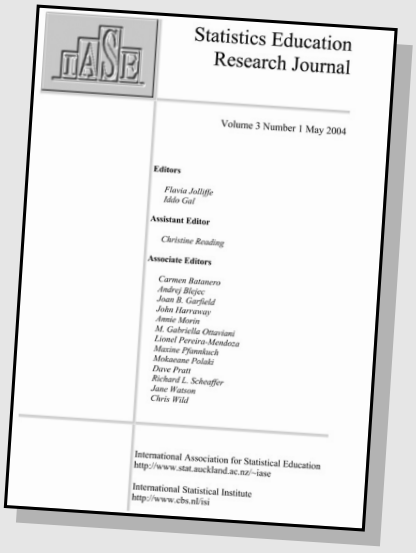
***CyberStats* produced by CyberGnostics, Inc.**, an educational publisher delivering knowledge in electronic form. "CyberStats: An Introduction to Statistics" is described as "a course delivered entirely on the Web".

The basic course content is divided into seven major sets of units: collecting and visualizing data (9 units), modeling random behavior (13), inference (10), regression (4), design of experiments and ANOVA (2), time series (1), and statistical process control (1). Overall, there are 40 individual units in CyberStats version 2.1. The instructor can customize the course map by adding/removing and re-arranging the units to fit a specific course program. Further information is available at http://www.cyberk.com.



The editorial board of the *Statistics Education Research Journal* (*SERJ*) is pleased to announce the publication of the May 2004 issue of the *Statistics Education Research Journal* (*SERJ*, Vol. 3, No.1, May 2004). This new issue, as well as archives of older issues, can be found on the *SERJ* web page at *http://www.stat.auckland.ac.nz/serj* and includes:

- Jose Carmona Márquez.(Paper in Spanish, English Abstract) *Una Revisión de las Evidencias de Fiabilidad y Validez de los Cuestionarios de Actitudes y Ansiedad Hacia la Estadística / A Review of Evidence Regarding Reliability and Validity of Instruments for Measuring Attitudes and Anxiety Towards Statistics.*
- Sonia Kafoussi, *Can Kindergarten Children be Successfully Involved in Probabilistic Tasks?*
- Sue Gordon, *Understanding Students; Experiences of Statistics in a Service Course.*
- Hernan Giorgini, *Some Issues about the Status of Statistics Teaching in Agricultural Colleges in Argentina.*
- Paula R. Williamson and Gillian A. Lancaster, *Statistical Education for PhD Students in UK Medical Schools.*



Dear Readers,

Please let us know if you found inspiration from any of these authors. This will help get STN on the right track. The next issue is on **chance** and the spring issue will deal with **inference**. Do you have any great ideas? Want to write? Please contact me at *stneditor@aol.com*.

Sincerely,
Beth Lazerick

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

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