Mathematics at UMW

Fall 2012

a newsletter of the Department of Mathematics at the University of Mary Washington

Welcome from the Chair

Dear Friends,

Faculty, students, alumni, and friends, it has been an excellent year in the department. Mary Washington is in a constant state of change and the department continues to evolve right along with the university.

On campus, you will notice construction near the library of the new Convergence Center which you can read more about on the provost's website. Construction on the new hotel in Eagle Village will begin soon, as well as the demolition of Chandler Hall in order to build the new student center, slated to begin in spring 2013. It is hard to keep up with it all.

Our newest faculty member Elizabeth Creath left us last spring to take a job in North Carolina. UMW was a great fit for Elizabeth, but she was anxious to be back in North Carolina and we wish her well. Her teaching and service to the department will be sorely missed. As a result of Elizabeth's departure, the department was able to hire a 1-year visitor for the 2012-2013 academic year. Dr. Robert Brown will be joining us in this capacity. Robert has extensive teaching experience at Virginia Union University and at Virginia

Commonwealth University. We are lucky to have found somebody with such a rich background in undergraduate teaching. Please welcome Robert when you see him around Trinkle Hall.

Students continue to shine and represent UMW well. We had an unusually large number of students present their research at regional and national meetings last year. In addition, we had a student participate in an NSF funded REU (Research Experiences for Undergraduates) this past summer, and several students did internships as well. In this newsletter, I have highlighted some of our mathematics majors who have studied abroad in recent years, an activity that we actively encourage as a life-changing educational experience.

Please stay in touch. Find us on Facebook, check our website, and for those who are far away, always stop by when you're in town. We enjoy seeing you.

With best wishes,

Keith E. Mellinger, Chair

Students Present At Professional Meeting

During the 2011 – 2012 academic year, a large number of students presented the results of their projects at professional meetings. In August 2011, **Catherine O'Doherty** and **Marianne Dubinsky** traveled to Lexington, KY, to present the results of their summer science projects at Mathfest, the annual summer meeting of the Mathematical Association of America.

In the fall, the same group was joined by **Kelly Scott** and **Ryan Vaughn** to present their work at the regional meeting of the MAA held at Christopher Newport University. Around the same time, **Rebecca Presor** and **Katie Dillinger** traveled to James Madison University where they participated in the Shenandoah Undergraduate Mathematics and Statistics conference. There, Katie took **2nd place** for her poster detailing her work completed during the summer science institute in 2011 under the direction of Dr. Leo Lee.

In January, **Catherine**, **Marianne**, and **Ryan** were joined by **Katie** and **Rebecca** to travel to the Joint Mathematics Meetings, the largest annual mathematics meeting in the world. This year, the conference took place in Boston, MA. Some of the students delivered presentations, while others participated in the national undergraduate student poster session.
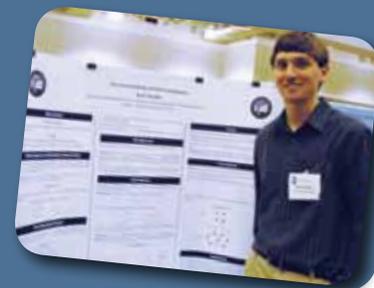
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where great minds get to work

Summer Science Research 2012
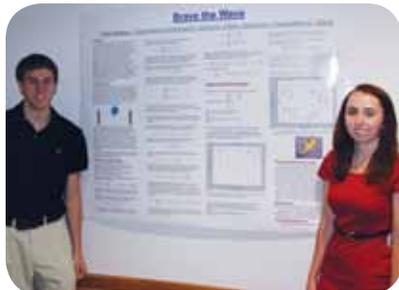
We had another great year with students engaging in research as part of the Summer Science Institute. **Peter Slattery** and **Morgan Brown** worked together on the description of waves by moving objects under the direction of Dr. Leo Lee. Peter's project was titled *Brave the Wave*. In his project, he found a mathematical expression for the wave of a vibrating string with fixed, motionless endpoints. He also wrote computer programs to simulate his findings. Then he applied his analytical results and computer simulations to win carnival balloon popping games. *How to Win Every Time* was the title of Morgan's portion of the project. She investigated numerical wave models with the Taylor series expansions of functions. After deriving and analyzing the models, she developed her own codes to give both a numerical and a visual representation of the object's motion. Then she used her models with their computer animations to find optimal times to shoot at a balloon attached to a vibrating string.
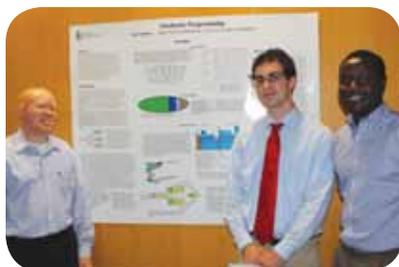
Kwadwo Brobbey and **Benjamin Tuxbury** worked with Dr. Julius Esunge on a series of problems in the field of stochastic programming and optimization. The perennial desire to maximize profit and minimize cost lies in literally every field. As such, mathematical models that accomplish the stated objectives are extremely desirable. One method of optimization, stochastic programming, has become increasingly useful as computers are being developed with greater processing power. There are a multitude of potential applications of stochastic equations and Monte-Carlo simulations (exhaustive simulations). They offer the ability to minimize risk, in order to maximize long run profits in almost any imaginable sector. In agriculture they can be used to model weather patterns, so farmers have a better idea of how to plant crops. Also, in any commercial setting, stochastic models can predict how many customers will show up given changing circumstances. When written correctly, simple programs have the ability to establish the most favorable decision given unknown variables. These programs can then be adapted to suit different contexts as they become more and more complex. Their project captured a number of real-world applications of stochastic optimization.

