Below: Students in Gail Johnston’s Mathematics class use pattern blocks and cuisinaire rods to model and deepen their understanding of fraction operations.

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Dear Friends,

Let’s take the initiative…

While in Washington, D.C. for a meeting of the American Mathematical Society on science policy last spring, Dr. Wolfgang Kliemann and I visited with Senator Tom Harkin and a senior aide to Senator Chuck Grassley about how a collaborative mathematics education initiative could help ease the difficulty many students face as they transition from high school to the university.

Since that time, the Chairs of the five mathematical sciences departments at the Regents institutions (Mathematics and Statistics at both Iowa State and University of Iowa, and the combined department at the University of Northern Iowa) have met to discuss coordinating how mathematics and statistics are taught from the time the student enters high school up to his/her graduation from one of the universities.

By better coordinating our expectations with the high schools and community colleges, the initiative will have a major impact on the way mathematics is taught in the state.

This initiative comes at a critical point in mathematics education.

Trend data provided by the Council of Chief State School Officers (CCSSO) report significant increases in the number of high school Math teachers across the United States in the last decade. However, this increasing demand for well-qualified
Also worth noting, according to the CCSSO State Indicators of Science and Mathematics Education 2005 report, is the fact that “course enrollment trends show that secondary schools’ course enrollments in math and science have increased significantly over the past decade, and currently more than 60 percent of students are taking upper-level courses in math and science in high school by graduation.”

A third area of concern – the need to increase America’s talent pool by vastly improving K-12 mathematics and science education – is part of the American Competitiveness Initiative, and is the first step recommended in Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future (2007). Prepared by a committee consisting of leaders in academe, industry and government, this Congressionally-requested report outlines steps that can best strengthen the quality of life in America – our prosperity, our health and our security. The first three implementation actions the group recommended federal policymakers should take to create high-quality jobs and focus new science and technology efforts on meeting the nation’s needs include (1) annually recruit 10,000 science and mathematics teachers by awarding 4-year scholarships and thereby educating 10 million minds; (2) strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master’s programs, and in Advanced Placement and International Baccalaureate training programs; and (3) enlarge the pipeline of students who are prepared to enter college and graduate with a degree in science, engineering or mathematics by increasing the number of students who pass AP and IB science and mathematics courses.

Plainly put: we have more students who need better teachers to prepare for changing life in the 21st century.

We here in the Department of Mathematics are taking a number of steps in response to the needs articulated by the CCSSO and Congressional reports. Some of these include:

1. **Creating a Mathematics Advisory Board.** We are in the process of populating this group with individuals who have an interest in the Department, and who will be called on for their vision of what the Department can and should be doing to address current and future needs.

2. **Expanding the presence of our Master of School Mathematics Program** within the state and explore the possibility of offering the degree nationwide. Currently the program has about 100 graduates working at high schools and community colleges around the state.

3. **Encouraging co-majors** to better satisfy the growing need of companies that require people to be trained in more than one area. As a start, beginning in the Fall of 2007, we will introduce the undergraduate Bioinformatics and Computational Biology program, initiated through the departments of Genetics, Development and Cell Biology, Mathematics, and Computer Science.

4. **Working to implement the combined BS/MS program in financial mathematics and statistics.** After taking a series of courses in mathematics, statistics, and business, students will be able to graduate in five years with both B.S. and M.S. degrees. This program has been approved by both departments, and we hope to begin accepting students in the near future.

5. **Offering internships to math students continuing to graduate school or going into teaching.** These valuable experiences will allow them to learn about actual life applications and how the information is being used.

Research confirms that investments in teacher education pay off. Recent studies consistently show a strong positive relationship between the amount of teacher course preparation in math and science and the level of student achievement in these areas.

We are at a critical point in mathematics education. As you know, such critical changes have associated costs. Your support—in hours and energy and ideas and dollars—as we work towards these goals is invaluable. I invite you to join us in filling life in the 21st century with opportunity, as mathematics equals opportunity.

