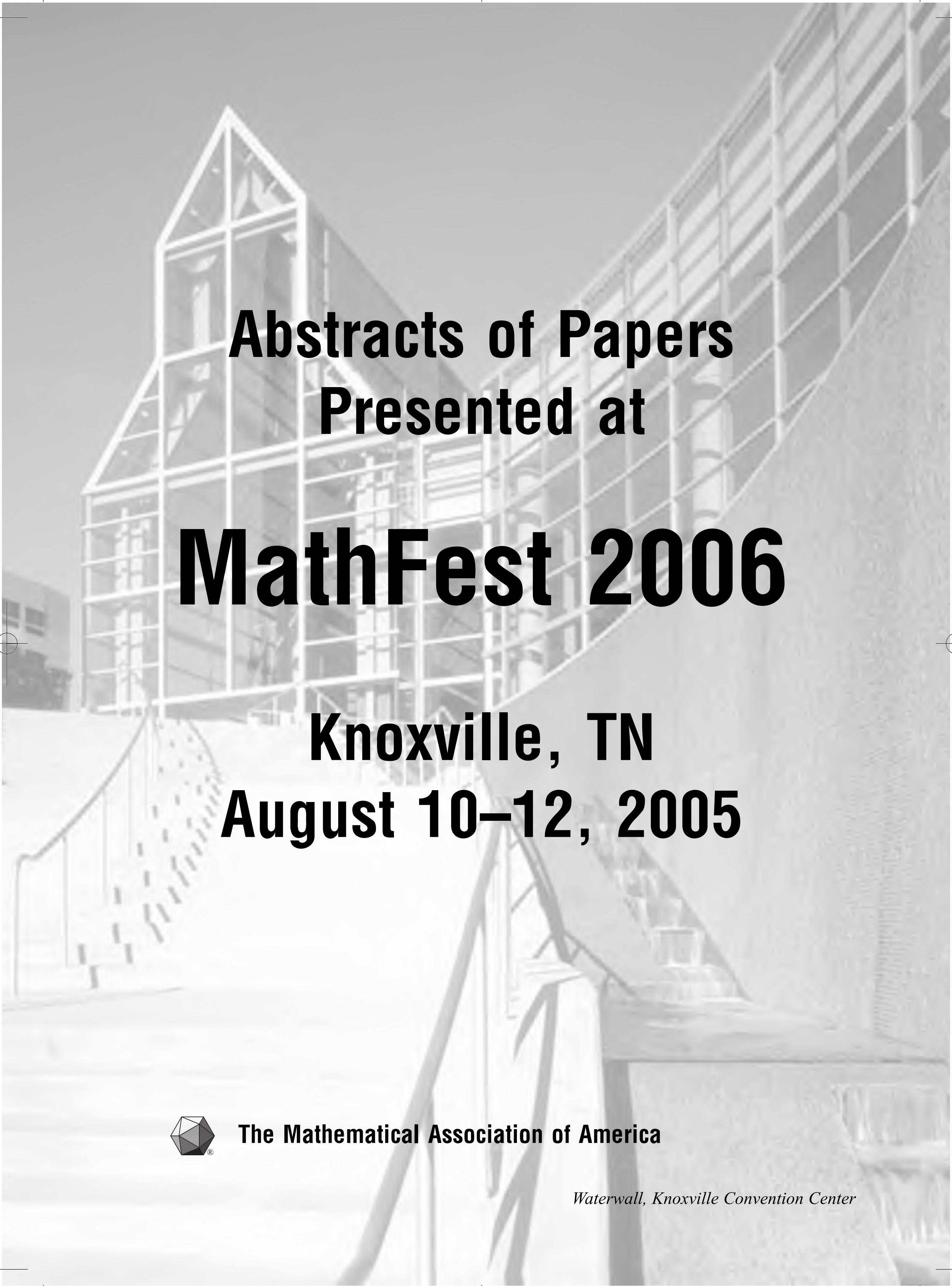

Abstracts of Papers Presented at

MathFest 2006

Knoxville, TN
August 10–12, 2005

The Mathematical Association of America

Waterwall, Knoxville Convention Center

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Published and Distributed by
The Mathematical Association of America

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Invited Addresses

AWM-MAA Etta Z. Falconer Lecture

Saturday, August 12, 8:30 AM–9:20 AM

Trachette Jackson University of Michigan

Cancer Modeling: From the Classical to the Contemporary

Cancer is one of the leading causes of death in the world today, and an abundance of research is being conducted in order to better understand tumor development, to evolve existing cancer therapies, and to discover new approaches to combat the disease at the cellular and molecular levels. Mathematical modeling, aided by computational tools and combined with the experimental data, have the potential to facilitate a deeper and broader understanding of the cellular and molecular interactions associated with tumor initiation, progression, and treatment, and can guide experimental design and interpretation. Many of the challenges cancer researchers are facing lie at the intersection of the mathematical and biomedical sciences and in this talk I will review the progress that has been made in modeling the various aspects of avascular and vascular tumor growth.

Earle Raymond Hedrick Lecture Series

W.T. Gowers University of Cambridge

What is Arithmetic Combinatorics?

Some mathematical problems and results belong to areas of mathematics with well-established names such as functional analysis or algebraic geometry. Others are harder to categorize. In recent years increasing numbers of mathematicians have found themselves using techniques from number theory, analysis, and combinatorics, which leaves them unable to answer what for most mathematicians is a simple question: "What area of mathematics do you work in?" However, this social disadvantage may soon be a thing of the past because some fascinating common themes are emerging, enough for the area to deserve its own name. And there is even a name that people seem to be happy with: arithmetic combinatorics. In these talks, I shall introduce some of the main results and open problems of arithmetic combinatorics, give some ideas of how they are proved, and explain some of the surprising connections between them.

Lecture 1. The Background: Some Theorems and Open Problems in Number Theory, Analysis, and Combinatorics
Thursday, August 10, 9:30 AM–10:20 AM

This lecture will set the scene for additive combinatorics by discussing several famous theorems and problems that predate it. Amongst them are van der Waerden's theorem on arithmetic progressions, Goldbach's conjecture, the Kakeya problem, some deceptively simple problems of Paul Erdos and a recent breakthrough of Ben Green and Terrance Tao. They have in common that they are easy to state, but hard to solve. Deeper similarities between them will be explored in subsequent lectures.

Lecture 2. Discrete Fourier Analysis: Its Power and Limitations
Friday, August 11, 9:30 AM–10:20 AM

Fourier analysis is concerned with the splitting up of a signal, such as a sound wave, into simple parts, such as pure sine waves. Its first cousin, discrete Fourier analysis, is an extremely useful tool for thinking about a certain kind of problem in number theory. I shall explain why this might be and then give examples of how Fourier analysis can be used to solve, or at least begin to attack, some of the problems mentioned in the first lecture. Oddly enough, the *failure* of Fourier analysis to solve some of those problems is almost more interesting than its successes, because it raises the possibility that arithmetic combinatorics can repay some of the debt it owes to analysis. The difficulties one encounters when one tries to improve the best known results about arithmetic progressions are genuine ones, and it looks likely that, in order for them to be overcome, it will be necessary to develop a new, more powerful version of Fourier analysis, which would almost certainly have applications beyond arithmetic combinatorics.

Lecture 3. Freiman's Theorem and Arithmetic Progressions of Length 4
Saturday, August 12, 9:30 AM–10:20 AM

Some of the most interesting problems in arithmetic combinatorics concern arithmetic progressions, that is sequences like 5, 11, 17, 23, 29, where each number is obtained from the previous one by adding some fixed amount (in this case 6). Fourier analysis is very useful for analyzing progressions of length 3, but runs into difficulties for longer progressions. However, ways have been found for getting around some of these difficulties, and these are leading to a new and more powerful theory of "quadratic" Fourier analysis. I shall explain in very broad terms what this means and why it is still by no means fully understood. A central role in this development is played by a fascinating result known as Freiman's theorem. Once again, the theorem is much easier to state than it is to prove, but it is possible to describe some of the ideas from a beautiful proof due to Imre Ruzsa. There are some questions that Ruzsa's techniques are not strong enough to answer, and a central problem in arithmetic combinatorics is to strengthen them. This could have profound consequences: the solution of several problems, the development of a new form of "linear" Fourier analysis, and a significant increase in the cohesion and maturity of arithmetic combinatorics.

James R. Leitzel Lecture

Friday, August 11, 10:30 AM–11:20 AM

Francis Edward Su Harvey Mudd College

Teaching Research: Encouraging Discoveries

What does it take to turn a learner into a discoverer? Or to turn a teacher into a coadventurer? I will describe a handful of experiences, from teaching a middle-school math class to doing research with undergraduates, that have changed the way that I would answer these questions. Some of the lessons I've learned have surprised me.

MAA Invited Address

Thursday, August 10, 8:30 AM–9:20 AM

Dorothy Buck Imperial College London

The Circle (and Knot and Link) of Life: How Topology Untangles Knotty DNA Questions

DNA is often referred to as 'the staff of life', as it is the blueprint for all hereditary traits and diseases, as well as the template for all proteins. But the structure of DNA structure is often more complicated than a straight 'staff'. DNA molecules can have a circular (e.g., bacterial), or topologically constrained (e.g., human), central axis. The axis can even be knotted or linked! We'll discuss how the topology of this axis affects important biological processes—both local (e.g., which proteins attach to DNA) and global (e.g., how a cell divides). We'll conclude with some examples of how topology (knot theory) has helped our understanding of these processes.

MAA Invited Address

Thursday, August 10, 10:30 AM–11:20 AM

Jesus A. De Loera University of California Davis

Some Open Questions About Complex Polyhedra

Convex polyhedra are familiar objects since our childhood. Indeed, cubes, pyramids, and triangles are common staples in all kindergartens! Unknown to most people polyhedra, in their high-dimensional version, are also widely used in applied mathematics (e.g., operations research, finances, computer networks, and more). Their beauty and simplicity appeal to all, but very few people know of the many easy-to-state difficult unsolved mathematical problems that hide behind their beauty. The purpose of this lecture is to introduce an audience without prior background to some of these open questions.

MAA Invited Address

Saturday, August 12, 10:30 AM–11:20 AM

David Bressoud Macalester College

Stories from the History of Mathematics

This is a collection of some of my favorite stories from the history of mathematics, stories that I use in my classes to illustrate what it really means to "do" mathematics.

MAA Student Lecture

Thursday, August 10, 1:00 PM–1:50 PM

Richard Tapia Rice University

Math at Top Speed: Exploring and Breaking Myths in Drag Racing Folklore

Either as participant, support individual, or involved spectator, Richard Tapia has been involved throughout his life in drag racing, and has witnessed the birth and growth of many myths concerning dragster speed and acceleration. In this talk, he will use mathematics to identify frameworks for the study of a particular popular belief and then apply mathematics to better understand the belief at hand. Some myths will be explained and validated, while others will be destroyed. Included will be attempts to determine how fast dragsters are really going as well as the maximum acceleration achieved by today's dragsters. He will explain why dragster acceleration is greater than the acceleration due to gravity, an age-old inconsistency. The talk will also include a historical account of the development of the sport of drag racing and lively videos.

He will also share relevant formative experiences encountered along his life's journey as a publicly educated first-generation Mexican American from the barrios of Los Angeles to a Rice University Mathematics Professor and President Clinton Appointee to the National Science Board. As the director of the mathematical and engineering sciences program at Rice, a program recognized for its production of minority PhDs, he will describe the challenges, successes, and lessons learned along the way.

NAM David Blackwell Lecture

Friday, August 11, 8:30 AM–9:20 AM

Dominic P. Clemence North Carolina A&T State University

Public Health and Mathematics: Some Emerging Challenges and Paradigms at the Interface

Public health issues concern us all: just a few include emerging and re-emerging diseases, the shrinking global neighborhood, health disparities, deliberately released infectious agents, and natural disasters. While in the past mathematics has played a significant role in addressing some public health concerns, one cannot but wonder, 'can more be done?' and in particular, 'in what ways can mathematicians contribute more?' when one looks at the status of public health world-wide. We share a mathematician's perspective on a few of these issues, and highlight some paradigms and challenges emerging at the public health-mathematics interface.

PME J. Sutherland Frame Lecture

Friday, August 11, 8:00 PM–8:50 PM

Donald Saari UC Irvine

Ellipses and Circles? To Understand Voting Problems??!

Why is it that whenever we put forth a carefully considered proposal, somebody can put forth an "improvement?" Sure. Yet, attend any meeting, even the MAA business meetings, and it happens on a regular basis. Why? Insight is possible by using just the geometry of circles. And then, to introduce a new game theoretic solution concept, I will use the geometry of ellipses.

Alder Awards Session

Friday, August 11, 3:00 PM -- 4:30 PM

Christopher Swanson Ashland University

Active Learning in the Non-Calculus Classroom: My Favorite Activities

When I completed my PhD at the University of Michigan in 1999, I had experience in teaching precalculus and calculus and had received training on how to use active learning in these courses. During my first two years at Ashland University, I taught eight different courses (none of which were precalculus or calculus), and struggled with how to create an effective active learning environment for these courses as well. Having just finished my 7th year of teaching at Ashland University, I have taught most of these courses multiple times and have developed/found numerous activities that my students and I enjoy. In this talk, I will present my favorite activities from some of these non-calculus courses.

Garikai Campbell Swarthmore College

Using Technology to Help Teach Mathematics

Recently, I've been experimenting with creating online resources and I will preview some of these resources in an effort to solicit some feedback. In the process, I will talk about my own struggle to find good ways to use technology to help ensure that we keep as many students as possible in the pipeline.

Invited Paper Sessions

Inquiry-Based Learning—The Next Generation

Thursday, August 10, 1:00 PM–3:00 PM

Edward Burger (eburger@williams.edu) Williams College

A Crash Course on How Not to Teach

Introducing students to mathematical thinking is a central part of their education—whether they are to be teachers, mathematicians, or scientists. Here we offer a discovery approach to such courses that has a new twist: Students have to conjecture which statements are true and which are false! Thus students are given the opportunity to experience mathematics as true research mathematicians.

Michael Starbird (starbird@mail.utexas.edu) Department of Mathematics, 1 University Station, C1200, Austin, TX, 78712

Developing Independent Thinkers

One goal of education is to make our students able to think for themselves. We hope to move them from being consumers of knowledge to producers of knowledge and insight. We can accomplish this transformation systematically by using methods of instruction designed for that purpose. Up-lifting, pain-free Inquiry Based Learning methods can be exceptionally successful at getting students to discover mathematical ideas, to learn to think for themselves, and to raise their standards for understanding.

Maria Terrell (mst1@cornell.edu) Cornell University, Department of Mathematics, Ithaca, NY, 14853

Good Questions for Mathematics Eduction

Mathematics *eduction*? Aren't we missing an 'a' in the middle of that word? We offer examples of how good questions can educe, or draw out the latent mathematics that students already know. We look at what characterizes a good question, and share some of what we have learned about teaching by asking.

Dick Canary (canary@umich.edu) University of Michigan, Department of Mathematics, Ann Arbor, MI, 48109

Inquiry Based Learning at the University of Michigan

The Department of Mathematics at the University of Michigan has recently begun the development of an Inquiry-Based Learning Center. We will discuss our progress to date and our plans for the future.

Isoperimetric Problems

Thursday, August 10, 2:15 PM–5:15 PM

Frank Morgan (Frank.Morgan@williams.edu) Williams College, Department of Mathematics and Statistics, Williamstown, MA, 01267

Isoperimetric Problems

Session abstract: Members and alums of the Williams College NSF SMALL Undergraduate Research Geometry Group and perhaps others will report on work on isoperimetric problems and open questions in various settings, including Riemannian manifolds and manifolds with density, such as Gauss space. Fifteen-minute talks with five-minute breaks.

Computational Convexity and Its Applications

Thursday, August 10, 1:00 PM–4:40 PM

Tyrrell McAllister (tmcal@math.ucdavis.edu) University of California Davis

Convex Polyhedra and Representation Theory

Techniques from polyhedral geometry have long provided insights into the representation theory of Lie algebras. Recent results include the encoding of tensor product multiplicities as the number of integer lattice points in special families of polyhedra. These results have theoretical implications as well as concrete computational applications. We discuss some of these results and conjectural consequences these ideas may have for theoretical computer science.

Matthias Beck (beck@math.sfsu.edu) San Francisco State University, Department of Mathematics, 1600 Holloway Ave, San Francisco, CA, 94312

Integer-Point Enumeration and Number Theory

We will outline Ehrhart's fundamental theory of counting integer points in rational polytopes, with a view towards number theory. Applications include:

- functional identities on generalized Dedekind sums, which form the building blocks of Ehrhart counting functions;
- classic enumeration problems, such as the Frobenius coin-exchange problem and counting magic squares;
- the study of a special class of polynomials (the Ehrhart counting functions for polytopes with integral vertices).

J. Maurice Rojas (rojas@math.tamu.edu) Texas A&M University, Department of Mathematics, 3368 TAMU, College Station, TX, 77843

Convexity, and Phase Transitions for Detecting Real Roots

Much like how water changes phase from liquid to gas at different temperatures (depending on air pressure), computational problems also exhibit phase transitions. For instance, certain problems that are usually doable in polynomial-time become NP-hard (or vice-versa) upon tweaking certain parameters.

I will illustrate this phenomenon for the problem of deciding whether a system of polynomial equations has a real solution. Also, known as Real Feasibility, this problem is fundamental in many branches of optimization and engineering, not to mention computational algebraic geometry. Along the way, we'll see some how certain piece-wise linear manifolds (Viro diagrams) enter the picture. No background in complexity theory or algebraic geometry is assumed.

James Lawrence (lawrence@gmu.edu) George Mason University, 4400 University Drive, MS: 3F2, Science & Tech. I, room 203, Fairfax, VA, 22030

Combinatorial Problems and Computational Convexity

Combinatorics has contributed to the forward movement of computational convexity, both by providing frameworks, for example in the form of data structures, for algorithms, and by providing a rich supply of interesting problems, the search for solutions to which has motivated the study of methods of computational convexity. We discuss some of the current interplay of this sort.

Paul Goodey (pgoodey@math.ou.edu) University of Oklahoma, Department of Mathematics, One Shields Avenue, Norman, OK, 73019-0315

Projections and Sections of Convex Bodies

We will survey some results regarding information about high dimensional sets that can be derived from knowledge of its projections and sections. This will include information regarding shape and size. It is surprising to see that data involving only the size of sections or projections can sometimes be used to obtain the shape of the original body. We will also encounter unexpected relationships between sections and projections. The techniques used are a mixture of geometry and harmonic analysis.

Gems of Recreational Mathematics

Friday, August 11, 1:00 PM–3:00 PM

Dan Velleman (djvelleman@amherst.edu) Amherst College, Department of Mathematics and Computer Science, Amherst, MA, 01002

Fast-Growing Sequences

I will present some surprising results comparing the growth rates of some fast-growing sequences.

Joe Gallian (jgallian@d.umn.edu) University of Minnesota Duluth, Department of Mathematics and Statistics, Duluth, MN, 55812

Weird Dice

Suppose that instead of using a pair of dice with the usual labels 1 through 6 we use the labels $1, 2, 2, 3, 3, 4$ on one die and the labels $1, 3, 4, 5, 6, 8$ on the other dice. Remarkably, the probabilities for the various sums of 2 through 12 are the same for the dice with the new labels as they are for dice with the usual labels (for example, the probability of rolling a sum of 7 is $1/6$ with either pair dice). In this talk we consider the analogous situation when we permit more than two dice and we permit dice of shapes other than cubes such as octahedrons or dodecahedrons.

