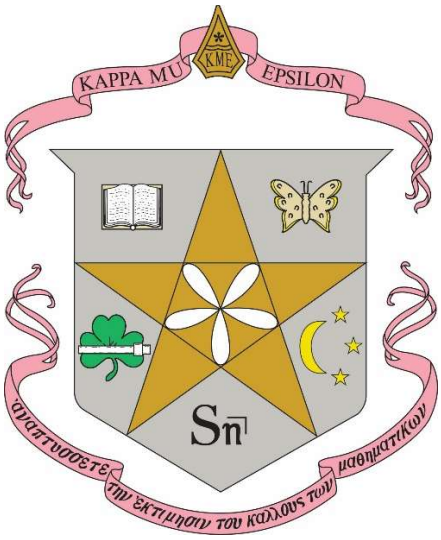

Kappa Mu Epsilon
National Mathematics Honor Society

KME 43rd BIENNIAL NATIONAL CONVENTION
April 16 - 17, 2021

Hosted by Missouri Beta Chapter at University of Central Missouri in Warrensburg, MO
Hosted on the Sococo platform by mathdept.org

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PARTICIPATING CHAPTERS

Alabama Alpha, Athens State University
Alabama Theta, Jacksonville State University
California Epsilon, California Baptist Univ
Georgia Zeta, Georgia Gwinnett College
Hawaii Alpha, Hawaii Pacific University
Indiana Gamma, Anderson University
Iowa Gamma, Morningside College
Kansas Alpha, Pittsburg State University
Kansas Beta, Emporia State University
Kansas Delta, Washburn University
Maryland Delta, Frostburg State University
Michigan Beta, Central Michigan University
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Nebraska Beta, Univ of Nebraska-Kearney
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Nebraska Gamma, Chadron State College
New York Eta, Niagara University
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Tennessee Gamma, Union University
Texas Gamma, Texas Woman's University
Texas Kappa, Univ of Mary Hardin-Baylor
Texas Mu, Schreiner University
West Virginia Alpha, Bethany College

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KME 43rd BIENNIAL CONVENTION AGENDA

Friday evening, April 16, 2021

7:00-9:00 p.m. CDT Reception and Mixer

Saturday morning, April 17, 2021

8:30 a.m. CDT First General Session

Welcome: Brian Hollenbeck, President, Kappa Mu Epsilon
Roll call: Rhonda McKee for Steve Shattuck, Secretary, Kappa Mu Epsilon
Brian Hollenbeck: Introduction of present officers
Brian Hollenbeck: Introduction of past officers
Katherine Kime: Introduction of Candidates for President Elect and Historian

9:00 a.m. Student Presentations, Session #1

1. Dakota Heathcock, Alabama Theta. Title: Square Rooting Logic: The Philosophy Behind Mathematics
2. Isaac Reiter, Pennsylvania Epsilon. Title: The VICCard Cipher: Our Contribution to the Field of Playing Card Cryptography
3. Christopher McHeffey, Rhode Island Beta. Title: Improve the accuracy of Tuberculosis Detection from Chest X-ray using Transfer Learning.

10:00 a.m. 10 minute break

10:10 a.m. **Workshops**

C. Bryan Dawson, Tennessee Gamma, Union University. Title: The Hyperreal Numbers

Shamita Dutta Gupta, New York Kappa, Pace University. Title: A study of teaching methodologies and their impact on varied audiences.

Son Nguyen, Rhode Island Beta, Bryant University. Title: Building an image recognition model from scratch.

11:10 a.m. **Student Presentations, Session #2**

4. Lindsey Moyer, Pennsylvania Epsilon. Title: Composition of Magic Squares

5. Tony Glackin, Iowa Gamma. Title: Forbidden Posets For A Class Of Interval Orders

6. Luis Sanchez Mercedes, Rhode Island Beta. Title: Cryptonomics: An Empirical Analysis of the Internal and External Performance of Blockchain Networks to the Determine Their Changes in Price

12:10 p.m. **Group Photo and Lunch Break**

Saturday afternoon, April 17, 2021

1:30 p.m. **Keynote Address: Using Mathematics to Create Symmetry Patterns**

Joe Gallian, University of Minnesota Duluth

We explain how to create symmetry patterns using graphs, exponential functions, logarithms, and modular arithmetic.

