ABSTRACTS OF TALKS PRESENTED TO THE ILLINOIS, INDIANA, AND MICHIGAN SECTIONS OF THE MAA

1. Introduction

The Spring 2018 Tri-Section Meeting of the Illinois, Indiana, and Michigan Sections of the Mathematical Association of America is at Valparaiso University, Indiana, March 23–24. The abstracts appearing here are based on text electronically submitted by the presenters. Contributed talks are listed in alphabetical order by presenter.

2. Invited Talks

Presenter: Steve Butler, Iowa State University

The Mathematics of Juggling

Juggling and mathematics have both been done for thousands of years, but the mathematics of juggling is a relatively new field that dates back a few decades and looks at using the tools of mathematics to analyze, connect, and count various juggling patterns. We will introduce some of the very basic results related to the mathematics of juggling with a particular emphasis at looking at the various methods used to describe juggling patterns.

Presenter: Allison Henrich, Seattle University

It's All Fun and Games Until Somebody Becomes a Mathematician

As former MAA President Francis Su recently reminded us, PLAY is essential for human flourishing. Whether you are a poet or a scientist, a grandparent or a child, play can powerfully enrich your life. For mathematicians, play is essential for building intuition. For undergraduates, play can inspire a desire to get involved in mathematical research. The world of knots provides fertile ground for understanding these connections. Playing games on knot diagrams can give us intuition about knotty structures, while learning about the theory of knots can reveal the "magic" behind rope tricks and excite us to learn more.

Presenter: Judy Holdener, Kenyon College

Homage to Emmy Noether: The Ideal Woman

In 1953 American painter Jackson Pollock created the diptych "Portrait and a Dream," which is generally believed to be a self-portrait of the artist. On the right-hand side of the work is a Picasso-esque depiction of Pollock's head, rendered with black line intersecting and enclosing regions of black, red, and yellow. On the left-hand side is Pollock's dream illustrated as an abstract black-and-white drip painting. The drips evoke movement and confusion, suggestive of the subconscious mind at work. In this way the two panels of the painting represent the inner and outer self of Pollock, displaying an interplay — or perhaps even an identification — between the subconscious and conscious minds of the artist.

Similar to Pollock's artwork, the creation of mathematical theory also involves a rich interplay between the conscious and the subconscious minds, and I portray this interplay in my digital portrait of the German mathematician Emmy Noether (1882–1935). Inspired by Pollock's "Portrait and a Dream," my artwork is also a diptych, displaying a portrait of Noether alongside mathematical writing on a chalkboard reflecting the conceptual, axiomatic way in which she approached her groundbreaking work relating to ideals.

Presenter: Michael A. Jones, Mathematical Reviews and Editor, *Mathematics Magazine*

A Voting Theory Approach to Golf Scoring

A surprising result in voting theory is that an election outcome may depend on how votes are tallied after the ballots are cast. This election scenario is relevant to the outcome of golf tournaments because the Professional Golfers' Association (PGA) is the only professional sports league in the U.S. that changes the method of scoring depending on the event. The PGA's stroke play and modified Stableford scoring system are equivalent to using different voting vectors to tally an election. This equivalence is discussed and data from the Masters and International Tournaments are used to examine the effect of changing the scoring method on the results of the tournament.

By focusing on 3-candidate elections, I will show how elementary linear algebra and convexity can be used to explain the effect of changing the voting vector. Sometimes, regardless of the voting vector used, the same outcome would have occurred, as in the 1992 US Presidential election. Can this happen in golf? I answer this question and determine whether there exists a golf-scoring method in which Tiger Woods would not have won the 1997 Masters, as his performance is considered one of the best ever.

Presenter: Jennifer Quinn, University of Washington Tacoma and MAA Board of Directors

Digraphs and Determinants: Determinants through Determined Ants

"There is no problem in all mathematics that cannot be solved by direct counting."

— Ernst Mach

In linear algebra, you learned how to compute and interpret determinants. Along the way, you likely encountered some interesting matrix identities involving beautiful patterns. Are these determinantal identities coincidental or is there something deeper involved? In this talk, I will show you that determinants can be understood combinatorially by counting paths in well-chosen directed graphs. We will work to connect digraphs and determinants using two approaches:

- Given a "pretty" matrix, can we design a (possibly weighted) digraph that clearly visualizes its determinant?
- Given a "nice" directed graph, can we find an associated matrix and its determinant?

Previous knowledge of determinants is an advantage but not a necessity. This will be a hands-on session, so bring your creativity and be prepared to explore the mathematical connections.

Presenter: Michael Starbird, University of Texas at Austin

Geometric Gems

Plain plane geometry contains some of the most beautiful proofs ever — some dating from ancient times and some created by living mathematicians. This talk will include some of my favorites from an incredibly clever way to see that a plane intersects a cone in an ellipse to a method for computing areas under challenging curves developed by a living mathematician, Mamikon Mnatsakanian; and many more. Geometry provides many treats!

3. Project NExT Panel Discussion

Panelists:

- Steve Butler, Iowa State University
- Allison Henrich, Seattle University
- Judy Holdener, Kenyon College
- Jennifer Quinn, University of Washington Tacoma and MAA Board of Directors

Moderator: Manda Riehl, Rose-Hulman Institute of Technology

Encounters with Experiential Learning

Experiential learning can take many forms in mathematics departments. Instructors may change their classroom environment by using an inquiry based learning model, incorporating projects into class activities, or designing service learning activities to extend the classroom to include the immediate community. Experiential learning occurs through undergraduate research, departmental activities that build community and knowledge, and experiences beyond the campus such as professional conferences, mathematical competitions, and study abroad experiences. The panelists will discuss their experiences engaging their students through experiential learning activities, including observed or measured improvements and advantages, lessons learned during implementation, and advice on how to get started. The intent of this panel is to not only introduce you to ideas from experiential learning, but also to share innovative ideas/experiences that may enhance your own classroom or departments.

4. Student Activities Workshop

Presenter: Victor Piercey, Ferris State University

Tic-Tac-Toe on Orientable and Non-Orientable Surfaces

For thousands of years, humanity has wondered about the large-scale shape of the cosmos. Einstein's general theory of relativity gave this question new life by showing that space and time were interconnected and that the presence of mass curves spacetime. More recent physical theories, such as string theory, raise questions about the number of dimensions present in spacetime. During this workshop, we will use apps developed by Jeffrey Weeks to explore some of the possible shapes through gameplay.

