

Idea Exchange Forum Abstracts

USCOTS 2007 – STATISTICS TEACHING TO THE NEXT LEVEL

(Abstracts in alphabetical order by author last name)

Assessment of the Teaching of Statistics in Nigeria: Problems and Prospects

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Nigeria is the most populous country in Africa, the largest in Sub-Sahara Africa and a developing country with great diversity in ethnicity, religious and cultures. Nigeria is a developing country that lacks basic social amenities; the dilapidating state of infrastructures at the universities is evident in the declining in standard of education in the country. This paper assesses the problems and prospects of the teaching of Statistics immediately after independent, through 70's to the present time. It also examines the old and current mathematics syllabus for West African Secondary School Certificate Examination and the non inclusion of Statistics as a subject at Secondary School level. Problems associated with teaching of Statistics at every level of education including the tertiary institution were enumerated and possibly solution proffered which include clear distinction between Statistics and Mathematics and provision of qualified professional statistics teacher. The paper concludes by giving numerous ways and suggestion on how to improve the teaching and learning statistics in Nigeria.

Developing Good "Clicker" Questions

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Personal Response Systems (PRS or "clickers") are often an excellent way to engage students and make them think during class. They give students a chance to use new definitions and concepts immediately after they are presented. Good questions also can trigger class discussions and peer instruction. One general reference for writing concept test questions is the book Peer Instruction: A User's Manual by Eric Mazur. Developing questions that fit with the content being covered on a particular day is time-consuming and difficult. Only a few statistics textbooks have instructor supplements that include a good variety of questions and even these generally need tailoring to meet the instructor's goals. To create questions it is useful to consider different types: "quick check", self-discovery, misconceptions, fun, graphical, data gathering, challenging, etc. Examples and techniques for writing or finding these types of questions will be presented.

Getting the Central Limit Theorem to "Stick"

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We plan to demonstrate an approach to introducing the concept of the Central Limit Theorem in Introductory Statistics classes. Participants will roll 5 dice and record the average on a poster using circle stickers. Each participant can/should repeat this procedure at least 5 times, recording their results on the poster. We will invite each participant to check back with our table to view the collective results and ask them what they expect of the results after many trials. We plan to have two additional tri-fold poster boards that will describe the activity as presented to our students with an accompanying handout of the activity. These posters will include photos of actual results from our classes.

Teaching with Interactive Internet Statistics Tutorials

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The "WISE: Web Interface for Statistics Education" Internet site provides on-line teaching tools for statistics that take advantage of the value added by Internet technology. Tutorials and applets can be used to supplement traditional teaching materials for introductory statistics courses, providing interactive demonstrations of concepts that are difficult to present using traditional classroom techniques. The site also can be used for self-paced learning, providing a means for advanced students to learn and review key concepts. Our research team created a set of interactive JAVA applets to illustrate relationships involved in core statistical concepts. We designed cognitively based tutorials that incorporate these applets to provide instruction that is more interactive and individualized than is possible with standard textbooks or lectures. The poster features tutorials for the sampling distribution of the mean, hypothesis testing, and statistical power. Examples of lessons will be provided and a laptop will be available for hands-on exploration. The full tutorials are freely available at the Web Interface for Statistics Education (WISE) website: <http://wise.cgu.edu>.

Permutation Tests for Comparing Two Populations

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Permutation tests for comparing two populations could be widely used in practice because of flexibility of the test statistic and minimal assumptions. The Wilcoxon sum rank test is more powerful than a t test statistic for moderate and large sample sizes for heavier tailed distributions. Using a Resampling Stats, this test is easy to implement and a significance level is exact when calculating all possible permutations. The approximate significance level can be used when the numbers of permutations are very large.

Calculus-based Stat 101 Using Chance/Rossman and R: Sharing Experiences and Support Materials

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At the University of Chicago, we have developed a new introductory statistics course with a prerequisite of single-variable calculus. This is not a mathematical statistics course. In one quarter, we cover essentially the same topics/methods as a typical algebra-based "Stat 101" course, while taking the mathematical prerequisite quite seriously. As we caution interested students: "Familiarity with at least limits, derivatives and integrals of polynomial and exponential functions, change of variable (substitution) in definite integrals, max-min problems, the use of summation notation, and sequences and series as well as a willingness to explore ideas mathematically are key to success in this course." We are using the new Chance and Rossman text (Investigating Statistical Concepts, Applications, and Methods) as the main textbook for this course. The textbook Investigations are presented "seminar style" to large sections (60-90 students). We are currently in the middle of our 5th quarter using the Chance and Rossman text and now have a fairly stable and detailed syllabus with a significant set of support materials developed that we are very willing to share. Stop by our display to see if there is something that you can use. We have detailed notes on what to do in class each day, chapter summaries (useful for study/review or as exam formula sheets), detailed solutions to over 100 exercises, instructions on using R for many of the textbook Investigations and exercises, R scripts for easy classroom demonstration of many Investigations, custom R programs for running

many of the simulations suggested in the textbook, and Excel worksheets with textbook data entered and ready for classroom demonstration. We also have over 120 pages of support notes that cover everything from a tutorial for students completely unfamiliar with summation notation to discussion and proof of the unbiasedness of the sample mean and sample variance and culminate with notes that introduce the theory of linear models (and least squares estimation) that ties together the work on inference for means appearing in Chapters 2, 4, 5 and 6 in the Chance and Rossman textbook. We are very happy with the text and find that it has changed the level of questions that we get from students (for the better). Students are thinking and struggling with ideas more fully on their own and have accepted that challenge. This text pushes students (and instructors) to think very hard about the statistical analysis process. For example, there is a surprising array of statistical theory, concepts and methods that are handled using only 2x2 tables at the start of the course. We will be happy to share some of the challenges and realizations (on our part) that we have encountered along the way.