2:40 p.m. **Student Presentations, Session #3**

7. Laura Batts and Megan Moran, Indiana Gamma. Title: Non-realizable polynomial root sequences.

8. Joshua Gottlieb, Pennsylvania Upsilon. Title: Integrating Factors Throughout Differential Equations

9. Stephen Bates, New York Omicron. Title: The Graphing Calculator and Achievement in Middle School Mathematics: The Effects of Course Level and Student Achievement Level

3:40 p.m. 10 minute break

3:50 p.m. **Breakout Sessions and Committee Meetings**

Student Session led by Alec McClendon

Faculty Session led by Brian Hollenbeck

Awards Committee Meeting chaired by Don Tosh

Resolutions Committee Meeting chaired by Gaspar Porta

4:40 p.m. 10 minute break

4:50 p.m. **Awards and Concluding Business Meeting**

Mention the convention survey https://www.surveymonkey.com/r/kme2021

Reports of National Officers

Reports of sectional meetings and committees

Elections

Installation of New Officers

Recognition of Outgoing Officers

Awards committee report and student awards

Mach award

Call for 2023 hosts

PAPER ABSTRACTS

Arranged alphabetically by author

Stephen Bates, New York Omicron, St. Joseph's College.

Title: The Graphing Calculator and Achievement in Middle School Mathematics:The Effects of Course Level and Student Achievement Level.

Abstract: The graphing calculator has been used by many mathematics teachers in the United States over the past two decades. Research regarding the impact of the graphing calculator on student achievement has been inconclusive, with a paucity of literature on its effects in the middle grades. This study utilized a single-group design in which $N = 106$ middle school students of varying achievement levels (low ($n = 55$) or high ($n = 51$)) and course levels (advanced ($n = 66$) or non-advanced ($n = 40$)) received instruction alternating the inclusion and exclusion of the graphing calculator over four units of study. A one-way ANOVA revealed significant interactions: students in seventh-grade advanced mathematics were all negatively impacted by the graphing calculator; high-performing males in eighth grade performed better with the graphing calculator relative to low-performing males, and, overall, females were more positively affected by the graphing calculator than males, highlighting both an achievement gap and a gender gap. Future research might well include an investigation into the gaps made evident from this study, including examinations into why younger students are negatively impacted by the graphing calculator, why higher-performing males and lower-performing females outperform their respective peers, as well as why females generally outperform males with the use of the graphing calculator.

Laura Batts and Megan Moran, Indiana Gamma, Anderson University

Title: Non-realizable polynomial root sequences

Abstract: Rolle's theorem is a classical result typically studied in first-semester Calculus that can be used to locate the roots of a derivative of a polynomial between two consecutive roots of the polynomial. We investigate polynomials with distinct real roots, whose derivatives also have distinct real roots, none of which coincide. By differentiating several times, we produce a sequence of the roots of all nontrivial derivatives of a polynomial. For a polynomial of degree n this process produces $n(n+1)/2$ distinct roots. Although the ordering of the roots is constrained by Rolle's theorem, surprisingly not all root sequences allowed by Rolle's theorem exist. We investigate these non-realizable root sequences and establish elementary proofs for the non-realizability of particular root sequences.

Tony Glackin, Iowa Gamma, Morningside College

Title: Forbidden Posets For A Class Of Interval Orders

Abstract: An interval representation for a poset $P = (X, \leq)$ is an assignment of an interval $I(x) = [L(x), R(x)]$ to each $x \in X$ such that $x < y$ in P if and only if every point in I(x) is less than every point in I(y). An interval order is a poset that has an interval representation. These posets have been studied for over 50 years, leading mathematicians to conclusions about what posets do not

have interval representations. Recently, several authors have investigated variations in the types of intervals allowed in an interval representation. We say an interval order P has a {0, 1} OC interval representation if for all $x \in X$, the length of I(x), denoted |I(x)|, is either 0 or 1. If |I(x)| = 1, we allow I(x) to be either open or closed. In this talk, we will introduce a set of forbidden posets for the class of {0, 1} OC interval orders.