Laura Taalman (taal@math.jmu.edu) James Madison University, Department of Mathematics, Harrisonburg, VA, 22807

Sudoku Variations and Research

Sudoku puzzles and their variants are linked to Latin squares, the rook problem, graph colorings, permutation group theory, magic squares, and polyominos. In this talk we will explore variations of Sudoku and the many open problems and new results in this new field of recreational mathematics.

Richard Guy (rkg@math.ucalgary.ca) University of Calgary, Department of Mathematics and Statistics, Calgary, AB, T2N 1N4

Three Gems We All Know (Don't We?)

All of mathematics is recreational, and there are uncountably many gems, so where do I turn? Here are three, which you all know, but may still wish to admire even further: the Sprague-Grundy theory of impartial games, O'Beirne's solution of The Great Tantalizer, and Rick Wilson's theorem on sliding puzzles.

Chaotic Dynamics and Fractal Geometry

Friday, August 11, 1:00 PM–4:30 PM

Annalisa Crannell (annalisa.crannell@fandm.edu) Franklin & Marshall College, Department of Mathematics, Lancaster, PA, 17604
Lindsay Hilbert (lbhilber@unity.ncsu.edu) North Carolina State University, Department of Mathematics, Raleigh, NC, 27695
Stephen May (sfmay@unity.ncsu.edu) North Carolina State University, Department of Mathematics, Raleigh, NC, 27695

The Fibonacci Harp and Subshifts of Finite Type

A fractal harp (or fractal string) is a one dimensional version of a fractal drum: a bounded region in R or R^2 whose boundary is a fractal. In Fractal Geometry and Number Theory, Lapidus and van Frankenhuysen introduce the Fibonacci Harp, whose strings have lengths $1, 1/2, 1/4, 1/8 \ldots$ with multiplicity respectively $1, 1, 2, 3, \ldots$. The authors note that "[this harp] does not seem to have been considered previously in the literature." We make explicit the connection between the Fibonacci Harp and two well-known dynamical systems: subshifts of finite type and the baker's map on the unit interval. In particular, we show that the boundary of the Fibonacci Harp is an embedding of a commonly-studied shift of finite type in the unit interval. Moreover, we show that, if a shift of finite type embeds as the boundary of a harp, that harp is a lattice harp.

Diana Thomas (thomasdia@mail.montclair.edu) Montclair State University, Department of Mathematical Sciences, Upper Montclair, NJ, 07043

The Mathematics of Fat

In this talk I will develop an energy balance differential equation model based on the first law of thermodynamics. From the steady state analysis of this model we can observe the impacts of changes in weight due to alterations in diet and activity. If time allows, I will present an extension of the original energy balance equation to a mass balance system that describes the dynamics of long term starvation. From this model, we can determine the length of survival time under prolonged fasting.

Suzanne Lenhart (lenhart@math.utk.edu) University of Tennessee Knoxville, Mathematics Department, Knoxville, TN, 37996

Optimal Control Applied to a CPR Model

A discrete time model of a circulatory system will be presented. Optimal control theory will be used to improve the standard technique of cardiopulmonary resuscitation, in which the profile of the external chest pressure is taken as the control.

Marc Chamberland (chamberl@math.grinnell.edu) Grinnell College, Department of Mathematics and Computer Science, Grinnell, IA, 50112

The Mean-Median Map

Starting with a non-empty finite set $S_n = \{x_1, \ldots, x_n\} \subset R$, generate the unique number x_{n+1} which satisfies the *mean-median equation*

$$\frac{x_1 + \cdots + x_n + x_{n+1}}{n+1} = \text{mean}(S_n).$$

As usual, we define the median of the set $S_n = \{x_1, \ldots, x_n\}$, where $x_1 \leq \cdots \leq x_n$, as

$$\text{median}(S_n) = \begin{cases} x_{(n+1)/2}, & n \text{ odd}, \\ \frac{x_{n/2}+x_{n/2+1}}{2}, & n \text{ even}. \end{cases}$$

By applying the mean-median equation repeatedly to a set one generates an infinite sequence $\{x_k\}_{k=1}^{\infty}$.

The dynamics of this map are surprising! Most maps tend to have either relatively simple dynamics or chaotic dynamics. While the mean-median map seems to be asymptotically constant, it seems very hard to predict. This talk will showcase the work done to date. This is joint work with Mario Martelli.

Youngna Choi (choiy@mail.montclair.edu) Montclair State University, Department of Mathematical Sciences, Upper Montclair, NJ, 07043

Markov Partitions from Two-Piece Eventually Expanding Maps

This presentation is about the existence of Markov partitions for two-piece eventually expanding maps. A two-piece eventually expanding map is a function $f : [a,b] \to [a,b]$ such that there exists a discontinuity c and a $\lambda > 1$ such that $a < c = f(c) < b$ and $\left|\frac{d}{dx} f^n(x)\right| > \lambda > 1$ whenever the derivative exists. We show that such a map has an invariant set that consists of finitely many closed intervals and provide a condition that enables the invariant set to possess a Markov partition. With a Markov partition, we can investigate the chaotic nature of the dynamical system generated by the map by classifying the possible periods and calculate the topological entropy of the map.

Todd Mullen (ToddJ.Mullen@gmail.com) Ashland University, 212 Broad St., Ashland, OH, 44805

Chaos and Metrical Universality

What happens when you plug the output of a function back into the function, then do it again, and again, and again... We will be looking at function iteration and patterns that emerge unexpectedly amidst chaotic behavior. We will then investigate this behavior at large and find that this "*order in chaos*" seems to have a surprising correlation in what seems to be—**everything**.

Mario Martelli (mario.martelli@claremontmckenna.edu) Claremont McKenna College

Chaos: the viewpoints of Analysis, Measure Theory, and Topology

Chaotic behavior of dynamical systems can be considered from the point of view of analysis, where sensitivity with respect to initial conditions plays a determinant role. However, topology is more concerned with transitivity and density of orbits, while measure theory is interested in invariance, ergodicity, and mixing. We show that some dynamical systems are chaotic in all cases, but others are not. However, conjugacy and a Cantor-like behavior seem to be present in every case.

Physical Knots

Friday, August 11, 3:15 PM–5:15 PM

Kenneth Millett (millett@math.ucsb.edu) University of California, Santa Barbara, Department of Mathematics, Santa Barbara, CA, 93106

Macromolecular Knots in Equilibrium

Although the overall dimensions of random closed equilateral polygonal knots provide important information about modeled polymers, for example under theta-conditions or in melt phase, some properties appear correlated with more refined spatial characteristics. This talk will start with the basics of polygonal knots, Monte Carlo simulations in this context, describe some interesting spatial properties, discuss their corresponding equilibrium lengths, and explain their physical meaning.

Louis Kauffman (kauffman@uic.edu) University of Illinois at Chicago, Department of Mathematics, Statistics, and Computer Science, Chicago, IL, 60607

Hard Knots and Collapsing Tangles

In this talk (joint work with Sofia Lambropoulou) we investigate the structure of unknots that are obtained in the form $N(T+S)$ where T and S are rational tangles, + is the standard sum of tangles and N is the numerator closure of a tangle. We prove that if T has fraction p/q and S has fraction r/s, then $N(T+S)$ is unknotted if and only if $ps+qr$ has absolute value 1. We use this result to construct minimal examples of knots that require complexifying Reidemeister moves in order to be undone, and we use the result to demonstrate some interesting properties of DNA recombination.

Thomas Banchoff (tfb@cs.brown.edu) Department of Math, Brown University, Providence, RI, 02912
Peter Giblin (pjgiblin@liverpool.ac.uk) Department of Mathematical Sciences , The Mathematics and Oceanography Building , Liverpool ENGLAND, BC, L69 7ZL
Davide Cervone (dpvc@union.edu) Department of Mathematics, Union College, Schenectady, NY, 12308

Piecewise Circular Space Curves

Piecewise circular curves, constructed as sequences of circular arcs with the same tangent lines at nodes, mirror much of the global geometry of smooth space curves. We exhibit computer investigations of such curves and their associate space polygons, including self-linking and knotting for curves in three-space and in the three-sphere.

Eric Rawdon (ericrawdon@gmail.com) Dept of Maths , University of St. Thomas, St Paul, MN, 55105

Tight Knots and Links

What happens when you tighten a knotted rope? In particular, what exactly does a tight knot look like? This is a simple question, yet precise answers are difficult to come by. The rope tightening problem started as a mathematical curiosity but has spawned interesting applications in several fields (including molecular biology and particle physics). Progress has been an interdisciplinary effort combining significant theoretical analysis with massive computer simulations (as well as the ritual sacrifice of many innocent computers). In this talk, we will explore the rope tightening problem: where we are, how we got here, and where the future may take us.

Pointing the Way to Proof

Friday, August 11, 1:00 PM–3:00 PM

Michael Starbird (starbird@mail.utexas.edu) The University of Texas at Austin, Department of Mathematics, 1 University Station, C1200, Austin, TX, 78712

Inquiry Based Learning Method for Teaching Proofs

Students can learn to prove theorems on their own by proving theorems on their own. Number theory is a great course for introducing students to proving theorems independently. Every day they can prove theorems new to them on their own and present their work to the class. They can begin with very simple proofs and develop the strength to prove increasingly more challenging theorems. They learn to think independently, to evaluate the correctness of proofs on their own, and to present their work clearly.

J. Morrow (jmorrow@mtholyoke.edu) Mount Holyoke College, SummerMath, 50 College Street, South Hadley, MA, 01075

Why Proof

On a typical page in a mid to upper-level mathematics textbook you will see something of the form, “Theorem: ... Proof: ...” The reason and the reasoning for such a theorem/proof structure is clear to the writer and to the teacher, but neither the reason for having a proof nor the reasoning involved in the proof is clear to many students.

I will describe a course, Laboratory in Mathematical Experimentation, which addresses difficulties encountered by students when they first work with proofs. The course is based on the assumption that when a person discovers something that she believes is true, she will want to understand why it is true and also want to explain to other people both what that truth is and why it is so; the motivation to write such an explanation—to *prove* that your discovery is correct—is a missing and critical piece in learning to write proofs.

In Laboratory in Mathematical Experimentation, students investigate four to six topics by doing guided experiments for each topic. Each student then experiments to generate more data in order to discover patterns. She also forms conjectures based on those patterns, and she writes proofs, partial proofs, or at least descriptions of what she has found. The culmination of the investigation of each topic is a paper that is typically 8 to 10 pages long. I will give brief descriptions of two of the topics and ways in which students explore them.

I will also describe some of the side benefits of such a course. For example, as a result of taking the course, students are more likely to try doing *something* when they do not know how to get started on a problem, to be more persistent in trying to solve a problem, and to generate helpful data when trying to solve a problem.

T. Christine Stevens (stevensc@slu.edu) Saint Louis University, Department of Mathematics and Computer Science, St. Louis, MO, 63103

Potholes on the Path to Proof

Every undergraduate mathematics program faces the challenge of teaching students to read and understand abstract arguments and to devise proofs of their own. Sometimes this task is addressed in a stand-alone “bridge” course, and sometimes it is incorporated into a course in discrete mathematics, linear algebra, or another advanced topic. No matter what pathway to proof is chosen, there are many potholes that students encounter along the way, including difficulties in understanding the role of formal definitions, in interpreting mathematical notation, and in reading proofs critically. Faculty, meanwhile, must balance the claims of content “coverage” with the goal of developing students’ ability to articulate sound mathematical arguments. Drawing upon my experience with a variety of courses at a variety of institutions, I will identify some of the problems that arise in teaching a course that introduces students to proofs and describe some strategies that may help to overcome them.

Donald Albers (dalbers@maa.org) Mathematical Association of America, 1529 18th Street NW, Washington, DC, 20036

(Bullet) Proof Resources for Getting to Proof

The speaker will provide a summary of outstanding resources from the MAA especially, but not exclusively, that will help faculty assist students to find the way to proof. Resources will include materials from the worlds of print, video, and the web.

Stories from the History of Mathematics as a Tool for Teaching

Saturday, August 12, 1:00 PM–3:00 PM

John McCleary (mccleary@vassar.edu) Vassar College, Box 69, Poughkeepsie, NY, 12604

Euler's Difficult Geometric Problems

In a (1765) 1767 paper, Euler considered the positions of the important points in a triangle, such as the incenter, circumcenter, centroid, and others. His analysis of these points and the measures of associated lengths led to his discovery of the so-called Euler line. However, his purpose in this analysis was something else. The end of proving a geometric result like the Euler line in class would lead to a different choice of proof. How does Euler's paper itself speak to what we teach? The roles of notation, symmetry, and invariant expression will be discussed.

C. Edward Sandifer (sandifere@wcsu.edu) Western Connecticut State University, Department of Mathematics, 181 White Street, Danbury, CT, 06810

Theorem first or Example first: Newton vs Leibniz

When we are teaching, we usually decide whether to start with the theorem or to start with some examples based on pedagogical principles. We may behave differently when we do research, especially as we try to discover what might be worth trying to prove. In the 17th and 18th century, a controversy raged. Leibniz was a "rationalist." He cited Descartes, and urged that we start with what we know for certain and from that deduce what must be true. He proved his theorems first. Newton was an "empiricist," and thought we should learn what is true from observing the world. Late in the 18th century, Euler, and then Kant, did much to resolve the problem.

Jennifer Haghpanah (Jennifer.Haghpanah@Quinnipiac.edu) Quinnipiac University, 197 Sugar Street, , Newtown, CT, 06470

The Chinese Remainder Theorem and Its History

The first Chinese Remainder Problem was stated by Sun-Tsu in Suan-Ching. The problem has evolved over the past 1500 years into a modern theorem, and is useful in solving a system of congruencies. This presentation will outline the history of the Chinese Remainder Theorem and will give a fruitful solution to Sun-Tsu's problem.

Andy Martin (admartin@ms.uky.edu) University of Kentucky, 509 Bayberry Bend, Lexington, KY, 40517

Volterra's Predator/Prey Model

In the early 1920s Italian biologist Umberto D'Ancona was researching populations of species of fish that interact with each other in the Adriatic Sea. He noted from data that the relative percentage of food fish to predator fish dropped during World War I. As fishing was heavily curtailed during this time, he was surprised by the finding, and sought an explanation. He discussed the problem with Vito Volterra, his mathematician father-in-law. Volterra modeled the interaction by a system of two differential equations in two unknown functions. This talk will present Volterra's nonlinear system and his ingenious, though elementary, qualitative analysis of the system's solutions.

Andy Martin (admartin@ms.uky.edu) University of Kentucky, 509 Bayberry Bend, Lexington, KY, 40517

A Slow-Burning Fuse: The Incompleteness Theorems

Goedel's 1931 announcement of his Incompleteness Theorems was a watershed event in the history of mathematics. What was the reaction when this bomb was dropped?

Robert Tubbs (tubbs@euclid.colorado.edu) Dept of Mathematics, University of Colorado, Boulder, CO, 80309

The Birth of Modern Transcendental Number Theory

To move beyond establishing the transcendence of e and π to that of e^{π} and then of $2^{\sqrt{2}}$ mathematicians were forced to successively adopt slightly more sophisticated points of view. In this lecture we discuss how early developments in transcendental number theory illustrate for students that mathematical research can progress incrementally, even naturally, and still lead to rather spectacular results (in this case a solution to Hilbert's Seventh Problem).

Fred Rickey (fred-rickey@usma.edu) U.S. Military Academy at West Point, Department of Mathematical Sciences, West Point, NY, 10996

Some Tested Examples for Using History in Your Classroom

The clepsydra is an ancient device for measuring time. But what is the proper shape for the bowl of a water clock? This question was not answered until after the mechanical clock was in use, but it does provide an interesting example of the early use of the calculus. The problem was solved by Emde Marriotte in 1686 and by Vincenzo Viviani, in an unpublished manuscript, in 1684. The solution provides a lovely use of solids of revolution, inverse functions, the second fundamental theorem of the calculus, and the chain rule. This sounds terribly complicated but the solution relies on the ideas and not on computation. This is a wonderful example of modeling and shows that a problem can have multiple solutions.

This is but one example of how history can be used to motivate and explain mathematical ideas. We shall also deal with the cables on a suspension bridge, a neat picture for the geometric series, and Bolzano's ideas about the intermediate value theorem.

Graph Theory Ideas for Undergraduate Research

Saturday, August 12, 3:15 PM–5:15 PM

Anant Godbole (godbolea@tsu.edu) East Tennessee State University, Math Dept, Box 70663, Johnson City, TN, 37614

Intersecting and Related Set Systems

After reviewing what I consider to be the *desiderata* of good undergraduate research projects in graph theory and combinatorics (the AMS 05 classification!), I will focus on a few students' projects conducted by REU and non-REU undergraduates under my supervision. Each of these projects used classical combinatorics theorems such as the Erdős-Ko-Rado theorem on intersecting families of sets, or the Kneser conjecture, as a starting point. The investigations were then given a probabilistic flavor, or generalizations were sought, or both.

Ermelinda DeLaVina (delavinae@uhd.edu) University of Houston - Downtown, CMS Dept., One Main Street, Houston, TX, 77002

Using Graffiti.pc for Undergraduate Research

The focus of this presentation is the utilization of the conjecture-making program Graffiti.pc as a graph theoretical problem generator for undergraduate research. At the University of Houston - Downtown, about 5–10 students per year graduate with applied mathematics degrees. In the past six years, eight undergraduate students have participated in optional research projects utilizing Graffiti.pc, and have given a total of a dozen external poster/oral presentations. The conjecture-making part of the program accepts as input a database (generated by the database building part of the program) of graphs with computed invariants. For a student with little or no graph theory knowledge, the database is severely limited and grows along with the student's knowledge. Motivation for topic selection varies from querying the program about well studied invariants to less studied invariants. The project guidelines can be structured or not. In a structured approach, once a list of conjectures is made by the program, the student provides to the program a counter-example with the fewest possible number of vertices and edges, and the program is queried again with the new information. Examples of two projects and results will be discussed, one on the matching number of bipartite graphs and another on the maximum number of leaves of spanning trees of graphs.

Cindy Wyels (cindy.wyels@csuci.edu) California State University Channel Islands, Mathematics, One University Drive, Camarillo, CA, 93012

Graphs: Graceful, Equitable and Distance Labelings

A graph labeling is an assignment of integers to the vertices of the graph. This induces a labeling of the edges: a common scheme is to assign an edge the absolute difference of the labels of the vertices incident to the edge. This talk will briefly introduce various labeling schemes for graphs, primarily graceful, k-equitable, and distance labelings. Problems arising from these sorts of labelings constitute excellent undergraduate research projects. For instance, if the labels assigned to the vertices of a graph with p vertices and q edges are chosen from the set $\{0, 1, \dots, k-1\}$, the labeling is k-equitable if there are approximately p/k vertices of each label and approximately q/k edges of each label. Students contributed significantly to the proof that all trees are 3-equitable; progress towards solving the conjecture that all trees are k-equitable (for all k) and towards resolving other problems will be discussed.

Glenn Hurlbert (hurlbert@asu.edu) Arizona State University, Department of Mathematics and Statistics, Tempe, AZ, 85048-1804

Graph Pebbling

Graph pebbling is an area of research nearing its 20th year of existence. Probably more than any other area, undergraduates have had a significant impact on its development — over 40% of the 60+ papers include undergraduates! Recent years have seen significant progress and new ideas. In this talk I will focus on work I have done with a number of undergraduate students, including the outstanding work of Shawn Elledge, whose application of graph pebbling results to combinatorial group theory earned him a Best Student Paper award at the 2004 MathFest. I also plan to offer new problems and lines of research (that also can be found on my website: the graph pebbling page).

