GEORGIA COLLEGE

GEORGIA'S PUBLIC LIBERAL ARTS UNIVERSITY

CAPSTONE DAY

Department of Mathematics

Georgia College

November 23, 2013

8:00 AM - 2:15 PM

Health Sciences Building

Department of Mathematics
Georgia College

Earning a college degree is a significant achievement and requires dedication and tremendous effort by each student. Several programs have been developed to help students majoring in Mathematics to succeed. The First Year Academic Seminar provides an introduction to department faculty, departmental and University expectations, policies, resources, and opportunities following graduation. The department conducts informal social activities and presentations by faculty and guest speakers to encourage faculty and student interaction. The department newsletter, Sum News, serves to inform, acknowledge and encourage student majors to become involved in activities related to the major such as mathematics competitions and professional meetings. The academic honor society Kappa Mu Epsilon has been organized to encourage and provide a supporting network for the student body.

Professional schools, businesses, government, and industry recognize that mathematics majors are problem solvers and are highly skilled in the use of logic and reasoning. A degree in Mathematics opens many careers that are closed to those without quantitative skills. Actuarial Science stands as one major example. Moreover, the demand for mathematics in education-especially in secondary schools-is tremendous. In fact, the chronic nation-wide shortage of mathematics teachers is due in part to the demand in so many other areas for talented mathematics majors.

2013 Capstone Day Schedule

8:00 – 8:40 Registration and Continental Breakfast **HSB Student Lounge (3rd Floor)**

8:40 – 9:00 Opening Remarks **HSB 300**

9:00 – 10:10 Parallel Session I **HSB 300**

9:00-9:20 **An Application of Algebraic Geometry in Control Theory,** *Jodeci Wheaden*

9:25-9:45 **Using Mathematics to Find Optimal Evacuation Routes,** *Sally Gilbreth*

9:50-10:10 **Mathematics and Baseball: Rethinking Slugging Percentage,** *Tanner Mortensen*

9:00-10:10 Parallel Session II **HSB 304**

9:00-9:20 **Talk Your MATH Off: Communicating in the Mathematics Classroom,** *Brittany Tharpe*

9:25-9:45 **Effective Teaching Strategies for Students with Autism,** *Lydia Ozier*

9:50-10:10 **Connections throughout the Standards**, *Peggy Kimmons*

10:10-10:25 Coffee and Snack Break **HSB Student Lounge**

10:30-11:40 Parallel Session III **HSB 300**

10:30-10:50 **Machu Picchu and the Rising Sun,** *Michael Eubanks*

10:55-11:15 **An Astronomical Analysis of a Inca Quipu**, *Julie Martins*

11:20-11:40 **Mathematics in Knots: Quipus Then and Now,** *Amanda Schmidt*

10:30-11:40 Parallel Session IV **HSB 304**

10:30-10:50 **From Euclid to Present: A Collection of Proofs Regarding the Infinitude of Primes,** *Lindsey Harrison*

10:55-11:15 **The Impact of the Allied Cryptographers on World War II: Cryptanalysis of the Japanese and German Cipher Machines,** *Katelyn Callahan*

11:20-11:40 **Equilibrium, Stability and Dynamics of Magnetocapillary Swimmers,** *Rujeko Chinomona*

11:40-12:40 Lunch **HSB 314**

12:45-1:55 Parallel Session V **HSB 300**

12:45-1:05 **Olympic Coloring: Go for the Gold,** *Zach Monaco*

1:10-1:30 **Classifying Lie Algebras for Abelian Groups Z_n and $Z_m \times Z_n$,** *Katy Hill*

1:35-1:55 **Algebraic Understanding of College Algebra Students through Story Problems**, *Tricia Swift*

12:45-1:55 Parallel Session VI **HSB 304**

12:45-1:05 **Symmetry Analysis of Inca Textiles and Ceramics**, *Miles Daly*

1:10-1:30 **Investigation of the Interactions of Argon Particles in a Closed Container**, *Matthew Hilliard*

1:35-1:55 **Lotka Volterra Predator-Prey Model with a Predating Scavenger,** *Monica Pescitelli*

2:00-2:15 Closing Remarks **HSB 300**

2013 Capstone Day Abstracts

Katelyn Callahan
The Impact of the Allied Cryptographers on World War II: Cryptanalysis of the Japanese and German Cipher Machines

Throughout history, cryptography has played an important role during times of war. The ability to read enemy messages can lead to invaluable knowledge that can be used to lessen casualties and secure victories. The Allied cryptographers during World War II had a major impact on the outcome of the war. The Allies' ability to intercept and decrypt messages encrypted on the Japanese cipher machine, Purple, and the German cipher machine, Enigma, empowered the Allies with a major advantage during World War II. Without this advantage, the war may have had a different end result.