A Real-Time Web-based System to Facilitate Meaningful Learning in Statistics

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Statistics deals with the uncertainty of real world phenomena. It is natural that statistics uses technology, especially in the part of 'doing statistics' by easing the burden of computation needed in statistical techniques. The modern technology provides an opportunity not only for easing computational burdens, but more importantly, for creating innovative instructional technology that integrates content, pedagogy and technology for teaching and learning statistics. This poster presents a real-time web-based system that mimics the entire process of a statistical investigation cycle for solving real world problems. The general learning framework used for the development of the system is the six characteristics of meaningful learning. The recommendations made by GAISE are used as the guidance for integrating content, pedagogy and technology in statistics. A case example is presented to demonstrate how the system is used in the teaching and learning of statistics.

Is this an English course? A Problem-based Learning Approach to a Second Statistics Course for Non-majors

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Answer—no; neither is this a mathematics course. While problem-based learning has been used extensively as a teaching tool in fields such as medicine and related professional education fields for many years, this approach is not as widely used to teach undergraduate courses in the mathematical sciences. Instead of "another mathematics" course where students perform rote calculations or are lectured to, they are exposed to a series of real-world case studies that require them to work in groups and apply course content to solve problems. In this setting, they not only develop critical thinking skills, but also acquire useful skills in collaboration, communication, and real-world problem-solving. This Idea Exchange Forum will serve as a platform for the exchange of methods, ideas, successes and difficulties encountered while using PBL in a second statistics course for non-majors.

SOCR General Central Limit Theorem (CLT) Activity

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This activity represents a very general demonstration of the effects of the Central Limit Theorem (CLT). The activity is based on the Statistics Online Computational Resource (SOCR) Sampling

Distribution CLT Experiment. This experiment builds upon a Rice Virtual Lab in Statistics (RVLS) CLT applet by extending the applet functionality and providing the capability of sampling from any SOCR Distribution • Goals: The aims of this activity are to o provide intuitive notion of sampling from any process with a well-defined distribution o motivate and facilitate learning of the central limit theorem o empirically validate that sample-averages of random observations (most processes) follow approximately normal distribution o empirically demonstrate that the sample-average is special and other sample statistics (e.g., median, variance, range, etc.) generally do not have distributions that are normal o illustrate that the expectation of the sample-average equals the population mean (and the sample-average is typically a good measure of centrality for a population/process) o show that the variation of the sample average rapidly decreases as the sample size increases.

The Two-Sample t-Test and Randomized Experiments

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Nearly all introductory statistics textbooks include a chapter on data collection methods that includes a detailed discussion of both random sampling methods and randomized experiments. But when statistical inference is introduced in later chapters, the idea of collecting data from randomized experiments is generally forgotten. The boxed displays containing a list of the required conditions and the language and notation used usually make it clear that the inference procedures require random samples from a population. A student could easily get the impression that you cannot use a t-test on data from a randomized experiment since they are not random samples from any population, yet many of the examples and exercises contain data from randomized experiments. In working out an example from a randomized experiment, some textbooks contain a passing statement to the effect of "the randomization allows us to view the groups as independent random samples." But a good student would ask, "Why?" This poster describes, in a way easily accessible to students, why the two-sample t-test is often an appropriate approximation for randomized experiments. The material can easily be used in a single lecture or can be adapted to allow good students to investigate the use of the two-sample t-test in randomized experiments.

Using STATS in the Classroom

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STATS is published by the American Statistical Association and is provided free to student members. The mission of STATS is to motivate students to "learn more statistics". Its goal is to encourage students to become life-long learners and to start on a path of professional excellence. Students report that they value most the classroom topics they see as relevant in their lives. When articles from current and recent issues of STATS are incorporated into classroom discussion, students see the topics as fresh and real. Since articles are written by statistics practitioners, statistics professors and statistics students on topics ranging from this year's baseball pennant race to global warming, students become engaged in seeing their world through a statistical perspective. We provide examples of classroom activities and examples from STATS articles that have been used in statistics courses. We show how to easily obtain reprints of articles and the data sets used in the articles. A complete index of topics for introductory and advanced statistics courses is provided also. References are provided on each topic so students can explore further the concepts and ideas they find the most intriguing. Since the greatest learning come from learning-by-doing, by following along with the author's analysis described in an article using the same data, students can replicate the results themselves. Then, the topic comes to life and becomes real for students. Based on student

comments, using STATS in the classroom is an effective way to generate a “Wow!” response from students.