Joshua Gottlieb, Pennsylvania Upsilon, Seton Hill University

Title: Integrating Factors Throughout Differential Equations

Abstract: Integrating factors are first introduced in an ODE course as a method of solving first order linear ODEs, and it is well known that the technique can be extended beyond first order equations to solve other types of ODEs. Solving the case with distinct solutions, we use multiple integrating factors to solve ODEs with constant coefficients of arbitrary order. In generic cases, using only material from Calculus 1, it can be shown that second order nonconstant coefficient ODEs are solvable using integrating factors without resorting to power series expansion, which departs from the standard methods used in ODE textbooks. Because of this versatility, we suggest this technique as an alternative unifying presentation of the concepts and proofs that are typically covered in an ODE course to provide intuition to students.

Dakota Heathcock, Alabama Theta, Jacksonville State University

Title of Presentation: Square Rooting Logic: The Philosophy Behind Mathematics

Abstract: Philosophy and mathematics, two of the most important intellectual tools mankind has ever had in its arsenal. They both serve multiple purposes and have fathered numerous advancements in both the hard and soft sciences. They often go hand-in-hand with multiple subjects such as physics, biology, sociology, and psychology. However, many people have failed to realize that philosophy exists inside of mathematics in its own way. Without the philosophy of mathematics, scientists and mathematicians would not be able to probe, analyze, and discover the origins of mathematics, nor examine the logic behind mathematical proofs and computations. This presentation takes a “look behind the curtain” and goes beneath the surface of mathematics to uncover the philosophical elements at its core. An examination will first be made of the common ground shared between philosophy and mathematics. We will then look at several ancient and modern contributors, such as Pythagoras, Plato, Descartes, and Leibniz, and the contributions these individuals made to the fields of both mathematics and philosophy. Furthermore, after highlighting the philosophical elements of mathematics, a discussion will be had about how mathematical logic is just as philosophic as it is scientific. This piece is designed, not to sway opinion regarding philosophy or mathematics, but to highlight the extensive correlation between these two fields.

Christopher McHeffey, Rhode Island Beta, Bryant University

Title: Improve the accuracy of Tuberculosis Detection from Chest X-ray using Transfer Learning.

Abstract: Over the past years, deep neural networks and transfer learning have developed into powerful tools to solve computer vision tasks such as image recognition and object detection. In this work, we will study the power of transfer learning applied to the problem of detecting

Tuberculosis using chest X-ray. We demonstrate that the knowledge transferred from well-known pre-trained models, such as MobileNet, Inception, Resnet and EfficientNet, effectively improves the accuracy of the Tuberculosis detection. This study also utilizes the power of free computing service offered by Google in implementing deep neural networks.

