FALL **2021**

Math News

A PUBLICATION OF THE NEBRASKA DEPARTMENT OF MATHEMATICS

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Trio shares honor of 100th doctorate to woman in mathematics

Fifty-eight years after the first woman earned a Ph.D. in mathematics at the University of Nebraska–Lincoln, the honor of the 100th Ph.D. was shared by three women who graduated in May 2021. Juliana Bukoski, Elizabeth Carlson, and Su Ji Hong (above, from left to right) brought the number of women who have earned the Ph.D. from the Nebraska mathematics department to 100. Prior to the 21st century, only 24 Ph.Ds. in mathematics had been earned by women at UNL. Taran Funk and Robert Huben joined Bukoski, Carlson, and Hong as May 2021

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Lewis reaches 50th year at UNL

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When Jim Lewis first arrived at the University of Nebraska–Lincoln to begin his job as an assistant professor in the Department of Mathematics in 1971, Richard Nixon was in his first term as president, the city of Lincoln was about half the size it is today, and the Nebraska football team was busy pursuing its second national championship.

At the time, he likely did not envision that 50 years later he would still be teaching students, securing grants,

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{ VIEW FROM THE CHAIR }

Tom Marley

Dear alumni and friends,

It has been another eventful year in the Department of Mathematics, filled with wonderful achievements by our student, faculty, and alumni. The front page of this newsletter features two of the biggest milestones: Three women shared the honor of being the 100th woman to earn a Ph.D. from our department, and Professor Jim Lewis celebrated 50 years of service to the university.

The two stories have a deep connection. When Jim became chair of the department in 1988, the department had awarded a total of six Ph.Ds. to women in its history, and none in the previous decade. It was clear that there were structural impediments, some obvious and others less so, that were making it difficult for women to succeed in our graduate program. As chair, Jim initiated a series of changes designed to make our graduate program a more supportive place for women, and by extension all students. When he stepped down as chair in 2003, an additional 27 women had earned Ph.Ds. and the department had won a Presidential Award for Science, Mathematics, and Engineering Mentoring — from the U.S. President, not the university president! — for its success in mentoring women to the Ph.D. degree. Of course, Jim would be the first to say this was the result of a department-wide effort, and still is. But, it is indeed fitting the two celebrations, the 100th woman Ph.D. and Jim's 50 years of service, coincided this year.

As you browse this newsletter, you will learn about prestigious awards won by faculty and students as well as department initiatives to make college more affordable and enhance diversity. You will see profiles of alumni, students, and faculty, and read about new donor-funded programs, such as the Ernie Haight Graduate Internship, and exciting new grant-funded programs. You can also sing along with Juliana Bukoski on "A Long Song to Mathematics." On a bittersweet note (bitter for us, sweet for them), the department saw the retirement of two long-serving and outstanding lecturers, Bill Rogge and Bob Ruyle. We also received the sad news of the passing of two retired faculty members, Dave Skoug and Skip Thomas. Dave was a longtime member of the faculty and served as chair from 1975 to 1983. Skip taught for the department from 1998 until 2008 after teaching for more than 30 years at Lincoln Northeast High School. They both will be dearly missed.

Finally, one more bittersweet note: After serving as six years as department chair, I will be stepping down and returning to our "regular faculty" at the end of this academic year. While arriving at this decision was not easy, I am excited to return the majority of my focus to teaching and research for a spell. It has been both a pleasure and an honor to serve the department in this way and to get to know the larger community of friends we have outside the walls of Avery Hall. One of the highlights each year has been to write this column, letting our community know about all the great things happening in the department — and that I will sorely miss. I wish all of you happy holidays and best wishes for the New Year!

Tom Marley

WHERE HAS YOUR MATH T-SHIRT BEEN? TAG US ON INSTAGRAM OR TWITTER @UNLMATHEMATICS WEARING YOUR NEBRASKA MATHEMATICS SHIRT!

OPEN SOURCE: New look to textbooks

Faculty in the University of Nebraska–Lincoln's Department of Mathematics were moving away from requiring students to buy textbooks long before the coronavirus forced classes online in 2020.

Brand-new, hardcover textbooks for Math 106 — Calculus 1 — go for as much as $200 apiece, while used textbooks can run $100, a price point that has risen by 90% over the past decade, limiting access for some students.

The commercial textbooks also didn't align with the active learning model the math department adopted in 2014, which transforms instructors from traditional lecturers into facilitators of class discussion.