Rujeko Chinomona
Equilibrium, Stability and Dynamics of Magnetocapillary Swimmers

Recent experiments have shown the interesting behaviors of floating ferromagnetic beads on a fluid interface. The beads tend to attract each other when there are no external forces acting on the system. Upon addition of a vertical magnetic field, equilibrium states are developed. Furthermore, the beads move through the fluid in a periodic fashion when exposed to a horizontal oscillating magnetic field. We investigate the equilibrium states of different numbers of beads analytically and numerically. A numerical simulation is developed that explores the full dynamics of magnetocapillary swimmers to find the optimal conditions for swimming.

Miles Daly
Symmetry Analysis of Inca Textiles and Ceramics

Textiles and ceramics were considered to be of major importance to the Incas. In this talk, we characterize the different types of symmetry seen in the textiles and ceramics of the Inca. We develop a geometric framework and discuss symmetries and periodicities that are present in the artifacts. We consider both planar and spacial symmetries.

Michael Eubanks
Machu Picchu and the Rising Sun

Tucked away in the Andes Mountains Machu Picchu is an amazing Inca site that has only recently been studied since its existence was made public in 1911. In this talk we focus on a specific building known as the Temple of the Sun, which is aligned with the winter solstice sunrise. We employ probabilistic methods determine the likelihood that the Inca built the Temple of the Sun to align intentionally.

Sally Gilbreth
Using Mathematics to Find Optimal Evacuation Routes

Most evacuation routes are determined by the shortest path from an occupied room to an exit. This design fails to take into account congestion caused by the number of evacuees on the routes. We model Georgia College's Arts and Sciences building with a modified minimum cost flow network and use non-linear and linear programming techniques to determine optimal evacuation routes with and without congestion respectively.

Lindsey Harrison
From Euclid to Present: A Collection of Proofs regarding the Infinitude of Primes

Prime numbers are considered the basic building blocks of the counting numbers, and thus a natural question is: Are there infinitely many primes? Around 300BC, Euclid demonstrated, with a proof by contradiction, that infinitely many prime numbers exist. Since his work, the development of various fields of mathematics has produced subsequent proofs of the infinitude of primes. Each new and unique proof gives the mathematical community a glimpse into better understanding the prime numbers. Here, we will examine a collection of proofs of the infinitude of primes, and explore why prime numbers are important.

Katy Hill
Classifying Lie Algebras for Abelian Groups Z_n and $Z_m \times Z_n$

In Calculus, one studies tangent lines as an important tool in solving problems of optimization and related rates. In Physics, matrix groups are used to model physical systems and they possess an associated useful tangent space called a Lie algebra. These Lie algebras are vector spaces that are used to better understand the group and therefore symmetries of the physical system. This research project involves classifying Lie algebras for certain finite abelian groups.

Matthew Hilliard
Investigation of the Interactions of Argon Particles in a Closed Container

The kinematics of Argon particles in a closed container was investigated using the Lennard-Jones Potential between the particles. The particles were determined to follow the Maxwell-Boltzman distribution of velocities.

Peggy Kimmons
Connections throughout the Standards

Since the 1980s, the state of Georgia has seen three stages of mathematics education reform from the Quality Core Curriculum (QCC) standards in 1988, to the next stage of standards, which was the Georgia Performance Standards (GPS) in 2005. The last stage of reform is the Common Core Georgia Performance Standards (CCGPS). The CCGPS is currently being implemented in our schools. The purpose of this paper is to see how implicit or explicit connections in mathematics are throughout the progression of the standards in Georgia for grades 9 and 10. We will discuss the types of connections presented in the literature and what opportunities exist in the standards for students to make connections. We will also qualify what counts as connections in mathematics.