5. IBL Workshop

Presenter: Michael Starbird, University of Texas at Austin

Inquiry Based Learning: Math and Beyond

When students prove theorems or solve problems on their own and present their results to their peers, interesting things happen. Expected outcomes include students' developing problem-solving and theorem-proving skills and the ability to tell whether reasoning is correct or flawed. But beyond those mathematical skills, this type of experience frequently involves important consequences on students' self-reliance, independent thinking, and willingness to make mistakes.

6. Contributed Talks

Presenters: Angela Antonou, University of St. Francis, Illinois; Amanda Harsy, Lewis University; Dave Klanderman, Trinity Christian College; Rita Patel, College of DuPage

Math Teachers' Circles: Professional development through mathematical problem solving

In this session, we introduce what a Math Teachers' Circle is and share some advice and lessons learned from creating the Southwest Chicago Math Teachers' Circle, highlighting the process of identifying leadership team members, submitting the grant proposal for seed money, along with hosting launch events, intensive summer workshops, and monthly meetings during the academic year. Join us for a clear path to starting your own circle!

Presenter: Michael Barz, Northside College Preparatory High School student

Unimodular roots and arithmetic progressions

Michael Brilleslyper and Lisbeth Schaubroeck investigated polynomials of the form $z^n + z^k - 1$, seeking when such polynomials had unimodular roots (that is, a root r such that $|r| = 1$). Their question was motivated by the polynomials of the form $z^n - 1$, whose roots (the roots of unity) are all unimodular and have many nice properties. At the end of their paper, they posed four follow up questions. I investigated one of these questions, asking when $z^n + z^k + z^j - 1$ has unimodular roots, and resolved it in the case where n, k, j is an arithmetic progression.

Presenter: Jonathan Beagley, Valparaiso University

Joint work with: Mindy Capaldi, Valparaiso University

Using cumulative homework in calculus classes

Homework is prevalent in mathematics courses, as are cumulative final exams. This study incorporated the memory science concepts of the *testing effect* and *spacing effect* in the homework and final exam of college mathematics courses. By replacing some new homework problems with review problems, students had additional opportunities to recall old material. Effects were analyzed by comparing the final exam scores of randomized groups of students, which showed small positive gains for students who had the experimental homework design. Additionally, students were split into the categories of low-scorers and high-scorers based on their first test score, prior to the intervention. Low-scoring students saw more benefits than the high-scoring students.

Presenter: Paul Bialek, Trinity International University

MSC 2010: 11E25

Euler's proof that every integer is the sum of four or fewer square fractions

In his paper entitled *Proof of a theorem of Fermat that every number whether whole or fraction is the sum of four or fewer squares* (E242 in the Enestrom index), Euler uses quadratic residues to prove that every integer or fraction is the sum of four or fewer square fractions.

Presenter: George Brooks, Saginaw Valley State University undergraduate student
Joint work with: Christopher St. Clair, Saginaw Valley State University undergraduate student
Faculty Advisor: Garry Johns, Saginaw Valley State University
MSC 2010: 05C15, 05C78, 05C85
An induced labeling of grid graphs

For a positive integer k and a connected graph G, let $c : V \to Z_k = \{0, 1, ..., k-1\}$ be a vertex labeling (or coloring) where adjacent vertices may be assigned the same label (or color). Then c induces another vertex labeling $c' : V(G) \to Z_k$ where $c'(v)$ is the sum (modulo k) of the original colors for vertex v and those vertices adjacent to v. The coloring c' is called a closed modular coloring of G if adjacent vertices are assigned different colors by c'. In this paper, we focus on finding the minimum value for k that has a closed modular coloring for various grid graphs (also known as lattice graphs or checkerboards found by taking the Cartesian product of two paths), discuss an application to cell-phone communication security, and determine that k is never more than 3 for these graphs. We show also that in several cases $k = 2$ and that $m = 7$ is that smallest integer such that $k = 2$ for every grid graph with m rows and n columns, where $m \leq n$.

Presenter: Alexis Byers, Western Michigan University graduate student
Joint work with: Zhenming Bi, Steve Devereaux, and Ping Zhang, Western Michigan University
On k-rainbow colorings of graphs

Let G be an edge-colored nontrivial connected graph, where adjacent edges may be colored the same. A path P in G is a rainbow path if no two edges of P are colored the same. Rainbow paths have been studied extensively. We present a closely related concept. For an integer $k \geq 2$, a path P in G is a k-rainbow path if every subpath of P having length k or less is a rainbow path. An edge coloring of G is a k-rainbow coloring if any two distinct vertices of G are connected by a k-rainbow path in G. The minimum number of colors required for a k-rainbow coloring of G is its k-rainbow connection number. We investigate k-rainbow colorings of several well-known classes of connected graphs and establish sharp upper bounds for the k-rainbow connection number of a graph in terms of the order of the graph. Other results on k-rainbow connection numbers are also presented.

Presenter: Wesley Calvert, Southern Illinois University, Carbondale
Symmetry and structure

A partial automorphism of a structure is a one-to-one function defined on a subset of a structure that respects the natural language of the structure. For instance, a partial automorphism of graphs is a map on *some* of the vertices that respects adjacency.

How much can be known about an infinite structure if all you know is how the finite partial automorphisms compose — without even knowing what specific elements are involved in each function?

It turns out that you can know quite a lot. In this talk, we will see the remarkable fact that an entire infinite structure can be rebuilt just from knowing this local symmetry information.

Presenter: Mindy Capaldi, Valparaiso University
When mathematics and politics collide: measuring gerrymandering

Gerrymandering is an increasingly important and spotlighted issue, especially with two cases currently being deliberated by the Supreme Court. One of the problems the justices have with ruling gerrymandering cases is a lack of consensus on how to measure, or prove, gerrymandering. This talk discusses popular metrics for scoring gerrymandering, as well as the mathematical and statistical methods that were seen by the Supreme Court this year.

Presenters: Christy Carlson and Lauren Klamerus, Lewis University undergraduate students
Faculty Advisor: Amanda Harsy, Lewis University

Analyzing and comparing the impact of mastery-based testing to traditional testing in mathematics courses

As educators, it is important to recognize that our assessment methods affect student attitudes. If we want students to learn from their mistakes and counteract a fixed-mindset of learning, perhaps we should look at what we incentivize in the classroom. One way that professors are attempting to counteract math anxiety, poor STEM retention, and a fixed-mindset of learning is through using and researching a new assessment model called "Mastery-based Testing" (MBT). In MBT, students are given problems in which they can only receive full credit for the problem after they demonstrate mastery of the concept being tested. Each test includes similar questions over the same concepts from previous tests which allows students who have not mastered an idea to retest and reevaluate old concepts. In order to help determine the effectiveness of Mastery-based Testing, we used statistical methods to analyze data collected from calculus and applied linear algebra MBT classes. Some of the research questions we explored included whether the students' attitudes about mathematics changed throughout the course, whether there was a difference in attitudes and perceptions between calculus students and applied linear algebra students, and whether or not there was a difference in attitudes and perceptions between MBT students and students who had traditional assessment.

