THE UNIVERSITY OF ARIZONA | College of Science

MATHEMATICS

UA SCIENCE

IN THIS ISSUE

Spring 2013
Volume XIII, Issue 1

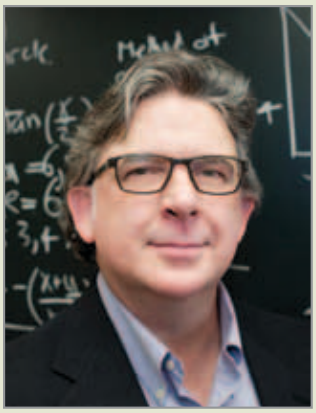
M·A·T·H and the city

FRIDAY, OCTOBER 26, 2012 – 5:00pm to 7:00pm

Math and the City Event guests, October 2012

BIG DATA BEAUTIFUL OR NATURAL

A PUBLIC EVENT ORGANIZED BY UA MATHEMATICAL SCIENCES IN COORDINATION WITH THE CITY OF TUCSON



View from the Head

BY BILL MCCALLUM

Last fall we had our first, and very successful, Math and the City event in Flandrau planetarium. Mayor Jonathan Rothschild and President Ann Weaver Hart gave welcoming speeches, statistics professor Walt Piegorsch told us about predicting the election, and participants from the university and the community enjoyed wine, snacks, and math at four stations staffed by 12 of our faculty. This event is just one example of the department's efforts to let the world know about the many dimensions of the mathematical sciences at the University of Arizona. Our faculty have also been active in the Science Cafés at the Cushing Street Bar and Grill, talking about patterns in nature, climate change, probability, mad limits, and the Common Core.

Over the last couple of years we have welcomed new faculty members Sergey Cherkis, Bin Dong, Bryden Cais, Sunder Sethuraman, and Helen (Hao Zhang). Bin's work on making medical body scans better and safer and Helen's work on mining the human genome for improved cancer therapies were featured in the Arizona Daily Star's science supplement last fall.

I am also very pleased to announce two new positions to help with our teacher preparation and professional development efforts: Cynthia Anhalt is the Director of Mathematics Teacher Preparation, and Cody Patterson is Director of the Center for Recruitment and Retention, and Assistant Director of the Institute for Mathematics and Education. And finally, Guada Lozano is our new Director of Development and Evaluation. She helps us develop the public face of the mathematical sciences, working with faculty in packaging and disseminating research for general audiences, working with the newly formed Advisory Board, and is the one responsible for finally getting this newsletter back on track!

Finally, I wanted to mention that our undergraduate Math Center received the 2011 AMS Award[1] for an Exemplary Program or Achievement in a Mathematics Department, for its work with undergraduates. And speaking of students, please take a look at the information on new opportunities for supporting them, particularly the exciting new matching fund opportunity for undergraduate scholarships and research.

[1]See the May 2011 issue of the AMS Notices for an article on the Math Center award: ams.org/notices/201105/rtx110500718p.pdf (accessed March 2013).

New Research Faculty Bios

Sergey Cherkis — After earning his PhD from Caltech Sergey held a postdoctoral position at UCLA and was a member of the Institute for Advanced Studies at Princeton. Sergey arrived at UA after 7 years at Trinity College in Dublin and a sabbatical year at Stanford University. Sergey's research area is in mathematical physics: string theory, integrable systems, and geometry. Believing that any division of sciences is artificial, Sergey enjoys learning about other fields outside his current expertise and meeting people from other departments. Sergey has collaborated with MIT oceanographers and UCLA geophysicists. Sergey is married to Brenda Frye, an Arizona native and UA graduate, who recently joined the UA Astronomy Department. They have three children who make sure they are not missing out on any fun.

Bin Dong was born in Beijing, China. He graduated from Peking University in 2003 and received his master's degree from National University of Singapore in 2005. He received his PhD from UCLA in 2009 and then spent two years at University of California, San Diego as a visiting assistant professor before joining the University of Arizona. Bin is an applied mathematician interested in developing models and numerical algorithms for medical imaging and image processing. His work is mainly focused on the applications of mathematics in CT and spectral CT reconstruction, image restoration and image segmentation. Bin loves playing video games and basketball, just as much as he loves doing research.

Bryden Cais received his Ph.D. from the University of Michigan and comes to UA after a 3-year postdoctoral position in Montreal and one year at the University of Wisconsin, Madison. Bryden is a theoretical mathematician who works in number theory and related areas. His recent work has focused on understanding the structure of the fundamental group of the rational numbers, which encodes all of the symmetries among polynomial equations and their solutions. Bryden is half Australian and has lived in many places, but none as beautiful as Arizona. He loves the outdoors, and spends most of his free time hiking with his wife and dog in the mountains around Tucson.

Sunder Sethuraman was born in India and grew up on the other side of I-10 in Tallahassee, Florida. After stops at Stanford University (BS), New York University (PhD 1995), postdocs at ETH-Zurich and University of Minnesota, and a long stay at Iowa State University, he finally arrived this Fall 2011 to Mathematics at UA on this end of Interstate-10. A 'coin-tosser,' Sunder's research is on probability and stochastic processes and their applications. More specifically, his recent work has been on the probabilistic analysis of statistical physics models of traffic flows and `real world' networks such as social networks. Much of Sunder's spare time these days is spent chasing, with his wife Lalitha, after their fleet 12-year-old daughter, and remembering when he was a 'real' soccer player playing somewhat competitively.

