SIXTH ANNUAL CAPSTONE DAY

Department of Mathematics
Georgia College

November 18, 2017
8:15 a.m. - 2 p.m.
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 nationwide shortage of mathematics teachers is due in part to the demand in so many other areas for talented mathematics majors.

2017 Capstone Day Schedule

8:15 – 8:55 a.m. Registration and Breakfast **HSB Student Lounge (3rd Floor)**

8:55 – 9 a.m. Opening Remarks **HSB 300**

9:00 – 10:00 a.m. Session I **HSB 300**

Modeling Grade Distribution**,** Jasmine Gray

A Reaction-Diffusion Model of Acid-Mediated Tumor Invasion with Chemotherapy Intervention**,** Patrick Pruckler

Music Through a Mathematical Lens, Shannon Smith

10 - 10:15 a.m. Break **HSB Student Lounge**

10:15 - 11:35 a.m. Session II **HSB 300**

An Introduction to Digital Image Processing**,** Calvin White

Eigenfaces for Face Detection, Christopher Kline

Learning Impact of an Instructor with Strict Content Knowledge and an Instructor with Mainly Pedagogical Knowledge, Emily Andriano

Diffusion-Driven Instability in a Reaction-Diffusion Model for Zooplankton Grazing on Competing Phytoplankton Species, Jaclyn Pescitelli

11:35 a.m. - 12:45 p.m. Lunch **HSB 314**

12:45 - 1:45 p.m. Session III **HSB 300**

Increasing Students' Understanding of Multiplying Binomials Through Manipulatives**,** Olivia Lindsey

Comparison of Two Definitions of Fractional Derivatives**,** Brian Skoglind

Comparative Analysis of Students' Performance Between Online and on Campus in an Introductory Statistics Course**,** Kendal McDonald

1:45-2 p.m. Closing Remarks **HSB 300**

2017 Capstone Day Abstracts

Emily Andriano

Learning Impact of an Instructor with Strict Content Knowledge and an Instructor with Mainly Pedagogical Knowledge

The educational background of educators may have an impact on how they get information across to students. I am examining the role of an instructors' educational background on the impact of a student's mathematical learning. Specifically comparing an instructor with substantial content knowledge with an instructor with more pedagogical knowledge. The purpose of my research is to uncover how these instructors prepare a lesson and enact their lesson in the context of a teaching experiment. I will also examine student knowledge gains in the topic of Rate of Change for each teaching experiment.

Jasmine Gray

Modeling Grade Distribution

The purpose of this project is to see how multiple variables are associated to a student's overall performance in courses from various departments. We looked at the length, level, semester, professor rank, course title and start time, in twenty-four-hour format, of the course as well as specific characteristics about the course such as number of students and professor to see how these are correlated to the distribution of grades. In the first phase, we started out collecting data from the Georgia College grade distribution for all college courses from all departments we studied from the past 7 semesters. We did not use online courses due to the fact that they had no set length to the class which would make one of our variables nonexistent in that instance. During the second phase, which was analysis, we used diverse models such as regression models, tree based models and random forest models to analyze the association between our variables. With this information, we used the statistical software R and a variety of its functions to evaluate the data we collected. Our goal is to show how these eight variables can affect a student's performance in the classroom. Here is a sample of a few of the results that we have found most interesting. We found that the highest percent of W's (withdraws) was in Summer 2017 in the class CHEM 1151K. Also, out of all 890 courses we studied 22 total had zero percent of A's. There was also roughly 36% of the courses we studied with less than 16 students.

Christopher Kline

Eigenfaces for Face Detection

The Eigenface approach is considered by many to be the first working facial recognition technology, and it served as the basis for one of the top commercial face recognition technology products. Eigenfaces refers to an appearance-based approach to face recognition that seeks to capture the variation in a collection of face images and use this information to encode and compare images of individual faces in a holistic (as opposed to a parts-based or feature-based) manner. For this work, we show that by using properties and rules of mathematics, in particular matrices, we can manipulate a set of images (matrices) in such a way as to extract the relevant facial information necessary for recognition

Olivia Lindsey
Increasing Students' Understanding of Multiplying Binomials Through Manipulatives

National Council of Teachers of Mathematics suggests that the use of Manipulatives in the mathematics classroom can improve a student's conceptual understanding of a mathematical concept. Kelly defines a manipulative as "any tangible object, tool, model, or mechanism that may be used to clearly demonstrate a depth of understanding, while problem solving, about a specified mathematical topic or topics" (2006, p. 184). The purpose of my study is to see if the use of manipulatives gives students a conceptual understanding of multiplying binomials. Eighth grade students from the Early College and students of the Middle Grades Cohort at Georgia College were given a pre-assessment and a post-assessment to assess the improvement of their understanding of the FOIL method after a lesson using Algebra Tiles.