Presenter: Stefano Chiaradonna, Benedictine University undergraduate student

The dynamics of an epidemiological model for HPV with partial vaccination in a heterogeneous population

The Human papillomavirus (HPV) is one of the most prevalent sexually transmitted diseases in the United States. HPV-16 and HPV-18 are the primary agents of cervical cancer, and HPV-6 and HPV-11 are responsible for most genital warts and juvenile-onset recurrent respiratory papillomatoses. Highly efficacious vaccines have been developed to prevent these high-risk types of HPV, which are typically administered in three doses. However, younger adolescents need only two-doses of the full three-dose vaccine regimen. We propose and analyze a mathematical model that investigates the implications of the population not completing the vaccine regimen as well as the scenario of younger adolescents receiving only two-dosages. By having differing age groups, the model can target a specific age group for vaccination to optimize the control of HPV spread, which could lead to the eradication of the disease.

Presenter: Elizabeth Clifford, Lansing Community College

Building student success through connections

Lansing Community College meets students' diverse needs for academic support through one to one appointments, walk in tutoring, and supplemental instruction. We will share data and how each format provides a different experience for students.

Presenter: Adam Coffman, Indiana University - Purdue University Fort Wayne
Joint work with: Yifei Pan and Yuan Zhang, Indiana University - Purdue University Fort Wayne
MSC 2010: 32Q65

J-holomorphic curves in rough almost complex structures

A pseudoholomorphic curve, or J-holomorphic curve, is a differentiable map from a Riemann surface to a manifold with almost complex structure J, that satisfies an analogue of the Cauchy-Riemann equations. When J is smooth, pseudoholomorphic curves have well-known regularity and uniqueness properties. I will survey what can happen when J is only continuous or satisfies a Hölder condition.

Presenter: Dennis G. Collins, University of Puerto Rico, Mayagüez (retired)

Toward the thermodynamics of picture and other puzzle solving

This talk follows up on the Author's and Scienceman's paper "Clusters of High Transformity Individuals" Chapter 36 in Emergy Synthesis 9. Here instead of substrate being converted into product by a generalization of Michaelis-Menton enzyme kinetics, the interest is in pieces of a puzzle being converted into a finished picture. Other applications involve returning and re-connecting people to their homes after a storm or flood, or restoration of electrical grid after a hurricane, or assembling DNA in one dimension. At the start of putting together a, say 1000-piece puzzle, there are 1000 components, and clusters are gradually built up as pieces are fitted together, until if successful there is only one giant cluster or component with all 1000 pieces (or say the electrical grid is restored). Features of the puzzle, such as border, buildings, trees, and sky, correspond to enzymes that aid in getting the puzzle done and their transformity can be measured by the jumps or fraction of the puzzle they help to complete. In doing a puzzle, pre-sorting into, say all the manmade structure pieces or border of a roof and then all the tree pieces leads to jumps in progress of doing the puzzle. Thermodynamically the problem involves completely distinguishable particles as perhaps a modification of Fermi-Dirac statistics, since each piece goes in exactly one place. Attempts to measure entropy can involve measuring the work required to add each piece, and topological properties, such as Betti numbers or number of holes left in each cluster, studied, sometimes in reference to Zipf's law with changing powers and the Author's previous work.

Presenters: Mitzi Cruz, Joseph Schulte, and Ethan Albany, Lawrence Technological University undergraduate students

Driving adoption to an electric future

We present our work from the 2018 COMAP competition in mathematical modeling on the propagation of electric vehicles. Our model is designed to drive demand of electric vehicles in a method that illustrates proportionality of electric vehicles to all vehicles. Being that we focused on two primary charger types, destination and on-route chargers, we found the total number of chargers needed to be built in relation to the number of electric vehicles emerging. Furthermore, we took into account the density and speed of traffic, the average charge time, and the average range per charge to calculate the on-route chargers needed. We discovered that the adoption of the electric vehicles follows that of a logistic curve. Also, we concluded that there was a relation between demand and adaptation. In order for users to transition, there has to be a demand and in order to drive this demand there has to be a decrease in range anxiety. Using Tesla as a benchmark, if Tesla perfectly meets the demand for chargers then the adoption curve could reach 90% by 2031. As other countries look to drive this transition by 2030, they have to make a network of charging infrastructure a priority.

Presenter: Kelly Currie, Lansing Community College

Embedded tutors within the mathematical classroom

In order to prepare our developmental students for college level mathematics within one semester, the Learning Commons at Lansing Community College provides each section of MATH 106 (Mathematical Literacy with Review) with an embedded tutor to assist the instructor with comprehension of the necessary material. In this presentation, we will describe the role and duties of an embedded tutor as well as share data which supports the fact that embedded tutors increase student success.

Presenter: Michael Dabkowski, Lawrence Technological University

On the numerical range of the product of a composition operator with the adjoint of a composition operator

We consider the numerical range the product of a composition operator C_ϕ with the adjoint of a composition operator C_ψ^*, both acting on the Hardy space H^2. For certain choices of ϕ and ψ with small L^∞ norm we show that the numerical range is a non-tangential approach region on the disc and explicitly compute the aperture at the boundary point of this region. We relate this problem to the problem of finding the spectrum of a certain class of Jacobi matrices.

Presenters: Keller Dellinger and Quinn Stratton, Lewis University undergraduate students
Joint work with: Simon Merheb and Audrey Pearson, Lewis University undergraduate students
Faculty Advisor: Amanda Harsy, Lewis University

Modeling DNA self-assembly using graph theory, linear algebra, and programming

Motivated by the recent advancements in nanotechnology and the discovery of new laboratory techniques using the Watson-Crick complementary properties of DNA strands, formal graph theory has recently become useful in the study of self-assembling DNA complexes. Construction methods developed with concepts from undergraduate level graph theory have resulted in significantly increased efficiency. One recent focus in DNA nanotechnology is the formation of nanotubes using lattice structures. These nanotubes are thought to have wide-ranging potential, such as containers for the transport and release of nano-cargos, templates for the controlled growth of nano-objects, and in drug-delivery methods. The rules governing the structure of these nanotubes are not yet well understood, and this naturally offers open problems in the realm of applied graph theory. In this presentation, we present the results of a semester-long undergraduate research project applying graph theoretical techniques to nanotubes and other complexes which can be created from self-assembling DNA. We will also discuss our efforts towards extending the construction matrix to Scenario 3 laboratory constraints and creating a program which will produce possible pots for complexes.