Helen (Hao) Zhang graduated from University of Wisconsin at Madison in 2002 with a PhD in statistics. She joined the Department of Statistics in North Carolina State University as an Assistant Professor, then as Associate professor, and remained there until 2011. Her recent move to Tucson was in part due to family reasons. Helen's research areas are nonparametric smoothing, model selection, data mining, and high dimensional data analysis. Her interdisciplinary research interests are in the biosciences and biomedicine. Her research activities have been supported by federal funding. She is on the editorial board for several major statistical journals. Helen has two young sons, Royce and Jayden, who keep her very busy after work but also bring her plenty of joy.

New Instructional Faculty Bios

Brenae Bailey is from Laramie, Wyoming. She is completing her PhD in Applied Mathematics at the University of Arizona and has recently been hired as an Adjunct Instructor. After earning her Bachelor's in Mathematics at Oberlin College and a Master's in Astrophysics at the University of Wyoming, Brenae spent two years teaching in Zimbabwe as a Peace Corps Volunteer. She then taught physics at the University of Wyoming before coming to the University of Arizona. Her research interests focus on modeling random processes in molecular biology. She is currently working on a model of protein synthesis focusing on the interactions between ribosomes and RNA as the RNA is translated into proteins. In her free time, Brenae is helping to raise two children and teaching them to enjoy her other interests: folkdancing, singing, hiking, climbing, and reading stories.

Aaron "Dr. X" Ekstrom returns to the Mathematics Department after a decade of teaching at various colleges and high schools from New York to Arizona. Aaron originally received his Ph.D. at the University of Arizona in 1999 under the direction of Dinesh Thakur. His interests include primality testing and the preparation of future high school teachers, and his proudest mathematical accomplishment is reducing his Erdös number to "2". Aaron's hobbies include

Editor: Guadalupe Lozano

Designer: Roma Krebs, AHSC BioCommunications

The Department of Mathematics Newsletter Spring 2013, Volume XIII, Issue 1, is published twice yearly by the University of Arizona Department of Mathematics, PO Box 210089, Tucson, AZ 85721-0089.

continued on next page

"applied probability experiments" (a.k.a. poker) and music - if you are in Tucson you can see him playing bass guitar with the bands Red Star Rebellion, Ellison Station, and El Loco.

Jose David Fonseca a Mathematics Instructor, is from Ciudad Obregon, in Sonora, Mexico. Jose came to the University of Arizona in 1993 and received his Master's Degree in 1995 with a focus in Multicultural Mathematics Education. He has over 30 years of teaching experience from high school to college levels. He has worked on several math curriculum projects, teacher training programs, and math education projects. He has also worked extensively with students of diverse ethnic and cultural backgrounds in supporting their transition from high school to college. Most recently, Jose worked in the GEAR UP Project with a cohort of approximately 3,500 students helping them with their college aspirations and plans towards ensuring a successful mathematics experience at UA. Jose has a strong interest in secondary Mathematics Education and is looking forward to collaborating with his new Math Department colleagues in various projects.

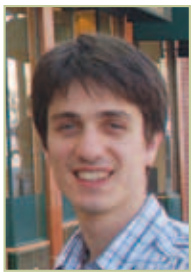
Amanda Goodenow received her BS in Mathematics Education from the University of Arizona in 2002. She taught high school mathematics at Sabino High School for seven years, then spent two years raising her daughter. Currently, she is an adjunct instructor for UA teaching courses such as college algebra, trigonometry and mathematics for elementary school teachers. She loves teaching part-time and raising her two children. Outside of work and home life, Amanda takes great pride in her church where she sings in the choir, teaches Sunday school, sits on the Faith Development board and plans the Sunday school curriculum. When she has a spare minute, she can be found reading in a quite corner or cooking some overly decadent desserts.

MaryAnne Kelly — After 26 years as an educator at the middle and high school levels, and five years teaching at Pima Community College, MaryAnne retired to teach at the University of Arizona. MaryAnne holds Bachelor's degrees in both Anthropology and Ecology and Evolutionary Biology, and a Master's degree in Educational Media. She has taken many graduate courses in secondary education, including math, science and vocational education. MaryAnne has recently decided to return to the university in search of a doctorate degree in Higher Education and K-12 Leadership. MaryAnne's goal is to contribute to making educational changes in the transition-retention levels of high school students, as they become college freshmen.

New Research Postdocs Bios

Nusret Balci is Turkish and completed his PhD in the Mathematics Department at Indiana University in Bloomington, Indiana. Nusret worked at the Institute for Mathematics and its Applications (IMA) at the University of Minnesota, visited Indiana University, and is now at the University of Arizona. He currently works with Juan Restrepo and Shankar Venkataramani in developing techniques for uncertainty quantification, improving mathematical models for the earth's oceans and atmosphere using data collected by scientists in observations and field campaigns. His team's current focus is assessing and measuring the environmental pollution caused by events like the oil spill in the Gulf of Mexico.

John Gemmer, a postdoctoral research associate, is originally from Pennsylvania where he earned his BS in mathematics and physics from Millersville University of Pennsylvania in 2006. John completed his Ph.D. in applied mathematics at the University of Arizona in 2012 where he studied pattern formation in swelling thin elastic sheets under the supervision of Shankar Venkataramani. John's research interests include nonlinear partial differential equations, applications of differential geometry, variational problems, and continuum mechanics. In his spare time John is an obsessive fan of the Philadelphia Phillies, reads, hikes, and enjoys playing board games.