Simplifying Computations for Binomial and Poisson Random Variables

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(with S. David Kriska, Maritza Jauregui, Marcia Sass, and Jallah Kennedy)

Among the simplest forms of random variables and with seemingly vast potentials for “real” applications, binomial and Poisson distributions are discussed in many introductory textbooks on probability and statistical methods. However, despite initial appearances, the uses of both distributions in actual practice are often limited by computational difficulties as N increases. This presentation describes the incorporation of simplifying “recursive” formulae into two Excel spreadsheet programs that combine graphics with the ability to handle “large” problems. Beginning with results for $X = 0$, the formulae “progress” through values of the random variables sequentially until reasonably large upper bounds for the outcomes have been reached. At each step, the formulae lead to the application of simple multiplications to “adjust” the results from the preceding step. Utilizing textbook and other health-related examples in classroom settings, these programs have enhanced illustrations of several important and often challenging statistical concepts, including: sampling distributions; hypothesis testing; the Central Limit Theorem; and normal approximations to both distributions.

Interactive Excel Tools for Constructive Learning (and Doing) of Statistics

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It is well understood these days that facilitating, guiding and encouraging students to construct their own learning is a powerful pedagogical modality. In my efforts to move further and further from (just) content delivery (i.e. lectures) to this mode of teaching, I have created a large collection of interactive Excel tools that allow and encourage the construction of learning by students. In this demonstration, I will both by show and share (feel welcome to hand me a flash drive; I plan on having files available on the Web as well) some of my growing collection: one for properties of confidence intervals, one that demonstrates the Central Limit theorem, one that does bootstrapping for two-sample data (a research tool in and of itself that allows the user to break the tyranny of “differences in means”; it makes easy the task of confidence intervals for ratios or differences of means and medians), interactive t- and z-tables, and others.

Students’ Conceptual Metaphors about Confidence Intervals

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Confidence intervals are an attractive means of conveying experimental results, as they contain a considerable amount of information in a concise format. If they are going to continue to replace p-values as a means of reporting results, it is important that they are well understood. There is anecdotal evidence that the topic and more importantly its understanding are not given much weight in some traditional statistics coursework. To better understand how the concepts are treated by students, two competing conceptual metaphors are proposed. In the Changing Ring Around a Fixed Point metaphor, confidence intervals are moving disks of various diameters covering a fixed but unknown point, like pitching horseshoes of varying widths to capture a fixed stake. Key to this correct

conceptual metaphor is that the interval is a property of a sample but not of the population. Here, the diameter of the disk (i.e., the length of the confidence interval) changes from sample to sample, while the location of the stake (i.e., the population parameter, or population mean) is fixed across samples, but generally unknown. In contrast, the Changing Point on a Fixed Disk metaphor conceptualizes confidence intervals as fixed-diameter disks onto which changing points are placed. In this incorrect metaphor, the population parameter can change from sample to sample. The interval is of fixed length and each experiment results in placing a new parameter somewhere onto the fixed-diameter disk. Interviews with three students following a year of traditional statistical instruction with an emphasis on computations reveal through gestures and statements the existence of two conceptual metaphors similar to the ones proposed. The Changing Point on a Fixed Disk metaphor will generally support a misinterpretation of the confidence interval that leads to inaccurate problem solving. By better understanding students' mental representations of confidence intervals, and appealing to the metaphors they convey, we can hope to improve both statistics instruction and educational researchers' uses of statistical tests.

The Next Level of Statistics for Environmental Science Majors

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Teaching a second semester course designed specifically for environmental science majors requires innovative ways of presenting, in easy-to-understand terms, some advanced topics that are not usually covered in a second semester statistics course, such as inference from non-normal data, handling censored data, and dealing with correlated data. I will describe, in terms of course content and how it's presented, some differences between a general second semester statistics course and one designed specifically for environmental science majors. I will also provide some resources for data that can help illustrate some of these more advanced topics.

Using Game Shows to Illustrate Statistical Concepts

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While students are usually good at the computational aspects of statistics – the number crunching – they often have difficulty with the conceptual aspects. Students often get bogged down in calculations and miss the bigger picture. Understanding what you are doing and, importantly, why you are doing it is vital. I calculate both a conceptual as well as a computational grade; tests include both components weighted equally (each is worth 50% of the grade). Students are required to pass both parts in order to pass the class. I am constantly searching for ways to illustrate statistical concepts and have incorporated television game shows to do so. Episodes of The Price is Right (TPIR) and Let's Make a Deal (LMAD) contain several examples relevant to my statistics course. These shows are available as reruns on the Game Show Network. The concepts I illustrate are: -Confidence intervals: I use TPIR's "Range Game" where the top and bottom prices indicated by the moving box represent upper and lower limits. -Anchoring bias: I use TPIR's initial pricing game (first item bid on after contestants are called to "Come on down!") to illustrate that the first contestant's bid almost always biases the subsequent bids. -Probability distributions: I use TPIR's "Plinko" to demonstrate normal distributions. - Probability calculations: I use LMAD's "Monty Hall Problem" to have students investigate the probabilities associated with switching vs. staying strategies. Other concepts could be illustrated with these game shows specifically, and others in general (e.g., Biesterfeld, 2001). Biesterfeld, A. (2001). The Price (or Probability) Is Right. Journal of Statistics Education 9(3), 1-13.

Involving Students in Their Own Statistics Class

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When attending USCOTS 05, a tiny post-it note on the "data board" read simply, "Did you know that height=2*(shoe size) + 50?" Intrigued, this little fact caused me to think about getting just a few measurements from students to utilize for examples throughout the introductory statistics course. Student response reflects improved student interest and much greater sense of relevance for the course. Or, an old dog learned different tricks at USCOTS 05.