Presenter: Matthew DeMoss, Eastern Michigan University graduate student
Faculty Advisor: Khairul Islam, Eastern Michigan University
MSC 2010: 46N30

Power of transformation in statistical inference: an empirical evaluation

The transformation of data in statistics is a common practice while dealing with non-normal or skewed data. An alternative to transformation is to consider parametric tests. In this presentation, an attempt is made to evaluate some common transformations in statistical practice against alternative counterparts using non-parametric and parametric approach.

Presenter: Isaac Dragomir, Trinity International University undergraduate student

The square-sum sequence problem

On January 11, YouTube channel Numberphile featured Matt Parker explaining an, as of then, open problem from his book *Things to Make and Do in the Fourth Dimension*: Does a permutation of the first n positive integers, with adjacent members summing to a perfect square, exist for all n greater than or equal to 25? We shall explore the interesting history of this problem, including a possible proof, and offer conjectures on its generalizations.

Presenter: John Drozd, Scientech - Fishers High School

Factoring — A short story at its roots

During the past 3 summers, I have been able to attend the one week content faculty development sessions sponsored by Scientech. In the first year, we explored quite a bit of content. The largest takeaway from the first year was the model of the discovery classroom provided by Dr. Leganza of the University of Indianapolis.

During the second year several of my colleagues and I concentrated on factoring, parabolas and the quadratic function. We explored some methods for factoring focusing on a method called "bottoms up." We wanted to understand the concepts behind it.

My focus during the school year became the quadratic formula. Completing the square proves the quadratic formula but tends not to be visual or conceptual. Teaching the quadratic formula focuses on memorization through rote songs. The formula gives a method for finding roots. However, using a calculator or program to find roots of a quadratic equation often replaces the use of the quadratic formula.

The lesson in this session presents a method for finding the roots of a quadratic equation that emphasizes the visual connection to a parabola without ever seeing the development of the quadratic formula.

Presenter: Chris Edwards, Fishers High School

The Scientech/Ball State University Summer Institute for Math and Science teachers: an overview

Professional development for secondary math and science teachers often comes in the form of top-down "training." A new model of professional development for secondary mathematics teachers involves connecting them with university professors for the purpose of generating enthusiasm and ideas through the study of mathematics content. Teachers who are inspired by new ideas can then develop curricula that bring that enthusiasm and expertise to their own students. This is the theory that informs the Scientech/Ball State University Summer Institute for Math and Science teachers.

Presenters: Hanson Hao and Jake Sutter, Benedictine University undergraduate students

Classifying symmetric spaces for $SO(3, p)$

Consider a set of three orthogonal (perpendicular) vectors in the finite field of order p, where p is an odd prime, such that the volume of the parallelepiped enclosed by these vectors is one. We investigate the set of all of these vectors which can be considered as 3×3 matrices, in a group called $SO(3, p)$. The size of $SO(3, p)$ is computed both manually, by considering the relationships between each pair of vectors, and also through the use of a C++ program. We also investigate certain functions, termed inner involutions, on these matrices that map a matrix back to itself after two consecutive applications, and we classify them into the Extended Symmetric Space R and the General Symmetric Space Q. Conjectures were made for formulas relating the sizes of R and Q to p. We will present several attempts at confirming these conjectures and current progress on the problem. Future directions include verifying our conjectures and generalizing our results to higher matrix dimensions. Applications of our research can be seen in physics, where the $SO(3, p)$ matrices are particularly effective at describing the effects of rotation and spin.

Presenter: Alycia Holmes, Roosevelt University undergraduate student

Zero knowledge proofs in cryptography

Modern encryption uses a process brought about in 1985 called zero knowledge proofs. Under certain circumstances, one can prove they have knowledge of something without revealing any information about what it is that they know. This involves an interactive proof system in which two parties exchange information to prove a statement such as proving one's own identity for the purpose of gaining access to information. My research aims to demonstrate the process of a zero knowledge proof to a general audience.

Presenter: Khairul Islam, Eastern Michigan University

Public Use cancer data for teaching and research

The Surveillance, Epidemiology, and End Results (SEER) data is a public use data and a comprehensive source of population-based data in the United States. It contains various cancer characteristics of millions of patients regarding cancer incidence, prevalence, and survival by age, gender, ethnicity, and many other characteristics. This data can be used in teaching and supervising students' research. In this presentation, we talk about accessing SEER data and provide some examples of data that can be incorporated in teaching and students' research.

Presenter: Khairul Islam, Eastern Michigan University

Joint work with: Tanweer Shapla, Eastern Michigan University

Sampling distribution and simulations of the sampling distribution of the mean: misconceptions and beyond

The simulation of the sampling distribution of the mean (SSDM) can mislead students, and can facilitate learning — such contradictory conclusions from recent studies could cast doubts in the minds of the instructors as to whether they should address an SSDM, and if they do, to what extent. As such, a further research on the SSDM is required for a better recommendation of the SSDM in pedagogy. Particularly, the properties of the sampling distribution of the mean (SDM) need to be restated and verified using examples as a preparation to an SSDM. In addition, a distinction between an exact SDM and an SSDM need to be made clear to understand scopes of an SSDM. In this paper, we first consider an exact SDM and then approach an SSDM with specific learning objectives and examples, which facilitate learning significantly.

Presenters: Brandon Joutras and Adrian Siwy, Lewis University undergraduate students

Faculty Advisor: Amanda Harsy, Lewis University

Using artificial intelligence and linear algebra methods to improve predictive modeling and analysis of sports data

This project utilizes an intelligence system to improve existing linear algebra methods used in ranking sports teams. Specifically we look to improve the performance of the Massey Method by automating the implementation of the model. Two interesting systems our research explores are NEAT (NeuroEvolution of Augmenting Topologies) and SARSA (State-Action-Reward-State-Action).