Nikola Kamburov, the Hanno Rund Postdoctoral Fellow, grew up in Bulgaria. He earned his bachelor's degree in mathematics from Princeton University in 2007 and he completed his PhD at MIT in June 2012. His research is in nonlinear partial differential equations (PDEs) with a focus on the study of global solutions of free boundary problems. Free boundary problems—the class of PDEs Nikola studies—arise in diverse fields of science and engineering, such as statistical physics, shape optimization, and financial mathematics. Nikola enjoys biking and hiking, and he is an avid soccer player.

Andres Larrain-Hubach was originally born in Rochester-Minnesota. He moved to Colombia with his family and, after finishing his master degree, Andres returned to the United States and started his PhD at Boston University under the supervision of Steven Rosenberg. After graduating in May last year, Andres joined the UA Mathematics Department. Andres mathematical interests concern problems in differential geometry inspired by quantum physics, such Yang-Mills theory, index theory and infinite dimensional geometry. Andres plays the guitar and loves tennis and chess.

Daniel Schultheis, the Richard Pierce Postdoctoral Fellow, is originally from Washington. He attended the University of Washington, where his varied interests included particle physics and human-computer interaction. Daniel completed his PhD at UC San Diego in 2012 with a research focus in enumerative algebraic geometry and its applications to mathematical physics. Frequently, this involves counting the ways that geometric objects can intersect in order to verify predictions made by string theory. Having grown up in a family filled with teachers, Daniel looks forward to both the continued research and teaching aspects of his position at the University of Arizona. In his spare time, Daniel enjoys hiking, rock climbing, caffeinating, and reading almost anything he can get his hands on.

Ivan Ventura was born in Guatemala City, Guatemala, but moved to the United States before he was one year old. After earning his BS in mathematics at Harvey Mudd College, Ivan completed his PhD at University of California, Berkeley. There he studied semiclassical analysis and other asymptotic analysis methods and how they can be applied to Partial Differential Equations. Ivan is happy to be an Alliance Postdoctoral fellow at the University of Arizona and is excited by the research and teaching opportunities his position will provide. In his free time Ivan is an avid soccer fan and enjoys watching games from all over the world, in particular those of his favorite club, Juventus, from Turin, Italy. When not doing math or watching soccer he also enjoys hiking, ultimate frisbee and most other outdoor activities.

New Teaching Postdocs Bios

Kristen Beck, a Teaching Postdoc, earned her PhD in Mathematics in May 2011 from the University of Texas at Arlington. Kristen's research interests lie primarily within the intersection of commutative ring theory and homological algebra, where she studies the homological properties of commutative rings and their modules. Aside from research, Kristen also has a passion for teaching and outreach, and especially enjoys working with undergraduates. Since joining the UA Math Department in 2011, Kristen has co-organized the Undergraduate Teaching Assistant Program and served as faculty sponsor for MathCats. She is also currently organizing a seminar for undergraduate math majors interesting in research. In her spare time, Kristen enjoys hiking, eating, and playing the ukulele with others in the Math Department.

Rohit Thomas, a Teaching Postdoc, received his PhD at UC Davis, supervised by Greg Kuperberg. He studies three-dimensional quantum topology and is also interested in the effective use of technology as a learning tool. He enjoys eating, drinking, and heavy metal.

Student-Run Tutoring and MathCats: Math Majors Helping Each Other Learn

By Austin Antoniou

MathCats is the undergraduate club for math majors on the University of Arizona campus. It meets once every two weeks to make members aware of career development opportunities, organize outreach opportunities in the STEM fields, and to socialize. One of the activities that offers potential for all three is the club's tutoring program.

MathCats tutoring isn't the biggest organized tutoring program on campus but a number of things set it apart from other on-campus tutoring resources. The club's tutoring efforts are geared toward two important classes in an early math major's career, vector calculus and linear algebra, for which help is hard to come by using other on-campus resources. MathCats tutoring offers personal guidance from fellow students who understand not only the content but also what makes the material challenging.

Mathematics Undergraduates with their Math and the City T-shirts!

Traditionally, MathCats has offered tutoring sessions before each exam in vector calculus. I have been in charge of these sessions since the fall 2011 semester. This semester, however, I also had the opportunity to be a part of an initiative independent of MathCats—with significant organizational help from Dr. William Yslas Velez—to offer tutoring to first-semester students taking linear algebra.

Introductory linear algebra is usually the first course in which students get a glimpse of abstract mathematics. This semester's trial sessions didn't have the high attendance for which one might hope, but those who did attend said that they benefitted. I am optimistic that, with some adjustments and help from the growing membership of MathCats, we will have a successful and self-sustaining linear algebra tutoring program.

The recent surge in membership of MathCats is exciting not only because of the outreach and other great opportunities available to members, but also because many of the members have expressed interest in tutoring. This is great for the both the students being tutored and for the tutors: regardless of how recently they have taken a course, tutors get to leverage a great opportunity to refresh key material, develop math communication skills, and help their peers.

MathCats tutoring is still young and very open to growth. As more members become interested, the club can do more to offer student-run tutoring. Hopefully the next steps include a fully established linear algebra tutoring program and more regular sessions for vector calculus. Perhaps the greatest goal of the MathCats club is to establish a community among Mathematics students in which everyone knows where to find whatever help they need to succeed.

Austin Antoniou is a Mathematics major at the University of Arizona with a minor in Linguistics. He has been a MathCats tutor and an undergraduate teaching assistant for three semesters. Austin is currently in Budapest for the Budapest Semesters in Mathematics.