Contributed Paper Sessions

Current Issues in Mathematics Education

Thursday, August 10, 1:00 PM–3:00 PM
Friday, August 11, 1:00 PM–3:00 PM

Mary Ann Connors (mconnors@wsc.ma.edu) Department of Mathematics, Westfield State College, Westfield, MA, 01086

Technology in Mathematics Teacher Preparation

Requirements for prospective mathematics teachers include mathematical modeling, problem solving, effective use of technology, and communicating mathematics. This session will focus on activities for problem solving with the use of technology in middle and high school mathematics teacher preparation courses.

John D. Lorch (jlorch@bsu.edu) Ball State University, Department of Mathematical Sciences, Muncie, IN, 47306
Elizabeth Bremigan (egbremigan@bsu.edu) Ball State University, Department of Mathematical Sciences, Muncie, IN, 47306
Ralph Bremigan (bremigan@bsu.edu) Ball State University Department of Mathematical Sciences, Muncie, IN, 47306

Do Pre-service Teachers Know Pre-college Math?

Are we graduating pre-service secondary math teachers who can compute the derivative of $\arctan(x^5 + e^x)$, but who don't know how to obtain the graph of $\sin(2x)$ from the graph of $\sin(x)$? Who can perform row-reduction to solve systems of linear equations, but can't explain why the product of the slopes of perpendicular lines is -1? Who know $\mathbb{C}$ is the algebraic closure of $\mathbb{R}$, but don't know where the quadratic formula comes from?

Over recent years, mathematicians and mathematics educators increasingly have recognized that school mathematics teachers need a deep understanding of the mathematics they actually will teach. However, pre-service teachers may spend very little time deepening their understanding of pre-college mathematics while they are undergraduate mathematics students.

Over the last four years, with NSF support, we (John Lorch, Ralph Bremigan, and Elizabeth Bremigan) have developed and taught a class that helps pre-service teachers gain a deeper understanding of middle- and high- school mathematics. We will give illustrations of the content and pedagogical methods in the materials we have created, and discuss our experiences teaching this evolving course.

Meg Moss (mvmoss@pstcc.edu) 8435 Rising Sun Lane, Corryton, TN, 37721

Specialized Understanding of Mathematics

Developing a specialized understanding of mathematics in preservice teachers must be a central focus of undergraduate math programs. Effective teaching and learning can only occur if teachers possess a deep content understanding. How and where this knowledge is developed is a question that needs to be explored. This presentation will report results of a large scale dissertation study which focused on the following research questions:

1. What are the areas of strengths and the areas of weaknesses in the mathematical knowledge for teaching, as measured by the Content Knowledge for Teaching Mathematics measures, of preservice elementary teachers as they enter their mathematics methods course?
2. Are number and type of math content courses indicators of mathematical understanding?
3. Does an understanding of mathematics grow as preservice elementary teachers take their methods course?
4. If differences in growth in mathematical knowledge are found, what learning opportunities during the methods course may have contributed to any growth in knowledge?

This study will add to the knowledge base of what specific areas of mathematics content are lacking, and, therefore, need to be improved during the mathematics content courses. It will also add to the knowledge base of how, when and where preservice elementary teachers might improve upon their mathematical understanding. The presentation at Mathfest will focus on the implications of the findings of this research to mathematics content courses and future grant projects.

Joyce Fischer (jf10@txstate.edu) Texas State University - San Marcos, 601 University Drive, Room 470 Math Building, San Marcos , TX, 78666

A Cross Border Plan for Second Language Learners

A vital current issue in mathematics education in the US is the lack of mathematics achievement by students who are also English Language Learners. Texas State University-San Marcos and Tecnológico De Monterrey at Guadalajara, Mexico, are partnering to share methods for teaching mathematics to second language learners through professional development summer conferences for K–12 teachers in Mexico and Texas. Just as the US is struggling to teach mathematics to English Language Learners, so is Mexico struggling to teach Mathematics to Spanish Language Learners. Both countries have developed strategies and methods to increase achievement for this special population of students. This pilot project named Mexico Empowering Texas Achievement (META) Matemática and Texas Empowering Mexican Achievement (TEMA) Matemático, depending on which country is the active teaching partner at that time, translates into Goal (meta) Mathematics and Theme (tema) Mathematics and uses grant funding to deliver mathematics to students additionally stressed with a language barrier.

Jeff Johannes (johannes@member.ams.org) SUNY Geneseo, Mathematics Dept., 1 College Circle, Geneseo, NY, 14454-1401

A Little Moore Probability

When teaching a secondary capstone course in the semester before students went to student teach, I ran a three week session on the topic of probability using a Moore-inspired approach. In this talk I will describe this session and then focus upon the student exit survey responses.

Glenn Hurlbert (hurlbert@asu.edu) Arizona State University, Department of Mathematics and Statistics, Tempe, AZ, 85048-1804

ASU’s Summer Certification Institute (SCISM)

In an effort to combat the severe high school mathematics teacher shortage in Arizona we have created an alternative path toward state certification for mathematics majors at Arizona State University, the Summer Certification Institute in Secondary Mathematics (SCISM). We will describe various aspects of our program, including it’s invention, it’s funding, and it’s innovative model, in hopes that others might be motivated to try similar approaches at their own institutions.

Michel Helfgott (helfgott@etsu.edu) East Tennessee State University, Department of Mathematics, Johnson City, TN, 37614

H.S. Mathematics from a Higher Point of View

There is an apparent disconnection between the mathematics that future High School teachers learn at college and the mathematics they will need to teach at school once they graduate. Pre-service teachers wonder whether linear algebra, abstract algebra, complex analysis and the like are relevant to their professional future. Of course, we tell them that they need to widen their mathematical horizon beyond High School mathematics in order to be successful teachers. However, this argument does not seem to convince them. So steps should be taken to make college mathematics more relevant to people that will not become professional mathematicians working in academia or industry, but rather High School teachers who have to get a B.S. in mathematics as part of the requirements for a degree in Secondary Education.

How can we bridge the gap? East Tennessee State University offers every year a course on the teaching of Secondary Mathematics (Math 4417), which has college geometry and an introduction to abstract algebra as pre-requisites. It is a course for seniors planning to teach mathematics at the secondary level. During the last few years it has evolved into a course on High School mathematics from a higher point of view.

Here is a sample of the topics that we cover: elements of financial mathematics, maxima and minima before calculus, tangents to conics using only analytic geometry (a modification of Descartes’ method), roots of biquadratics, cubics, and quartics, limit processes in geometry, mathematical principles of basic optics, and advanced plane trigonometry. These are some of the topics that are not normally covered in the B.S. curricula of mathematics majors, but are quite relevant to High School mathematics.

Besides the content area described above we discuss some of the works of G. Pólya (especially parts of “Mathematical Discovery”, Vol. II) and emphasize several “common sense” principles of mathematics teaching as well as the use of the programming capabilities of graphics calculators. We hope that in the near future Math 4417 will become a capstone course fully linking college and secondary mathematics.

Doug Aichele (aichele@math.okstate.edu) Oklahoma State University, Department of Mathematics, Stillwater, OK, 74078

Geometric Structures for Elementary Teachers

Geometric Structures for Elementary Teachers (GeoSET) is an NSF-funded initiative to develop a one-semester geometry curriculum for prospective elementary teachers; textbook materials are currently being published commercially. I will present an overview of this unique geometry curriculum and discuss how to manage pedagogical issues associated with its delivery. I will discuss in depth a teaching/learning model involving collaborative learning—study teams—that has been refined over several semesters. I will share aspects of this model, observations from student-generated data, and suggestions for making the "group approach" truly collaborative.

Theodore Gamelin (twg@math.ucla.edu) UCLA, Mathematics Department, Los Angeles, CA, 90095-1555
Heather Calahan (calahan@math.ucla.edu) UCLA, Mathematics Department, Los Angeles, CA, 90095-1555

Teacher Preparation in a Math Research Department

We will discuss various strategies for developing a strong subject matter preparation program for undergraduates who are interested in going on to teach math in a secondary school. Challenges arise from all sides: accrediting agencies, funding sources, college administration, the neighboring graduate Teacher Education Program, and the mathematics department itself. What emerges is a subject matter preparation program that could serve as a model for math departments with a strong research focus.

Wendy Weber (weberw@central.edu) Central College, Box 066, 812 University Street, Pella, IA, IA, 50219

Mathematical Questions from the Classroom

How can we bridge the gap between prospective teachers' knowledge of mathematics and the mathematics they will teach? In 1987, Richard J. Crouse and Clifford W. Sloyer published the (now out of print) two-volume book *Mathematical Questions from the Classroom*. Using this book as a guide, a *one semester hour* course was designed to help pre-service teachers learn how to handle mathematical questions that arise in the classroom. We explore questions from the middle school level, introductory through advanced algebra, geometry, trigonometry, functions, probability, and calculus. The questions we discuss help "unpack" the mathematics students have been learning as mathematics majors and minors into what Zalman Usiskin refers to as "teacher mathematics." Some questions expand pre-service teachers' knowledge of mathematics while others help them identify and correct typical student mistakes and misunderstandings. All questions are explored from the perspective of helping middle school and high school students understand mathematics at the appropriate level while making sure pre-service teachers understand the mathematics at a deeper level. Examples of questions we explore include: Why is division by zero not allowed? How is "congruence" different from "equality" when exploring properties of triangles? What does the symbol ∞ really mean? What properties is a student who writes $(6t)\sqrt{3} = 6\sqrt{3} \times t\sqrt{3}$ confusing? How do you help him/her? Armed with this course, teachers will NEVER answer a student question with "Because."

Stuart Moskowitz (sm14@humboldt.edu) Humboldt State University, Mathematics Dept, 1 Harpst St, Arcata, CA, 95521

Calculators, Number Sense, PreServiceElem Teachers

Calculators are a common tool in school classrooms at almost all grade levels. Yet, while the technology keeps improving, both with increased functionality as well as pedagogical advances, few teachers take advantage of these improvements. The calculator then becomes a tool used for little more than allowing students to "check their work," leading instead to an over-reliance on the calculator for basic skills.

While the graphing calculator is loaded with advanced capabilities and ideas for teaching with it are published regularly, less has been written about the basic four-function calculator, still the most common computational tool used in elementary classrooms. These non-graphing calculators have the potential to be valuable tools for teaching concepts that develop number sense and problem solving skills. The best way to prepare teachers to teach with these modern tools is to reach them while they are still in school. If they do not learn during their content/methods courses as student teachers, it is less likely they will learn later.

Tracie McLemore Salinas (salinastm@appstate.edu) Appalachian State University, 233 Walker Hall, Boone, NC, 28608

Motivating PreService Teachers' Deep Mathematical Understanding

Successful teachers of mathematics must possess deep knowledge of the subject and of the pedagogy necessary to teach it effectively. One task in which this combination of knowledge is particularly explicit is in the evaluation of student-generated algorithms or problem-solving strategies. Such invented strategies offer rich opportunities for students to evaluate the correctness or the contexts within which the strategy is appropriate. The discussion of invented strategies can also motivate students, support their ability to justify their work to themselves, and discuss and compare multiple strategies. Teachers, however, must be mathematically competent to evaluate the correctness of the strategies themselves and pedagogically deft to negotiate the ensuing discussion. Offering pre-service teachers opportunities to observe and reflect on student-generated strategies then is a worthwhile introduction to a task that may be a significant part of their teaching. Such work also motivates non-mathematics specialists to seek a deeper level of understanding and encourages mathematics majors to develop more flexibility in their responses to invented techniques. In this talk I will share examples of student-generated algorithms and discuss techniques for using them in the classroom. Ideas for resources of such examples will be shared as well as results of using them in my own classroom.

Janet McShane (Janet.McShane@nau.edu) Northern Arizona University, Department of Mathematics and Statistics, Box 5717, NAU, Flagstaff, AZ, 86011-5717
Cynthia Hernon (chernon@math.boisestate.edu) Dept of Mathematics, Boise State University, 1910 University Drive, Boise, ID, 83725-1555

Connecting Abstract Algebra to Secondary Curriculum

In 2004, the M.A.T. (Master's in the Art of Teaching) in Mathematics degree program at Northern Arizona University was redesigned. Responding to national research and policy recommendations for mathematics teachers professional development, the new courses emphasize the connections between middle school, high school, and college level mathematics content, effective pedagogy, and reflective practice. Ten courses were developed for web delivery, and this online program began in Fall 2004. The online graduate course Connections: Algebra and Number Theory was developed to teach the mathematical content of abstract algebra and to provide opportunities for the inservice teachers to create learning activities that could be integrated into the secondary school curriculum. The teachers modified existing online number theory lessons and textbook algebra problems in developing grade appropriate classroom activities. This presentation examines the teachers' reflections about the online learning experience and the teachers' evaluations of the lessons they developed and taught.

Andrew Wilson (wilsona@apsu.edu) Austin Peay State University, 1004 W. Lakeview Dr., Burns, TN, 37029
Mary Lou Witherspoon (witherspoonm@apsu.edu) 319 Fairway Dr., Clarksville, TN, 37043
Jackie Vogel (vogelj@apsu.edu) P.O. Box 4626, Clarksville, TN, 37044

Can Your Students Speak Fractions?

Attendees will gain understanding of change in children's thinking by examining pre-tests and post-tests related to proper and improper fractions and mixed numbers. Attendees will gain appreciation for the importance of building connections among real life, concrete, pictorial, spoken, and written representations of fractions by examining activities that occurred between the pre- and post-tests. Attendees will learn about a model for involving pre-service teachers in standards-based instruction.

Sandra Richardson (richardson@math.lamar.edu) Lamar University, PO Box 10047, Beaumont, TX, 77710

Voices of Mathematics Teachers of ELL Students

Texas secondary mathematics teachers were surveyed and interviewed about their perceptions of available professional development designed to aid mathematics instruction for students who are English Language Learners. In this session, I will report on and summarize the data collected and discuss indications of the findings.

Monika Vo (monika.vo@saintleo.edu) Saint Leo University, 7543 Kickliter Lane, Land O’ Lakes, FL, 34637
Jacci White (jacci.white@saintleo.edu) Saint Leo University - University Campus - MC 2188, Post Office Box 6665, Saint Leo, FL, 33574-6665

Teach 21 Project

The speakers will share their initial experiences participating in the Teachers for the 21st Century project, a program of the Council of Independent Colleges. This is a year long project, which started in the spring of 2006 and is sponsored by Microsoft Corporation. The goal of the project is “to establish a national faculty development network for college and university faculty members responsible for teacher preparation programs.” The Saint Leo University team has selected Intermediate Mathematics (grades 3–8) as the curricular focus for the Teach21 project. This decision was based on the grades that are tested on the state’s yearly exam—FCAT. These grade levels address the same topics of mathematics focusing more on thinking and problem-solving abilities, how to communicate their thought-processing with their peers, and is a time when students begin to address critical thinking skills at a higher level. Even though all of these topics and skills are introduced in the primary years, the team believes that students are more independent and self-reliant beginning at the third grade.

Examples that Use Abstract Algebra in Other Disciplines in Mathematics

Thursday, August 10, 1:00 PM–3:00 PM

Thomas Koshy (tkoshy@frc.mass.edu) Framingham State College, Framingham, MA, 01701

Check-Digit Schemes and Dihedral Groups

Check digits are often used to detect errors in strings of alphanumeric characters. Banks, publishers, libraries, American Chemical Society, United Parcel Service, US Post Office, traveler’s checks, and credit cards, to name a few, use check digits in their identification numbers. A number of states in the U.S. and provinces in Canada employ them in driver’s license numbers, and many European countries in passport and registration numbers. The operations involved in all those cases are commutative.

In 1990, the German Bundesbank introduced a delightful, algebraic scheme to compute the check digit d in the serial number of a German bank note. Based on the check digit scheme developed in 1969 by J. Verhoeff, the German method uses the dihedral group D_{10} of symmetries of a regular 5-gon to compute d. Since the group is non-abelian, the scheme catches most of transposition-of-adjacent errors; but it does catch all single-digit errors.

Accordingly, this talk introduces check digits in general, focuses on the check digit scheme employed by the Bundesbank, and then explores the possible application of D_{36} to identification numbers consisting of alphanumeric characters.

Jianqiang Zhao (zhaoj@eckerd.edu) Eckerd College, 4200 54th Ave. S., St. Petersburg, FL, 33711

Multiple Harmonic Sums

We will study the congruence properties of multiple harmonic sums. Because these sums form a Quasi-Hopf algebra we can use the general theory of QHA to study them. In particular we provide some generalizations of the classical Wolstenholme's Theorem to both homogeneous and non-homogeneous sums. We will also make a few conjectures at the end.

John Lorch (jlorch@bsu.edu) Ball State University, Department of Mathematical Sciences, Muncie, IN, 47306
Crystal Lorch (clorch@bsu.edu) Ball State University, Department of Mathematical Sciences, Muncie, IN, 47306

Using Algebra to Enumerate Sudoku Puzzles

Sudoku is a popular number puzzle consisting of a 9×9 grid divided into nine 3×3 blocks. Given some initial information, the solver attempts to fill the grid with numbers 1 through 9 so that (1) the completed grid is a latin square, and (2) each of the numbers 1 through 9 appears exactly once in each 3×3 block. While no mathematics is required to solve a sudoku puzzle, there are natural combinatorical problems related to sudoku. In the presentation we will show how concepts from a first algebra course (groups, group actions, orbits, invariants, etc.) can be used to count sudoku puzzles.

Victor Terrana (vterrana@newberry.edu) Newberry College, 1908 Main Street, Newberry, SC, 29108

Using Magic Squares in Linear and Abstract Algebra

This paper illustrates the use of 3×3 magic squares as a 3-dimensional subspace of the 9-dimensional vector space of all 3×3 matrices over the field of reals. The presentation is based on a project assigned in an undergraduate linear algebra course. Students assigned this project find Gauss-Jordan bases for this space and for the subspace of zero-sum magic squares. The original magic square space is then shown to be a subspace of the 5-dimensional space of row-column magic squares. This latter space is closed under matrix multiplication and so is a subring of the 3×3 matrices as viewed in an abstract-algebra setting. Through the use of the nature of the characteristic equation of such matrices; other vector subspaces, subrings and ideals can be found.

Charles Hampton (Hampton@wooster.edu) The College of Wooster, Mathematics Department, Wooster, OH, 44691

All Matrices are Nearly Diagonalizable

Advanced topics in linear algebra used to be part of abstract algebra but have disappeared in recent years. One of those topics, the Jordan Canonical Form Theorem, makes a great project in the second abstract algebra course. A proof is most often set in a broader setting and is based upon significant material new to the students. It doesn't have to be this way. As a project lasting across several weeks I ask my students to provide the proofs for a series of lemmas that lead up to a constructive proof of the Jordan Canonical Form Theorem. This proof doesn't require any new ideas or methods and I believe leaves the student with a better understanding of the theorem. I will sketch this approach.

Kurt Ludwick (keludwick@salisbury.edu) Salisbury University, Department of Mathematics and Computer Science, Salisbury, MD, 21801

PascGalois Activities for a Number Theory Class

Although it is more frequently used in an abstract algebra context, PascGalois can be quite useful for a number theory class. We will demonstrate a few PascGalois activities and assignments that were designed for use in a number theory class. Some of these challenge students to discover connections between patterns in 1-D or 2-D automata (modulo n) and the prime factorization of n. In another example, we use Pascal's Triangle (modulo p), for prime p, to guide students toward discovery of Lucas's Correspondence Theorem for the binomial coefficients.