Presenter: Bir Kafle, Purdue University Northwest

Joint work with: Robert Perlis, Louisiana State University

Conjugation in S_n and connections with number fields

Two permutations τ, σ in the symmetric group S_n are conjugate in S_n if and only if they have the same number of cycles of length i for $i = 1, 2, \ldots, n$. This is well-known. In this talk, we present two more criteria for conjugacy, one in terms of the cycle number of fixed-points and the other in terms of the total number cycles. Then we discuss its connections with other areas of mathematics, in particular, with arithmetically equivalent number fields, with pairs of finite graphs having identical Ihara zeta functions, and with isospectral Riemann surfaces.

Presenter: Lauren Keough, Grand Valley State University

Extremal Lights Out

The original Lights Out game is played on a $n \times n$ grid in which some vertices are "on" at the start of the game. When you toggle a vertex, that vertex and all of its neighbors switch their on/off status. This game has been generalized in several ways including playing the game on general graphs and playing the colored version in which the labels come from $\mathbb{Z}_k$. In the colored version of the game, toggling a vertex means that vertex and all adjacent vertices have their labels increased by 1 modulo k. We say a graph is always winnable if for any initial labeling there exists a sequence of togglings that terminate with all vertices having the label 0. For example, the complete graph on n vertices is not always winnable. We seek the maximum number of edges a graph on n vertices can have and be always winnable. We'll answer this question in some cases using linear algebra techniques.

Presenter: Casey Koch LaRue, Grand Valley State University undergraduate student

Faculty Advisor: Steven Schlicker, Grand Valley State University

Geometries from groups

We present a new way of representing the subgroup structures of groups using finite geometries. Equipping any group with a generating set, word-lengths offer a way to put a metric on the group. The corresponding Hausdorff metric then determines a distance between pairs of subgroups of any finite group. We use the Hausdorff metric to define lines and create finite geometries in which the points are the subgroups of a given finite group. We apply these ideas to the finite cyclic groups. We prove a complete characterization for lines in the resulting geometries. Our result suggests relationships between the geometry corresponding to the cyclic group $\mathbb{Z}_n$ and the prime factorization of the integer n. We illustrate this point with a corollary of the characterization of lines that gives a class of pairs of finite cyclic groups $\mathbb{Z}_m$ and $\mathbb{Z}_n$ for which we can say that each line in the geometry for $\mathbb{Z}_m$ has a unique extension (as we define appropriately) to a line in the geometry for $\mathbb{Z}_n$. This undergraduate research was funded by the GVSU Student Summer Scholars program of 2017.

Presenters: Gabrielle Kuszewski and Katelyn Ware, Grace College undergraduate students

Faculty Advisor: Ryan Johnson, Grace College

Concise cyclotomic sums

A quadratic integer is a root of a monic quadratic equation with integer coefficients. It has been known since Gauss that any quadratic integer can be written as a sum of roots of unity. In this talk we will demonstrate the least number of roots of unity needed to sum to certain quadratic integers.

Presenters: Krystina Leganza, University of Indianapolis; Crystal Lorch, John Lorch, and Jerry Woodward, Ball State University

Designing and implementing a Summer STEM Institute

This session presents the role of the mathematics content and pedagogy university faculty in a week-long professional development experience, the Scientech/Ball State University Summer Institute for Math and Science teachers. Mathematics content faculty discuss how they designed and implemented activities to engage secondary mathematics teachers in challenging mathematics. Topics covered include "Geometry and Trigonometry," "Cubic Polynomials," and "Inquiry and Mathematics." Mathematics pedagogy faculty describe an inquiry-based approach to teaching mathematics and how the participating teachers were supported in developing lessons for their own students from the newly-learned mathematics.

Presenter: Stephen Luecking, DePaul University emeritus[1]
MSC 2010: 01, 97
Conics in Gaudi's Palais Guell

Gaudi is well known for his use of funicular curves in his architecture. His first building, designed for the Guell family of Barcelona, reveals the preliminary steps that led him to employ parabolic and catenary arches. Palais Guell is built around a conical vault that protrudes from the roof as a spire. Passages into the vault are vertical cuts through this cone and therefore hyperbolic. Main entries into the building are three-arc approximations of parabolas — a method that Gaudi would have learned from his family's metal working business. This methodology allowed Gaudi to maintain the construction of a classic arch while building an apparently parabolic arch.

Presenter: Rodney Lynch, Indiana University - Purdue University Columbus
MSC 2010: 15A24
How to recover a matrix from its adjoint

Recall that the adjoint of a square matrix is the transpose of its matrix of cofactors. Let B be an $n \times n$ matrix. Under what conditions on B can we find an $n \times n$ matrix A with $B = \text{adj}(A)$? If B is invertible then we can always find such an A, but it may not be unique. If B is not invertible, the interesting case is when $\text{rank}(B) = 1$. I will explain how to recover the matrix from its adjoint in this case. As an example, I will show how one can describe the set of all 3×3 matrices with entries in $\mathbb{R}$ which satisfy $\text{adj}(A) = \begin{pmatrix} 1 & 2 & 3 \\ 3 & 6 & 9 \\ 4 & 8 & 12 \end{pmatrix}$.

Presenter: Xuan "Shwan" Ma, Pearson Education
Identify at-risk students using predicative modeling

One of the prevailing challenges facing an online technical college was the high attrition rate among students during their first year in college. With limited resources in academic support services, the college explored data analytical tool to identify at-risk factors among freshmen using early enrollment data, such as demographics, financial aid eligibility, degree program, and prior college experience, etc. The resulting predicative tool allowed the college to proactively deploy timely remedial support to those students in need. This presentation walks through at high level the project methodology, data analysis process, and the regression model, while sparing the audience much details on the statistical techniques. The goal of this talk aims to illustrate how mathematical science can be applied to solve real-world problem.

Presenter: Johnathan Marquardt, University of St. Francis, Illinois, undergraduate student
A partial characterization of the symmetric spaces of the 2^{nd}-degree unitary group

This work presents a characterization of all matrices in $U(2)$, as well as specific symmetric spaces of $U(2)$. Specifically, the generalized and extended symmetric spaces of $U(2)$ given by inner automorphisms about a particular class of matrices whose squares are scalars are parameterized. This work contributes to the ongoing process of characterizing these symmetric spaces.

[1]Post-meeting footnote: Prof. Luecking was unable to present this talk at this meeting, but some of his work was on display at the Art Exhibit.

Presenter: Grace McClurkin, Saginaw Valley State University
Joint work with: Joshua Mike, Michigan State University
MSC 2010: 97

Utilizing Mathematica for higher level thinking in multivariable calculus

I will describe our design and implementation of an inverted multivariable calculus classroom, which utilizes computer-based computation (via Mathematica). In our approach, we delegate the lower cognitive thinking to outside class using notes and short practice. Conversely, higher-level thinking is developed in-class through Mathematica-based conceptual activities and other explorations. Our goal is to use Mathematica to simultaneously alleviate computational burden and reveal mathematical concepts.