Lindsey Moyer, Pennsylvania Epsilon, Kutztown University

Title: Composition of Magic Squares

Abstract: Magic squares originated over 3,000 years ago from a legend about a Divine Turtle found in the ancient Chinese book *Yih King*. According to the legend, it is mathematically possible to form n x n squares where each row, column, and diagonal add up to the same magic constant or value using the numbers 1 through n^2. Over time, mathematicians have developed different methods to compose extraordinary magic squares, other than the original Lo-Shu 3 x 3 magic square. The main focus of my research consisted of six composition methods that would produce specific magic squares. All three main types of magic squares, odd, singly-even, and doubly-even were intensely investigated. Odd magic squares can be composed utilizing either the Siamese Method, or the Lozenge Method. The Siamese Method was found to be the primary composition method as it was used in most other composition methods, whereas the Lozenge Method was found to be a more advanced concept in creating odd magic squares. Singly-even magic squares have an n value that is divisible by 2 but not 4 and can be composed using the Singly-Even Method. The Singly-Even Method involves creating four magic squares with the Siamese Method and swapping certain columns and rows to create a full singly-even magic square. Doubly-even magic squares have an n value that is divisible by 2 and 4 and can be composed using the Doubly-Even Method. The Doubly-Even Method includes multiple n x n squares where values have to be strategically placed to establish a doubly-even magic square. Following the three main types of magic squares, my research lead me to investigate two specialized magic squares, concentric and pandiagonal. Composing a concentric magic square consists of breaking a magic square into nine different sections and completing different steps in each to create a magic square where if the outer shell of the magic square is removed, the inner square is still magic. The composition for a pandiagonal magic square includes five different requirements that need to be followed to produce a magic square that has all the normal properties, but the wrap around diagonals also equal the magic constant. My research goes in-depth with the composition by utilizing multiple visual aids and representations of each stage in each type of magic square.

Isaac Reiter, Pennsylvania Epsilon, Kutztown University

Title: The VICCard Cipher: Our Contribution to the Field of Playing Card Cryptography

Abstract: Before computers, military tacticians and government agents had to rely on pencil-and-paper methods to encrypt information. For agents that want to use low-tech options in order to minimize their digital footprint, non-computerized ciphers are an essential component of their toolbox. Still, the presence of computers limits the pool of effective hand ciphers. If a cipher is not unpredictable enough, then a computer will easily be able to break it.
There are $52! \approx 2^{225.58}$ ways to mix a deck of cards. If each deck order is a key, this means that there are $52! \approx 2^{225.58}$ different ways to encrypt a given message. To create some perspective, most computer ciphers feature either 2^{128} or 2^{256} different ways of encrypting the same message. Hence,

a cipher created from a deck of cards has the potential to emulate the security of many computer ciphers. Dr. Landquist and I spent the summer of 2019 examining existing playing card ciphers. This led to the main focus of our paper: the creation of a unique, secure playing card cipher. Because of the inspiration provided by the cipher VIC, I am calling our original cipher VICCard. VICCard has gone through multiple versions, each better than the last. Its security is rooted in its combination of numerous cryptographic principles, including a substitution checkerboard, columnar transpositions, lagged Fibonacci generators, and junk letters. As evidenced by certain randomness tests, VICCard has the potential to extensively randomize an English plaintext. In my talk, I will discuss the workings of our cipher, the inspiration behind it, and the associated randomness tests.

Luis Sanchez Mercedes, Rhode Island Beta, Bryant University

Title: Cryptonomics: An Empirical Analysis of the Internal and External Performance of Blockchain Networks to the Determine Their Changes in Price

Abstract: Are cryptocurrencies the next advance in monetary systems? To some the answer to such a question is rather simplistic, they simply are not. Unlike traditional currency, they encourage illegal activity through their systematic privacy, they lack the governmental census to provide accountability to its users, and most importantly, they do not have a self-regulating system that would maintain the value of its currency and regulate the actions of users. They lack the infrastructure to overthrow a system which has ruled for centuries. Yet, that itself raises a set of questions; what can they do to gain those qualities? What can cryptocurrency do to successfully manage themselves and truly advance the monetary systems? What is stopping them from achieving set set status? The answer is both complex and yet simple, they lack a manager. Yes, the logic built within them allows for complete immutability and yes, they have a proven way to take in and verify transactions from its users and entities. However, similar to how the Federal Reserve manages the U.S monetary supply, cryptocurrency lacks an in-built body to successfully manage their system; they lack a management system that looks at the incoming metrics and changes based on a set analysis of the results. The idea behind this paper is to lay out the framework for this management system through an analysis of the metrics that a management system could use to truly be able to manage its currency autonomously. To effectively answer this, an empirical model was built testing the different sections of metrics that a cryptocurrency system can produce in comparison to the changes in price.