Mathematics and Sports and Games

Thursday, August 10, 2:30 PM–4:30 PM

Howard Penn (howardpennphoto@comcast.net) U.S, Naval Academy, 502 Holloway Rd, Annapolis, MD, 21402

Which Ballparks are Homer Friendly, Part 2

Last year, the title question was discussed using 6 years of home run data. During the question and answer session, a member of the audience asked which parks are easy or hard for left-handed or right-handed batters. At the time, the presenter did not have the data broken down that way. Since then the information has been obtained. We can now consider such questions as, were Babe Ruth and Roger Maris helped by playing their home games in Yankee Stadium, which is reputed to be an easy place for lefties to hit home runs? Would Ted Williams and Joe DiMaggio both have broken the Babe's single season record if they had been traded? Were Barry Bonds and Mark McGuire helped or hindered by their home ball parks?

Peter Schumer (schumer@middlebury.edu) Middlebury College, Mathematics Department, Middlebury, VT, 05753

Some Mathematical Aspects of the Game of Go

Go is an ancient board game with simple rules but of unfathomable complexity. In this talk we will introduce the game and show how "life and death" problems in Go provide an endless source for teaching problem solving skills and for demonstrating the essence of mathematical proof. We will briefly discuss how other significant aspects of mathematics are also reflected in the game of Go.

Brian Hollenbeck (bhollenb@emporia.edu) Emporia State University, 1200 Commercial St. Box 4027, Dept. of Mathematics, CS, and Econ., Emporia, KS, 66801

Analyzing Farkel: A Prob & Stat Class Project

Farkel is a game involving 6 dice in which each player tries to obtain as high of a score as possible. Although luck plays a large role in the game, a probability-based strategy will improve a player's score. This presentation will describe an activity that allows students to implement their knowledge of probability and counting techniques as well as conduct various statistical tests to analyze the game of Farkel. We will look at some of the consequences of the analysis and note that it does not always support the conventional strategy. The project has been used as an individual assignment primarily done outside of class and has been extended to be an undergraduate research project.

Doug Ensley (deensl@ship.edu) Mathematics Department, Shippensburg University, Shippensburg, PA, 17257

Recursive Games in First-Year Discrete Mathematics

Many common games are recursive in nature. Examples include tennis games (in which one must "win by two") and children's board games (in which parents wonder if anyone will ever reach square 100 in Chutes and Ladders). This presentation will discuss how this type of game can be used in a first-year discrete math course to reinforce recursive and iterative thinking as well as basic facts about probability and expected value. The games allow a student-centered approach in which answers are first simulated, then modeled, and then solved using simple algebra. We will also discuss briefly how this can lead naturally to an elementary treatment of Markov Chains in this course.

Joe DeMaio (jdemaio@kennesaw.edu) Kennesaw State University, Department of Mathematics, 1000 Chastain Road, Kennesaw, GA, 30144

A Knight's Tour with Minimum Square Removal

A closed knight's tour is a tour that using legal moves of a knight visits every square on a chess board exactly once and returns to its starting position. In 1991, Schwenk classified all rectangular chess boards that admit a closed knight's tour. For a rectangular chessboard that does not contain a closed knight's tour, this paper determines the minimum number of squares that must be removed in order to admit a closed knight's tour. Also, constructions that generate a closed tour once appropriate squares are removed are provided.

George Gilbert (g.gilbert@tcu.edu) TCU, TCUBox 298900, Fort Worth, TX, 76129

Modeling Expected Value in Poker Tournaments

In cash games, a poker player with a sufficient bankroll should play to maximize his or her expected cash value. In poker tournaments, players are faced with limited bankrolls and, much more importantly, payouts that are spread out among several contestants. It follows that all but the worst players should be risk averse. We look at two simple models for expected payout as a function of chip count that could apply to the early stages of a poker tournament. In later stages, the distribution of chips among other players becomes significant. We describe the Independent Chip Model and some generalizations that take a player's skill level into account.

Patrick Headley (headley@gannon.edu) Gannon University, 1121 Matthew Ct., Erie, PA, 16504

Who Wants to Be a Half-Millionaire?

Two years ago I appeared on *Super Millionaire*, a special version of *Who Wants to Be a Millionaire?* with even larger prizes. In spite of being one of the show's most successful contestants, I still found that many people questioned my decisions. The game has a resemblance to the one described in the St. Petersburg paradox, which has long been a source of debate. I will discuss some possible approaches to strategy, illustrated by my own experience. My hope is that this might provide an interesting discussion topic for an undergraduate course in probability.

E. Lee May (elmay@salisbury.edu) Salisbury University

Thoughts on Teaching Statistics through Baseball as a Liberal-Arts Mathematics Topic

The liberal-arts mathematics course at Salisbury University, like most such courses, is one designed to be used by humanities majors to satisfy a mathematics requirement. During the past spring semester, the speaker taught "statistics through baseball" as the sole topic of the course. This was a radical departure from his previous offerings of the course, which had featured studies of *The Man Who Loves Only Numbers*, a biography of Paul Erdos by Kenneth Hoffman; *Zero, the Biography of a Dangerous Idea*, by Charles Seife; and *The Da Vinci Code*, by Dan Brown. The speaker will briefly describe his course, discuss some of its highlights (and lowlights), comment on changes that he plans for the fall offerings of it, and opine about the suitability of the course as one occupying the liberal-arts-mathematics category.

Promoting Integrative Learning in Mathematics Through Learning Communities

Thursday, August 10, 3:15 PM–5:00 PM

Dora Ahmadi (d.ahmadi@moreheadstate.edu) Morehead State University, Department of Mathematics and Computer Science, 150 University Blvd. Lappin Hall 105, Morehead, KY, 40351

Tiered Mentoring Program: A Learning Community

The presenter will share progress on a project that involves professors, other community partners, teachers in the schools, and their students in a tiered mentoring program. Through the use of technology, this group is involved in the analysis of data. Working in conjunction with the Daniel Boone National Forestry, teachers have become part of a team analyzing existing data and involving their students in the collection and analysis of forest related data. There are plans of establishing some permanent inventory plots on the district. These will be established near some local schools where the students could go and measure the plots periodically. Students will be measuring tree diameter, determining species, using fixed area and horizontal point samples, etc. The Daniel Boone National Forestry will be removing understudy vegetation in several areas across the district over the next several years. Students will measure the heights of the seedling in the areas where the work has been completed and compare that to growth in adjacent untreated areas. As part of this project, a U.S. Forestry Wetlands Expert from the Department of Fish and Wildlife assisted in the selection of locations for wetlands near McBrayer Elementary School. Students did soil permeability/porosity testing to determine if the soil was suitable to support a wetland. Students also determined the factors available as components for wildlife habitat. Through the Tiered Mentoring Program, teachers made plans for data collection and data analysis. In the spring, as the wetlands have filled, and begun to attract wildlife, students began to observe the wetlands and collect data to determine which organisms have adopted the wetlands as their home. Students have been recording these data. Students at Tilden Hogge Elementary have been collecting the same data at their wetlands, which have been established for nearly ten years. Data will be analyzed and students at McBrayer Elementary and Tilden Hogge Elementary will be involved in part of the analysis. McBrayer students will try to predict how their data might change in one year, five years, and ten years, based on the data they have received from Tilden Hogge Elementary students. As part of this program, professors will assist teachers in planning instruction connecting mathematical concepts through the applications of this study. The presenter will also discuss methods of assessment used to evaluate this all round learning community project.

William Ardis (bardis@ccccd.edu) Collin County Community College - Preston Ridge Campus, 9700 Wade Blvd., Frisco, TX, 75035

Integrating Mathematics in Learning Communities

For disciplines such as sociology, psychology, or biology, statistics plays an integral role. Because of this role, an introductory statistics course is an ideal course for pairing in a Learning Community. At Collin County Community College, recent Learning Community pairings involving a mathematics course have all included MATH 1342 - Statistics. This session will give a brief overview of the Learning Communities program at Collin and discuss the pairings: Mind Over Numbers (combining MATH 1342 - Statistics and PSYC 2301 - General Psychology), Chances In Life (combining MATH 1342 - Statistics and BIOL 1406 - General Biology I), and Quantifying Culture (combining MATH 1342 - Statistics and SOCI 1301 - Introduction to Sociology). In each case, the session will provide background on the development of the Learning Community, the methods of assessment used in the Learning Community, and any relevant observations.

Yolanda Sankey (yksankey@pstcc.edu) Pellissippi State Technical Community College, 10915 Hardin Valley Rd, Natural & Behavioral Sciences Department, Knoxville, TN, 37933
Meg Moss (mvmoss@pstcc.edu) Pellissippi State Technical Community College, 10915 Hardin Valley Rd, Math Department, Knoxville, TN, 37933

5 E as a Tool for Planning a Learning Community

How a learning community can serve as a bridge between the community college classroom and an elementary school field site, and provide an interdisciplinary anchor for teaching math and science is examined. With funding from the National Science Foundation, a community college encompassing urban, suburban, and rural campuses designed a unique professional development assignment for elementary education majors. In addition to the traditional undergraduate field experience courses, students were engaged in a learning community that integrated math and science content with pedagogy. The learning community was organized using a 5 E model of instruction. Students participated in the learning community through enrollment in a biology course, Concepts of Biology, and/or math course, The Structure of the Number System. Descriptive data on the learning community was collected from surveys, while journals and electronic discussion boards of student activities provided additional qualitative records.

Donna Beers (donna.beers@simmons.edu) Simmons College, 300 The Fenway, Boston, MA 02115
Ellen Davidson (ellen.davidson@simmons.edu) Simmons College, 300 The Fenway, Boston, MA, 02115

Prospective Teachers Bridge Content and Pedagogy

This presentation will describe a learning community, initiated this past spring by the mathematics and education departments, to promote integrative learning for prospective elementary school teachers. We will describe what motivated us to form the learning community and how it was organized administratively. We will also describe the learning goals and outcomes for the learning community, as well as the use of journals, portfolios, and writing to align assessment with learning goals and objectives. In our presentation we will provide examples of experiences that were used to enhance students' understanding of mathematical content so that they can teach it confidently and effectively. Last, we will report on the results of pre- and post surveys, describe lessons learned, and outline plans for revising our learning community for next year.

What Can We Do to Help Our Freshmen See that There is More to Mathematics than Calculus?

Friday, August 11, 1:00 PM–2:40 PM

Mary Goodloe (goodloem@mail.belmont.edu) Belmont University, Department of Mathematics and Computer Science, 1900 Belmont Boulevard, Nashville, TN, 37212

Mathematical Inquiry

The introduction of a new general education program at Belmont University presented an opportunity to significantly change the nature of the courses that would satisfy the quantitative reasoning requirement. For the past two years, all incoming students have been required to take one of four classes that emphasize logic, problem solving, number theory, and an array of other topics, as we attempt to introduce students to both the unique beauty and the utility of mathematics. Students who enter the university with strong mathematical skills take our Mathematical Inquiry course. I will discuss my own experience teaching this course and the reactions of students to the course. In addition, I will present results from a statistical study that examined not only the mathematical knowledge of students in the course but also their attitudes towards mathematics. Data from the study, student comments, and our successful recruitment of some majors and minors indicate that the course is having a positive effect.

Agnes Rash (arash@sju.edu) Saint Joseph's University, Department of Mathematics and Computer Science, 5600 City Avenue, Philadelphia, PA, 19131

Number Theory—A Freshman Experience

While all math majors take calculus, at some level, during the first year. At Saint Joseph's University we are interested in introducing freshmen to other branches of mathematics so that they can see the richness of the major. To this end, the freshmen mathematics majors take number theory in the spring semester. Each student has a faculty advisor/mentor who guides the students through the program. Once they are exposed to number theory, they appreciate methods of proofs and interesting problems. In this talk, I will discuss the content of the course as well as the level of the course, and the types of problems that students solve.

Connie Campbell (campbcm@millsaps.edu) Box 150086, Millsaps College, Jackson, MS, 39210

Mathematics Abroad

Study abroad experiences offer students a way to see that mathematics is universal and is all around them. Millsaps College has recently offered an elective course in which students travel abroad with a mathematics faculty member. Some of the course content includes number patterns, sacred geometry, simple coding theory, number systems, and geometric constructions. To date, one class has traveled to London and two others have traveled to Mexico. For this session we will discuss the details of these offerings as well as our general impressions as to how implementation of this program has raised student interest in mathematics.

Kevin Hartshorn (hartshorn@moravian.edu) Moravian College, Department of Math/CS, 1200 Main St, Bethlehem, PA, 18018
Michael Fraboni (mfraboni@moravian.edu) Moravian College, Department of Math/CS, 1200 Main St., Bethlehem, PA, 18018

Culture Points

In the typical first-year math course—whether it be calculus or a general education quantitative proficiency course—we struggle to help students see the relevance of mathematics to their own lives. Particularly in a focused course such as calculus, there is a danger that students see mathematics as an isolated subject, with applications that feel contrived or over-focused on particular specializations.

Culture Points refers to a semester-long activity that encourages students to engage themselves in mathematical culture (colloquia, newspaper articles, movies, conversations, mathematical articles, etc.), thus discovering the role that mathematics plays outside the classroom. This activity is decidedly unstructured—rather than particular assignments, students are required to explore the nature of mathematics on their own.

Robert Vallin (robert.vallin@sru.edu) Department of Mathematics, Slippery Rock University, Slippery Rock, PA, 16057

“Modern”-izing Class at Slippery Rock University

At SRU, freshmen are introduced to formal proof in a class entitled Modern Concepts. Rather than just teaching logic and proof techniques, I decided to take the word “Modern” to heart. Turning part of this course into a writing course I have them write a term paper on mathematics or mathematicians from the 20th century along with synopsizing various short articles on the nature of mathematics. The goals of this is to (a) help students see that mathematics is a thriving subject, (b) broaden both their world view and their mathematics view, and (c) get the students intensive writing credit for a subject in which they are intested. During this talk I will elaborate on what the students do, discuss successes and failures, and give future plans for when I teach this again in the spring.

Fun and Innovative Techniques for an Abstract Algebra Class

Thursday, August 10, 1:00 PM–3:00 PM
Saturday, August 12, 1:00 PM–3:00 PM

Matt Lunsford (mlunsfor@uu.edu) Union University, 1050 Union University Drive, Jackson, TN, 38305

Substitution Groups and Remarkable Subgroups

Mathematics is a creative process and unfortunately that process is often hidden from students of the discipline. This is certainly the case in the area of mathematics commonly referred to as abstract algebra. Current pedagogy conceals from the student many of the great ideas generated by significant problems in the history of the discipline. In his famous paper *Memoirs on the Conditions for Solvability of Equations by Radicals*, Galois introduced the mathematical term *group* and identified a specific property of groups, now known as *solvability*, which enabled him to translate his original problem from the theory of equations into an equivalent problem within the newly established theory of groups. This talk will explore how Galois’ definitions of three key concepts: *group* (as a group of substitutions or permutations), *normal subgroup* (as a smaller group with a “remarkable” property), and *solvable* (a group that can be successively diminished until it contains only one permutation), can be used to enhance the learning of students as they encounter these concepts in a first course in abstract algebra.

Thomas Langley (tlangley@callutheran.edu) California Lutheran University, 60 W. Olsen Road, Thousand Oaks, CA, 91360

Does $ab = ba$?

A beautiful, but relatively unknown, result in group theory is that the probability that two elements of a nonabelian finite group commute is less than or equal to $5/8$ (the bound is realized by the dihedral group D_4, among others). Commutativity can be generalized in many different ways, for example, $ab = ba$ can be replaced by $abc = cba$ (or some other permutation of a, b and c), leading to other interesting bounds. The $5/8$ bound and related generalizations can be deduced and proved in a discovery-based environment by undergraduates with the help of software such as GAP. We will discuss how this plays out in the classroom, starting from “doesn’t ab always equal ba?” and ending with conjectures (suitable for undergraduate research projects) flying around with wild abandon.

John Jones (jj@asu.edu) Department of Mathematics and Statistics, Arizona State University, Tempe, AZ, 85287-1804

Group Tables and Subgroup Diagrams for Everyone

We will demo several activities for exploring properties of finite groups using group tables and subgroup diagrams. These make use of interactive computer software so that students can explore a larger number and variety of examples than could be dealt with by hand.

The software is built into a web page, so all the student will need is a good web browser and access to the web; there are no plugins or other software to install or operating system issues or software costs. Since accessing the software is so easy, one can use it for a large portion of the course, or just a few selected spots.

Bill Yankosky (byankosky@ncwc.edu) North Carolina Wesleyan College, 3400 N. Wesleyan Blvd, Rocky Mount, NC, 27893

Transposition Musical Chairs

This presentation, consisting of an introduction and brief mock class session, will focus on an interactive classroom activity where students in an Abstract Algebra class were able to discover some properties related to permutations and transpositions by physically moving from chair to chair according to suggested guidelines. During the exercise students were able to discover a way to write a permutation as a product of transpositions and a way to use transpositions to find the inverse of a permutation.

Su Chi Wen (swen@monmouth.edu) Monmouth University, Howard Hall C-8, Department of Mathematics, 400 Cedar Avenue, West Long Branch, NJ, 07764

Social Activities for Groups and Rings

Introducing abstract algebraic concepts and teaching students how to write rigorous proofs at the same time has been a very challenging experience. In the past two spring semesters, I had the opportunity to teach a two-semester course: Modern and Abstract Algebra, in a small class(less than 20 students) setting. In this session, I will be sharing a few fun activities I used to introduce algebraic structures such as: rings, ring homomorphisms, ideals, quotient rings, isomorphic rings, and fields. All activities began in class and then would extend to discussions/group work outside the classroom, throughout an entire semester. Our campus wide technology, E-campus, was used extensively for student's group work and discussion. I will also give some examples to illustrate how they may be helpful for the student to develop a deeper understanding of the abstract concepts, and better proof writing.

Darren Parker (dbparker@udayton.edu) University of Dayton, 300 College Park, Dayton, OH, 45469-2316

Group Theory and "Lights Out"

I use the game "Lights Out" in my abstract algebra class to help students work through an example of a group that consists of operations. This helps them better understand the symmetric and dihedral groups. It has also proved to be a great help in unlocking students' creativity. In this talk, I will explain how the game works, how I work the game into my class, and some interesting mathematical questions that the game inspires.

James Uebelacker (juebelacker@newhaven.edu) University of New Haven, 300 Boston Post Road, West Haven, CT, 06516

Using Cayley Diagrams to Discover Group Concepts

In 1878 Arthur Cayley introduced the use of colored digraphs as a way of visually representing groups which are identified with a set of generators. In the class laboratory discussed in this paper, Cayley's concept is used in a discovery-approach learning module to help students improve their understanding of fundamental concepts of group theory: closure, generator and relations, order of an element, commutivity, endomorphism and automorphism, as well as some categories of groups: cyclic, dihedral, alternating, etc.

In preparation for the lab portion, Cayley digraphs are introduced using the cyclic group of order 6, first with one generator and then with two. Then the digraph for the dihedral group of order 6 is shown and contrasted with the previous digraph. An audio/visual recording of this session is made with the Tegrity system, and uploaded to the course site on BlackBoard for later review by students.