Justin R. Peters, Chair
Research experience for undergraduates
Leslie Hogben

For years, mathematics faculty members have invited Iowa State University undergraduate students to work with them on research projects. That practice shifted to a bigger, broader and deeper level during the past three summers through a model research program funded primarily by the National Science Foundation (NSF).

With up to sixteen undergraduates and a total of about thirty people involved each summer, the Iowa State University Math Research Experience for Undergraduates (REU) was one of the larger NSF mathematics REU sites and one of the largest undergraduate summer research programs on the ISU campus. Students came from all over the country, attending school in more than 20 states. Approximately 45% of the students lived or attended college in Iowa or adjacent states.

Directed by Justin Peters and Leslie Hogben, the program was specifically designed to exploit the strengths of a large research university (ready access to a large number of faculty and graduate students doing research), while at the same time giving students the kind of individual attention and mentoring that is often found only at smaller colleges. Specific goals of the program were to (1) provide a supportive environment where students can discover the joys of mathematical research; (2) increase the number of U. S. citizens receiving Ph.D.s in the mathematical sciences; and (3) produce high quality, publishable research.

An average of eight projects were offered each summer. A typical research team consisted of two undergraduates, one graduate student and one faculty member. Research groups met daily for at least an hour. Initially, faculty taught the necessary background to students; later students reported progress and discussed obstacles. Each project team produced a final paper (typically 20 pages) and presented an hour-long report at the symposium held in the eighth (final) week of the program.

As all mentors are active researchers who publish regularly, it was intended that many of the projects result in papers in professional journals. Five papers from projects have appeared in professional journals such as *Linear Algebra and Its Applications*, *Journal of Mathematical Analysis and Applications*, and *Mathematical Biosciences and Engineering*. One additional paper has been accepted and three more are under review.

Approximately ten students

Annual math REU picnic at Big Creek Lake. From her sailboat, Hogben captures this race between Team Kayak and Team Pedal Boat, while Team Double-Hydro-Bike looks on.
made research presentations at undergraduate conferences (primarily the Young Mathematicians Conference at Ohio State).

As part of the REU, the Department funded seven or eight research assistantships each of the three summers. These graduate students were encouraged to talk to the undergraduates about the graduate school application process and graduate student life, in addition to serving as research mentors. Evaluations show that the undergraduate students found the participation of graduate students to be very valuable to their experience, and the graduate students found the experience beneficial also.

During the 2006 session, a campus-wide group of REU directors met regularly. This collaboration resulted in many positive outcomes, including a mentoring workshop for graduate students, a campus-wide REU picnic funded by the Dean of the Graduate College at the beginning of the summer, a presentation to all REU students about graduate study by the ISU Vice Provost for Research, an end of the summer campus-wide poster session, etc. The undergraduates in the Math REU enjoyed interacting with those in other programs and this cooperation gave all the REUs greater internal visibility. It is expected that this collaboration will continue.

The mathematical diversity of the ISU Math REU can be seen from list of projects and the number of faculty involved:

- **Leslie Hogben** Matrix theory: Matrix completion problems; Rational realization of eigenvalues of tree sign patterns; Minimum rank of symmetric matrices described by a graph; Matrix D-stability.
- **Wolfgang Kliemann, Justin Peters, Jiyeon Suh** Dynamical systems: Dynamical systems in projective space; Morse decompositions, attractors and chain recurrence; Dynamical systems and group theory; Mathematics of the heart beat cycle; Dynamically coupled linear ODEs and Markov chains.
- **Khalid Boushaba, Howard Levine, Michael Smiley** Modeling of tumor angiogenesis: Negative feedback systems; Fibroblast growth factor competition; Tumor dormancy; SELEX against multiple targets; Regulation of secondary metastases by plasmin.
- **Roger Alexander** Numerical Analysis: Analysis of software for stiff ODEs; Range-Kutta Design and Optimization.
- **Sung-Yell Song** Combinatorics and graph theory: Polygonal designs; Strongly regular graphs.
- **Zhijun Wu** Biomolecular modeling: Thermodynamic fluctuations of proteins; Optimizing protein structural alignment.
- **Dan Ashlock** Evolution of hybrid grid robots.
- **Cliff Bergman, Jennifer Davidson** Methods of steganalysis.
- **Jonathan D. H. Smith** Partial semigroups and binomial coefficients to prime square modulus.
- **Eric Weber** Attack on hiding messages in oversampled Fourier coefficients.