Marianne Cooke Johnsen Scholarship: Two years of Supporting Undergraduate Women in Mathematics

Ashley Anhalt, and Laurie Varecka, Undergraduate Program Coordinator

Taylor Corcoran, Melissa Johnsen, and Ashley Anhalt

In 2009 siblings Randy Johnsen and Melissa Johnsen created the Marianne Cooke Johnsen Endowment in honor their mother. The endowment, announced in the Fall 2010 Mathematics Newsletter, funds a $500 annual scholarship supporting young women studying mathematics at the University of Arizona.

Two undergraduates, Ashley Anhalt in 2011 and Taylor Corcoran in 2012 were the first and second awardees of the scholarship, respectively. Ashley and Taylor are both earning second degrees in addition to Mathematics: Ashley in Systems Engineering, and Taylor in Economics. Both were selected from an excellent pool of applicants based on their outstanding academic records, resumes, and essays. An excerpt from Ashley's essay appears below:

> *Eleanor Roosevelt's quote, "Life is what you make it; always has been, always will be," resonates within me; I work hard and persevere in everything I do [and] I naturally see myself as a leader. I believe that the individual is only as merited as the degree of impact they have on their environment, and it is for this reason that I am greatly involved. My decision to major in systems engineering and mathematics resulted from my undeniable passion for mathematics [...]. I see a natural correlation between systems engineering and mathematics because in both fields, my goal is to improve, optimize, and solve problems in the most efficient and applicable manner. I hope to [...] positively impact society by extending my sense of hard work and dedication onto others so that they feel inspired to achieve their dreams.*
>
> *—Ashley Anhalt*

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Give!

To contribute to this endowment online, please visit:
uafoundation.org/give/fund/04110116389

For information on the Marianne Cooke Scholarship and other undergraduate scholarships in mathematics, please visit:
math.arizona.edu/ugprogram/awards/departmental.html

Algebraic Numbers: Their Place in History, Mathematics, and Current Work

By Romyar Sharifi

The first numbers we learn about are the whole numbers, the numbers we use to count: 1, 2 ,3, ... We can throw in zero and the negative numbers to form the integers ..., –2, –1, 0, 1, 2, ... we can then form the rational numbers (fractions), real numbers (having decimal expansions), and so on, building ever more complex number systems. I study *algebraic numbers*: numbers that solve polynomial equations (in one variable) with coefficients that are integers. So, for instance, 0.321 and $\sqrt{5}$ are algebraic numbers:

0.321 solves the equation $1000x - 321 = 0,$ and
$\sqrt{5}$ solves the equation $x^2 - 5 = 0.$

The famous number π is not an algebraic number, although that's very hard to prove. Algebraic numbers are often found as solutions to polynomial equations in several variables like:

$$y^2 = x^3 - x,$$

which is an example of what is known as an *elliptic curve*.

Number theory dates back to ancient Greece, where it was studied by such famous mathematicians as Pythagoras, Euclid, and Diophantus, who investigated solutions to elliptic curves and more general polynomial equations that are now known as Diophantine equations. *Algebraic* number theory is a branch of mathematics, and in particular number theory, dedicated to the study of algebraic numbers. Within the world of mathematics, algebraic number theory is perhaps most closely related to abstract algebra, an area of research that provides an axiomatic framework for studying sets of numbers together with the familiar operations on them, such as addition and multiplication. It is abstract algebra that makes algebraic number theory "algebraic". However, algebraic number theorists routinely borrow from other major branches of mathematics in their work: geometry, topology, and analysis all offer key tools for gaining insight and solving problems involving algebraic numbers. In fact, my research is motivated in large part by deep and oftentimes surprising interconnections between algebraic numbers and objects of a different mathematical nature.

The use of abstract algebra in number theory dates back to the mid 1800s, so algebraic number theory has had a chance to grow over the years. It is a vast subject. Inside of it, an amazing edifice of highly abstract constructions has been developed to understand algebraic numbers, as well as to understand the constructions that are used to understand algebraic numbers, and then to understand those.... It may appear to an outsider that the subject is an infinitude of layers of ever increasing abstraction. Even for the most seasoned of experts, understanding a specialized talk in algebraic number theory can often prove a daunting task. Yet, the detailed and highly abstract studies that number theorists perform can provide tremendous insight into the more down-to-earth questions that originally motivated their work.

In spite of, or many might say because of, their abstract nature, the tools of algebraic number theory have in recent decades brought spectacular successes. The most famous of these was the proof of Fermat's Last Theorem (or FLT) by Andrew Wiles (in part with Richard Taylor), which was published in 1995. The theorem, scribbled by Pierre de Fermat himself on a narrow notebook margin around 1630, claimed that the equation:

$$x^n + y^n = z^n,$$

has no solutions in whole numbers x, y, and z when the whole number n is larger than 2. The claim is curious because the case of n = 2 is known to have infinitely many solutions. The triples (x, y, z) of

integers that are the lengths of the sides of a right triangle all solve the equation $x^2 + y^2 = z^2$ of Pythagoras. For example:

$$\begin{aligned} (x,y,z) &= (3,4,5) &&\longleftrightarrow && 3^2+4^2=5^2 \\ &\quad\ (5,12,13) &&\longleftrightarrow && 5^2+12^2=13^2 \\ &\quad\ (48,55,73) &&\longleftrightarrow && 48^2+55^2=73^2 \end{aligned}$$

Though trial-and-error quickly convinces one that finding solutions to Fermat's equation is at best quite difficult, Fermat's famous words scribbled in a textbook:

"I have discovered a truly remarkable proof which this margin is too small to contain,"

puzzled mathematicians for centuries, as no one could come up with a proof.