Julie Martins
An Astronomical Analysis of a Inca Quipu

The Inca were undoubtedly highly skilled architects and sophisticated astronomers. However, with no written language, we must rely on the Inca quipu (khipu) to relay insight into this culture. In this talk, we present an analysis of a quipu. We discuss elements of quipu structure and how they encode quantitative information in general and astronomical information in particular. The quipu we investigate displays a high degree of periodicity in its knot and color scheme. We argue that this scheme is highly suggestive of a calendrical quipu from the Inca Empire.

Zach Monaco
Olympic Coloring: Go for the Gold

Coloring the vertices or edges of a graph leads to a variety of interesting applications in graph theory. These applications include various scheduling questions and other optimization problems. For this paper, we consider the idea of edge-coloring a graph, which is a coloring of the edges such that adjacent edges are distinctly colored. The minimal number of colors required to edge-color a graph is called the chromatic index. This paper discusses the chromatic indices of graphs obtained from certain symmetric matrices.

Tanner Mortensen
Mathematics and Baseball: Rethinking Slugging Percentage

In baseball, slugging percentage represents power, speed, and the ability to generate hits. However, this statistic does not account for the relative skill of the opponent. We develop a new statistic that will more accurately rank players based on their opponent's performance in addition to their own. We assign weights to the slugging percentage of batters and pitching effectiveness of pitchers and use linear algebra to determine these weights.

Lydia Ozier
Effective Teaching Strategies for Students with Autism

This paper examines effective strategies for teaching autistic students in the mathematics classroom. As the number of children diagnosed with autism spectrum disorder grows every year, the public's attention on the subject has naturally increased as well. It is important to understand that autism is not as portrayed by popular culture or as depicted in some movies, especially in an autistic student's ability to do or not do higher order mathematics. There are, however, some effective teaching strategies that allow autistic students to improve their critical thinking and problem solving skills needed to solve mathematical problems. The purpose of this paper is to provide teachers with a better understanding of what autism is, and how autism can hinder students in learning mathematics

Monica Pescitelli
Lotka Volterra Predator-Prey Model with a Predating Scavenger

The classic Lotka Volterra equations are used to model the population dynamics between two species: a predator and its prey. This analysis will look at the population dynamics of a three-species Lotka Volterra model: a predator, a scavenger and their common prey. We will use a set of parameters that result in stable limit cycles and the coexistence of the three species.

Amanda Schmidt
Mathematics in Knots: Quipus Then and Now

The Inca Empire, although short lived, was a very advanced civilization. In this presentation we will dive into a unique form of record keeping with a system of ropes and knots, known as quipus, that the Incan society used. The intricate system had mathematical ties that still intrigue researchers. We provide an example of a modern quipu to illustrate how mathematical information may have been encoded.

Tricia Swift
Algebraic Understanding of College Algebra Students through Story Problems

Students are expected to have a solid foundation in algebra which is assumed to have been developed during high school. In reality, many of them typically do not possess the conceptual understanding required to analyze and interpret algebraic story problems. In this study, we tested students using a bidirectional method of story problem analysis. One method tests students' abilities to write a story problem, whereas the other method tests their abilities to interpret a story problem through a step-by-step process.

Brittany Tharpe
Talk Your MATH Off: Communicating in the Mathematics Classroom

One of the six process standards outlined by the National Council of Teachers of Mathematics is communication. This talk outlines how language, the foundation for communication, can be used to create both detrimental and beneficial communication in the classroom. Additionally, the different ways the language of mathematics can be learned and practiced by students will be presented.

Jodeci Wheaden
An Application of Algebraic Geometry in Control Theory

Control theory is the study of dynamical systems with many applications. In this talk we discuss how to apply techniques from algebraic geometry to find equilibrium points. We demonstrate this technique with a basic example of congestion control. We introduce the basic terminology of feedback systems and summarize results on Groebner bases that we apply.

GEORGIA COLLEGE

GEORGIA'S PUBLIC LIBERAL ARTS UNIVERSITY

DEPARTMENT OF MATHEMATICS