"We didn't think the students were getting a lot out of the textbooks," said Nathan Wakefield, director of UNL's first-year mathematics programs, "so we produced three of our own that were entirely open-source."

The open-source materials produced by the department, which include course packets and worksheets developed by faculty and cost $15-$30 depending on the class, went live shortly before COVID-19 forced UNL to cancel in-person classes for the remainder of the 2020 spring semester.

The move to remote, asynchronous learning effectively scrapped the department's prepared curriculum for the semester. (Read more about the research into the impacts of this transition on page 7 and the OER efforts specific to Math 203 on page 9.)

Faculty quickly recorded video lectures to accompany the open-source materials and directed class discussion to online message boards, a stopgap of sorts to get through the semester.

"Everything had to happen so fast," Wakefield said. "We had students spread across the state and beyond, so it was a pretty rough start."

It also forced faculty to think critically about further expanding access to students and improving learning

CRAIG CHANDLER | UNIVERSITY COMMUNICATION

Hailey Smith works on a math group problem during Math 101 class in Brace Hall in 2015.

outcomes for students who engaged the math department in a new way, said Allan Donsig, professor and vice chair of the department.

"We were in this situation in March of 2020 where suddenly everything was asynchronous," Donsig said. "It might not have been great, but it set us up in the summer to try and say, 'Let's make this work better; let's improve upon it.'"

Some of the work done by the math department throughout the summer of 2020 to prepare for in-person classes, remote classes or some combination of the two will continue this academic year as well, nearly 18 months after the pandemic reached Nebraska.

At the same time, the university was upgrading technology in 400 classrooms across the system to allow for simultaneous in-person and remote instruction, and acquiring 1,000 mobile Wi-Fi units to be made available to students, a spokeswoman said.

The impact will be felt far and wide: The math department alone will reach roughly two-thirds of UNL's incoming students this year — last year's freshman class topped 4,600 — collectively earning more credit hours than the next several course subjects combined.

According to Donsig, UNL's math faculty first made the decision to stop teaching courses asynchronously in the summer of 2020 in lieu of requiring students to be online during a normally scheduled class time.

They leaned on UNL's online master's program and in-service math teachers across the state for tips on structuring an all-online course, as well as tricks for keeping students engaged through Zoom.

"People teach people," Donsig said. "Videos themselves are not enough — there has to be a person the student has a connection to, and that is what we need to support and sustain our online work."

Math faculty also improved the department's online homework system, cutting down costs for students and providing an ease-of-use for both students and faculty.

And they started offering tutoring sessions and meetings with faculty

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through Zoom, services that will continue as they help expand access to those living off campus, or those who live on campus who may not be able to make in-person events.

"It's a bit of 'Field of Dreams,'" Donsig said. "You don't know if you build something if there is going to be any usage of it, but we know students know how to use Zoom, so it certainly serves as a resource."

Wakefield — who coordinates freshman-level courses such as intermediate algebra, college algebra, trigonometry, business calculus and contemporary math — said the videos created as lecture materials will still be available to students as well.

"We still have all of those resources, so we want to leverage them and give students a resource if they get behind or need another explanation on a topic that might click with them in a different way," he said.

Jaci Lindburg, NU's associate vice president of digital education and IT strategy, said efforts like those in UNL's math department during the pandemic have "really leveled the playing field" for all students moving forward, when it comes to access.

"Some of these efforts were in play before," she said, "but we also knew we had the opportunity to create possibilities for students that would serve them after the pandemic as well."

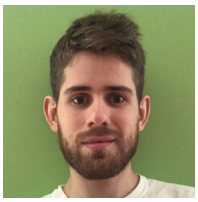
Donsig said the pandemic spurred the department to adopt some technology and strategies more quickly than it would have otherwise, and that many of the improvements will continue after the threat of the coronavirus subsides.

"We definitely have looked for the things that have been useful improvements in order to keep them going and build upon them in a way that improves students' success," he said. "We have done a lot in the last decade to improve student success in introductory courses, and we want to make sure that continues."

– Chris Dunker, Lincoln Journal Star, Aug. 20, 2021

TRIO { FROM PAGE 1 }

Taran Funk



Robert Huben

Ph.D. recipients from mathematics. Seven more Ph.Ds. were earned in 2021, including two from women (see the list on page 25).

Mildred Gross was UNL's first woman to earn a Ph.D. in mathematics, in 1963. The department did not award its 10th Ph.D. to a woman until 1995 when Ferhan Atici, Nancy Campbell, Betty Harmsen, and Kristin Pfabe earned their degrees.