Workshop Abstracts

Title of workshop: The Hyperreal Numbers

Presenter: C. Bryan Dawson, Tennessee Gamma, Union University

Abstract: This "hands-on" workshop will begin with an introduction to the hyperreal numbers, which include infinitesimals and infinitely large numbers. Concepts such as approximation, different levels of hyperreal numbers, and rates of growth will be discussed. The workshop ends with the "level comparison test" for series, a computationally simple and widely applicable replacement for the limit comparison test. Although some presentation of material will be necessary, throughout the workshop participants will have opportunities to work with the hyperreal numbers for themselves.

Title of workshop: A study of teaching methodologies and their impact on varied audiences.

Presenter: Shamita Dutta Gupta, New York Kappa, Pace University

Abstract: In this workshop we will discuss several teaching methodologies such as

- Service-Learning Courses,
- Writing Enhanced Courses,
- Learning Communities, and
- Online synchronous, asynchronous, and web-assisted courses.

We will engage in a discussion of what works or doesn't, addressing questions such as

- Does a specific teaching methodology only work for a certain level of Math course?
- Does the mode of delivery depend on the level of Mathematics?

The workshop will engage in conversations revolving around the above questions and look for active audience participation.

Title of workshop: Building an image recognition model from scratch.

Presenter's name: Son Nguyen, Rhode Island Beta, Bryant University

Abstract: This workshop walks you through the steps of building an image recognition model from scratch. We will demonstrate by training a model (a neural network) to recognize a dog and a cat. After the workshop, the students can train models to do recognize any image categories they wish (for example: a house vs. a tree or cancer chest x-ray vs. non-cancer chest x-ray). The model is trained on a free cloud computing service offered by Google. The students must have a google account to join the workshop.

Biographies of Candidates for Office

Candidate for President Elect: Scott Thuong, Oklahoma Beta

Scott Thuong is an associate professor of mathematics at Pittsburg State University. There he serves as faculty advisor for the Kansas Alpha chapter. He teaches a wide variety of courses such as discrete mathematics, real analysis, and topology. Dr. Thuong recently taught special topics courses on Lie theory and the philosophy of mathematics. Broadly speaking, his research interests are in topology, differential geometry, and more recently, the history of math. The past several years he has coordinated the annual Kansas Collegiate Mathematics competition. He completed his graduate education at the University of Oklahoma, and received bachelor's degrees in math and computer science from Missouri Southern State University. His hobbies include both tennis and table tennis (going as far as to start a student ping pong club at PSU!) , as well as spending time with his two basset hounds.

Candidate for Historian: Mark Hughes, Maryland Delta

Professor, Department of Mathematics Frostburg State University

Education

B.A. in Mathematics, University of Chicago, June 1982

Ph.D. in Mathematics, Rutgers University, May 1987

Thesis: Finite Abelian Group Actions on Homotopy Complex Projective Spaces

Mathematical Interests

I initially focused on research in topology. An extension of my thesis was published as Finite Group Actions on Homotopy Complex Projective Spaces (Mathematische Zeitschrift, Band 199, Heft 1, Sept. 1988, pp. 133 – 151). I published two other papers in this area (in the Pacific Journal of Mathematics (1991) and in the Transactions of the AMS (1993)). I also did work with a colleague at Florida State University on the determinant of the Laplace operator. After taking a position at Frostburg State University in 1992, I have primarily focused on teaching. I have a long standing deep interest in the history of mathematics and over the years I've enjoyed developing materials for my course in that subject here at FSU.

Involvement in Kappa Mu Epsilon

- I've been a member of KME (Maryland Delta Chapter) since 1993.
- I've been a faculty advisor and corresponding secretary for our chapter since 2003.
- I mentored three student members on projects which they presented at the April 2018 KME Great Lakes Regional Convention held at Wheeling Jesuit University. The topics were Euler's Polyhedral Formula, Penrose Tilings, and Elliptic Curve Cryptography. The student presenting on ECC published her project in The Pentagon (Spring 2019).
- I helped organize the KME National Convention held in April 2019 at Frostburg State University.

Other Interests

- reading history
- collecting antiquarian books
- genealogy
- hiking