Moving to the lab environment, students working in teams and using the FGB software are assigned specific groups to model with digraphs. Questions are posed to guide them in exploring the fundamental concepts of group theory. Afterwards, the students are shown the effect of two possible endomorphisms on the dihedral group. The digraph illustrates why one works and one does not. Finally, a homework assignment asks students to review the recording and then create more digraphs and to conjecture about various questions concerning group concepts. This module can be used in segments to introduce fundamental group concepts or as a review to enhance understanding of the fundamental concepts.

Karen Aucoin (aucoin@mcneese.edu) 6901 Windmill Ln, Lake Charles, LA, 70605

Fostering Familiarity with Examples

In order to understand the structures studied in abstract algebra, students must become familiar with a variety of specific examples of these structures. This presentation will explore strategies for reinforcing students' knowledge of specific examples. These strategies include an adaptation of a popular guessing game which can be extended to deepen understanding of the concept of isomorphism.

James Hamblin (jehamb@ship.edu) Shippensburg University, 1871 Old Main Drive, Shippensburg, PA, 17257

Using Technology to Explore the Dihedral Group

When students first encounter group theory in Abstract Algebra, one of the first examples of a non-abelian group is the symmetry group of the square. While to experienced mathematicians this may seem like a good, concrete example, experience has shown that students often have trouble grasping this concept. I will demonstrate some interactive Shockwave tools that can be used to allow students to explore the concepts of symmetry and transformation, which will allow them to naturally develop the ideas of the dihedral group.

Allen Hibbard (hibbarda@central.edu) Central College, 812 University St., Pella, IA, 50219

Three activities in my Abstract Algebra course

This session will focus on three different activities that I do in my abstract algebra course. One describes a process that I use to confirm that the students can discriminate among the five groups of order 8. The second discusses the logistics in how I use design quizzes based on the reading of a proof. The third will illustrate an activity that helps student visualize the quotient ring $\mathbb{Z}[i]/<a+bi>$.

Attracting and Retaining Students to Mathematics Programs via Outreach

Friday, August 11, 3:15 PM–5:15 PM

Lois Knouse (LoisKnouse@letu.edu) LeTourneau University, P.O. Box 7001, Longview, TX, 75607

Accelerated Math for Engineering Students

What do you do when a young person interested in majoring in Engineering is not prepared to start his/her college mathematics in Calculus I? This was the dilemma that we faced at LeTourneau University. To resolve this situation, we started an accelerated mathematics program which includes Precalculus and Calculus I in sequence in the first semester. This prepares the student for Calculus II in their second semester which keeps them from being behind in mathematics for their engineering curriculum. This paper addresses the selection criteria for the program, the structure of the program, and the results as we track the students through the program and Calculus II.

William Hawkins (bhawkins@maa.org) University of the District of Columbia, 3046 Nash Place, SE, Washington, DC, 20020

The MAA Student Research Programs

The MAA and its Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) Program have supported small research teams of a faculty member and a minimum of four minority undergraduates since the summer of 2003. The funders are NSF, NSA, and the Moody's Foundation. This National Research Experiences for Undergraduates Program (NREUP) has grown from three sites in 2003 to six sites in 2004 to twelve sites in 2005. Funding has been requested again so NREUP can continue in 2006 and beyond.

Eight students were served in 2003, twenty-five in 2004, and fifty-two in 2005. The paper will focus on outcomes of NREUP. Specifically, for students that have responded to inquiries, more than half are attending graduate school in mathematics-based fields. Professor Hawkins directs the SUMMA Program and teaches at the University of the District of Columbia.

Philip Yasskin (yasskin@math.tamu.edu) Dept of Math, Texas A&M University, 3368 TAMU, College Station, TX, 77843-3368

Texas A&M Enrichment for Middle School Students

For the past 5 years, the Texas A&M Math Department has sponsored a Summer Educational Enrichment Program (SEE-Math) for middle school students entering the 6th, 7th or 8th grade under the direction of Dr. Yasskin. Each year, the instruction has been provided by about 10 faculty with the help of 5 grad students, 8 undergrad students and 5 high school students. Averaging about 200 applicants each year, we have accepted 45-60 students based on their ability and interest in math and science as reported by their teachers. Each year, we have had about 50% females and about 30% minorities. An effort is made to accept a few students from each of the Brazos Valley schools.

The focus of this talk will be on the activities covered. Many of the activities are organized so that the students recognize patterns, make conjectures and either prove or disprove them. These include Platonic solids, Euler numbers, mirrors and symmetries, straw puzzles, Pythagorean theorem, map coloring, logic puzzles and state space. Other activities teach applicable computation, such as computer animations, geometric constructions, pigeon hole principle, Venn diagrams, cryptography and probability.

More information is available at http://www.math.tamu.edu/outreach/SEE-Math/

Sangeeta Gad (GadS@uhd.edu) University of Houston - Downtown, Department of Computer and Mathematical Sciences, Houston, TX, 77002

Outreach — Planting Seeds for the Future and Retaining Students in Mathematics Through Mentoring and Tutoring

Women and disadvantaged minorities lag behind in the technology sector. The migration away from the science, technology, engineering and mathematics (STEM) fields starts in middle school and continues until the undergraduate years. We risk our nation's leadership role in the high technology society we have developed if the declining college enrollments in STEM subjects remain unchecked.

To arrest this trend and inculcate interest in STEM fields, University of Houston-Downtown offers two mathematics based enrichment programs for pre-college students, Houston PREP and Saturday Academy, starting as early as 7th grade. These programs are producing results.

For retaining students in mathematics once they enroll in UHD, we have developed several students' assistance programs such as open labs, one on one tutoring and computer labs. Faculty and student mentors are assigned to STEM majors.

Larry Johnson (jlsheltonjohnson@comcast.net) Metropolitan State College of Denver, PO Box 173362, Denver, CO, 80217-3362

The Summer Science Programs at Metro State College

As Director of the Center for Math, Science and Environmental Education (CMSEE), I have been involved in the development of outreach programs for the College for more than ten years. During that time, I have had projects for teachers ofDenver Public Schools as well as summer programs for Denver and other area school district students. All of these efforts have been aimed towards improving the teaching and learning of mathematics, science and technology. The two programs I wish to discuss here are called the Summer Science Institute (SSI) and the Summer Science Scholars Program (SSS).

The SSI is a ten-day activities-based summer camp for area middle school students. The SSS is a three-week science and math camp for high school students with the target of serving primarily underrepresented and minority students. Both camps have the general goal of keeping students in the pipeline in math and science.

The presentation will be about the origins, history, development and evaluation of each of these camps and I will have evaluative statistics to discuss regarding the success of the camps. The middle school camp is currently undergoing evaluation funded by the National Science Foundation. We are seeking to prove that these camps do indeed assist students in staying in the pipeline and that the camps help to prepare them for College attendance and majoring in STEM fields.

Mathematics and Popular Culture

Friday, August 11, 3:15 PM–4:15 PM
Saturday, August 12, 8:30 AM–10:30 AM

Dan Kennedy (dkennedy@baylor.chattanooga.net) Baylor School, PO Box 1337, Chattanooga, TN, 37401

NUMB3RS: From TV to the Classroom

The hit CBS TV show NUMB3RS has inspired a joint project by NCTM and Texas Instruments to write exploratory activities for high school and middle school students. One of the authors will explain the "We All Do Math Every Day" project and show some examples of the activities.

Sarah Greenwald (greenwaldsj@appstate.edu) Appalachian State University

rdrr: Math Comedy from The Simpsons & Futurama

Did you know that "The Simpsons" and "Futurama" contain hundreds of humorous mathematical and scientific references, put in by talented comedy writers who have advanced degrees in mathematics? Popular culture can reveal, reflect and even shape how society views mathematics, but care must be taken because studies have shown that stereotypical representations can actually discourage students. We'll use quotes from the writers to discuss the challenges of representing mathematics and mathematicians in Hollywood, and we'll examine numerous recent mathematical references, including the April 2006 episode of "The Simpsons" called "Girls Just Want to Have Sums" that was inspired by controversial comments made by outgoing Harvard University president Lawrence Summers. We'll explore activities from the shows that have been class-tested to alleviate math anxiety and explore significant mathematics. For more information see SimpsonsMath.com

Tim Chartier (tichartier@davidson.edu) Davidson College, Department of Mathematics, P.O. Box 6908, Davidson, NC, 28036

Putting a Spring in Yoda's Step

When the character Yoda first appeared on the silver screen, his movements were due to the efforts of famed muppeteer Frank Oz. In *Star Wars Episode II: Attack of the Clones*, Yoda returned to the movies but this time the character was not a puppet but a digital image within a computer. This talk will discuss the role, or more aptly the force, of mathematics behind a few aspects of movie special effects. Armed with differential equations, animators can create a believable flow to Yoda's robe or a convincing digital stunt person.

Christopher Barat (c.barat@comcast.net) Villa Julie College, 1525 Greenspring Valley Rd, Stevenson, MD, 21153

"The New Math" in Popular Culture

The would-be pedagogical revolution known as "The New Math" marked one of the first times that a development in mathematics attracted the attention of the wider American culture. This presentation will highlight some of the ways in which the public, as reflected in newspapers, magazines, and other media, was introduced to, formed popular images of, and ultimately discarded the influences of the "New Math" movement. In so doing, we will explore how popular culture can be used to illuminate trends in the history of mathematics and mathematics education.

Jihwa Noh (jihwa.noh@uni.edu) University of Northern Iowa, Mathematics Department, Cedar Falls, IA, 50614
Soo Hostetler (soo.hostetler@uni.edu) University of Northern Iowa, Art Department, Cedar Falls, IA, 50614

Proportions in the Music of Mozart

Connecting mathematics with other disciplines is one of the important goals of grade school mathematics classrooms and also many general-education mathematics courses taught at universities and colleges. A team of collaborative scholars in art, music and math will report on the analysis of many of Mozart's sonatas, showing that not only they divide into two parts at the golden section point but also musically important themes are proportionally balanced with the golden section in almost all cases. This golden section analysis will be presented in part by way of kinetic design using one of Mozart's famous sonatas, K.333.

Leigh Edwards (ledwards@english.fsu.edu) Department of English, Florida State University, Tallahassee, FL, 32306-1580

Subtracting Gender: Math in Popular Culture

This conference paper analyzes recent images of math and gender in popular culture. As an English professor, I use cultural theory and methodologies derived from literary studies. I am interested in conferring with mathematicians about popular culture representations of math, and I think that an interdisciplinary discussion could be quite productive.

This paper addresses the recent example of The Simpsons episode, "Girls Just Want to Have Sums," in which the character Lisa Simpson cross-dresses in order to take the boys' math class. I argue that the episode illustrates how television and film depictions often use math as a shorthand way to reference current debates about gender and intelligence. The episode does not substantively address mathematical content or teaching. Rather, it satirizes well-known stereotypes about girls and math and uses those themes to engage in broader satire of popular arguments about gendered intelligence, such as Harvard President Lawrence Summers's infamous 2005 comment about men perhaps having an "innate" advantage over women in scientific aptitude.

As the episode uses familiar math and gender stereotypes as an entry point to these broader issues, it implies that everyone agrees about what would constitute rigorous teaching in mathematics. The episode thus remains reductive about the discipline itself. It implies that both boys and girls should be encouraged to engage in a substantive math curriculum, and that none of the students should be afraid of math. Yet by leaving the scenes about math and teaching superficial, the episode does not do much to encourage students to think complexly about mathematics itself.

Christopher Goff (cgoff@pacific.edu) University of the Pacific

Movie Math: Mathematical Talent = Mental Illness

Recent Hollywood films such as *Pi* (1998), *A Beautiful Mind* (2001), and *Proof* (2005), have depicted mathematicians as lead characters. However, each of these films somehow conflates the character's mathematical ability with her or his mental illness or neurological health. This talk will catalog some of the subtle and not-so-subtle ways these films link mathematical talent with schizophrenia or manic behaviors; then will speculate on the effects such portrayals of mathematicians may have on students and on the general (non-mathematical) public.

Sarah Mabrouk (Smabrouk@frc.mass.edu) Framingham State College, 100 State Street, P.O. Box 9101, Framingham, MA, 01701-9101

Viagra, the Pill, and the Patch, Oh My!

Television, magazines, and newspapers bombard us with advertisements for prescription and nonprescription medications, making "the little blue pill", "the purple pill", Lipitor, and Prevacid, among others, familiar to all and a part of popular culture. In this presentation, I will discuss how these television and print annoyances become fantastic resources for discussion topics and examples for introductory statistics courses.

Laura Harrington (laura.harrington@asbury.edu) Asbury College, 1 Macklem Drive, Wilmore, KY, 40514

The Role of Mathematics in *The DaVinci Code*

This paper focuses on the mathematical ideas presented in the recent film release of *The DaVinci Code*. From the Fibonacci series to transposition codes, viewers are introduced to several topics typically covered in discrete mathematics. While the casual moviegoer will not understand the specifics of these links to mathematics, our students can be engaged to explore these ideas in more depth and with greater interest because of their connection to pop culture.

Advances in Recreational Mathematics

Saturday, August 12, 1:00 PM–3:00 PM

R. Douglas Chatham (d.chatham@moreheadstate.edu) Morehead State University, Department of Mathematics and Computer Science, 150 University Blvd., UPO Box 701, Morehead, KY, 40351
Maureen Doyle (m.doyle@moreheadstate.edu) Department of Mathematics and Computer Science, Morehead State University, Morehead, KY, 40351
Gerd H. Fricke (g.fricke@moreheadstate.edu) Department of Mathematics and Computer Science, Morehead State University, Morehead, KY, 40351
R. Duane Skaggs (d.skaggs@moreheadstate.edu) Department of Mathematics and Computer Science, Morehead State University, Morehead, KY, 40351
Matthew A. Wolff (mawolf01@moreheadstate.edu) c/o Department of Mathematics and Computer Science, Morehead State University, Morehead, KY, 40351

Separating Queens on the Chessboard

The classic n-queens problem asks for a placement of n queens on an $n \times n$ chessboard so that no two queens attack each other. We show that for any $k > 0$, if n is sufficiently large, then we can place $n + k$ queens and k pawns on an $n \times n$ chessboard so that no queen attacks any other queen. We consider the numbers of such placements, and we look at the effect that adding pawns to the board has on other chessboard placement problems.

Marc Renault (msrena@ship.edu) Shippensburg University, 1871 Old Main Drive, Shippensburg, PA, 17257

Stupid Divisibility Tricks

Why does the "rule of 3" work, and why is it so similar to the "rule of 9"? Is there a larger category of divisibility rules that these two belong to? Is there a rule for divisibility by 67? We collect together divisibility rules for the numbers 2–101, describing five broad categories they all fall into, and using (very) elementary number theory to explain why they work.

Irl Bivens (irbivens@davidson.edu) Davidson College, Box 6913, Davidson, NC, 28035

Wazir Circuits, Pick's Theorem, and Parity

A "wazir" is a now obsolete chess piece that moves exactly one square at a time vertically or horizontally. (It is sometimes referred to as a "single-step rook".) In this talk we will discuss an interesting parity result for wazir circuits on chess boards of arbitrary size. We allow our chess boards to be obstructed in the sense that movement into certain squares may be forbidden by "guideposts". Any square of the board without a guidepost will be called "acceptable". A "wazir circuit" is a sequence of moves in which the wazir begins in an acceptable square, ends in the same square, and visits every other acceptable square on the board exactly once. Our goal is to determine the parity of the number of moves the wazir makes in a specified direction (e.g., to the right) during a circuit.

Mihai Caragiu (m-caragiu1@onu.edu) Ohio Northern University, Department of Mathematics, Ada, OH, 45810

Recurrent Sequences Based on the Greatest Prime Factor Function

We will use the greatest prime factor function (gpf) to generate a class of prime sequences in the following way: $x(1) = p$ (an arbitrary prime) and $x(n+1) = \text{gpf}(a * x(n) + b)$, $n = 1, 2, 3, \ldots$, where a and b are two fixed positive integers. There are many interesting problems involving these "linear gpf sequences". Most interesting is what we called "the GPF conjecture": it appears that all linear gpf sequences are ultimately periodic! For example, if $a = 2, b = 1$ and p arbitrary, we eventually enter the period $3, 7, 5, 11, 23, 47, 19, 13$. We will use MATLAB to provide extensive computer evidence for the GPF conjecture. We also provide a complete proof of the special case of the GPF conjecture in which b is a multiple of a. In some special cases, we discover interesting connections with Mersenne primes.

Doug Ensley (deensl@ship.edu) Mathematics Department, Shippensburg University, Shippensburg, PA, 17257
Jeff Becker (jb3242@ship.edu) Department of Mathematics, Shippensburg University, Shippensburg, PA, 17257

On a Generalized Josephus Problem

The Josephus problem involves a "game" in which n people are arranged in a circle and every kth person is eliminated until only one person remains. This game is typically studied in beginning discrete mathematics courses as an example of recursive reasoning. When $k = 2$, there is a beautiful connection between which person remains and the binary representation of n, the original number of people. Students are somewhat crestfallen when this connection does not hold up for $k > 2$. This paper addresses a slightly different generalization of the Josephus problem in which a connection to base k numbers persists. The work is the result of a joint effort by a faculty member and an undergraduate student, and most of the conjectures were formed through explorations in Excel.

Charles Ashbacher (cashbacher@yahoo.com) Charles Ashbacher Technologies, 1300 Oakland Road #1419, Cedar Rapids, IA, 52402

A General Sudoku Problem Solving Program

The Sudoku style problem has become a mini-craze around the world. My daughter works on them for hours and hours and I have purchased several books for her to use. The problem is very easy to understand. An 81×81 grid is decomposed into nine different 9×9 grids. Each of the digits 1 through 9 is to appear once in each of these grids, and each digit can appear only once in every row and column. The values of some of the entries are given and it is the task of the solver to fill in the remaining positions. When I examined these problems for the first time, I noted that depending on the positions of the values that are given, the problem could either be very easy or very hard. After solving a few of the problems by hand, I noted that I was using certain patterns in finding the solutions. After a bit of thought, I began writing a program in the programming language Java designed to accept a problem and then determine the solution. This presentation is a report on my success in writing a general Sudoku problem solving program.

Jonathan Sondow (jsondow@alumni.princeton.edu) New York City

A Geometric Proof that e Is Irrational

We give a simple geometric proof that e is irrational, using a nested sequence of closed intervals. As a bonus, the proof yields a new measure of irrationality for e, involving the so-called Smarandache function. We make two related conjectures; both can be attacked by computer. One is on the greatest prime factor of an integer, the other on the partial sums of the Taylor series for e. See my note to appear in the August 2006 issue of the *Monthly*.

Bruce Torrence (btorrenc@rmc.edu) Randolph-Macon College, Department of Mathematics, Ashland, VA, 23005

The Locker Problem

The locker problem is well known in both the secondary and university curriculum. In November of 2005 it appeared as a "Puzzler" on NPR's Car Talk, attaining even wider circulation. It goes like this: A school corridor contains 1000 lockers, all shut. Imagine 1000 students walk the hallway in turn as follows — the first student opens every locker. The second student closes every second locker, starting with the second. The third touches every third locker, closing it if it is open and opening it if it is shut. This continues until all the students have marched. The question is: which lockers remain open after all the students have walked the hall?

In this talk I will present methods for dealing with the extended locker problem: If one wishes to keep a particular collection of the lockers open, which students should be dispatched? For instance, which students must march to keep open only the first locker? I will demonstrate both theoretical and computer-based modes of inquiry, and provide some powerful techniques and surprising results.