That Large "I Have to Take It" Statistics Service Course: Kicking It Up a Notch

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(with Herle McGowan and Amy Wagaman)

Many colleges and universities offer a large introductory service course in statistics. Often this same course is taught in multiple sections and the level of coordination between these sections can vary. This poster will share a number of key elements for running a successful large introductory statistics course. Any number of these elements can be varied as needed and incorporated into your introductory statistics course to "Kick it up a Notch". These key elements include: • Graduate Student Training: the training of the graduate student instructors (GSIs) or also known as Teaching Assistants (TAs) – the evolution of a GSI training course from structuring meetings, to teaching projects, to peer-to-peer observation and evaluation; • Technology – from the utilization of a new lecture capture technology (called MScribe) for recording and archiving review sessions or other course sessions, to the implementation of tablet PCs and clickers; • Materials – interactive style lecture notes, activity-based computer lab modules, grading and assessment via homework and exams; • Handling of special case students – special needs and learning disabilities. Extensive handouts providing details of key elements used in the coordination of our large statistics course will be provided for all those interested. These key elements could easily be adapted to various introductory statistics course structures.

Matching Curriculum to Subsequent Expectations for Student Performance

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(with Mark Fulcomer and Marcia Sass)

Most agree of the need to make statistics courses relevant, and both students and faculty want to know what elements of an introductory statistics course are most important. Kriska, Fulcomer, and Sass (2006) proposed a 68 item survey instrument to be used in a variety of situations including determining what students are expected to know and do when they enter a course that follows the statistics class or accept employment. The instrument includes two sections with one addressing specific topics commonly taught in introductory statistics, e.g., t-tests. The other section addresses statistical tasks a student should be expected to perform, e.g., identify a misleading graph. When the finalized version becomes available, this instrument will be used to survey the faculty of a large business school who will respond based on literacy demands for specific courses they teach. At the USCOTS meeting, information about the instrument will be obtained through a participant activity that will have attendees assign statistical tasks to one of the levels of cognitive reasoning defined by Bloom's taxonomy.

Bringing Interdisciplinary Research into the Classroom

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Multi-day lab modules that emphasize the process of science and data analysis will be presented in this poster. These labs emphasize collaborative projects, conceptual understanding, genuine data sets, use of technology and activity-based learning. In addition, they encourage students to experience the role of a research scientist in searching the literature, preparing a proposal for analysis, planning and carrying out experiments, and presenting the results. These labs can be combined to form a second statistics course, individually incorporated into an introductory statistics course, or used in courses in other disciplines.

Rides from the Graph

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Students in early statistics classes spend a great deal of time creating descriptive representations of their data, while little time is spent analyzing those descriptive representations. This display will present an original computer program where students are asked to examine different graphs of data collected from amusement park rides and to analyze the relationship between two variables, such as height and time or potential energy and time. Students then have to decide which ride the graph most closely represents. The images of the rides will be presented using point of view video or panoramic video of the rides in motion. Conference attendees will have the opportunity to use the program and test their own skills. Information about how this program can be integrated into a classroom and a field trip setting will also be provided.

Beyond Fun and Games: Activities for AP Statistics

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As a doctoral student with a major in Mathematics Education, I went to local schools for the practicum. I visited a number of high school AP-Statistics classes. In the poster, I will discuss the activities used in the AP Statistics classrooms, including the pros and cons of using these activities. - Dominant Hands? (Paired Sample T-test) All students were asked to place string around their fingers twice, once with their dominant hand and once with their non-dominant hand. Students were asked to record the speed of dominant hand and non-dominant one and test the hypothesis: "Is the mean rate for dominant hands generally higher than the mean rate for non-dominant hands?" - The Effect of the Music Students were asked to solve two puzzles, one with music playing in the classroom and one without any music. Students were required to record the time spent on two mazes and to test the hypothesis: "Listening to music will improve student's performance in solving mazes." - The Winter Olympics- The Long Jump Students were divided into two teams. Any Henry Clay athletes are put on a team and non-athletes are put on a team. Each individual positioned itself behind the starting line. Without touching anything beyond the starting line, students will reach as far as possible and make a mark on the floor with a piece of chalk. The distance the mark is from the line is recorded. Students are asked to test the hypothesis: "The athletes will outperform the non-athletes in the long jump." - Hershey's Kisses VS. Hershey's Hugs Students get Hershey's Kisses with Hershey's Hugs from a bag. They are asked to compare the proportions of and test the hypothesis: "There are same amount of Hershey's Kisses and Hershey's Hugs in the Chocolate bag." - Is the coin fair? (Testing for a Single Population Proportion) If we flip a fair coin, we believe that heads comes up 50% of the time. If the coin is fair, then the proportion of times heads comes up is 0.5 and if the coin is not fair, the

proportion of times is not equal to 0.5. Each student is asked to flip a coin for three times and to record the results. They will formulate the null and alternative hypotheses, determine the distribution for the test, use the statistic calculated from the data to calculate the p-value and draw the conclusion.