So, FLT remained a conjecture for over 350 years until Wiles' eight years of determined effort yielded, at last, a proof. Though FLT is straightforward to state, Wiles' argument relied on a complex ensemble of constructions expertly built using tools from several mathematical fields of research. The proof was incredibly round-about. Let me summarize its basic logical outline: if there was a solution (x, y, z) to FLT, one could use it to construct a certain elliptic curve (like one in the example above). Now, thanks to work of Ken Ribet, we would know this elliptic curve is not "modular".[2] Yet, Wiles proved that (just about) every elliptic curve is modular. This means that a non-modular curve of the kind we would have constructed cannot possibly exist and, therefore, neither can the solution to FLT that would have given rise to it.

The allure of down-to-earth problems about numbers being solved by a wondrously abstract theory has in recent years attracted large numbers of bright young mathematicians to the field. The complex methods that Wiles' used in his proof were once considered the pinnacle of knowledge in the field and known only to a select few. Now, these methods are widely used and have been greatly generalized, such is the current pace of growth of mathematics. This pace and the sheer volume of available knowledge make it challenging for a young researcher to come to grips with the field. Perhaps, the gradual transition to researcher is for a young Ph.D. student as it was for me: when I began, I was a bug stuck in a huge mess of cobwebs, and after a long struggle, I emerged as a spider weaving new strands into a beautifully intricate web.

A mathematician doing research in algebraic number theory in today's world can only hope to carve out a niche in one or several parts of the subject, and I am no exception. My research grows out of some very classical aspects of number theory and intersects heavily with key modern developments. The modular forms that played a key role in Wiles' proof of FLT are also central to my own work. Cyclotomic fields, sets of numbers pivotal in earlier approaches to FLT, also play a major role in my research. Just a few years ago, I discovered an unexpected connection (an equality, in fact) between two sets of numbers: one coming from modular forms, the other from cyclotomic fields. My discovery was actually a conjecture: I could show its truth in any number of examples, but not for all of the infinitely many instances. Since then, two mathematicians at the University of Chicago, Takako Fukaya and Kazuya Kato, have given a fantastic proof that covers most cases. True to the inquisitive nature of mathematicians, we're not content to stop there. We continue to look not only for a proof in the remaining cases but also for a broad generalization of the phenomenon. This will lead us deeper into the rabbit hole of abstraction, revealing as we go along a hidden truth, the sort we mathematicians find so fascinating.

Romyar Sharifi received his Ph.D. from the University of Chicago in 1999. He was a postdoctoral research fellow at the University of Arizona in 2000–2001 and returned to the university as an associate professor in 2009.

[2] *A modular form is one of a class of functions with remarkable symmetries. An elliptic curve is modular if it arises from some modular form in a specified manner.*

Building Advocacy for the Mathematical Sciences: A New Board for a New School

By Guadalupe Lozano

In an era of integration and interdisciplinarity, at a time when specialists share the spotlight with generalists, universities are turning their eyes and ears outwards, establishing and fine-tuning mechanisms for sharing their mission with multiple stakeholders. Increasingly popular public lecture series, science cafés, and other events that bring academics together with civic leaders, industry leaders, and the public at large, are evidence of powerful common interests. When intentionally nurtured, these common interests become shared purposes and lead to external advocacy for the work we, mathematicians and scientists, do; advocacy that extends beyond, but also permeates within, university walls.

In 2010 Bill McCallum and I began the work of creating an External Board of Advisors (EAB) for the then newly formed School of Mathematical Sciences. We drafted several documents that outlined and fleshed out the mission of the school and gave us a common language to reach out to potential friends and advocates for the UA Mathematical Sciences from all walks of life. Nearly three years later, we find ourselves with a robust, active board, whose members are deeply committed to upholding the mission of our School by making it tangible and practically present.

Tucson Mayor Jonathan Rothschild talks to guests and mathematics undergraduates during the Math and the City event last October.

Advisory Board Members together with School of Mathematical Sciences faculty. From left to right: Bill McCallum, Joe Watkins, John McLean, Kathleen Perkins, Guadalupe Lozano, Michael Tabor.

Since its inauguration, two Chairs have led the EAB: John McLean, PhD and CEO of Areté and Associates, and Kathleen Perkins, member of the Southern Arizona Leadership Council and chair of the BIO5 Industry Board of Advisors. John has led the way in creating a strategic plan for the mission of the board, growing internal and external advocacy for statistics and supporting mathematics students through the Galileo Circle and other scholarships. Kathleen has been instrumental in integrating the School within the larger Tucson community, through research dinners with Tucson Mayor Jonathan Rothschild, key input on events such as the Math and the City forum (the first public event organized by our School in coordination the City of Tucson) and much more.

The EAB is an asset to the School, but it is also something that recognized leaders like John and Kathleen love to do. The next article collects John McLean's thoughts on what has led him to give of his time and influence to the UA School of Mathematical Sciences, the federation composed of the Graduate Interdisciplinary Programs in Applied Mathematics and Statistics and the Department of Mathematics.

From a Board Member: The Worth and Value of UA Mathematical Sciences

By John McLean, Chief Executive Officer, Arete' and Associates

My association with the UA math programs dates back to my undergraduate days in the '70s (BS Engineering Math 1975). Since there was no applied math program at the time, I pursued my passion for math out of state (PhD Applied Math Caltech 1980). My time at the UA and Caltech prepared me for an interesting early career in applied research (viscous fingering, stability of nonlinear waves, imaging through turbid media). Surprisingly, a foundation in mathematics also prepared me for an unplanned career as an entrepreneur: I opened the first office of Areté Associates in Tucson in 1992, and became CEO of the entire company some years later. My return to Tucson was prompted by the beauty of the Sonoran Desert and the robust scientific/engineering ecosystem grounded by UA.