In 2006, all ISU REU directors organized several events, including this picnic sponsored by the Provost’s Office and the Graduate College. Our math students enjoyed interacting with and being housed with other REU students in Frederiksen Court.

Secondary Teaching

Coursework in mathematics and teacher education, combined with field experiences in secondary classrooms lead to initial licensure to teach mathematics in grades 7-12 in Iowa.

7-12 Mathematics has been identified as an area of teacher shortage in Iowa, thus forgivable loans are available for students who meet the requirements.

Teaching mathematics opens the doors to impact the next generation of professionals, scientists, problem solvers and world changers. We need competent, qualified and caring teachers.
Dr. Robert Kohn, of the Courant Institute at New York University, opened the two-day conference with a talk on the evolution of a crystal surface below the roughening temperature.

Matania Ben-Artzi
Hebrew University
A pure streamfunction approach to Navier-Stokes Equations in two dimensions

Gui-Quang Chen
Northwestern University
Transonic flow, shock reflection and free boundary problems

Costas Soukoulis
Ames Lab/ISU
Bending back light: The science of negative index materials

Charles Doering
University of Michigan
Twist & shout: Maximal enstrophy production in the 3D Navier-Stokes equations

Mitchell Luskin
Univ of Minnesota
Alternative solution methods, error estimation, and atomistic-continuum adaptivity for the quasi-continuum approximation

Robert Pego
Carnegie Mellon
Some results from the analysis of LSW and one-dimensional coarsening models

Yannis Kevrekidis
Princeton University
Coarse-grained computations (multiscale modeling)

Lihe Wang
University of Iowa
Estimates for degenerate equations

Chiu Yen Kao
Ohio State University
Shape optimization for eigenvalue problems with applications in photonic crystals and vibrating systems
Computational and Mathematical Aspects of Materials and Fluids

Over 70 faculty members and graduate students from 18 institutions (as far away as Hebrew University) spent two days talking about the computational and mathematical aspects of materials and fluids.

Participants viewed and discussed around a dozen posters that were presented Friday afternoon.

More at: http://orion.math.iastate.edu/hliu/cam2007/
Forensic statisticians hunting for hidden messages

If terrorists aren’t already using it, it’s only a matter of time. It’s called steganography, a way to hide messages in seemingly innocent digital images. Apparently harmless JPEG files, such as family vacation photos containing hidden data, could be e-mailed or posted on the Web -- possibly activating terrorist cells.

To help catch the bad guys, two Iowa State University mathematicians have developed software that will detect secret files in images. Jennifer Davidson and Cliff Bergman, both professors in the math department, are fine-tuning the artificial neural net (ANN). When plopped into a computer, the ANN works like radar that pulls out suspicious images.

The software was created with local law enforcement in mind. Plans to have it field-tested in Iowa are under way.

“Any forensic tool you can get your hands on is valuable,” said Michael Morris, special agent supervisor with the Division of Criminal Investigation in Iowa. “The whole Internet and computer world changes by the minute. That’s why having new tools to combat the changing technology is important.”

Morris added that an application for the ANN would be terrorist-type investigations.

So how does it all work?

“An image is just a series of dots,” Bergman said. “One way to embed data is to just change the value of those dots. If you change those numbers slightly, that change contains the hidden data.”

There are steganography, or “stego” programs that criminals can download for free to embed a secret file, or payload -- which can be another image or text. The programs look at the payload as represented by a string of zeroes and ones. The program then adjusts pixel values (or dots) in the “cover” image to even-odd numbers that represent the zeros and ones from the secret file. For instance, it may adjust a grayscale value of 146 to 145. The receiver on the other end can look at the even-odd pixel values to reconstruct the secret file’s string of zeroes and ones.