SERC Pedagogic Services: Bringing Together Activities to Teach Statistic Concepts with Materials and Information on Teaching Methods

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The Science Education Resource Center (SERC) pedagogic service uses teaching examples to inspire faculty to try new teaching methods. Each example is linked to the needed teaching materials as well as to a module on the methods that are used. Information in the teaching method module addresses what the method is, when and why it is valuable to use, and how it can be implemented. These modules are well referenced providing a bridge to the scholarly literature on the method. Digital libraries, centers for teaching and learning, or other groups can draw from a library of modules and activities to create their own customized websites supporting their particular community. They can also contribute modules and activities to the collection for use by others. CAUSE has created an implementation of the service for the statistics community.

Interact with Inquiry-based Learning Modules for Statistical Concepts

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With support from the National Science Foundation, the researchers are developing Interactive Independent Inquiry-based (I3) learning modules that include audio-visual enhancements to supplement learning materials for potentially complicated statistical concepts. Building on existing materials such as those developed by Allan Rossman and Beth Chance (California Polytechnic State University) and Kyle Siegrist (University of Alabama, Huntsville), the authors strive to provide interactive, online learning resources including tutorials and guided discovery-based lessons that could be assigned as out-of-class learning exercises. The authors will present several learning modules, and participants will be given an opportunity to test drive the learning modules and provide the authors with feedback. Topics include the binomial distribution, confidence intervals, the randomization process, and the concept of statistical significance.

Taking the Group Project to the Next Level

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Would you like to incorporate a group project into your stats class, but aren't sure where to start? Or have you been thinking about changing your current course project to improve student learning? This poster chronicles the evolution of a group project over eight semesters in a large introductory data analysis course. The project began as an extra credit assignment where students were given little statistical guidance and has progressed through various stages to become a course requirement where students are guided through all steps of the statistical process. These steps include hypothesis formation, data collection and analysis, and formal reporting of results and conclusions (via a written paper and a presentation to their peers). Extensive handouts providing instruction for each of the steps currently included in the group project will be provided for all those interested. Suggestions could also easily be adapted to individual projects, if desired.

What Should Students Be Allowed to Bring with Them to a Statistics Examination?

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A few years ago a new assistant professor at an Ivy League institution provided information about the course's first mid-semester examination to his undergraduate statistics students. After he explained what topics would be examined and the format of exam, he asked if there were any questions. The first was if the exam was open book, which the instructor answered in the affirmative. The second was if it was open notes, which he also answered in the affirmative. The third was if it was open computer output, at which time the instructor realized that such questions could continue for most of the class. Hence in haste he told the students that anything that an individual could carry into the lecture hall would be allowed for the examination. But, at the beginning of the exam the assistant professor realized he had made a big mistake when he observed one student carrying a graduate student on his back! Today there are a number of ways that a new assistant professor could answer similar questions. This was not the case when I took mathematics and statistics courses in the 1960s and 1970s. All in-class examinations were closed. But by the time I began my academic career things had begun to change. Some of my colleagues allowed their students to bring one page of formulas with them to the exam. Today at my college, and other institutions from my perusals of syllabi for transfer credit, most instructors allow students to bring a page of notes with them to an examination. (These pages are often called "cheat sheets" by the students, even though they are permitted by their instructors!) One reason given for permitting such notes is that in today's world memorizing is not as important as it was due to advances in technology. Another reason is that by constructing these notes students are learning how to summarize information. Over the years the notes that I permit my students to bring with them have changed. Starting with a page of formulas, I began to let the students bring a page of notes, of their own creation. But soon I realized the students were not summarizing, they were just copying a good portion of the text onto two sides of paper. Then they began to put an amazing amount of material onto their sheet of paper by using photocopies and computer printers. Hence I began to restrict them to only a fixed number of items and call their lists summary sheets. As two examples, 40 items for an exam and 10 items for a quiz. But because some students considered a worked-out example to be one item, I now provide them with an operational definition for an item. It is a definition, a formula, or a procedure. Still there continues to be a variety of opinion in my division on what is the appropriate for the students to bring to an examination. In a recent discussion of a multi-section course, one instructor felt that it should be completely closed. Another argued that the examination should be open laptop, including the text's PowerPoint slides, because his students need to use their laptops during the examination and it is impossible to enforce the use of electronic material. No one argued for communication with other individuals which is possible with today's technology. I suspect that many USCOTS 2007 attendees would be interested in discussing what undergraduate students should be allowed to bring with them to a statistics examination. Hence I propose to make a poster presentation in the upcoming USCOTS Idea Exchange Forum (IEF). In addition to posting a large number of examples of "cheat sheets" (and the advantages and disadvantages associated with each type of allowed material), I plan to go "beyond the poster" by polling the USCOTS attendees on what they currently allow for their students and what they may allow in the future. The results of this poll might be reported in an USCOTS E-NEWS.

Using Multiple Choice Questions to Enable Immediate Feedback for Learning and Instruction

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(with Robert Terry)

Education research has provided evidence that active learning strategies have a considerable positive impact on student understanding of concepts. Classroom response system technology can facilitate some of these active learning strategies, by enabling immediate feedback to students and instructors. The technology includes a handset (a.k.a., a clicker) that allows a student to respond, anonymously, to a multiple choice question; software records the student's response. Once all of the students have responded, the software offers a bar graph display of the response distribution. Use of this technology enables timely and frequent feedback to both students and instructors. This feedback can lead to cognitive gains through increased student engagement in active learning and affective gains including increased student attendance and enthusiasm (Duncan, 2005). We have confidence in the potential impact of such technology because it has been used successfully in other disciplines such as physics (Mazur, 1996).