This joint work with Joshua Mike was implemented at University of Tennessee, Knoxville in the 2016-2017 academic year. The course and its materials will be revisited and implemented at Saginaw Valley State University in Fall 2018.

Presenter: Monica McGrath, Saint Mary's College undergraduate student
Faculty Advisor: Jacob Duncan, Saint Mary's College

A fast-slow dynamical system model of addiction: predicting relapse frequency

Substance use disorders are prevalent and endemic in modern society. A patient of a substance use disorder is likely to have periodic relapses and periods of recovery. We propose a fast-slow dynamical system model which relates the levels of addictive substance to the levels of dopamine in the patient's brain. High levels of dopamine (DA) are responsible for the rewarding effects of using drugs of abuse (DOA). A patient is likely to seek recovery, which is a slow process, but increases in DA lead the patient to recall the rewarding effects of using a DOA. This leads to a very fast relapse, which is characterized by a spike in DOA levels in the brain. Then, the body's liver works to remove the DOA from the system, which is a relatively slow process. Once the DOA is completely removed, the patient has re-entered the recovery phase, and the cycle repeats. We use our model to predict the DA level which triggers a relapse, called the relapse threshold. We also use the fast-slow dynamics (geometric singular perturbation theory) of the system to predict the period of the cycle, which can be interpreted as relapse frequency. Both predictions can indicate when a patient is at risk of relapsing.

Presenter: Anthony Mendoza, Benedictine University undergraduate student

A two-prey, one-predator model with age structure and impulsive effects for integrated pest management

We investigate the dynamics of a two-prey, one-predator system for integrated pest solutions. The generalist predator in this system is *Orius insidiosus* while the two prey are the soybean aphid, *Aphis glycines*, and the soybean thrip, *Neohydatothrips variabilis*. The model features stage structure for all species and birth pulses for the prey species. The birth pulses, spraying of pesticides, and predator augmentation occur periodically. We investigate the local and global stability of the model. We establish conditions for which the model exhibits a total pest eradication solution, solutions in which one prey is eradicated, and a permanent solution in which the pests are kept at a low sustainable level.

Presenter: Claire Merriman, University of Illinois at Urbana-Champaign graduate student
MSC 2010: 37B10
Using geodesics to generate continued fractions
Continued fractions are frequently studied in number theory, but they can also be described geometrically. I will give both pictorial and algebraic descriptions of the flows that describe continued fraction expansions.
This talk will focus on continued fractions of the form $a_1 \pm \cfrac{1}{a_2 \pm \cfrac{1}{a_3 \pm \ddots}}$, where the a_i are odd. I will show how to describe these continued fractions as geodesics on the hyperbolic plane, and how they cross cells of the Farey tessellation.

Presenter: Allison Myhelic, Roosevelt University undergraduate student
Oscillating sounds from drums and their formulas
Partial differential equations and Fourier transforms can be used to describe the sound made by different drums. Python or Mathematica will be used to find solutions and separate the sound into the waves that make it up.

Presenter: Jon Oaks, Macomb Community College
Bringing the STATS to I.N.D.I.A.N.A.
In this session, the presenter will discuss some of the challenges that might arise when teaching a statistics course that has an intermediate algebra prerequisite. What might a class like this look like compared to other mathematics and statistics courses? That's right, we're bringing the STATS to I.N.D.I.A.N.A. (Interquartile range, Nonresponse, Discrete variable, Independent variable, Alternative hypothesis, Normal distribution, Average).

Presenter: Drake Olejniczak, Western Michigan University graduate student
Joint work with: Zhenming Bi, Gary Chartrand, and Ping Zhang, Western Michigan University
A bipartite party problem
A well-known party problem with a graph theory connection is the following: What is the smallest number of people who must be present at a party such that there are three mutual acquaintances or three mutual strangers? This problem has many generalizations. Here, we consider the following bipartite party problem along with some of its extensions and its graph theory connection: at a party with six girls, what is the smallest number of boys who must be present at the party to guarantee that there are three girls and three boys such that

(1) each of the three girls is an acquaintance of each of the three boys or
(2) each of the three girls is a stranger to each of the three boys?

Presenter: James Olsen, Western Illinois University
MSC 2010: 97G40
Some rich geometric diagrams and connecting the mathematics beneath
We will look at some geometry problems (and associated GeoGebra diagrams) which are mathematically beautiful in their own right, but which also help our students reason proportionally, algebraically, and numerically. Manifestations of the geometric mean and the harmonic mean are common in these diagrams. We'll discuss problem-solving and proof-writing strategies. This is a combination mathematics and mathematics education presentation.

Presenter: Melissa Pickett, Benedictine University undergraduate student

Teaching velocity problems

In this talk I will start by exploring some of the common difficulties that students have when learning about the relationships between speed, velocity, and acceleration. I will show a sample lesson plan and illustrate a few activities that I developed to help students better understand these concepts when they look at a graph. We will then connect these concepts to the definitions specifically we will look at how we find the instantaneous velocity at a point by creating smaller and smaller intervals of average velocity. This will lead to the definition of the derivative. Finally we will explore what algebraic structures are needed in order to study velocity problems, and identify the minimum concepts necessary to compute the acceleration function from a velocity function defined over a field.

Presenter: Victor Piercey, Ferris State University

The New Jim Crow: Using social justice to teach quantitative literacy

One of the premises of quantitative literacy is the sophisticated application of elementary mathematics (mostly arising from ratios and proportions) in authentic and complicated contexts. There are many complicated and important contexts that arise out of social justice issues that are particularly timely and valuable to our students. In this talk, I will share an example involving the use of Michelle Alexander's book *The New Jim Crow*.

Presenter: Heather Ray, Lewis University undergraduate student

Joint work with: Keller Dellinger, Simon Merheb, Audrey Pearson, Chandler Stimpert, and Quinn Stratton, Lewis University undergraduate students

Faculty Advisor: Amanda Harsy, Lewis University

Graph theoretical design strategies for modeling self-assembling DNA

Motivated by the recent advancements in nanotechnology and the discovery of new laboratory techniques using the Watson-Crick complementary properties of DNA strands, formal graph theory has recently become useful in the study of self-assembling DNA complexes. Construction methods developed with concepts from undergraduate level graph theory have resulted in significantly increased efficiency. In this talk, we present the preliminary results of a semester-long undergraduate research project applying graph theoretical techniques to constructing complexes like general bi-partite graphs which can be created from self-assembling DNA. In particular, we explore various design strategies given three different laboratory constraints.