Kendal McDonald
Comparative Analysis of Students' Performance Between Online and on Campus in an Introductory Statistics Course

In this research, we compare students' performance in an online and on campus introductory statistics and probability course. The online data is produced by five summer courses between Summer 2014 to Summer 2017 and the on-campus data is produced from nine on campus courses from Spring 2014, Spring 2016, and Spring 2017. For homework, the research compares the mean scores made, and how early a student completed the homework in the online and on campus courses. For quizzes, we tested if the mean scores are same, if there is a difference in how early a student completed the quiz, and the number of attempts taken out of the ten attempts granted in the online and on campus courses. We also analyzed the difference between the first attempt score and highest score to see if there is significant improvement in scores by taking the assignments again. In addition, we also modeled the final quiz average as a function of number of attempts and the number of days a student attempted the quiz before the due date. MyStatLab is the learning management system used in both an online and on campus courses for homework and quizzes.

Jaclyn Pescitelli
Diffusion-Driven Instability in a Reaction-Diffusion Model for Zooplankton Grazing on Competing Phytoplankton Species

Plankton play an important role in a freshwater ecosystem and food chain. In this project, we consider a predator-prey system modeling the interactions between a freshwater zooplankton herbivore and two types of competing phytoplankton species. The zooplankton grazes on one of the species of phytoplankton while the other phytoplankton species secretes a toxin that deters the zooplankton. Taking the motility of the species into account, we formulate a mathematical model governing their interactions via a three-component reaction-diffusion system of equations under no flux boundary conditions. We will prove that in absence of diffusion, the system admits a stable coexistence equilibrium state for a suitable choice of parameter values. However, this equilibrium state can become unstable in the presence of diffusion. We will find sufficient conditions on the diffusion coefficients that would lead to diffusion-driven instability. We also perform numerical simulations to study the spatial patterns generated by the system.

Patrick Pruckler
A Reaction-Diffusion Model of Acid-Mediated Tumor Invasion with Chemotherapy Intervention

It has been studied that most cancer cells rely on aerobic glycolysis, a phenomenon termed the "Warburg effect" to generate energy needed for cellular purposes. Warburg effect is a phenomenon wherein cells ferment glucose to lactic acid using glycolysis even in the presence of normal levels of oxygen. This altered metabolism results in an acidic extracellular tumor environment leading to destruction of normal tissue at the tumor-host interface, while promoting proliferation of cancer cells against normal cells. In this talk, I will present a four-component reaction diffusion system of equations describing the effect of chemotherapy intervention on the spatial distribution and temporal development of tumor tissue and excess H^+ ion concentration. Our model is an extension of the seminal work by Gatenby and Gawlinski (Cancer Res. 1996). We perform mathematical analysis and as well as numerical simulations to investigate how treatment affects the strength of the acid-mediated invasion and intervene the progression of cancer cells.

Brian Skoglind
Comparison of Two Definitions of Fractional Derivatives

Students who take a calculus class, learn about the first and second derivatives as well as their properties but what about the fractional derivative or even the functional derivative? From this idea stems Fractional Calculus. In this research, we will look into Fractional Calculus and consider two specific definitions of fractional derivatives: The Reimann-Louville approach and the fractional derivative by means of Fourier Transform. The latter will then be further tested to determine some of its basic properties.

Shannon Smith
Music Through a Mathematical Lens

One thing most everyone agrees on is that music is an important part of our lives. Music has the ability to change our mood and emotions, and it is natural to create music. When individuals create something, we then want to understand it. Most people might not be aware of the occurrences of mathematics in music such as those between music and abstract algebra. In particular, certain structural choices found in music so happen to exhibit group theoretic connections. While these compositional choices might not always be made for purely mathematical reasons, it is interesting to see what algebraic structures might be found within a given piece of music. In this project, we will outline some of the operations that transform music, listen to some of these transformations, and also demonstrate the associated combinatorics of such structures as we will discover how to view music through a particular mathematical lens.

Calvin White
An Introduction to Digital Image Processing

Image processing is a rapidly growing technology with many applications in Engineering and Computer Sciences. There are two types of image processing: Analogue and digital.
In this work, we present basic notions of digital image image processing and we use the software MATLAB to perform some operations on images. We show that digital image processing uses results developed in linear algebra, especially properties of matrices.

Notes

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Department of Mathematics