2012 Scholarship Winners

Benjamin Tuxbury - Dodson Scholarship

Kelly M. Brown – Loughran Scholarship

Darren Getts – Robertson Scholarship

Joseph Nguyen – Talley Scholarship

Calculus Tournament Attracts Corporate Sponsorship

The UMW High School Calculus Tournament continued its strong growth trend in its sixth annual installment, held on March 31st of this year. The success of this year's event was due in no small part to the generosity of the tournament's corporate sponsors: SimVentions, HDT Global, GEICO, and Texas Instruments. With the help of our sponsors, we were able to double the amount of prizes awarded, even in light of seeing the highest participation numbers in the history of the tournament. The Commonwealth Governor's School took this year's team championship, with Paul VI from Fairfax as the runners-up. Paul VI also took both first and second place in the individual challenge exam. Keep your eyes open for the announcement of the Seventh Annual UMW High School Calculus Tournament in the spring of 2013.

Honors in Mathematics

Rebecca Presor started her project in the spring of 2011, conducted summer research, and then continued working on her research her senior year, under the direction of Dr. Lee. In her honors thesis, she used both analytical and numerical math models to analyze the fairness of an option price; she developed four different computer programs for her analytical and numerical methods and compared their outputs; she also applied her results to real-life European options on the market

to determine whether or not to buy a specific option and see if these investments are profitable. She wrote a nice thesis and submitted it to the *Metamorphosis* student journal that is part of COPLAC.

Hannah Baumgardner did an honor thesis with Dr. Yuan-Jen Chiang on "The Gauss-Bonnet Theorem and Its Applications on Manifolds". She showed the proof of the Gauss-Bonnet Theorem in 2-dimensional surfaces, and gave some applications. She also studied S. S. Chern's simplified version of Gauss-Bonnet Theorem in higher dimensional Riemannian manifolds.

Directed by Dr. Esunge, **Marianne Dubinsky**'s thesis involved a presentation of the Basel problem, and a discussion of various techniques for solving it. An outline of the solution proposed by Leonhard Euler served as an excellent motivation, and this was followed by a series of proofs, the centerpiece being a proof involving techniques from probability.

Teresa Yao's main result was to find the analytical solution to her time dependent chemical pollutant model with non-homogeneous Dirichlet boundary conditions in one- and two- dimensional spaces. After deriving the exact solution to the model in Fourier form, she wrote computer programs to approximate her solution and animate the diffusion over time. Finally, she used three different vector norms to discuss the difference between the exact solution and the several numerical solutions. Teresa worked with Dr. Lee and is now a math teacher at St. Timothy's School in Chantilly, VA.

Generalized function theory, in addition to giving credence to the famous Dirac-delta "function", is useful for non-function solutions to differential equations and in potential theory. In **Alan Liddell**'s thesis, advised by Dr. Collier, he demonstrated the existence of non-trivial complex-valued C-infinity functions with compact support on R, which serve as the domain space for a collection of continuous linear functionals known as generalized functions of Schwartz type. He independently justified theorems, produced illustrative examples, and fleshed out the calculus of these functionals. This historic and seminal work was a glimpse into rudiments of functional analysis for Alan, who at present is working in Chapel Hill on a project under the oversight of Oak Ridge National Laboratory and the EPA; he plans to attend graduate school in mathematics within the year.

Kelly Scott, advised by Dr. Mellinger, started working in the summer of 2011 to investigate an object in discrete mathematics known as an anti-blocking set. More common are the blocking sets which have been studied extensively due to their application to modern cryptologic protocols. Kelly's work focused on sets that could never be extended to a blocking set. Her thesis included many theoretical results as well as constructions of these special sets in finite projective planes. The work is being prepared for submission to a journal while Kelly is actively pursuing employment at the NSA and considering graduate study.