A Team-based, Active Learning Approach that Enhances Students' Cognition and Communication in Introductory Statistics

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A major obstacle for students in an introductory statistics course is the transition from descriptive to inferential statistics. Exercises deal less with "number crunching" and more emphasis is put on analysis of context-related situations through abstract deductive reasoning. The first hurdle for students in the inferential statistics curriculum is properly identifying normal sampling distributions as described in a paragraph setting. To this end, a cooperative learning activity was developed which incorporates interdependent teamwork among students and guidance via a flow chart. Through participation in this learning activity, students will be encouraged to think about which normal distribution a paragraph is representing. They will then be asked to communicate this information back verbally and with appropriate written notation, pictures, etc. The purpose of this is to increase the level of statistics students' problem-solving skills regarding sampling distributions, as well as enhance their identification of the basic types of normal distributions.

Do You Speak Statistics? Lessons from Language Acquisition Practice

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It can be argued that an important goal in statistics education is statistical literacy. When we consider the "chain of statistical information" (Rumsey, 2002), almost everyone (if not all) of us is touched by statistics in some form and therefore we need to have an understanding of the language of statistics, statistical reasoning and thinking. Efforts in statistics education reform have focused on statistical thinking and conceptual understanding rather than mere knowledge of procedure. Researchers (e.g. Gal, 2003) note the importance of statistical literacy but acknowledge the lack of specific research on how it can be taught. To reiterate the importance of this concept the journal *The American Statistician* (2003) carried a special section on statistics literacy. The GAISE report (2005) includes statistics goals for students based on what it means to be statistically literate. Indeed statistics researchers (Haack, 1979; 1980) have discussed the importance of statistics communication. Quite often my students tell me that learning statistics is like learning a foreign language. This has made me wonder if the strategies used to acquire a language can be used to learn statistics. The question to

consider is: in what ways is the learning of statistics similar to acquiring a new language and in what ways is it different? With this knowledge we can determine which language acquisition strategies would be most readily applicable to the learning of statistics. Both areas share the common goal of moving students beyond merely knowing the vocabulary of the “language” to the next level of functioning effectively in the “language.” There are various concepts in language acquisition that describe this movement to the next level. We can consider how, if at all, these concepts can be applied to statistics education.

Using Simple Linear Regression to Assess the Success of the Montreal Protocol in Reducing Atmosphere Concentrations of Chlorofluorocarbons

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I have used this exercise in my introductory statistics course and also in second courses in applied statistics or applied regression. First, an explanation is given on the depletion of the ozone layer due to chlorofluorocarbons (CFCs), which became a global concern in the 1980's. A brief history of the global effort and subsequent international agreement called the Montreal Protocol signed in 1987 is given. Atmosphere concentrations of CFCs data recorded at Mauna Loa in Hawaii from January 1977 to March 2005 is downloaded from <http://gaw.kishou.go.jp/wdcgg.html>, the World Data Center for Greenhouse Gases. The students are asked to plot and analyze the data in order to answer the question “What has been the effect of the international agreement to reduce CFCs on the atmosphere concentrations of CFCs as recorded by the monitoring station at Mauna Loa?” A plot of the data (uploaded as a .bmp file) shows a linear increase in CFC concentrations prior to 1990, about the time that the Montreal Protocol was implemented. There is a slowing and reverse of the increase until about 1995 when there continues a linear decrease in CFC concentrations until the end of the time series. One obvious strategy is to fit two regression lines, one to data prior to 1990 and the other to data subsequent to 1995. The first regression can be used to predict CFC concentrations as if no intervention had been enacted. The second regression can be used to predict CFC concentrations under the current trend. The difference in these two predictions can be thought of as the effect of the Montreal Protocol. There are many opportunities for additional questions and discussion during the solution of this problem. A few of these are: How does one transform data recorded as year, month, and day into a scale of time measurement that can be used to plot the data? What feature of the data besides the trends seems to have changed between before and after 1994 (the level of variability decreases markedly), and what possible explanations could account for the change? What part of the regression model was used to model this aspect of the data? How does this example parallel the global warming problem and the Kyoto Protocol (this provides segue into another regression problem using atmosphere CO2 concentration data)?

More SATS from BSU

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SATS survey was completed by students in two introductory college statistics courses - an algebra based course and a calculus based course. What are the similarities and differences in the attitudes of students before and after a first course in statistics? Instructors also completed a survey concerning their approach to a 1st course in statistics. Are there any similarities or differences in the students' attitudes and characteristics of the instructor? This is an update to data presented at ICOTS7.

The Bubble Gum Mock Clinical Trial: An Interdepartmental Exercise in Trial Design and Statistical Analysis

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The Biomedical Writing Program and the Math/Statistics Department at the University of the Sciences in Philadelphia are collaborating in designing and implementing a mock clinical trial. The mock "drug" is actually bubble gum. The bubble gum trial started as an exercise in clinical trial design as part of a biomedical writing class on protocol development. Statistics faculty and students joined in designing the trial, and preparing the statistical analysis plan for the protocol. This has been a very effective learning tool for undergraduate and graduate students, since they had the opportunity to learn firsthand about the work of statisticians, physicians, biomedical writers, and biomedical investigators in designing and conducting a clinical trial. Also, the interaction between disciplines produced an enormous synergy, and it has left students with an appreciation of the difficulties that the different professionals face in attempting to investigate new medical treatments. The plan is to have other classes and departments join in this project and to actually run the trial. Students in the SAS programming class will work on preparing the trial database and performing the data analysis once the trial has concluded and data are available. The students in the statistics introductory courses among others will serve as patients or investigators in the mock trial to give them experience in the practical side of statistics.