Adding another complication for investigators, there is a good chance secret files would be encrypted.

“We’re hopeful that just the fact that you’ve found, say, a cache of suspicious images, ought to be enough to at least warrant further investigation,” Bergman said.

“When you insert this information into the image file, encrypted or not, there are certain statistical values or measures of images that will change from one that has a message in it and one that doesn’t,” Davidson said. The ANN is trained to use sophisticated pattern recognition as it takes multiple measures of statistical values in an image.

The ANN program was trained on a database of more than 10,000 images. The database was built using 1,300 clean images, a certain percentage of which were altered using various stego embedding techniques. In preliminary tests, the ANN identified 92 percent of the stego images and flagged only 10 percent of the innocent images.

Bergman and Davidson hope to improve those results to come up with statistics convincing enough for forensic scientists to use in a court of law. The two foresee the evidence being used much in the way DNA evidence is used to establish a link between the defendant and the crime.

Their research was initially funded through the Midwest Forensic Resource Center, operated by Ames Lab and the university. The center provides research and support to crime laboratories and forensic scientists throughout the Midwest.

Currently, Bergman and Davidson:

...have completed work on the graphical user interface (GUI) that allows one to use the software on a personal computer.

...are working with a security company who recently expressed interest in licensing the software.

...are pursuing additional funding avenues to support research that will allow them to increase the sophistication of the detection process.

...have submitted a paper documenting their results to the new IEEE journal, Transactions on Information Forensics and Security.
Growth of our graduate program

Paul Sacks

The Mathematics Department has substantial and growing graduate programs in pure and applied mathematics, training students for a variety of career options.

When 20 students began their study in the Mathematics and Applied Mathematics graduate programs in August, 2006, it brought the total enrollment close to 65 students, the highest total in fifteen years.

About half of the students are from the US, and the remainder from China, South Korea, Turkey and eight other countries.

During the last five years (2002-2006) the department has awarded 36 masters’ degrees and 27 doctoral degrees.

Master of School Mathematics

Heather Thompson

“I had the time of my life with the geometry you opened up to me,” wrote Des Moines public school teacher Lana Lyddon-Hatten about a course she had just completed as part of the Master of School Mathematics (MSM) program. “It made me aware of much more geometry than is usually present in high school geometry curriculum in the United States, and showed me what geometry is around the world.”

The MSM program allows those who teach mathematics at the secondary level (grades 7-12) or at the developmental level at community colleges to obtain an advanced degree which focuses on mathematics with some emphasis on educational issues. Candidates must complete 6 core courses including Intermediate Calculus, Discrete Mathematics and Applications, Intermediate Geometry, Algorithms in Analysis, Statistical Methods for Research Workers, and a seminar in Mathematics Education. The core courses are currently offered on a three-summer cycle via the Iowa Communications Network, a fiber-optics network allowing live two-way video and audio interaction. Offering the courses during the summers afford the practicing teachers the ability to concentrate on the courses when they are not consumed with their typical school year responsibilities.

Teachers in the program also complete three additional elective courses and a creative component. In writing the creative component, teachers investigate mathematics that is “new to them” and then relate that mathematics to the mathematics they teach in the secondary schools.

Since the program began in the mid-1980’s Iowa State University has graduated 99 teachers with many more having taken coursework in the program. Many MSM graduates have or have had successful careers in the high schools or Iowa Community Colleges. Many others have also held roles on the Executive Board of the Iowa Council of Teachers of Mathematics, helping to advance mathematics education across the state of Iowa.

Courtney Wahlstrom, who teaches in Indianola, found her summer MSM course both refreshing and challenging. “I enjoyed the opportunity to interact with other educators,” she wrote.

MSM faculty members look to expand the program by soon offering courses through video streaming, online interaction, and in-Ames (on-site) community-building problem-solving sessions.