The Best Approximation of a Good Numerical Methods Course

Saturday, August 12, 1:00 PM–3:00 PM

Anthony Tongen (tongen@math.jmu.edu) James Madison University, Department of Mathematics and Statistics, MSC 7803, Harrisonburg, VA, 22807

Stepping to Success in Numerical Analysis

A huge challenge when teaching numerical analysis to undergraduates is discerning the amount and depth of material to cover. Should a good numerical analysis course include at an introduction to partial differential equations (PDE)? We believe that it should. Oftentimes, a good illustration can go a long way toward augmenting student understanding while not taking an inordinate amount of time. In this talk, we will discuss how solving a straightforward hyperbolic PDE can give the student insight into the solution of more general PDEs.

The technique is demonstrated by solving a simple hyperbolic PDE with a constant time step h and space step k. After analyzing this solution, we will discuss solving the aforementioned hyperbolic PDE with a time step h combined with two space steps of length $\frac{k}{2}$. By analyzing the latter case it appears that we have a new method with twice the time step restriction and half the error. Since this result sounds so good, what happens if we take m steps of length $\frac{k}{m}$? Can we take infinite steps?

Joan Weiss (weiss@mail.fairfield.edu) Fairfield University, Department of Mathematics and Computer Science, 1073 Norht Benson Road, Fairfield, CT, 06824-5195

The JW2 Computer & an Illusive 3×3 Linear System

Two short, but related concepts, will be described. The first is the JW^2 twelve-bit computer. The JW^2 computer illustrates finite digit arithmetic, the next largest and the next smallest machine numbers, overflow and underflow, etc. with equivalent base ten numbers students can easily fathom. The second is a contrived 3 by 3 linear system that results in an erroneous solution if directly solved via four digit rounding arithmetic, but produces a correct solution if partial pivoting is applied.

Betty Mayfield (mayfield@hood.edu) Dept of Mathematics, Hood College, 401 Rosemont Ave, Frederick, MD, 21701

Numerical Methods: Minimizing the error(s)

How (not) to choose a textbook for a numerical methods course. How to find interesting and useful material to supplement the text. How to strike a balance between theory and application. One survivor's true story.

David Coulliette (david.coulliette@asbury.edu) Asbury College, 1 Macklem Drive, , Wilmore, KY, 40390

Finite Difference Methods for BVPs

Using the finite difference method (FDM) for 1-dimensional boundary value problem (BVP) solutions provides an excellent platform to review several vital numerical methods and introduce a powerful technique for attacking a wide variety of applications. A computer algebra system like Maple is the ideal environment for teaching these techniques; the right combination of demonstration and student discovery allows the student to focus on the major concepts free of the tedium that hampered understanding in years past.

Assuming a basic background in differentiation approximations and linear and nonlinear system solution that would be typical for an undergraduate student in the last third of a numerical methods course, this paper presents a straightforward plan for implementing FDM on linear BVPs first, and then extends the method to nonlinear BVPs.

The key to successful student assimilation is balancing what parts to give or demonstrate versus what concepts to allow the students to discover on their own. The danger for the overly enthusiastic instructor is to provide an elaborately-coded worksheet which requires very little student input. This mistake leaves students with a false impression of confidence: they can solve many typical problems with the instructor's worksheet but they often fail to understand the principles behind the solution. The fundamental contribution of this paper is to share the most effective combination of student assignments that have been developed over several years of trial-and-error (many errors!) classroom experiences at the undergraduate level and provide a forum for learning from the shared experiences of others.

Kyle Riley (kriley@taz.sdsmt.edu) South Dakota School of Mines & Technology, 501 East Saint Joseph Street, Rapid City, SD, 57701

Introduction to Cellular Automata

Cellular Automata have long been a topic of study in the computational sciences, but have not been traditionally a part of a numerical methods course. The ideas that drive the construction of cellular automata can be very intuitive and students often find these tools very interesting. This talk will provide a very basic introduction to cellular automata and illustrate their use with a couple of examples. There will also be connections made between the implementation of cellular automata and a few of the more traditional topics from numerical methods.

Richard Neidinger (rineidinger@davidson.edu) Davidson College, Dept. of Mathematics, Box 7002, Davidson, NC, 28035-7002

Automatic Differentiation, MATLAB and OOP

Most students leave numerical analysis thinking that derivative or series computations require either symbolic manipulation or some kind of difference approximations. Automatic differentiation shows an alternative where exact rules (no approximation) are used on numeric values (so only roundoff error). It makes a very convenient tool within the numerical environment of MATLAB. Normal function expressions take a numeric value of the variable(s) and return a numeric value. The same expressions can take and return objects that include derivative or series values. This naturally introduces object-oriented programming and uses simple algorithms to overload the operators (+, *, sin, exp, etc.) to manipulate these objects. While these are valuable lessons, the resulting tool can be used whenever you need a derivative, gradient, Jacobian, or series in subsequent methods. This can clearly be applied in Newton's rootfinding method for a one-variable equation and, just as simply, for a system of multi-variable equations using the matrix and vector facility of MATLAB. High-order Taylor series method for solving ODE's can be made practical using series objects.

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James Rolf (jim.rolf@usafa.af.mil) 2354 Fairchild Hall, Suite 6D2, Dept of Mathematical Sciences, USAF Academy, CO, 80840

A Discovery-Based Interpolation Assignment

The mechanics of fitting a curve through a set of discrete data points is reasonably straightforward; what is harder is getting students to visualize and internalize similarities and differences between different types of interpolations. We have developed a Java applet that allows students to visually explore interpolation of any user-specified function via polynomial interpolation, natural splines, least-squares fits, Taylor series polynomial expansions, Chebyshev polynomials, and Legendre polynomials. This applet is flexible enough that students can explore many different facets of curve-fitting but still has a user-friendly interface. Users can easily add and move nodes, change the order of approximation(s), and view as many (or as few) of the approximations concurrently as desired.

We have also created a discovery-based writing assignment that leads students through a series of experiments and encourages them to look for patterns and connections in order to better understand the strengths and weaknesses of each approximation technique. Students write an essay in which they connect the theory learned in class with observations made during experimentation. Here, we demonstrate the ApproxTool applet and discuss our implementation of this discovery-based learning-focused assignment.

Cynthia Wyels (cynthia.wyels@csuci.edu) California State University Channel Islands, Mathematics, One University Drive, Camarillo, CA, 93012

Electronic Materials for Numerical Methods

An overview of two types of course materials will be provided: 1) electronic and hard-copy worksheets to facilitate the introduction of new topics (e.g., Gaussian elimination and scaled partial pivoting), and 2) labs designed for students to explore the underlying concepts of a particular numerical method (e.g., splines). The examples and other course materials will be made available for adoption/ adaptation through a website.

Research into Practice: The Teaching and Learning of Undergraduate Mathematics

Saturday, August 12, 3:15 PM–5:15 PM

J. White (jacci.white@saintleo.edu) 408 Sunset Dr. S., St. Petersburg, FL, 33707
Monika Vo (monika.vo@saintleo.edu) Saint Leo University, 7543 Kickliter ln, Land O Lakes, FL, 34637

Student Success Using My MathLab in Finite Math

In this study student test scores and final course grades were analyzed in Finite Mathematics Online and Introductory Algebra in person. Statistically significant differences were found between online students who utilized My MathLab as a learning resource tool and those who did not in Finite Mathematics. No differences were found between students who utilized My MathLab and those who did not in Introductory Algebra.

Raymond Boute (Raymond.Boute@pandora.be) Sint-Pietersnieuwstraat 41, Gent, Belgium, B-9000

Proofs as Calculations in Undergraduate Analysis

Certain results from research on formal methods in systems modeling offer far-reaching opportunities in undergraduate mathematics.

One such result is a notational design approach that avoids the numerous defects (ambiguities, inconsistencies etc.) in traditional conventions. Educationally this eliminates many sources of confusion, misconceptions and counterproductive attitudes.

The most important result is a set of *practical* rules for letting mathematical reasoning be guided by the shape of the formulas. Educationally this eliminates the traditional distinction between calculations and proofs, thereby lowering the threshold that keeps many students from making the crucial transition between mathematics as just a bag of tricks or facts and mathematics as a systematic style of reasoning.

In undergraduate calculus, for instance, manipulation of derivatives and integrals is fairly smooth thanks to well-established calculation rules. By contrast, the logical arguments in analysis justifying these rules are traditionally far less systematic. They are typically expressed in words, using logical operators and especially quantifiers ($\forall$, $\exists$) by *syncopation*, i.e., as mere abbreviations for pieces of text ("for all", "there exists") rather than as a powerful logical calculus for reasoning. Worst-case examples are the usual δ-ϵ arguments about limits, continuity and so on.

A *functional predicate calculus* casts all logical arguments in a clear and elegant calculational style, not only for exposition but also as a tool for discovery. It is shown how this unifies expression and reasoning in areas as far apart as mathematical analysis and program semantics. In the same vein, calculating with *concrete generic functionals* removes all notational defects reported in the literature concerning transform methods (Fourier, Laplace) and allows deriving relationships that are hard to express with traditional conventions.

As for any departure from custom, acceptance in educational environments is quite variable: enthusiastic by the better students, favorable by the majority, unfavorable by weaker students (who dislike proofs in any form as a matter of principle) and conservative calculus teachers (who prefer sticking to habit), as literature references and case examples briefly illustrate.

For further information, see `www.funmath.be`.

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Cecelia Laurie (claurie@as.ua.edu) The University of Alabama, Department of Mathematics, Box 870350, Tuscaloosa, AL, 35487-0350

Evaluation of Elementary Preservice Mathematics

Will report of preliminary results of an evaluation of mathematics courses designed for elementary education majors. This evaluation includes external practicing teacher reviews, student learning assessment using LMT and DTAMS instruments, and student anxiety ratings using MARS-30. The results of the evaluation are being used to further revise the courses which went through a major revision three years ago.

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Douglas Meade (meade@math.sc.edu) Department of Mathematics, University of South Carolina, Columbia, SC, 29208

Maplets for Calculus

Maplets are Java applets written with Maple that retain all the algebraic computational power of Maple. Most of the Maplets available with Maple either display something or compute something avoiding the standard Maple syntax. The authors have written a collection of Maplets for Calculus which are more pedagogical in nature in that they ask a student to do something, provide some hints and guidance along the way, and inform the student if their responses are correct or incorrect. The Maplets try to improve the students' intuitive and computational abilities while covering graphical, numerical and analytical aspects of calculus.

The table of contents for over 40 Maplets and sample videos may be viewed at `calclab.math.tamu.edu/maple/maplets/`.

Hortensia Soto-Johnson (hortensia.soto@unco.edu) University of Northern Colorado, 838 Roma Valley Drive, Ft. Collins, CO, 80525

Evaluating Students' Abstract Algebra Knowledge

Assessing students' knowledge of abstract algebra via traditional methods such as, homework and tests can lead to incomplete conclusions regarding the students' comprehension. In an attempt to better assess my students' knowledge in a first and second semester algebra course, I incorporated oral components to the midterm and final. I will discuss the format of the interviews, the students' reactions to this assessment and how these interviews painted a picture of my students' abstract algebra knowledge. Through these oral assessments I discovered some students could not write a formal proof, but were able to articulate the structure of the proof. Furthermore I will address how this personal inquiry research guided my teaching.

Joy Becker (beckerjoy@uwstout.edu) University of Wisconsin-Stout, P.O. Box 790, Menomonie, WI, 54751

The "Perfect" Related Rates Lesson

The topic of related rates often causes anxiety in calculus students. This year, a group of faculty at the University of Wisconsin-Stout decided to complete a lesson study project on the topic of related rates. Lesson study is a process of collaboratively planning, teaching, observing, revising, and reporting results from one class lesson. Through this project, we created the "perfect" related rates lesson. The project design will be shared, as well as preliminary results from the project. Our project is being funded through a Lesson Study Training Grant from the Office of Professional and Instructional Development of the University of Wisconsin System.

David Ewing (ewing@cmsu1.cmsu.edu) Dept. of Math & Computer Sci, Central Missouri State University, Warrensburg, MO, 64093

Geometry on a HubCap!

What geometry can exist on the surface of a Hubcap, Kiss, Saddle or a Donut? Teach Geometry more effectively by having students create their own geometries on these surfaces. Several lessons will be demonstrated and will include Creating Definitions, Exploring Shapes and Their Relationships, Formulating Theories, and Writing Proofs.

Mathematical Modeling, Projects, and Demonstrations that Enhance a Differential Course

Saturday, August 12, 3:15 PM–5:15 PM

Joe Harris (harrisjt@sapc.edu) Saint Andrews Presbyterian College, 1700 Dogwood Mile, Laurinburg, NC, 28352

A Least-Squares Approach to Modeling

Using differential equations to model real-world phenomena is an important part of any introductory differential equations course. Such experiences can be particularly poignant and educational if they involve the modeling of real-world data collected by the student. In this presentation, we will look at ways to fit a differential equations model to experimental data using a least squared differences approach.

A good introduction to a problem of this kind is the well-known Newton's Heating and Cooling law type of problem. Numerical data collection for a heating or cooling object is relatively straightforward using standard data collection equipment. Even seasoned instructors may be surprised that the standard Newton's law model does **not** give a particularly good fit. A better fit can be achieved by using a more sophisticated model:

$$\frac{dT}{dt} = a_3T^3 + a_2T^2 + a_1T + a_0 \tag{1}$$

The student (and the instructor!) learn to fit the model to the numerical data by requiring that the sum of the squared differences between the predicted and actual temperatures are minimized. Thus we find a minimum for the function:

$$\Delta^2(a_0, a_1, a_2, a_3) = \sum_{i=1}^{n} (T(t_i) - T_i)^2 \tag{2}$$

Another physical situation which may be modeled using this method is the situation of a bacterial colony growing in a nutrient solution. Biologists are familiar with the "log," "stationary," and "death" phases of such a population. The population grows, reaches a logistic plateau as the carrying capacity of the available resources are met, and then decays as those resources are exhausted and as waste accumulates in the environment. A very rough model of this situation can be given by the system

$$\frac{dP}{dt} = \kappa P(L - P) - \alpha w P \tag{3}$$

$$\frac{dL}{dt} = -P \tag{4}$$

$$\frac{dw}{dt} = P \tag{5}$$

with initial conditions

$$P(0) = P_0 \tag{6}$$

$$L(0) = L_0 \tag{7}$$

$$w(0) = 0 \tag{8}$$

Here $P(t)$ is the population of the colony, $L(t)$ represents the capacity of the environment to sustain the bacteria, and $w(t)$ is the amount of waste in the environment. Thus the parameters of the model are P_0, L_0, κ, and α. As before, we find suitable parameters by requiring that the sum of squared differences between the predicted and actual population values be minimized.

The above model is rough; there are ample opportunities for refining it and expanding upon it. Thus there are opportunities for expanding the student's work with differential equations into the sphere of student research.

The above gives an indication of the kind of modeling projects that can be handled using the least squares method, and there are others. By including projects which involve the modeling of real-world data, we can both expand our students' awareness of the uses of mathematics, and attract students of other disciplines to our differential equations courses.

Olga Brezhneva (brezhnoa@muohio.edu) Miami University, 123 Bachelor Hall, Department of Mathematics and Statistics, Oxford, OH, 45056

Games for Review in Differential Equations Course

In this talk, I will discuss and illustrate games that I am using in teaching Differential Equations. It is well known that many people learn better when they are actively involved in learning activities. The main purpose of the games that are used in teaching mathematics is to increase student knowledge of the subject in an interesting form that motivates their learning. In choosing a type of the game the most important criterion for me is keeping the instruction at the appropriate learning level. Using games for review helps students put all of the material and concepts together. One of my goals in using games is not only make students apply the knowledge they had grasped from the course, but also challenge them by showing problems that they did not see before. In addition to this, an appropriate game is a good way to make students think about answers to questions of "how" and "why" in addition to "what," hence, this is a way to deeper understanding of the subject. The comments received from students as well as exam results indicate that the games were an effective form of teaching Differential Equations.

David Torain (dtorain@juno.com) Clark Atlanta University, 5749 Cove Lane, Lithonia, GA, 30058

An Analytical Approach to the Bio-economic Dynamics of a Fishery, Which Includes Simultaneous Harvesting of Other Species.

This bio-economic model reduces essentially to a set of parametric coupled non-linear differential equations. The major difficulty stems from the fact that sixteen external parameters appear in various places in the equations. As of today, only numerical methods have been developed to investigate this problem. The practical impossibility to handle such large parametric space obscures the understanding of the main features of the solutions of the equations. A new approach that is analytical and not numerical is proposed. This approach is based on the remark that when one of the sixteen parameters is sent to infinity, the general solution, involving the remaining fifteen parameters can be expressed in terms of elementary functions. This is made possible because, in this limit, besides the time invariance group, an exact invariance scaling group exists. Then the traditional perturbation method of relatively bounded operators can be applied to the exactly solvable previous equations. Furthermore, it seems that the value of the perturbation parameter corresponding to real world fisheries is itself very large. We, therefore, expect excellent results to be achieved with only a first order perturbation. In order to try to get a global view of the harvesting problem modeled by these types of equations, we have made a dimensional analysis of the sixteen parameters appearing in the equations. We have been able, in all generality, to reduce them to three fundamental dimensionless parameters that carry all the features of the system. This allows making a full analytical study of the fixed points or stationary points of the system. Besides the standard fixed point, two "catastrophic" new fixed points have been studied. These are called "catastrophic" because they lead to an exhaustion of the biomass. A global study of the relevance of each stationary fixed point over the range of the dimensionless parameters is presented.

Talitha Washington (tw65@evansville.edu) University of Evansville, Department of Mathematics, 1800 Lincoln Avenue, Evansville, IN, 47722

Modeling the Spread of Gonorrhea

In this talk, a project that investigates modeling the spread of gonorrhea will be discussed. In the United States, gonorrhea is one of the most common infectious bacterial diseases. The disease is spread by sexual contact and, if left untreated, can result in pelvic inflammatory disease, blindness, infertility, arthritis, and possibly death. Under certain assumptions, we can construct a nonlinear system of first order differential equations that describes the spread of the disease. Using pplane, we can modify parameters to analyze the spread of the disease so that a public policy can be recommended. In addition, we also recognize the strengths and weaknesses in the model.

Kenneth Stolarsky (stolarsk@math.uiuc.edu) University of Illinois, Math Dept, 1409 W. Green Street, Urbana, IL, 61801

Radioactivity as motivation

Turning points are omitted from every introductory differential equations text known to the speaker (aside from one footnote in one text) but can be used to give beginners a non-trivial glimpse into Schrodinger's equation after exposure to the classical harmonic oscillator. The motivation requires only a naive notion of radioactivity. Moreover, the bare fundamentals of radioactive decay can be used not only to discuss age of the earth controversies, but also to motivate convergence acceleration with concurrent applications to the calculation of Pi, and some remarkable infinite products.

Catherine Cavagnaro (ccavagna@sewanee.edu) University of the South, 735 University Avenue, Sewanee, TN, 37383

Modelling Aircraft Longitudinal Motion

When disturbed from straight and level flight by a sudden gust or inadvertent pilot input, an aircraft will pitch up and down. Whether it returns to the original condition and, if so, in what manner are governed by its inherent longitudinal stability characteristics. Some aircraft are equipped with stability augmentation systems to repair poor handling characteristics. We will describe a research project in which a single engine aircraft with a stability augmentation system was set up to share the same longitudinal characteristics as twin engine aircraft in configurations that varied from good to unacceptable.