Presenter: David Redman, Delta College

Practical origami nanotube construction techniques

The presenter will illustrate some educational and entertaining applications of origami in the classroom. The activities use ordinary office sticky notes, traditional origami paper and Thomas Hull's PHiZZ units to construct models of graphene, buckyballs, tori, and nanotubes, as well as non-orientable surfaces. The presenter will show how to construct models of nanotubes of various chiral angles.

Presenter: Trevor Richards, Monmouth College

The infinite train

A train rides down a track blowing its whistle all the way. If it is moving faster than the speed of sound (at a constant or varying speed), then it will pass a house by the side of the track before the occupants hear its whistle. But when it passes the house (that is, gets to a given point on the track), who **has** heard the whistle? Can we determine the region over which the sound of the train has passed by that time? We will answer twice, once with calculus and once with differential equations.

Presenter: Rebecca Robinson, University of Michigan - Flint undergraduate student
Faculty Advisor: Cameron McLeman, University of Michigan - Flint
Chromatic polynomials, counterexamples, and conjectures

The *chromatic polynomial* of a graph G, denoted $\chi_G(k)$, is the function which to each natural number k, returns the number of proper k-colorings of G. A large family of graphs can have their chromatic polynomials determined by the multiplication principle – for example, the chromatic polynomial of the complete graph on 4 vertices is $k(k-1)(k-2)(k-3)$, since we can choose any one of the k colors for the first vertex, leaving $k-1$ allowable colors for the second vertex, and so on. The graphs for which this technique works are called *chordal* graphs, and it is easy to see that the roots of all of their chromatic polynomials are integers. A natural conjecture is the converse, i.e., that having $\chi_G(k)$ with all integer roots implies that G is chordal. This question was open until 1975, when Read found an explicit counterexample. We'll address some refinements of this conjecture, focusing on a specific conjecture by Dong and Koh conditioning the result on the graph's chromatic number.

Presenter: Ranjan Rohatgi, Saint Mary's College
Joint work with: Tri Lai, University of Nebraska - Lincoln
MSC 2010: 05A15, 05B45
Counting tilings of almost-hexagons

You need to tile your hexagonal bathroom floor, measuring n feet on each side. We can use tiles shaped like rhombi (interior angles 60 and 120 degrees), called lozenges, with each side 1 foot, to tile this floor. In how many ways can we do this? There is a nice formula for the number of tilings of hexagonal regions, but no formulas are known for most regions. I will provide historical context for tiling problems and present new results for some very weirdly-shaped bathrooms!

Presenter: Marko Saric, Benedictine University undergraduate student
Matrix conditions on iterated function systems that generate a fractal

Fractals are self-similar structures which can be defined by an iterative process. In this paper, we use a computer system and iterated function systems (IFSs) to study the role of matrix norms and its effect on the type of fractal generated. In particular, we propose a connection between the spectral norm of the matrices in the IFS and the type of attractor that is graphed.

Presenter: Itai Seggev, Wolfram Research
Some subtleties of asymptotic approximations

An asymptotic approximation, also called an asymptotic expansion, is a generalization of the familiar concept of Taylor polynomial. Rather than restricting to polynomials, many different types of functions can be used in the approximation, as long as they satisfy the basic property that they form an "asymptotic scale." A key concept is that the asymptotic approximation has small relative error to the function being approximated, but not necessarily small absolute error or convergence. While this allows approximating many different kinds of functions, it also leads to some surprising failures of approximation. This will be illustrated using Bessel functions as an example.

Presenter: Linda Shaw, Benedictine University undergraduate student
Outside in

Sphere eversion is a unique paradox studied in differential topology that explains the process of turning a sphere inside out. The process allows for self-intersections although no creases or punctures can be made. Different methods will be shown as we discuss the unique characteristics that make them possible.

Presenter: Emily Sheetz, Monmouth College undergraduate student
Joint work with: James Brown, Southern Connecticut State University
Faculty Advisors: Richard Chapman and Saad Biaz, Auburn University
Optimized snapshot-based visual homing for UAVs

As unmanned aerial vehicles (UAVs) are more widely used, visual homing becomes an increasingly important area of research. Several researchers explore visual navigation or visual target finding on UAVs or ground robots with promising results in simulations and implementation. To explore new approaches for UAV visual homing, techniques for image processing and machine learning must be carefully evaluated, selected, and implemented in order to develop a system that is efficient and practical for real time applications. This work explores a unique visual homing approach for UAVs. Snapshots taken during the UAV's exploratory journey from home create a sparse representation of the traveled path. Feature extraction and brute force feature matching are used to estimate the homography between reference snapshots and camera images on the return journey. The homography is then used to navigate the UAV home. The same feature matching techniques are used in a visual approach to path optimization. This approach allows the UAV to follow near-optimal return paths based on similarities between saved snapshots. These techniques were tested in simulation and showed promising results for accurate and near-optimal visual navigation to home.

Presenter: Michael C. Sostarecz, Monmouth College
MSC 2010: 11E25
Using linear algebra and probability to solve Minesweeper

Minesweeper is a computer puzzle game played on a rectangular grid. From the current board layout, a single player determines which squares are "safe" and which are believed to contain a "mine". If a safe square is selected, more details of the puzzle are revealed. However, the game is lost if a mine is accidentally selected. While some moves can be determined by short logical arguments, a system of linear equations can be derived for more complex situations. Ideal moves are found using a combination of conditional probability, counting arguments, and the rank-nullity theorem from linear algebra. From this background, simulations are carried out on three levels of difficulty which vary the size of the board and the total number of bombs. Estimates for the probability of winning Minesweeper via logic alone or via logic with selective guessing are found.

Presenter: Aliza Steurer, Dominican University
How inquiry based learning is like parenting

While learning how to teach using inquiry-based learning (IBL), the presenter noticed some similarities that it has with parenting. IBL mathematics can be thought of as an active learning method by which students discover concepts by doing exercises and communicating solutions to their peers and instructor, while the instructor acts as a facilitator rather than the primary source of information. In this talk, we will examine parallel aspects between IBL and parenting, including growth mindset, deconstruction of tasks, and instructor-student and parent-child interactions. This appears to be a perspective on IBL not found in the current literature. The aim is to illuminate and better understand aspects of both parenting and IBL.