To date, the department has awarded 349 Ph.Ds. The 100th was awarded in 1986, the 200th in 2008, and the 300th in 2017. After no women earned Ph.Ds. in mathematics in the 1980s, 18 were earned by women in the 1990s, 26 in the 2000s, 45 in the 2010s, and seven thus far in the 2020s.

Nationally, only about 26% of new Ph.Ds. are women, and this milestone continues the department's reputation as being a place where women graduate students are successful. Women earned 40% of Nebraska mathematics Ph.Ds. in the 2010s.

Read on to learn more about May graduates Bukoski, Carlson, and Hong.

Juliana Bukoski

Advised by Professor Allan Donsig, Bukoski's area of study is operator algebras, and her dissertation topic was free semigroupoid algebras from categories of paths.

Born and raised in Johnstown, Pennsylvania, Bukoski received her bachelor's degree in 2014 from Colgate University, double majoring in mathematics and French. A professor at Colgate recommended that she apply to Nebraska because of its reputation as having a friendly mathematics department, and Bukoski agreed with that assessment when she came to visit.

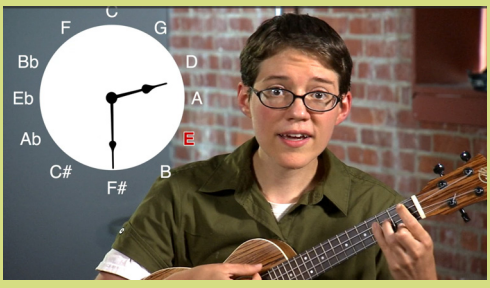
Bukoski also participated in the nationally known Enhancing Diversity in Graduate Education (EDGE) program for women entering graduate school, which introduced her to many other women in mathematics.

"When I think back about my interactions with the math department over the years, my main impression is how clearly the graduate students here are valued, from the pedagogy class and other teaching mentorships, to each semester's Q&A with the chair or vice chair, to the lunches with visiting candidates," Bukoski said. "We are really treated as an important part of the department."

Bukoski is now an assistant professor of mathematics at Georgetown College in Kentucky. Her favorite math courses to teach at Nebraska were trigonometry and linear algebra.

"I feel proud to be part of a program that has been so successful in helping women to succeed, and also honored to be one of the women recognized at this milestone. Each woman who succeeds makes it a little easier for the next, so I am grateful to all those who came before me," Bukoski said.

BUKOSKI'S 'LOVE SONG' TO MATH



In "Clocks, Chords, and Roots of Unity: A Love Song to Mathematics," Nebraska graduate Juliana Bukoski ties together the mathematics behind how we tell time, music, and Roots of Unity (which were a focus of her thesis work while a graduate student in the Department of Mathematics). Modular arithmetic ties all three of these concepts together.

Modular arithmetic works similarly to regular arithmetic except that numbers "wrap around" when

Elizabeth Carlson

Carlson's undergraduate advisor at Carroll College, Associate Professor Eric Sullivan, met Carlson's eventual graduate advisor, Associate Professor Adam Larios, at a conference, when they were both graduate students. Knowing Larios's research, Sullivan encouraged Carlson to apply to Nebraska. After Carlson met Larios during her graduate school visit, the deal was sealed, she said.

"My advisor was fantastic to work with," Carlson said. "Dr. Larios has so much energy, so many ideas. He pushed me to do my best."

Carlson was a National Science Foundation Graduate Research Fellow during her time at Nebraska. She also prepared students for several math modeling competitions and graded for those contests.

"I really appreciated when professors in the department supported my efforts to restart undergrad math modeling competitions," Carlson said. "They really stepped up to run preparatory sessions for the undergrads when I didn't have the time. Without their support, that unique part of my graduate journey wouldn't have been possible."

Carlson has now begun a PIMS Postdoctoral Fellowship at the University of Victoria, Canada, under the mentorship of Assistant Professor David Goluskin.

"My grandfather says he remembers me telling him when I was 15 that I was going to get my Ph.D. in mathematics," said Carlson, whose favorite courses as a student at UNL were measure theory and functional analysis.

Raised in Helena, Montana, Carlson received a Bachelor of Arts in mathematics and a minor in physics in 2016 at Carroll College.

"My goals currently are to continue to work at the intersection of pure and applied mathematics, using the tools of each to further the understanding of both in ways that could not be done by studying the individual fields alone," Carlson said.