UA President, Dr. Ann Weaver-Hart, addresses the crowd at last October's first Math and the City event at Flandrau Science Center.

I was very fortunate to be able to renew my association with the Math department through Michael Tabor, who introduced me to the GIDP in Applied Math and a number of his very capable and enthusiastic students. The EAB has helped me and other members appreciate the full scope of accomplishments of the School of Mathematical Sciences. Board members are bound by a shared commitment to the ongoing success of this regional and national center of excellence.

Birds-eye view: Math and the City event, October 2012.

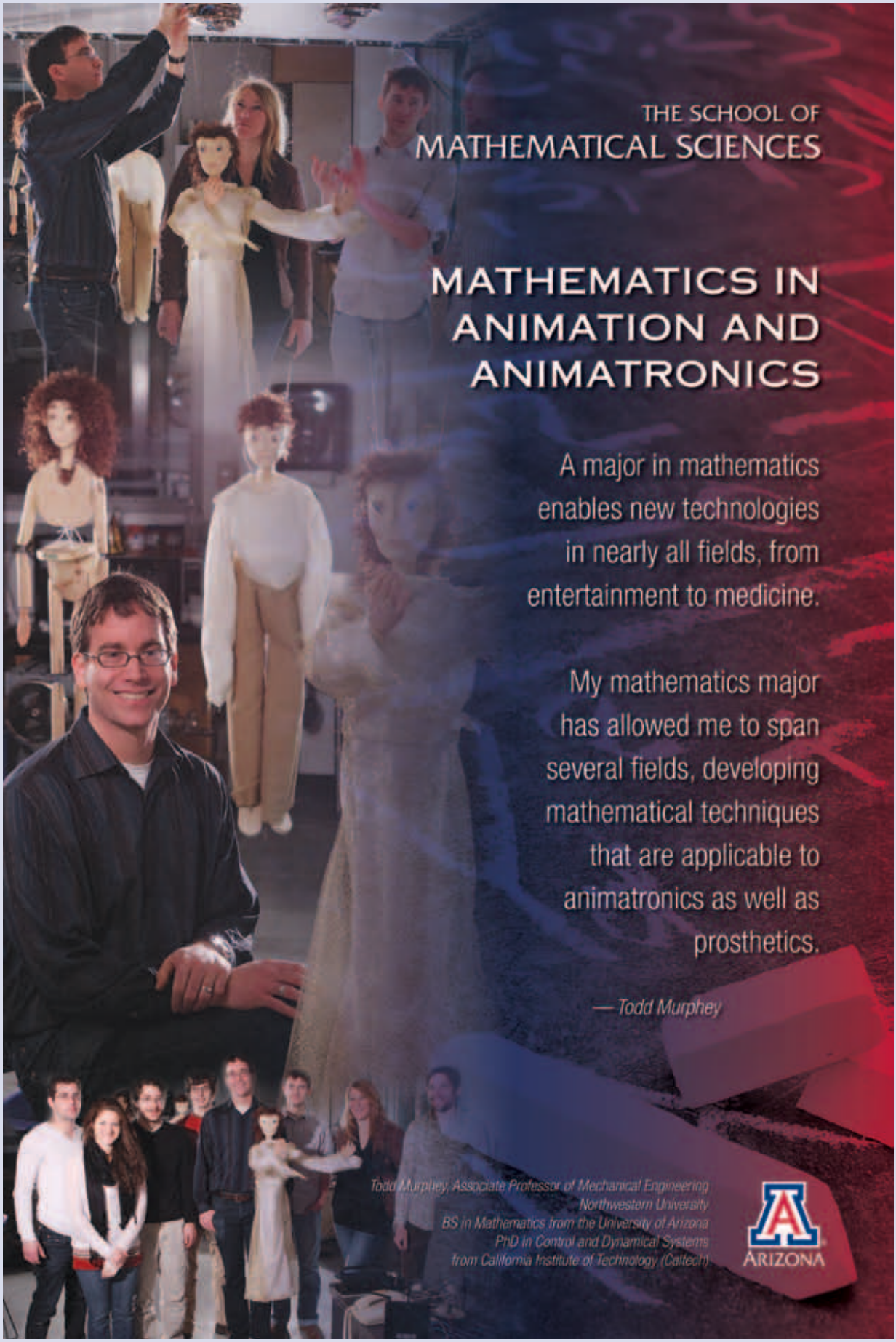
The first year of the Board focused on getting a sense of the breadth of activities in the College, including an appreciation for the strengths (and vulnerabilities) of this multi-dimensional enterprise. One of the most striking observations was that how poorly the contributions of the School are appreciated outside the Mathematics building. These initial observations have guided our priorities for the second year: enhance awareness of the programs through community education, be a staunch advocate for the programs within the University community as well as at the State level, and help facilitate development of new programs with our industrial partners.

So why do I serve on the Board? There are three reasons. First, my math education at UA was foundational to all of my professional success, and I want others to be able to enjoy the benefits of a first rate education. Second, the intellectual capital that is derived from UA (innovative ideas and well prepared graduates) has allowed my company to thrive in Tucson. And third, a robust mathematics program is essential for the success of the entire university enterprise.

In short, math is cool, but it cannot be taken for granted.

Alumni Poster Design

To highlight mathematics alumni and share career options for Math graduates, a series of posters were created for display in the department. A quote was included from each alum as well as photos of math in the real world.