Presenter: William Stowe, Augustana College undergraduate student
Faculty Advisor: Thomas Bengtson, Augustana College
On the subsets of spreads

A spread is a discrete set of points such that no three are in a straight line. In this talk, we will define a function that generates the centers of subsets of spreads. We will see a pattern involving Pascal's Triangle that emerges when counting necessarily similar subsets in the domain and range of this function.

Presenter: Holly Summers, Monroe Central Jr./Sr. High School

Indiana Summer STEM Institute talks

This talk will focus on the teacher experience at the Scientech Summer STEM Institute. The presentation will cover the format of the experience, the benefits of participating and the inquiry-based lesson that I developed as an outgrowth of the experience. The Summer STEM institute was a unique opportunity for secondary mathematics teachers to learn new mathematics content and to work with other teachers to share ideas and develop lessons.

The lesson I will discuss is a 3 to 4 day, inquiry-based Geometry lesson created to serve as an introduction to proofs. The lesson is designed to build the foundational reasoning necessary for students to develop a deep understanding of two column proofs. It is part of a larger curriculum revision I have done in my classes where proofs are taught as a separate unit instead of being placed sporadically within various units.

Presenter: Enrique Treviño, Lake Forest College

MSC 2010: 11T06

Counting perfect polynomials

A number is perfect if it is the sum of its proper divisors. For example $6 = 1 + 2 + 3$. In the setting of polynomials modulo 2, we can make an analogous definition of perfect polynomials by saying that a polynomial p is perfect if the sum of its divisors is p. For example, the polynomial $p = x^2 + x$ has divisors $1, x, x + 1, x^2 + x$, and their sum is $1 + x + (x + 1) + (x^2 + x) = 2 + 3x + x^2 \equiv x + x^2 \bmod 2$. Therefore $x^2 + x$ is perfect modulo 2. In this talk we describe bounds for how many perfect polynomials can exist.

Presenter: Chris Tweddle, Governors State University

Modeling and simulation of a bicycle race

The sport of cycling includes a wide variety of racing situations and disciplines. Track races are held both indoors and out in velodromes on an oval track with banked corners; road races are held on flat, hilly, and mountainous courses on urban and rural paved streets; mountain bike and cyclocross races are held on dirt tracks that may include obstacles and hills. Disciplines include individual and team races, sprint and endurance distances, as well as single-day and multi-stage events. In this presentation, we will discuss the assumptions and features of the proposed model and present preliminary simulation attempts to model the individual time trial. A revised model will be presented and the simulation results compared to the outcomes of the individual time trial at the 2017 Tour de France.

Presenter: Ming-Jer Wang, Richard J. Daley College

A STEM learning-level-enhancement methodology for long-term knowledge retention

In this presentation, an innovative STEM Learning-Level-Enhancement Methodology of building mental schemata is presented. It is designed to help students to construct common question types and corresponding common procedures and subsequently relate these to master formula or concept at the higher levels under the guideline of a working STEM taxonomy of learning and teaching.

Students' lack of sufficient abstract thinking ability, problem solving ability, and long-term knowledge retention are three typical problems identified among the STEM educators. All these problems might be caused by one of the common methods of teaching students detailed step-by-step procedures without making connections to higher abstraction levels of common question types, common procedures, master formula, and concepts. This methodology is specially designed to solve these problems. Previous preliminary data of a Calculus II class on the feasibility of this approach will be presented and discussed.

More well designed and comprehensive studies will be conducted in the future in order to verify or disprove the features, the contents, or the connections in this methodology and eventually to enhance the STEM educational quality. This will require more parallel sections of Calculus courses in order to study this methodology and its effects in more details.

Presenter: Uditha Wijesuriya, University of Southern Indiana

Identification of the data distribution using a plot based on sample variance

The graphical interpretation of the data which captures important characteristics of the population such as symmetry, skewness, and outliers, is an important part of statistics. In similar manner, if one can graphically interpret complex formulas such as sample variance, a measure of spread of data, it will make people in other disciplines visualize it simply. In this study, the sample variance formula is graphically interpreted by a plot which is associated with square deviations, called SV-plot. In addition, this plot is used to explore the population characteristics mentioned above. Finally, these results are displayed and interpreted using a simulation study. It is found that the SV-plot is more effective in identifying the shape of the distribution.

Presenter: Mikaela Wyatt, Grand Valley State University undergraduate student

Faculty Advisor: William Dickinson, Grand Valley State University

A San Gaku pentagon

While Japan was a closed society during the Edo period (1603–1867), the Japanese discovered many properties of Euclidean geometry prior to their "discovery" in Western culture. As a form of worship, many geometric arrangements were drawn on tablets called San Gaku and hung in the temples and shrines. Many of the San Gaku left the viewer the opportunity to discover what special property was being portrayed, often giving little to no explanation on the tablet. We will focus on a San Gaku that has a regular pentagon and several congruent right triangles. We will show the *golden* relationship of certain lengths and generalize this relationship on the sphere.

Presenter: Michael Xue, Vroom Laboratory for Advanced Computing

Refuting a conjecture on $x^n - 1$ using a Computer Algebra System

There was a conjecture stating that the absolute value of a non-zero coefficient in the factor of $x^n - 1$ is always 1. This presentation refutes this conjecture by a counter example using a computer algebra system (CAS). Furthermore, this talk will pose a similar problem to either prove or refute another conjecture regarding the uniqueness of a solution found by CAS.

Presenter: Aaron Zerhusen, Dominican University

Euclid through the windows of Rosary College

When many of us think of the geometry of Euclid, we think of straightedge and compass constructions. Prior to the industrial age, the straightedge and compass (or dividers) were also a symbol of craftsmen. Whether in the symbol of the Freemasons or in Dürer's *Melancholia I*, dividers or compasses have been used to denote a skilled mason or woodworker capable of laying out complex forms such as the arches of Gothic cathedrals. In this talk I will describe a classroom activity from my Modern Geometry class in which the students were charged with reconstructing the layout of architectural details from the century-old Gothic campus of Dominican University (formerly Rosary College) as they would have been done by a craftsman of old.

Presenter: Ellen Ziliak, Benedictine University

MSC 2010: 20G40

Orbit decompositions of the generalized symmetric spaces of $SL_2(\mathbb{F}_q)$

In celestial mechanics, an orbit is the path an object traces out as it moves around the sun. In a group, the orbit is a path through elements in the group as we act by an interesting subgroup. In this talk our interesting subgroup is the fixed point group, and I will explain how this breaks up an interesting set called the generalized symmetric space.