The Magic of Statistics...Revealed

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Entertainment livens the classroom and brings the potential of new insight into statistical problems and properties. "Out of this world" was created in 1942 and was rated as one of the top ten magic tricks by magicians around the world. (It's also cited as the trick that fooled Winston Churchill.) While it is the only magic trick I know, students express their intrigue and excitement about it throughout the semester and on end of semester course evaluations. Beyond capturing students' attention with activities other than lecturing, this trick brings excitement to discussing the statistical concepts which I have linked to it. These include (especially with a modification of the trick that I have included) probability, independence, the binomial distribution, and hypothesis testing. The trick can be used when introducing these concepts or when reviewing these concepts for second classes on statistics. The trick will be demonstrated, the link to statistical concepts made, and, a la Penn and Teller, the secrets of the trick will be revealed!

A Statistics "Pyramid of Success"

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As much as (or more than) course sequences in other disciplines, statistics courses are characterized by their cumulativeness. Concepts learned in early classes are built upon in later classes or, stated conversely, concepts learned in later classes derive from those learned in earlier classes. A graduate-level course that I teach, Structural Equation Modeling (SEM; also known as Covariance Structure Modeling), draws from the earlier topics of path analysis, multiple regression, and exploratory factor analysis, all of which in turn are elaborations upon the Pearson correlation. In teaching a relatively complex course such as SEM, I feel it is helpful to students to begin by tracing the lineage from the more rudimentary techniques up through the more complex ones. Such a framework may also aid students in integrating different statistical techniques in their minds. To these ends, I have created the

"SEM Pyramid of Success," something that could be modified for courses on other advanced statistical topics. My statistics Pyramid is modeled very loosely on legendary UCLA basketball coach John Wooden's "Pyramid of Success," the components of which include not only attributes necessary for success on the court (e.g., "Competitive Greatness") but also off of it (e.g., "Industriousness"). The John Wooden Pyramid is shown at <http://www.coachwooden.com>, whereas mine is shown at <http://reifman-sem.blogspot.com> (see archives for my January 10, 2007 entry). The specific ways in which I use the SEM Pyramid to show linkages among the statistical techniques running up and down it include the following: --Tracing rules from path analysis (e.g., identifying direct and indirect routes between two focal variables, as well as common-cause paths) are demonstrated, showing that by multiplying relevant regression coefficients and adding various products together, the known Pearson correlation between two variables can be re-derived from the path model (also known as an implied correlation). --Results of correlational and factor analyses can be used to illustrate how pairs of variables exhibiting relatively large bivariate correlations will tend to load strongly on the same factor in a factor analysis.

MERLOT Personal Collections: Creating Useful Resources for Teaching Statistics

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(with Scott McDaniel, Lisa Green, and Megan Hall)

CAUSE and MERLOT provide easy access to the best learning resources for teaching statistics through an online digital library (www.causeweb.org/, www.merlot.org). These resources, many peer-reviewed, include lecture materials, activities and simulations, and assessment ideas that can be easily integrated into lesson plans. However, items are catalogued individually, and finding the right combination of materials for a particular lesson can be time-consuming. MERLOT Personal Collections offer a great solution by providing organized lists of learning resources with implementation strategies. This poster outlines best practices for creating personal collections and gives examples so teachers can share effective teaching materials and strategies with colleagues.

Digital Storytelling for Small Group Projects

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This session considers adding a digital story or short film to help unpack the results of a standard statistics project. Not only do these images convey statistical information, they also tap into an emotional connection to the subject being studied. These short movies can be created in Photostory in the PC environment or in iMovie in the Mac environment. We will discuss the learning curve associated with popular movie making software, the key elements of a digital story in statistics, and the triumphs and pitfalls that came with this assignment. Student samples will be shown and discussed.

Quartile Uniform Plot: Adding a Dimension to the Boxplot

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A graphic device I call the Quartile Uniform Plot (QUPlot) which I use in my introductory stat courses is described and illustrated. The QUPlot is essentially an enhanced boxplot, constructed by drawing a "box" whose height is $\frac{1}{4}$ the reciprocal of the quartile length over each quartile range. A true "density" function graph results, the function being what one might consider the most basic possible

corresponding to the given 5-number summary. In my experience, introductory students, many of whom have very weak math skills, seem to be able to easily see the “middle” (median) and the “spread” (range or IQR) from the ordinary boxplot, but they often have trouble when asked to imagine what the “shape of freq. dist’n” might look like. This graph seems to help them significantly with this. The graph is fairly easy to construct “by hand,” but I have a crude Minitab program which I wrote which my students use, and which I could bring along for demonstration purposes and for attendees to “play with.”