Finally, **Catherine O'Doherty** considered a problem focusing on a mathematical model for the Virginia real estate market. Correct modeling of the real estate market can mean the difference between making a profit off of local trends or losing money and house, when the real estate market crashes. Yet, the quick pace of the market and the randomness of people's desires can make accurate representations challenging. Stable distributions allow for such market conditions, giving mathematicians a better grasp on the rather heavy-tailed phenomenon.

REU in Fresno, California

By Ryan Vanghn

Over the summer, I had the opportunity to participate in a Research Experiences for Undergraduates (REU) program hosted by Fresno State University. REU programs are fully-funded research projects available to U.S. undergraduate students from across the country, with a major focus on learning and development for students. The program I was a part of at Fresno State consisted of about 10 other students from across the country split between two separate projects, one in Finite Geometry (my group), and one in Statistics.

The program was a great experience, especially for people who are interested in doing research mathematics. My project was essentially studying the properties of complete bipartite graphs when they are "drawn" in a certain type of geometric structure which is quite different from the geometry we are used to working with. I was able to come up with several interesting original results, which hopefully will be published in an academic research journal.

Outside of research, the REU sponsored several trips to the surrounding areas. We were able to visit Sequoia National Park and see the largest tree (by volume) in the world. On another weekend, we traveled to San Francisco, and I ended up biking the city with a friend. We also had regular Ultimate Frisbee games, tennis matches, and other activities within Fresno. The other students at the program were really fun to be around, and everyone seemed to love what they were doing, both academically and otherwise. It was a great experience overall, and I would recommend it to anyone who has the slightest interest (or curiosity) in doing research mathematics.

Mathematics Majors Can Study Abroad!

Kevin Robertson, Italy

My experience abroad showed what my true interests were, both personally and academically, and has had a profound effect on my outlook of different cultures. During my time studying abroad in Orvieto, Italy, I lived in an authentic, furnished apartment with two other students from Mary Washington, dined in family owned Italian restaurants, purchased items in local convenient and grocery stores, and tried to speak as much Italian as possible. Throughout my time in Italy I constantly found myself in new situations and explored unfamiliar areas, such as Florence and Rome, with my friends and attempted to use my newly learned language and intercultural skills. From the formal classroom etiquette to conducting Italian interviews outside of class with local storeowners, it was amazing how I felt that not only could I survive in the Italian culture, but even continue to grow with further study. I was enthralled by the amount of art history that was represented throughout the country. After taking countless walking tours of some many Italian cities, I was inspired to take Art History 115A at UMW because the first half of this course is dedicated to Italian Renaissance. I would highly recommend this abroad trip to any student at Mary Washington. Not only do you acquire substantial knowledge of the Italian culture, but you also have the opportunity to travel to a foreign country and build a sense of individualism while doing so.

Sara Hulvey, Italy

Last summer, I had the chance to study abroad in Orvieto, Italy (the same trip as Kevin). When I first came to UMW, I knew I wanted to study abroad somewhere, even if what I studied wasn't in my major. Italy always sounded appealing to me, so after completing Italian 101 and 102, I went abroad. Not only did I cover two semesters of Italian in four weeks, I also got to do it in one of the most beautiful places I've ever been, with a new and exciting culture to explore. As a mathematics major, my classes are often analytical, so studying a language in its native country was a nice change of pace that I would recommend to anyone. With UMWs extensive Gen Ed requirements and opportunities to take elective classes, there's no excuse not to study abroad, regardless of your major.

Christopher Braden Vernet, Wales

Since September 2011 to August 2012, I was studying at Swansea University in Wales. When I first came to UMW I knew that I wanted to study abroad for a year. After a lot of meetings and email exchanges with the Center for International Education, I was ready to leave the US for a year of adventure.

A great benefit of studying abroad is the different classes one can take. At Swansea University, I was able to take classes that UMW doesn't offer, such as Astronomy and Cosmology, or classes that I wouldn't have taken otherwise, such as History of Philosophy. Taking classes that were not required for my major allowed me to arrange three-day weekends. During the weekends I would travel around the UK. One week I could be climbing the peak of Sugarloaf mountain with the Swansea hiking society, the next I could be roaming the Roman ruins at Bath. Some of my longer trips took me to Ireland and Spain. Over the summer I took advantage of the Interrail pass and traveled through Scandinavia and Germany.

Studying abroad was an awesome experience. I was able to see parts of the globe that I never saw before, meet people I never would have met, and do things that I would never have done. I learned a lot and had an experience that I will never forget.