Charles Hampton (Hampton@wooster.edu) The College of Wooster, Mathematics Department, Wooster, OH, 44691

Surgical Solutions in Differential Equations

First order linear differential equations can be used to model transfusions in the operating room. When and how ought blood plasma be given to a patient rather than normal saline? How much additional blood loss and/or additional time can the patient tolerate? It's a classic mixture problem with a few twists. I have used this illustration often in my first Differential Equations course.

Jim Rolf (jimrolf@yahoo.com) Math Department, 2354 Fairchild Hall, Suite 6D124, USAF Academy, CO, 80840-6252

Modeling the War of Nieberian Aggression

I present a project utilized in a sophomore differential equations course to model a fictional ground war. This project required students to construct and analyze a four-dimensional, non-linear model of warfare using qualitative and numerical techniques. I will discuss assumptions inherent in modeling both directed and undirected fire in ground warfare and how these assumptions can be modified to further integrate the effects of fratricide and airpower on a ground battle. Students used their newly constructed model to suggest policy for decisions regarding resource expenditure on the training of existing troops versus increasing the number of untrained troops. These policy recommendations were guided by an eigenvalue/eigenvector analysis of a linearized version of their warfare model. I will discuss various student implementations of these techniques and demonstrate freely available software that students used to numerically solve their four-dimensional system.

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Kenneth Grosselin (kenneth.grosselin@usafa.af.mil) P.O. Box 1633, USAF Academy, CO, 80841

A MATLAB-based 3D Vector Flows Visualization Tool

Most introductory differential equations courses focus primarily on two-dimensional systems. However, the addition of the third dimension adds the potential to explore much more interesting behavior. Teaching three-dimensional systems can be challenging for instructors, as few tools are available to assist in easy visualization. Here, we introduce a MATLAB-based tool named Flows3D, written by Kenneth Grosselin as part of a project for an undergraduate Dynamical Systems course taught by Michelle Ghrist. We demonstrate this program on both linear and nonlinear systems and also show how Flows3D can be used to expose students to chaotic systems and strange attractors.

General Contributed Paper Session

Thursday, Friday, and Saturday, August 10–12, 1:00 PM–5:15 PM

Jay Schiffman (schiffman@rowan.edu) Rowan University, 200 North Broadway, 201 Mullica Hill Road, Camden, NJ, 08102

A Survey of Collatz k-tuples Employing Mathematica

The famous Collatz sequence is defined as follows: Take any positive integer n. If n is even, divide by 2. If n is odd, triple and add 1. Repeat this process on each new number obtained. The Collatz Conjecture asserts that after finitely many steps, one reaches the integer 1. This problem has been verified for all integers $\leq 3 \times 2^{53}$ but remains unsolved to the present day. Probably more computer time has been associated with the Collatz problem than any other. Related to the Collatz problem is the notion of a Collatz k-tuple. A Collatz k-tuple is a sequence of k consecutive intitial values $C[0]$ for which the Collatz sequence has the same length. For example, the integers $\{65, 66, 67\}$ all have length 27 in the sense that it takes 27 iterations to reach 1. We do not count the initial value in determining the length of the integer. In this paper, we will present the first occurrence of Collatz k-tuples for k in the range $[1, 32]$. In addition, we will seek the initial values for which the Collatz sequence has lengths from 1 to 300 inclusive as well as the initial collatz k-tuples associated with these lengths if they exist. We will attempt to resolve the following questions: Is there an upper bound for the number of steps required to reach 1 for a given integer via this iterative procedure? Do Collatz k-tuples (where $k \geq 2$) exist for every length? We will conclude by illustrating some interesting Collatz k-tuples with certain prescribed lengths. Please join us to witness the interface of a classical problem in number theory and the CAS Mathematics in generating interesting explorations and discovering neat mathematics.

Meredith Greer (mgreer@bates.edu) Bates College, 213 Hathorn Hall, Lewiston, ME, 04240

Roller Coasters and the Mathematics Behind Them

Amusement park roller coasters excite us, scare us, and capture our imagination. What records will designers break next? How do they create rides that are exhilarating, yet physically safe? Most riveting of all: what part does mathematics play in all this?

In a class requiring just one semester of Calculus as a prerequisite, we considered these questions and more. In this talk, learn why the twists and turns of some rides throw us from side to side, yet others feel completely smooth. Then consider the “design flaw” that causes the new strata-coasters to nearly stop, or even slide backward, as riders crest their 400-plus-foot-tall hills. The math involved already appears in undergraduate classes, but the application to roller coasters has helped students to understand vectors, parametric equations, and other concepts in a new — dare we say visceral? — way.

Sandra Caravella (scaravella@njcu.edu) New Jersey City University, 2039 Kennedy Boulevard, Jersey City, NJ, 07305

Describing the Accuracy of Ptolemy’s Models

In this paper we survey some of the literature regarding the accuracy of Ptolemy’s models of planetary motion, particularly for the planet Mars. Estimates of the error inherent in Ptolemy’s longitude model for Mars vary and depend on the method used to estimate it. For example, one source puts the maximum error at 55 minutes, while another puts it at 4 and a half degrees! This presents something of a conundrum to the history of mathematics instructor who wants to present accurate and concrete information to his or her students. We examine some of the issues surrounding how to best determine and describe the error inherent in Ptolemy’s models, and present our own analysis of the models’ accuracy.

Michael Catalano (micatala@dwu.edu) Dakota Wesleyan University, 1200 University Ave. W., Mitchell, SD, 57301

College Algebra in the Context of Real-World Data

A report on a National Science Foundation CCLI-EMD project supporting the development and implementation of a learner-centered, inquiry-intensive, data-driven, activity-oriented college algebra course, incorporating realistic problem situations emphasizing social and economic issues, including hunger and poverty, energy, and the environment. The project seeks to address two national needs, namely a need for U.S. citizens with a greater level of quantitative literacy, and a need for improved mathematics education for K–12 teachers. Pilot sections of the course have been taught using tablet laptop computers, supplemented with the use of graphing calculators. The project is also intended to help support the mission of the McGovern Center for Public Service, developed to celebrate the life and continue the legacy of Senator George McGovern, an alumnus of Dakota Wesleyan University. The project is influenced and informed by Andersen and Swanson, *Understanding Our Quantitative World*.

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Metric Regularity for Variational Systems

This paper mainly concerns with the applications of generalized differentiation theory in variational analysis to metric regularity of generalized equations and variational systems. The basic tool we used is the coderivative characterization of metric regularity and we are able to compute the so-called reversed mixed coderivative for these two important systems in optimization theory and establish new conditions that ensure the metric regularity of such systems around a particular solution of the systems. I will demonstrate the concept of metric regularity using simple examples from the theory of matrix computations.

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Deranged Socks

A classic combinatorial technique is the principle of inclusion-exclusion, used for counting the number of elements in some universal set which satisfy none of n different properties. A classic application of this principle is to show that the number of derangements of n objects is $D_n = n!\left[\frac{1}{0!} - \frac{1}{1!} + \frac{1}{2!} - \dots + \frac{(-1)^n}{n!}\right]$. An immediate consequence of this formula is that the fraction of all permutations that are derangements quickly converges to $1/e$ as $n \to \infty$. The principle can also be used to solve the following exercise from Alan Tucker’s *Applied Combinatorics*: Given five pairs of gloves, how many ways are there for five people each to choose two gloves with no one getting a matching pair? If we replace gloves with socks, and assume we cannot distinguish a left sock from a right one, the problem becomes surprisingly more difficult. The generalized Deranged Sock Problem is: Given n distinct pairs of socks, how many ways are there for n people each to choose two socks with no one getting a matching pair? If we attack this problem with the principle of inclusion-exclusion, then it suffices to solve the more general Universal Sock Problem: Given n distinct pairs of socks, how many ways are there for n people each to choose two socks? In graph theoretical terms, we are counting d_n, the number of 2-regular bipartite (vertex-labeled) graphs of order $2n$, and u_n, the number of 2-regular bipartite (vertex-labeled) multigraphs of order $2n$. Using recurrence relations to compute values of d_n and u_n, we can see d_n/u_n also approaches $1/e$ as $n \to \infty$. An explanation of this behavior involves the uses of partitions, cyclic permutations, complex analysis and "double-exponential" generating functions.

Laura Taalman (taal@math.jmu.edu) James Madison University, Department of Mathematics, Harrisonburg, VA, 22807

Teaching the Derivative One Rule at a Time

Introducing and proving the differentiation rules one at a time throughout a calculus course can be a worthwhile alternative to presenting them all at once. Building up the differentiation rules slowly and systematically can provide opportunities for better understanding not only of the derivative, but also of the nature of mathematics and simple proofs. This method can be particularly beneficial to students who struggle in calculus due to weak precalculus and algebra backgrounds.

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Bisections and Reflections

We consider the set of angle bisectors of an arbitrary polygon and discover that repeated reflections across these lines often displays an interesting property. In particular we show that for any polygon with an odd number of sides, a point on any side will return to its original position after a finite number of reflections that is either one or two times the number of sides. Additionally, for a polygon with an even number of sides, a point is guaranteed to either return to its original position as soon as possible or not at all.

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Online Java Package IAPPGA for Graph Algorithms

Teaching and learning graph algorithms is a great challenge to both instructors and students. Instructors are seeking software that is specifically designed to demonstrate the algorithms and for students to learn these algorithms efficiently. The software program should be readily available and provide an environment so that students are able to review the algorithm, solve a practical problem, and intuitively study the working process via a graphical display all together. I developed such an online program package (IAPPGA) for teaching and learning graph algorithms. I have applied my preliminary work to my teaching, and received very positive reaction from my students. This package can be accessed via an Internet browser at any time, anywhere without downloading or installing any software. A paper entitled "Teaching Graph Algorithms Using Online Java Package IAPPGA" was published on the journal SISCGE inroads. (Volume 37, Number 4, December 2005). I will be presenting and demonstrating this package.

Ollie Nanyes (onanyes@yahoo.com) Mathematics Department, Peoria, IL, 61625

Limits of Functions of Two Variables

When introducing the concept of a limit of a function of two variables, one usually gives an example of a function which fails to be continuous at a point because its limit differs as one approaches the limit point along different paths. For example: $\lim_{(x,mx)\to(0,0)} x^2/(x^2+y^2) = 1/(1+m^2)$ which differs with m. Of course, one adds the caveat that one cannot prove that the limit exists merely because the limit exists when the function is evaluated along a generic class of paths. For example, there are functions which have the same limit at the origin when evaluated along all paths of the type: $y = mx^{p/q}$ or along all analytic paths and yet fail to have a limit at the origin.

In this talk, we show that a necessary and sufficient condition for a two variable function to be continuous at a point is that it has a limit when evaluated over every C^1 path through the given point.

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Kaleidoscope

In this talk we will discuss the mathematics of the kaleidoscope. Along the way we will see tie ins to several different mathematics courses along with plenty of lovely images from kaleidoscopes.

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Popular Math Talks for Bright Students and Others

What do Art Benjamin, John Conway, Persi Diaconis, Joe Gallian, Ron Graham, Hendrik Lenstra, Frank Morgan, Carl Pomerance, Jennifer Quinn, Donald Saari, Doris Schattschneider, etc., have in common? Yes, they have all given MAA invited national addresses, but they have also given talks in our very successful Bay Area Mathematical Adventures (BAMA) series. Our free talks by outstanding mathematicians are aimed at bright high school students, but they also attract many parents and teachers, and even some adults and younger students who just like mathematics.

We will describe some important features of the fifty BAMA talks that have been given over the past eight years in the San Jose, California, area. For example, which topics are the biggest draws? (Hint: number theory, combinatorics, and recreational mathematics are among the winners.) We will also discuss some nuts and bolts for implementing a successful series:

- Reaching such a diverse audience;
- Financial issues, such as honoraria (modest), travel money (rare), and possible outside financial support;
- Logistical tips, such as which evenings are best, and combining BAMA talks with local university colloquia or MAA section talks for out-of-town visitors.

Some MAA members who are from large metropolitan areas might consider offering a similar series of general-interest talks. A complete list of all past BAMA talks, including their titles, abstracts, and some photos of speakers, is at our website www.MathematicalAdventures.org. Many of the speakers might be willing to repeat or update their talks elsewhere.

Finally, the MAA paperback "Mathematical Adventures for Students and Amateurs" (291 pages, 2004) contains articles based on nineteen BAMA talks from its first five years.

Mike Pinter (pinterm@mail.belmont.edu) 1900 Belmont Blvd, Nashville, TN, 37212

"Popular" Mathematicians in an Honors Course

In a course I teach for Belmont University's Honors Program, I incorporate several readings, discussions and assignments that expose the students to contemporary mathematics through the lives of several mathematicians. For example, *The Man Who Loved Only Numbers* (by Paul Hoffman) is a required course text that provides a rich look at Paul Erdős. The class views and discusses The Proof video (from the PBS television Nova series) which examines the story of Fermat's Last Theorem and Andrew Wiles' proof of the theorem. Early in the term, the class reads about Robert Moses and discusses his work with the Algebra Project. Direct references to John Nash, including some excerpts from the book *A Beautiful Mind*, are included in a brief study of voting methods. In addition to having the students write a variety of response essays during the course, tests and problem sets include questions or activities that incorporate elements from the readings where possible.

My primary objective for including these popular culture elements is to inform and challenge the students' perceptions of mathematics and those who do mathematics.

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Linear Optimization: the Simplex Workbook

This is a project funded by NSF-CCLI-EMD to create a new format of upper-level mathematics textbook that is amenable to use in a discovery method setting. We will discuss the approach of my co-author Garth Isaak and myself by example, as well as display some tools we have developed for this purpose. We will also present some preliminary assessment of the approach, based on the several classrooms in which it has been piloted so far.

Elena Constantin (constane@pitt.edu) Department of Mathematics, 130 Krebs Hall, 450 Schoolhouse Road, Johnstown, PA, 15904

Higher Order Sufficient Optimality Conditions

The talk provides some higher order sufficient conditions for a constrained minimization problem with C^n data, $n \geq 2$. We analyze some examples for which the second derivative test fails and/or the method of Lagrange multipliers can not be used.

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Enhancing Student Motivation through Software

Using technology for assessment and evaluation is becoming increasingly popular in mathematics classrooms across the country. While the type of software and degree of implementation greatly varies, the ultimate goal of software incorporation should be increased student involvement, understanding and comprehension. To explore how software enhances student motivation, we will discuss the impact of such features as intelligent feedback, tutorials and mastery-level homework assignments on students in our college algebra and developmental classes. We will also discuss how our department has successfully incorporated software in all of its developmental and entry-level courses to facilitate assessment, monitor progress and encourage students to take an active role in their education.

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Bifurcations in a mammalian cell cycle model

Protein interactions which regulate mammalian cell cycle control are described by a system of coupled, nonlinear ordinary differential equations. A seven-variable system developed to model the phases of DNA synthesis (S) and Mitosis or cell division (M) of the cell cycle is presented. Bifurcation analysis of this system is performed and some significant results are discussed. In particular, a period doubling cascade exhibited by the model is addressed and compared with existing biological results.

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How do we combat math anxiety?

Popular culture says that math is hard and boring. It tells us that mathematics is an elusive subject that can never be understood. Tell anyone that you teach math, and nine times out of ten, you are met with a negative reaction. With such a strong cultural influence, how can we change our students' perception of math?

Although a single remedy does not exist, I believe we can make positive steps towards a change. I will highlight a handful of things that I have done in my classes to fight math anxiety. Setting a tone at the beginning of a College Algebra class can make a difference in the long run. Being a cheerleader for a lagging Quantitative Reasoning class can affect student performance. I will give examples from my classes and discuss students' evaluations at the end of the course. I once had a student remark, "I can't believe I'm saying this, but math is my favorite course this semester." Not all of our students will come to this realization, but we can steer them in a more math-positive direction.

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Moore's Law and Semilog Plots

One of the most important cultural phenomena of the last 50 years has been the development of the silicon-chip based computer. What has made such an instrument possible? A partial explanation is given by Moore's law, which says in part that the number of transistors that can economically be fit on a silicon chip grows exponentially with time. This growth law was discovered by Gordon Moore, co-founder of Intel, in 1965. Now we can pique our student's interest in **how** this growth came about, and guide them in learning about the uses of semilog plots.

The objective of this presentation, then, is to demonstrate a project that will guide students in discovering Moore's law for themselves. Students work with data on the number of transistors on a chip as a function of time, taken from the Intel website. Students see that the common log of the number of transistors is indeed approximately a linear function of time. They model the growth of this function using an exponential function and are able to see why new versions of programs like windows tend to come out every two to three years.

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Quality Adjusted Lifetime Hazard Function

One of the important parameters of interest in survival analysis is the cumulative hazard function. Our main goal in this paper is to find and evaluate estimators of the cumulative hazard function of the quality adjusted lifetime. This paper proposes several classes of monotonic estimators for the survival function of quality adjusted lifetime. All proposed estimators are shown to be consistent. This paper also proposes three estimators for the cumulative hazard function of restricted quality adjusted lifetime (RQAL). These estimators are derived from monotonic estimators of survival functions of quality adjusted lifetime. When the RQAL is equal to overall lifetime, the proposed estimators are shown to reduce to the Nelson-Aalen estimator. A simulation study is performed to compare these estimators.

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A Comparison: Biocalculus and Calculus Students

In an effort to better prepare research oriented biology majors for the increasing level of mathematical background needed for their future coursework and research, the Department of Mathematics at Benedictine University began to offer a rigorous two-semester biocalculus sequence for this audience in the Fall of 2003. The biocalculus course sequence has a greater emphasis on using and understanding biological data and models than the traditional calculus sequence, but it is delivered with the same level of mathematical rigor as the traditional course. Our biocalculus courses are designed so that students taking either the first semester biocalculus or traditional calculus course can succeed in the second semester course of the other sequence. Additionally, we have designed our second semester biocalculus course so that students completing this course would be able to succeed in a traditional third semester calculus course.

To confirm ease in transition between the biocalculus and traditional calculus sequences, we have begun to track student progress in both the traditional and biocalculus sequences. We track performance on common final exam problems on basic calculus content and performance in a joint laboratory course for both biocalculus and traditional calculus students. We also track the percentage of the students in each track who continue to and succeed in the subsequent calculus course (either second or third semester courses). Our preliminary data indicate that students from both tracks have comparable calculus skills. Interestingly, a greater percentage of biocalculus students do continue with the second semester course. As our biocalculus course is particularly geared toward students who will pursue research activities as undergraduates, we are also tracking those who become involved with undergraduate research and those who continue to pursue graduate work in the sciences. A good number of the biocalculus students do indeed become involved with research activities.

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Teaching the Big Picture in Calculus

A common problem when teaching calculus is that students perceive calculus as merely a bunch of random ugly-looking formulas that need to be memorized. In this talk, I discuss my experiences in teaching calculus so that students leave the course understanding the big ideas of calculus and that there is an inherent logic behind these ideas. The goal is for students to understand what calculus really is all about. With such an understanding, the formulas follow naturally and practically no memorization is required.

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Are Diagrams Worth a 1000 Words?

We frequently use diagrams in mathematics to illustrate a point, construct a model, or represent mathematical objects. But how well do we understand this use of diagrams? In mathematics diagrams are frequently used as tools, sometimes represent mathematical objects, and may act as proofs. However, we do not understand exactly how diagrams are used in mathematics — to learn, to drive sudden intuitive jumps in understanding, or as a memory aid. Collectively, this use of diagrams to assist in the reasoning process has been termed "diagrammatic reasoning." This is an area of research where mathematicians seem strangely absent. I will introduce examples of how psychologists, computer scientists, and cognitive modelers are working together to understand diagrammatic reasoning in mathematics. In conclusion, I will discuss my own research project in the area of cognitive modeling — planning routes on a grid.