UA Math 100: Adaptive virtual learning for those who come in knowing less

By Michelle Woodward

George, an incoming freshman, just finished his English class and is in a rush to get to his Math 100 class. Halfway across campus he realizes he is not going to make it. So he finds a table in the library, pulls out his laptop, puts on his headset, and gets to class just in time. How did he do it? George, like all of our Math 100 students, has just signed into his virtual classroom. His teaching staff has started the class with opening announcements and he will soon be working on math problems individualized for him.

The problem of underprepared freshmen is not new in Arizona and the UA mathematics department has been working with it for many years. George, like a third of his incoming class, is not ready to take a university level math class. We have tried many approaches to help students like George continue onto higher-level math courses. Recently, we have been exploring an impressive adaptive on-line learning tool called ALEKS (Assessment and Learning in Knowledge Spaces) and have designed an interactive course around it. Math 100 is held in virtual synchronous classes using Elluminate. In this "space" teaching staff and the students interact throughout the entire 50-minute meeting period three times a week. With ten students for each instructor we have created a small, individualized classroom that happens to be virtual. Students work one-on-one or in small groups, interacting with their teaching assistant as they solve problems collaboratively. They also keep a digital portfolio of their written mathematics work, which is graded regularly throughout the semester.

Math 100 students are fairly varied in mathematical background and needs. Yet the adaptive nature of ALEKS allows us to customize their learning: students can create their own paths through the mathematics and tackle problems when they are ready to master them.

During the 2011-2012 school year, Math 100 served about 1600 students, 77% of whom placed into a college level mathematics course. This success rate is particularly relevant for students like Steve, who need to fulfill a college math requirement but have struggled with math in the past. Steve, for example, knew as an incoming freshman that he would need college algebra for his major. Yet he also felt he had not been successful in mathematics since about 6th grade. For Steve, getting through the Math 100 material was a struggle. However, with the help of his teaching assistants and a lot of dedication he made it into college algebra and fulfilled his mathematics requirement.

Looking at the totality of students who complete Math 100 and move on to other math courses, we have found mixed results. Students who progress into our general education course (the mathematics of voting or banking) outperform the general population by a substantial margin. However, results are less clear-cut for students who go into college algebra. In our more data-driven version of college algebra, Math 100 graduates are now doing as well as the general population. In our more algebraic-intensive version of college algebra, we still have work to do.

Like Steve, most Math 100 students do not intend to major in mathematics, science or engineering. However some are interested in pursuing STEM careers. Math 100 opens up a path to success for this group. One of our recent students, Sonia, took our Math 100 summer school course through the summer bridge New Start program. After six-weeks, she placed into pre-calculus. Sonia is now a sophomore, and is taking third-semester calculus.

Math 100 offers students like Sonia, Steve, George and many others the opportunity to catch up to their peers mathematically. With the right support, underprepared students can be successful. Please come down to see us in the ground floor of the Mathematics Building, Room 101. We will be happy to give you a tour.

As seen in articles in UANews and The Arizona Daily Star, there has been great interest in this course due in part to the population we are serving and the innovative way that we offer the course. Starting in the fall of 2011, the central university administration asked the department to expand this program to students that placed below Math 100. This is part of a greater programmatic effort focused on retention of these students. In the fall of 2012, Michelle Woodward received the Innovative Teaching Award for the College of Science.

Local Teacher Voices: What They Love about Mathematics... and other things

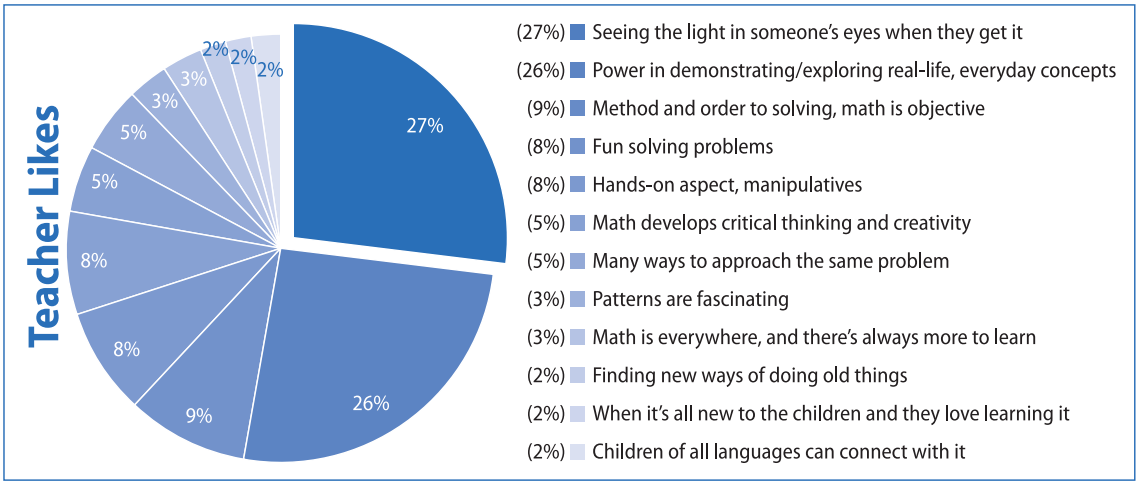
by Guadalupe Lozano (data compiled by Christa King)

"I am teaching my students the purest form of communication. Math is a universal language that the whole world speaks."