Teaching Statistics Using an Online Tool D2L (Desire2Learn) Challenges and Advantages

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Internet has introduced a wide variety of teaching resources and the access to on-line teaching materials (presentations, research papers, classroom examples, suggested projects for students, ...) and also communication tools such as (e-mail, discussion board, chat, blog,...). The efficient use of these facilities would introduce many advantages such as time flexibility and increasing student interaction in the learning process. I will present my experience of teaching elementary statistics and the use of statistical packages using the D2L online tool. I will discuss the challenges and advantages I faced during my teaching of elementary statistics courses using D2L online tool in the Minnesota State University, Mankato and also in the McMaster University Canada. I will discuss my experience with the use of D2L features such as discussion board, online quizzes, grading and other teaching tools.

Using Peer Assessment of Group Presentations to Improve Statistical Listening Skills

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We have produced and piloted a preliminary set of multiple choice questions for use with classroom response systems in introductory statistics courses. We have generated some items from scratch and adapted others from existing sets (e.g., ARTIST). Our items range from computational questions to questions that emphasize conceptual understanding. Topics covered by our project include: descriptive statistics, probability, probability distributions, sampling, confidence intervals, hypothesis testing, and measurement. We have piloted items in algebra-based statistics (housed in Psychology) and calculus-based statistics (housed in Mathematics, and Meteorology).

Assessing the Knowledge of Future Middle School Teachers in Statistics by Lesson Design

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The assessment of future teachers of statistics at the middle school level is gaining importance as new textbooks and courses are being developed to target this specific population. The assessment of future teachers is different than the assessment of other undergraduates taking statistics. As the statistical content is linked to the job of teaching statistics, so are the assessment activities. In this paper, I illustrate an assessment project conducted in a class for future middle school teachers in statistics. The project consisted of designing and presenting a lesson that addressed a statistical concept taught in middle school following the Japanese Lesson Study model. Future teachers were asked to identify the big ideas covered, its connections to previous and future content by aligning the lesson to state, national standards, and the GAISE recommendations, make predictions about students misunderstandings based on readings about statistics education research, propose activities

or procedures on how to teach the concept, and create an evaluation plan. Future teachers wrote and presented the lesson in pairs to their peers and the professor. After each presentation a reflection, in the form of a discussion, followed. Future teachers refined their lessons based on the comments of others and prepared a final lesson design. At the end of the semester, the future teachers voted for the “best” lesson and implemented the lesson at a local middle school (5th graders). Rubrics were developed to assess both lesson design and presentations.

Getting Your Students to Click with Statistics

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This poster explores the process of implementing clickers (a student response system) in a statistical classroom setting for a large introductory statistics course. We will provide examples of presentation content complete with a live demonstration! We will also explore choosing a clicker system, sources of support for getting started, and how we introduced clickers into a laboratory setting (25-30 students per lab) for a course with over 1200 students. In this course, clickers were used as a novel exam review that included both worksheet-based questions and fast fact-based questions (handouts of a sample review will be available). Finally, we will discuss other potential clicker uses that may be implemented in the future, including use of a university-adopted clicker system in both lecture and laboratory settings.

Mathematics and Social Justice

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Can mathematics and statistics be used to explore issues of social, political and economic justice? Can they potentially change the world, and make it a more fair and just place? I'd like to outline a new course I'm teaching this semester: Mathematics and Social Justice. The idea of the course is to use the power of mathematics as an essential analytic tool in understanding justice issues in our community and in the world. Mathematical topics include voting theory, power indexes, game theory, fair division, probability and statistics. Issues we explore will include income distribution and poverty, political representation, job discrimination, racial profiling, and more. We also participate in a service-learning project in our community.

Interactive Knowledge Resources: Concept Maps, Tiddlywiki's and Hypergraphs

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(with Sean Fox, Ellen Iverson, and Bill Bruihler)

Today's students are often learning mind mapping in middle or secondary schools using tools like Inspiration. They also spend many hours using micro-content web sites like myspace and facebook to express themselves and communicate with friends. Concept (or mind) maps provide an excellent tool for exploring ideas and organizing knowledge but lack depth. Wiki's and particularly javascript based TiddlyWiki's provide easily editable media for presenting more in depth knowledge with micro-content on the web or locally through standard browsers. These micro-content Wiki's can be used and edited locally on personal computers, or stored on the web. Extensions of TiddlyWiki's are being developed at a rapid pace. Some the author is currently using include jsMath for LaTeX based mathematics notation and Hypergraph navigation showing a graphical map to the Wiki content and beyond. When combined, these tools can provide both an aide to organize the instructors thoughts and as student

resources. As resources, students can also adopt the instructor's knowledge model and link it to their own knowledge to help them incorporate course content into their own experience. References:

Cmap Tools: <http://cmap.ihmc.us>,

TiddlyWiki: <http://www.tiddlywiki.com>,

Hypergraphs: <http://project.dahukanna.net/tiddlywiki/twextensions.htm>

Incorporating Online Real-Life Activities in Large Lecture Classes for Introductory Statistics

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In this talk we will present tips and some lessons learned on implementing active learning to teach large statistics classes for science majors at Michigan State University. The class was taught using online real-life activities at Michigan University. The class size was over 120. Conducting real-life online activities in a large class setting faces variety of different problems from small class size. Some strategies used to incorporate online real life activities and group projects will be shared including tips for group formations, group projects and classroom assessment of student learning. Some of the difficulties encountered and our approach for dealing with the problems will be addressed. We will also address issues related to attitudes and motivation to do real-life online activities and offer some suggestions for conducting real-life activities in large lecture class settings.