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A Mean Value Theorem for a Number Field

Let K be an algebraic number field and let $N(K, C_\ell, m)$ denote the number of abelian extensions L of K with $Gal(L/K) \cong C_\ell$, the cyclic group of prime order ℓ, and the relative discriminant $\mathcal{D}(L/K)$ of norm equal to m. In this talk, we derive an asymptotic formula for $\sum_{m \le X} N(K, C_\ell, m)$.

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Integrating Math into Introductory Science Labs

Because science and mathematics have been traditionally taught as discrete courses, students often fail to make connections between disciplines. To resolve this "mismatch", we have created an integrated science curriculum for all math and science majors. The primary focus of this curriculum is a 5-course introductory science (chemistry, biology and physics) laboratory series and a 6-course mathematics (algebra, trig, calculus, differential equations and some statistics) sequence. The science materials focus on more complex problems requiring application of concepts from the other science disciplines and use of mathematics in context. Here we present examples of how we have integrated calculus content into the science lab series, featuring a biology lab where students examine a growth curve for algae, a chemistry lab involving an instantaneous rate calculation for a rocket launch, and a physics lab where students approximate the instantaneous speed of a cart on an inclined plane.

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Issues with Integrals.

Techniques of integration are a staple of the calculus curriculum,and computer algebra systems (CAS) are frequently used in conjunction with traditional methods. We shall discuss some potential pitfalls of using computer algebra systems using a basic calculus integral, $\int dx/x\sqrt{1-x^2}$, as an illustration. The following questions will be addressed:

1. Doesn’t graphing provide at least a rough and ready check of a student’s answer with that of a CAS?
2. Can we transform the CAS solution to a standard solution using only algebra and calculus level methods?
3. Don’t all “antiderivatives” just differ by a constant?

The somewhat surprising answer to these questions is NO! We shall briefly how these results relate to teaching calculus.

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Integration Bees: A Team Competition

The popularity of integration bees increased with the December 2002 FOCUS article on the University of Pittsburgh’s Integration Bee. Presently, over twenty schools host bees. While most bees have one student competing at a time, the University of Dayton has had students compete in teams for the past four years. We will discuss the organization and implementation of a group bee model and give a brief overview of the rules associated with other models.

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Cost thresholds for dynamic resource location

The traditional dynamic resource location problem attempts to minimize the cost of servicing a number of sequential requests, given foreknowledge of a limited number of requests. One artificial constraint of this problem is the presumption that resource relocation and remote servicing of requests have identical costs. Parameterizing the ratio of relocation cost to service cost leads to two extreme behaviors in terms of dynamic optimizability. The threshold at which a specific graph transitions between these behaviors reveals certain characteristics of the graph’s decomposability into cycles.

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A Modified Hill Cipher

This paper treats the ciphers described by Lester S. Hill in his 1931 paper. First, a known plaintext attack on the ciphers is described. Then several modifications to the ciphers are given which make their cryptanalysis more difficult.

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Calculus-based Physics at West Point

For over a hundred years, the United States Military Academy has required (at least) two semesters of calculus-based physics for all students during the sophomore year. Today, with every cadet pursuing an academic major and 55 percent majoring in fields other than math, science, or engineering, calculus-based physics remains relevant because of the modes of thought it develops. This paper explains the importance of calculus skills to the achievement of specific goals of the Academy’s academic program through physics instruction.

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Math thread in USMA’s Advanced Physics Program

The Advanced Physics Program at USMA requires its majors to know physical principles and experimental techniques, as well as to apply advanced mathematics to solve complex problems. Mathematics, Physics Theory, and Experimental Physics comprise the major threads woven together to help physics majors accomplish program goals. We present the background and reasons for the innovations found in the mathematics thread that takes cadets from their computer-intensive core math sequence through the advanced physics program which enhances student mathematical and scientific literacy.

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Linking Exponential and Geometric Distributions

There is a well known relationship between the probability distributions of exponential random variables and Poisson random variables. This paper considers how the probability distributions of exponential random variables and geometric random variables are related and provides necessary and sufficient conditions for defining either one of these distributions in terms of the other.

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Counting Zero-Divisors (and other adventures)

In this talk, a simple question about the zero-divisors of a commutative ring is presented. Very quickly, the problem turns from a purely algebraic question to an exercise involving combinatorics and number theory. Along the way, we'll meet the Goldbach conjecture and use technology to investigate the question. At the end of the talk, we'll meet a curious counterexample to the original question. The mathematics presented is not deep and should be accessible to any first year graduate student.

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Decompositions of Group Actions on Tensors

Consider the family $G = SO(2m, 2n)$, $m \leq n$, of Lie groups with the standard ordering on the roots relative to the standard compact Cartan subgroup. Let $\mathfrak{u} \cap \mathfrak{p}$ be the span of the root vectors for the positive noncompact roots, and let L be the compact subgroup built from the compact Cartan subgroup of G and from all linear combinations of compact simple roots. The decomposition of the associated symmetric algebra $S(\mathfrak{u} \cap \mathfrak{p})$ under L plays a role in cohomological induction. Although all the irreducible representations of L fall into an $(m + n)$-parameter family, it turns out that the highest weights of the irreducible representations of L that occur in $S(\mathfrak{u} \cap \mathfrak{p})$ fall into a $2m$-parameter family. In this talk, we will discuss a good upper bound for the multiplicities of these representations.

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Faculty Perspective on American Diploma Project

In 2004, in an effort to "make the high school diploma count", the American Diploma Project (ADP), a partnership of Achieve, The Education Trust, and the Thomas B. Fordham Foundation, published detailed English and mathematics benchmarks describing the knowledge and skills that American high school graduates need to succeed in college or the workplace. The benchmarks are a result of two years of research conducted in colleges, universities and high-performance workplaces across the country. These real-world ADP expectations are significantly more rigorous than current high school standards in many states, which helps explain why many high school graduates now arrive at college or the workplace with major gaps in their preparation. To date, twenty-two states have joined the ADP Network in an effort to close the achievement gap in their respective state. Based on the experiences of a university mathematics faculty member with the project, this talk will highlight some of the ramifications of the project for both K-12 and higher education.

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Arithmetic from an Algebraic Point of View

How can we best prepare students to succeed in algebra? One way is to teach arithmetic from an algebraic point of view. This is illustrated with the order of operations, building compound expressions, and solving equations. The successful use of these ideas in an elementary algebra class will be presented.

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Discovering the Cauchy-Riemann equations

In a traditional first course in complex analysis, students often fail to develop an intuitive understanding of the origin of the Cauchy-Riemann equations as they are derived in a formal way from the definition of differentiability. This is unfortunate since these equations lead to many elegant and sophisticated ideas that unite a great deal of the undergraduate mathematics curriculum.

This talk will demonstrate a series of computer-based laboratory experiences in which students utilize Java applets to explore the underlying geometry of the complex numbers and ultimately to discover the Cauchy-Riemann equations.

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Bradley Warner (brad.warner@usafa.edu) Department of the Air Force, 2354 Fairchild Drive, Suite 6D124, USAF Academy, CO, 80840

Getting Students to Read the Text Before Class

Students in several undergraduate mathematics courses are required to respond to lesson reading assignments via a course website. The instructor then reviews the responses and questions prior to class and adapts the lesson focus as needed. The method’s effectiveness will be discussed, as well as its easy adaptability to other subjects. This effort supports a major assessment initiative on getting students in mathematics courses to critically read their texts. The web-based reading form approach has been used in several mid and upper level undergraduate math courses. The key benefit for the instructor is real-time insight into how well the students are assimilating the information in the text. The benefits for students are improved reading comprehension and a course better-tailored to the areas where they need more help. Data will be provided that supports these outcomes.

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A Discovery-Based Curriculum for Advanced Calculus

In this talk, we will consider a few examples from a set of discovery-based activities that are currently being developed for use in a Moore-style, undergraduate-level course in advanced calculus. In addition to considering the activities themselves, we will also briefly discuss both the advantages and the challenges of teaching advanced calculus in a discovery-based manner.

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Alexandru Zaharescu (zaharesc@math.uiuc.edu) University of Illinois at Urbana-Champaign, Department of Mathematics, Urbana, IL, 61801

A New Distance Between Galois Orbits

We define a new distance between Galois orbits over $\mathbb{Q}$ and use it to study the behavior of the trace of algebraic numbers. We give an example of a sequence $(\alpha_n)_{n\in\mathbb{N}}$ of algebraic numbers that does not converge in the spectral norm, for which the sequence of traces $(Tr_K(\alpha_n))_{n\in\mathbb{N}}$ does converge in the new distance.

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Jake Wildstrom (dwildstr@math.ucsd.edu) 3891A Miramar St., La Jolla, CA, 92037

Look for mathematical properties of hexaflexagons

Having played with hexaflexagons since we were in high school, the presenter(s) believe that hexaflexagons must exhibit some sort of mathematical group structure. Because they are entertaining to make and to map for their flexing patterns, they could potentially provide an engaging setting for original undergraduate research. Some of the most basic hexaflexagons and their flexing patterns will be shared in the presentation. Instructions for making hexaflexagons will be given as well.

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Analyzing the Mathematics TAKS Results

The Texas State University System (TSUS) Math for English Language Learners (MELL) initiative is a multiyear effort funded by Texas Education Agency (TEA) to develop instructional resources designed to increase the effectiveness of math instruction for ELL (English Language Learners) students in PK-12 schools. As a part of this study, the statistical analysis of Mathematics TAKS data is needed to identify and develop instructional tools. Moreover, this analysis will be used to guide policymakers in the state of Texas. In this talk, a summary of the TAKS analysis will be presented.The performance of ELL students has been compared with non-ELL students.It has been found that ELL students are improving, but the gap is still very large.

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Using The Geometer's Sketchpad to Form Connections

One of the NCTM process standards establishes the importance of emphasizing and developing connections between mathematical topics so that students can form a deeper, relational understanding of mathematics as a whole. We provide examples of how the Geometer's Sketchpad can be used to establish connections between geometry and algebra. These examples are specifically designed for use in a geometry course for future elementary teachers but, with appropriate modifications, could be used in high school geometry courses or content courses for future middle and high school teachers. The aforementioned course is the second course in a two-course sequence, the first of which is a course that devotes a significant amount of time to number and operations, basic algebraic thinking, and the basic of functions. These Sketchpad activities enable students to revisit and connect content from the first course to the geometric notions explored in the second course. The first activity guides the students to conjecture and prove the standard result that the quadrilateral formed by joining the midpoints of an arbitrary quadrilateral is a parallelogram. The second activity uses Sketchpad to investigate the symmetries of square.

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Rings and Things.

A remarkable property of spheres is that the volume of the spherical ring that remains after "coring" a sphere by boring through its center with a cylindrical drill bit depends only on the height of the resulting ring (in the direction of the bore), and not on the radius of the sphere. One proof of this is a standard calculus exercise. Here we explore some generalizations of this property for surfaces in three dimensional space, and for $n-1$ dimensional hypersurfaces in n-dimensional space. Are there other surfaces in three dimensional space that satisfy such a property? Do higher dimensional spheres satisfy an analogous property?

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Using Labs in Trigonometry

I have usually run my lower division courses in what I consider to be a traditional fashion, alternating between instructor examples and student practice. In the last year, I have tried to include more "laboratory" experiences in my lower division courses, especially Trigonometry. In this presentation, I will share four of these experiences and discuss my observations of the results.

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Extension of Mean Value theorem to space curves

Let $\gamma : [a,b] \longrightarrow \mathbb{R}^3$ be a continuous and differentiable space curve in 3-dimensional real space. We say that any 3 points $A_i = \gamma(t_i)$, $i = 1,2,3$ are in general position if the subspace spanned by $\overrightarrow{A_1A_i}$, $i = 2,3$, is a 2-dimensional real vector space. Our generalized theorem states that if the 3 points are in general position then there exist at least one point $t_0 \in (a, b)$ such that $\gamma'(t_0)$, the tangent vector to the curve at t_0 lies in the 2-dimensional subspace spanned by $\{\overrightarrow{A_1 A_i}, i = 2, 3\}$. The result generalizes to spaces curves in any dimension n.

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Vector Fields in the Linear Algebra Classroom

An advanced group of linear algebra students can begin to see the interplay between algebra and topology through the theory of vector fields. We present one approach to this topic, where the only topological prerequisite is an understanding of the calculus of vector fields in the plane or 3-space. Applications accessible to the students are also presented.

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The Mathematics Major in the U.S., 1945-1995

In order to study how the requirements for the mathematics major have evolved during the latter half of the 20th century, we reviewed catalog copy from a variety of institutions at ten-year intervals from 1945 through 1995. Results will be presented, which show some indications of interesting trends in course requirements.

Carrie Finch (cfinch@math.sc.edu) University of South Carolina, Mathematics Department, LeConte College - 1523 Greene Street, Columbia, SC, 29208

Irreducibility of 0,1-polynomials with Exponents in Arithmetic Progression

Beginning with the binomial $1 + x^n$ and fixing a natural number d, we form a sequence of polynomials with exponents in arithmetic progression: $1 + x^n + x^{n+d}$, $1 + x^n + x^{n+d} + x^{n+2d}$, etc. In this talk we discuss the (ir)reducibility of the polynomials in this sequence.

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Variations on a Theme of Sierpinski

Using an idea of Erdős, Sierpinski proved that there exist infinitely many odd positive integers k such that $k2^n + 1$ is composite for all positive integers n. In this talk, we discuss variations of this theorem that have been examined, including the work of Riesel, Brier, Chen, and most recently, Filaseta, Finch and Kozek. Finally, we present some results on our own variations of Sierpinski's original problem.

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Math for K–6 Preservice Teachers and the Standards

A quick summary of lessons learned in the first year of a three-year NSF Advanced Technological Education Grant linking two universities and seven community colleges in East Tennessee. One of the primary goals of the grant is to improve the math, science and technology training of future elementary teachers through collaboration and systemic change. This summary will focus on six days of professional development for the mathematics faculty who teach the three mathematics courses required of Tennessee preservice K–6 teachers in a new Associate of Science in Teaching degree. The faculty examined the state curriculum standards for K–6: number and operation, algebra, geometry, measurement, data analysis and probability. Since preservice teachers will teach as they have been taught, the emphasis was on faculty engaging in activities appropriate for their preservice teachers. It was important for math faculty to become aware of licensure standards in mathematics as well. Faculty also collaborated on how to create a classroom/lab habitat that fosters learning pedagogical content knowledge using technology and manipulatives.

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Ellipses of maximal or minimal arc length

Let T be a triangle in the xy plane. It is well known that the ellipse of maximal area inscribed in T is unique and is the midpoint ellipse, which is the ellipse tangent to T at the midpoints of its sides. We investigate the existence and uniqueness of ellipses inscribed in T with maximal or minimal arc length. Let D be a convex quadrilateral in the xy plane. In an earlier paper, this author proved that there is a unique ellipse of maximal area and a unique ellipse of minimal eccentricity inscribed in D. We also investigate the existence and uniqueness of ellipses inscribed in D with maximal or minimal arc length.

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Minnesota standards; my involvement and views

Although I am quite pleased with the standards 40 of us in Minnesota wrote in 2003, I see, in hindsight, that they could have been much better. There are issues surrounding the actual process that are relevant to the process in various ways: Why are the standards being written? For whom are they being written? What is their relation to state tests? What is their relation to legislation? What is an appropriate format? Should there be coordination with state standards for other disciplines? To what extent, if any, should they be concerned with pedagogy? I will present some thoughts on these and related matters.

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Assessment of the Mathematics Program at a Small, Catholic, Liberal Arts College

Assessment is a highly-valued process at the College of Mount St. Joseph, a small, Catholic, liberal arts college located near Cincinnati, Ohio. Three years ago, as part of the college-wide general baccalaureate assessment process, the mathematics department created a capstone course to complement an already successful year-long senior research course while also supporting the baccalaureate-level interdisciplinary learning outcomes for the college. Within the mathematics department we have learning outcomes emphasizing communication, critical thinking, and professional development. We have created an ongoing process for assessment of these outcomes. This talk will describe the design of the capstone course, the assessment methods that we are using in our department, and the results that we have obtained over the past few years.

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Math Teaching Efficacy of Future Elementary. Teachers

Many pre-service elementary teachers are anxious about their mathematics knowledge and potential to teach elementary school mathematics. This concern is often shared both in mathematics content and in mathematics techniques courses. To better prepare our future elementary teachers in mathematics, we use a two-semester models-based math concept focused curriculum, followed by an integrated field experience based math techniques course. The math techniques course is part of a team approach where students also study science and reading techniques the same semester and are applying math methods learned to field experiences over the last seven weeks of the semester. Besides the seven weeks in the field, best practices teaching video vignettes of elementary teachers are used to provide meaningful contexts of math teaching. To assess possible changes in attitude toward teaching mathematics, the Mathematics Teaching Efficacy Beliefs Instrument was utilized both at the beginning and end of the mathematics techniques course with a focus on Personal Mathematics Teaching Efficacy and Mathematics Teaching Outcome Expectancy. Although significant gains were made overall, interestingly most may be attributed to the measure of Personal Mathematics Teaching Efficacy.

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Discussing Statistics Online

Practice is essential for learning, and students learn more and better when they interact, discussing course material, asking questions and teaching one another. Unfortunately, many students do not work on practice exercises on their own and there are those who do not want to interact with their classmates or participate in face-to-face class discussions. Online discussions whether on Blackboard, by email, or by Instant Messenge, provide an opportunity for every member of the class to interact and to have a "voice". In this presentation, I will discuss how I have used assignments and projects involving online discussion in introductory statistics to enhance class interaction and to provide students with an opportunity to discuss practice exercises to help them to understand and to apply course material.

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Nurturing Young Mathematicians at a Local Level

A recent survey conducted by KRC Research found 84 percent of students would rather do one of the following than their math homework: clean their room, eat their vegetables, go to the dentist or take out the garbage. The fact is, not enough people in America are pursuing the field of mathematics, and the culprit lies in the high school atmosphere.

Drawing upon his experiences in a mathematics honor society from a small urban public high school, the speaker will share his secrets to building a successful local organization from scratch and how to establish lasting influence in your community. Examples of using your organization to inspire and deepen interest in math and to encourage young mathematicians to develop vital leadership and fundraising abilities are reviewed. Techniques such as tapping into regional networks, sending delegations to math conferences, and organizing math teams and math publications will be discussed.

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The Curricula of Church Schools in the Qin Dynasty

The Curricula of Church Schools in the Qin Dynasty shows the true meaning of "western invention but eastern implementation," or yangwei zhongyong. At the end of the Ming dynasty, a few western missionaries went to China to start small church schools for the poor and working class children. Western mathematics was first taught in China in these schools but there was no standard curriculum yet. After the Opium War, missionaries flooded China to help the Chinese, increasing the number of church schools from 800 to 2000. Chinese people strongly viewed this as an invasion of Chinese culture and education. However, increasing numbers of upper class children begin to be enrolled in these church schools, and by that time a standard curriculum for mathematics was established among all these schools. Many western mathematics textbooks were also translated into Chinese. By the end of the Qin dynasty, the church school reached its height, and played an important role in the development of capitalism and republican society in China. This coincided with the introduction of the college level mathematics curriculum.

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