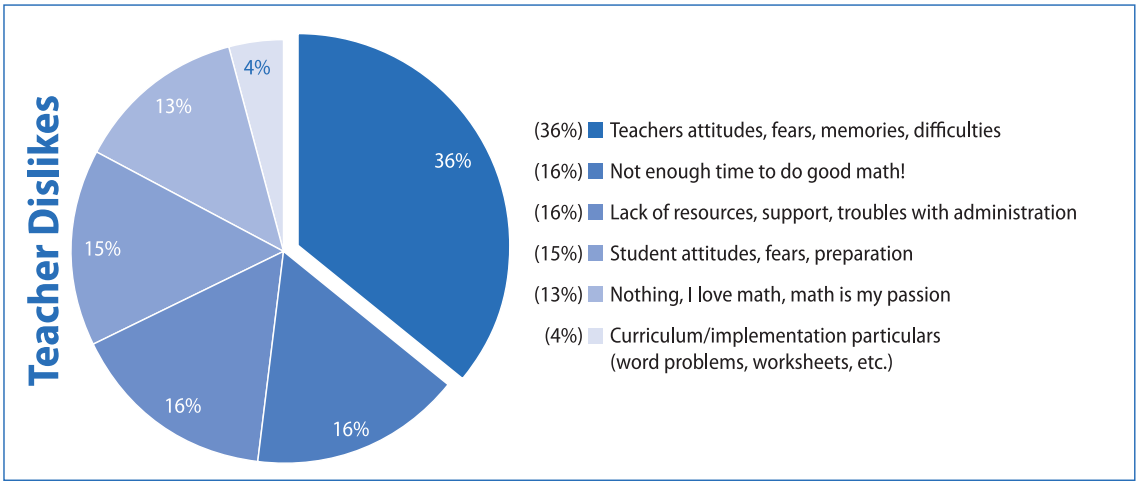
"I dislike the damage others do to kids when they say things like: 'That's OK, I was bad at math too' or 'You don't really need it'... I wish we had a better attitude towards mathematics."

We live in a country where mathematics is considered essential to K-12 education. Yet many of us view mathematics as obscure and unexciting, a view at odds with the value we place on mathematics education. In the Spring of 2010 the School of Mathematical Sciences conducted a public opinion poll to learn how Arizona teachers view the work of doing and teaching mathematics. One hundred local teachers completed the anonymous two-question poll during the first Tucson Values Teachers campus-wide event.[3]

What do you like about mathematics or teaching mathematics?



What do you dislike about mathematics or teaching mathematics?



The preceding quotes illustrate answers to the "dislikes" and "likes" sections of the poll. But overall, what did teachers have to say? The charts below summarize teachers' answers to each question.

It is interesting to note that the most popular answer category among the "likes" and also "dislikes" focus on how mathematics makes us feel, rather than on characteristics intrinsic to the discipline. The prevalence of (negative) memories, attitudes and fears among "dislikes" may be taken as a call to action: building a public-friendly image of mathematics that portrays the discipline as a landscape for forging and empower creative K-12 minds.

The UA School of Mathematical Sciences is working toward shaping and disseminating this view of mathematics, among others. Listening to teacher voices helps us work towards the change we want to see.

[3] *tucsonvaluesteachers.org, accessed April 2013*

Matching Funds Challenge: Instantly Double your Math Gifting

Math undergraduates are thriving at Arizona. With over 600 majors and almost 700 minors that include five Goldwater Scholarships winners since 2009 and several outstanding research award recipients, the mathematical sciences at UA are taking a leap forward. Because we are grateful for your continued support of our math undergraduates and their work, we are excited to tell you about a new opportunity for growing your contribution to the Mathematical Sciences at the University of Arizona.

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UA Department of Mathematics Wins $1Million Teacher Recruitment Grant

By Cody L. Patterson

The Center for Recruitment and Retention of Mathematics Teachers (CRR), a program of the Department of Mathematics, has been awarded a Transition to Teaching grant from the U.S. Department of Education to help address the shortage of secondary mathematics teachers in Tucson. The Southern Arizona Inducting New Teachers (SAINT) Program, a collaboration between CRR and the Teach Arizona Master's Program, is assisting high-need middle and high schools in Tucson by recruiting, training, and inducting fifty new teachers.

Recent college graduates and mid-career professionals with background in mathematics are invited to join the SAINT Program and teach in high-need schools in Tucson. Each participant receives $5000 in tuition assistance, along with additional scholarship support from the UA College of Education, to complete the Teach Arizona program. In return, each candidate commits to teach for three or more years in a high-need school while taking part in the CRR Induction Program and mathematics workshops.

The million-dollar grant not only provides tuition assistance for prospective math teachers, but also supports an expansion of the Induction Program, which provides a valuable learning community and support structure for new mathematics teachers. Over 75% of teachers who have participated in the Induction Program have remained in the teaching profession for three years or more, compared to the national average of 50%. Many graduates of the Induction Program have gone on to become leaders in their schools and at the district level.

We in the Department of Mathematics are grateful to have the chance to work with Teach Arizona and the U.S. Department of Education to alleviate the mathematics teacher shortage in southern Arizona. The Center for Recruitment and Retention's mission is to use our expertise and resources to honor and support local teachers while providing professional development to foster student achievement. The SAINT grant is an exciting opportunity to broaden the Center's reach.

Cody L. Patterson is the Director of the Center for Recruitment and Retention of Mathematics Teachers and the Assistant Director of the Institute for Mathematics and Education. He is a faculty member in the Department of Mathematics.

Become a part of UA Mathematical Sciences now. Give today. Help us shape the future for all.

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To give a gift towards the UA Mathematics CRR teacher programs, please visit:
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UA School of Mathematical Sciences graduate students at Math and the City event, October 2012.