Andrew Cole, France

For the Fall 2011 Semester I studied abroad in Grenoble, France, a medium sized city in the south east of France, close to Italy and Switzerland, where they held the winter Olympics in 1968. My study abroad experience was amazing. I got to travel to tons of places including Barcelona, Paris, Dublin, Casablanca, Marrakesh, Strasbourg, and many other smaller cities and towns. But my trip was not all about traveling and touring other cities, I spent most of my time at the University of Grenoble III, Stendahl, where I studied the French language.

My classrooms were not what I had expected going into it. My class was 4 hours long each day at the university and

consisted of only French language practice. The goal was total immersion into the language for a faster, more complete learning process. I had heard this goal projected before in my other foreign language classes back in the states, but what I didn't realize was that if it is done right, it really works. In 2 weeks, I was comfortable using French in most normal situations. In one month I was conversationally fluent in French and could speak to all of my new French friends, while picking up slang at the same time. By the time I left I was effortlessly switching from French to English, and at some points it was easier for me to use French, (particularly when talking about wines, we had gone to a few wine tastings where they taught us about wines in French).

What I got out of this amazing travel and learning experience was twofold. One of the best bonuses was that I became so fluent in a foreign language (and fulfilled my gen ed requirement). But the other bonus that really stuck with me even more than the language itself was that I got to see most of Western Europe and learn about their very diverse culture. Everyone there had a different point of view and I got stuck in many situations talking for hours about different views and particularly French people interested in asking me tons of questions about the American system. I learned how to question everything I had originally been taught as it became very evident when I went over there how much I think and do like a "typical American". Even though while I was abroad I didn't take a single math class, I still was able to learn more about so many other things in that one semester than I have in any other semester of my academic career.

Internships with the Navy

By Sara Hulvey and Katie Dillinger

This summer we had the opportunity to intern at the Naval Surface Warfare Center Dahlgren Division as Mathematics Technicians. We received security clearances, got our own desks, computers, and badges, and began work. Our main focus this summer is writing and updating Java code to launch missiles. Although we have minimal computer science backgrounds, everyone has been helpful, and we're catching on quickly. We've also had the luck of becoming co-ops, which means we'll work a total of 16 weeks before graduation, and then be able to be hired as full time employees. This has been an amazing experience, and we urge those interested in such an opportunity to explore and apply to some of Dahlgren's many internships.

Are you a member of our Facebook group?

Look us up – UMW Mathematics – and join today!

Faculty Highlights

The mathematics faculty have been very active professionally in the last year, including a healthy list of publications in refereed journals. These include **Leo Lee**'s paper "A Stochastic Galerkin Method for Stochastic Control Problems" which was accepted for publication in *Communications in Computational Physics*, and **Yuan-Jen Chiang**'s article "Some properties of Biwave Maps" which was published in the *Journal of Geometry and Physics*. In addition, **Randall Helmstutler** authored "Finite topological spaces as a pedagogical tool" which appeared in the journal *PRIMUS*.

Julius Esunge published the article "Density dependent utilities with transaction costs" in *Communications on Stochastic Analysis*, **Janusz Konieczny** wrote the article "A proof of Devadze's theorem on generators of the semigroup of Boolean matrices," which appeared in *Semigroup Forum*, and **Keith Mellinger** authored "Semiovals from unions of conics" published in the journal *Innovations in Incidence Geometry*.

Travel to present and network at conferences and other universities has also been a focus this past year. **Julius Esunge** traveled to the University of Kansas in March 2012 where he presented "Hamiltonian-Jacobi schemes for cost-sensitive markets" at their seminar on stochastic processes. **Suzanne Sumner**, along with colleague **Mary Rigsby** from the Department of English, Linguistics and Communication, traveled to the 2011 Teaching Professor Conference in Atlanta, GA, where they presented "Busting walls and overcoming blahs: knotty problems and speed dating."

Leo Lee traveled to Kyonggi-do, Korea, in December where he presented "A stochastic Galerkin FEM of an optimal control problem for stochastic PDE" at Ajou University, and **Yuan-Jen Chiang** presented a paper "f-biharmonic maps between Riemannian Manifolds" at the 14th International Conference on Geometry, Integrability and Quantization, near Varna organized by Bulgarian Academy of Sciences this summer.

This past May, **Debra Hydorn** attended the US conference on Teaching Statistics where she presented "The Research Process: A Statistics Course for Biology Majors" in Cary, NC. That same month, **Keith Mellinger** traveled to Fort Collins, CO, to attend the Rocky Mountain Discrete Math Days where he delivered the presentation "Anti-blocking sets."

Check out our website

– cas.umw.edu/math –

view our page devoted to our alumni and, better yet, email Dr. Mellinger at kmelling@umw.edu to get yourself included!

Gallery

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