Lana Lyddon-Hatten (right) enthusiastically integrates new concepts gleaned from the MSM program into her teaching.
A special recognition was made in honor of Jerold Mathews (he’s the one with white hair...) for his hours of volunteer work assisting International math students with integration into American society, and helping improve their language skills. Students Key One Chung, Ji Hyeok Choi, Jangwoon Lee, Yeon Jung Seo and Jaemin Shin hang out with Jerry and his wife, Eleanor.

Awards & Honors

Undergraduate Student Awards
Adamson Award – Chelsea Kaihoi, Hannah Park.
Marian Daniells Award – Jaemyung Kim, Brian Peck, Chelsea Sackett, Nicholas Meyer, Andrew Dust, Michael Westphal, Jason Crowley, Lee Trask, Eric Wilson, Noel Peggs, Hannah Park, Tao Zeng.
Herta & H.T. David Scholarship - Kenneth Tapper.
Alan Heckenbach Award for a student seeking Secondary Certification - Sue Barnes.
Dio Lewis Holl Awards for Outstanding Senior – Jason Kline; and Outstanding Junior – David Imberti.

Graduate Student Awards
The Aggie Ho Pure Mathematics Award – Key One Chung.
J. J. L. Hinrichsen Applied Mathematics Award – Jangwoon Lee.
Robert J. Lambert Award Teaching Excellence – Gargi Bhattacharyya.
Henry Thielman Award – Elizabeth Kleiman.
Wolfe Graduate Research Fellowship - Key One Chung, Zhongming Wang.
Research Excellence Award – Isaac Chepkwony.

Are you curious about research topics of ISU MS and PhD students? Check out the online Thesis Archive, located at:
www.orion.math.iastate.edu/dept/ThesisArchive.html
We plan to expand the coverage of the archive to include earlier years. If you are a former ISU graduate student with a thesis or dissertation available in electronic form, please send it to gradmath@iastate.edu.

Math Graduate Student Council now official, live
This year GSC submitted the paperwork required to be recognized as an official ISU student organization.
The group posted a web page at http://orion.math.iastate.edu/dept/GraduateStudy/MGSC/index.html
Fernando Miranda-Mendoza will serve as president next year.
New Books by Faculty


In honor of his outstanding participation, commitment and leadership in the field of mathematics, The University of Minnesota, Duluth inducted Howard Levine into the College of Science and Engineering’s Academy of Science and Engineering.

Levine, a 1964 UMD graduate, is a distinguished professor on our faculty. He is listed in the ISI Web of Knowledge among 300 highly-cited mathematicians. Focusing on partial differential equations, Professor Levine’s most recent research topic is the mathematical modeling of tumor-driven angiogenesis. He has also published more than 100 referred works and presented over 250 invited lectures.

Images of Athreya and Maddux texts provided by Iowa State University Library/Special Collections Department.

Miller Lecture

Professor Neal Koblitz, University of Washington, delivered the Spring 2007 Miller lecture. He spoke on The Strange Relation of Mathematics to Cryptography.
The Sprague Room is named in honor of Professor Richard Sprague, who retired in 1995.

Since his arrival in 1961, Professor Sprague had a special interest in mathematics education and a special concern for undergraduates. He was active with Pi Mu Epsilon (the mathematics honorary society) and gave much appreciated talks on such subjects as “Pigeon-Hole, Shepherd, and Ice Cream Parlor Principles” and “Applications of Modular Arithmetic”.

The space is used by undergraduate students to relax, study and meet with other students, and contains books, magazines, job resources and computers.


The first person to receive a diploma from Iowa State was:

Edgar Stanton. Stanton arrived at Iowa Agricultural College in 1869 and was a member of the first graduating class of 1872.

Stanton was elected a member of the faculty in the month of his graduation, November 1872, and served Iowa State with distinction until the day of his death. During the fifty years of his residence upon the campus he filled the positions of student, Economics Department Chair, Head (1876 to 1920) and Professor of the Department of Mathematics, Secretary of the Board of Trustees, Dean of the Junior College, Vice President, and four times Acting President. --from ISU Library Archives

Current Faculty
2 Distinguished Professors
18 Professors
15 Associate Professors
9 Assistant Professors
12 Lecturers, Visiting Faculty & Post Docs