Su Ji Hong

Hong studied algebraic combinatorics and was co-advised by Associate Professor Kyungyong Lee, who is now at the University of Alabama, and Assistant Professor Tri Lai. Her dissertation was on diagrammatic descriptions of real Schur roots.

Lee, who continued to advise Hong's research after he moved to Alabama, asked Lai to co-advise Hong, to continue meeting her research interests.

"I cannot thank Kyungyong enough for always looking out for me," Hong said.

Hong received her bachelor's degree from California Lutheran University in 2015, double majoring in mathematics and physics. At Nebraska, she enjoyed a discrete mathematics class with Professor Jamie Radcliffe the most, as it was her first time learning about combinatorics in-depth.

An alumna from California Lutheran was a mathematics graduate student at Nebraska when Hong was applying to graduate schools.

"She encouraged me to attend the Nebraska Conference for Undergraduate Women in Mathematics, and told me how supportive the UNL math department is," Hong said. "I applied and after attending NCUWM, I was set on coming to Nebraska if I got accepted."

After graduating, Hong started working at Yale University. She will be a lecturer for three years, teaching mostly calculus courses. She hopes to earn a tenure-track position at a liberal arts college in the future and attend NCUWM with her own students.

"I have been a participant, an invited panelist, and an organizer of NCUWM, so it would be great to participate as a faculty," Hong said.

Hong was born on an island called Jeju in South Korea. She grew up on that island until her family moved to Ventura, California, when she was 13.

While Hong said she has encountered some gender-based bias and some racial bias, she has never felt discouraged by any of those interactions since she could talk it out with her friends in the math community.

"I'm sure it was extremely difficult for the first woman to receive a Ph.D. from UNL and survive in that community. But, I'm the 100th woman, and I never felt out of place in the math community," Hong said.

– Lindsay Augustyn

they reach a certain value, called the "modulus." Counting "modulo 12" "mod 12" works similarly to basic math, we just start over after counting up to 12 ("..., 10, 11, 12, 1, 2, 3,..."). So "(10+13) mod 12 = 11. Telling time using a 12-hour clock provides a real-world representation of the integers modulo 12, a set of 12 distinct elements.

Modular arithmetic is one of the first examples we encounter of addition working differently from what we expect, and it appears in various forms in real life. One example is in music. If you've ever looked at a piano keyboard, you'll notice how the keys have a repeating pattern to them: groups of 12 keys: seven white keys and five black keys (starting at the key labeled "C"). These form an "octave." Each octave has 12 pitches (a C pitch, a D pitch, etc.). The set of all C pitches from all octaves is the C "pitch class."

In Bukoski's song she hits all 12 pitch classes. She represents these 12 pitch classes on a clock (to emphasize the connection with the 12 hour places on a clock), which represents something called the "Circle of Fifths," useful in helping musicians read music.

Bukoski also won the UNL Science Slam competition in May 2021 for the performance of this song.

Watch and listen to the song (along with a brief introduction from Bukoski) at: ***https://youtu.be/ViaUJBW-2IA***

– Rachel Funk

GIRLS INC.: Bennett hosts math camp

This summer, Amy Bennett led high school students through a mathematics program called Eureka!, which is an affiliate of Girls Inc. of Lincoln.

Girls Inc. encourages the development of academic commitment and self-confidence for students in the Lincoln community, and Eureka! focuses on developing skills in the STEM fields. When teaching mathematics, Bennett, a postdoctoral faculty member in the University of Nebraska–Lincoln's Department of Mathematics, aims to reduce students' fear and anxiety surrounding the subject.

Two cohorts of students participated in the two-week summer program. Bennett led a cohort of high school girls beginning their sophomore year.

"They loved to joke with one another and tease me about 'being alive in the 1900s,' but maybe most importantly, they were incredibly supportive of one another and willing to learn new, challenging things," Bennett said.

The other cohort was taught by Nebraska mathematics graduate student Emily McMillon. McMillon used resources from nationally known math educator Jo Boaler and Boaler's website youcubed.org, including an activity that explored and debunked some myths about the qualities of people who are "good at math."

Bennett also met with Eureka! program coordinator Brooke Crider before the camp to learn more about it and collaborate with McMillon.

The program led students through activities that differed from traditional math topics covered in schools, such as numbers in other bases; constructing a Mobius strip, torus, and a hexaflexagon; topology with playdoh by morphing donuts to coffee mugs; visiting the Sheldon Art Museum to measure the head sculpture and find the height of the person who belongs to it; geometry and fairness in gerrymandered districts; graph theory with the Konigsberg Bridges problem and map colorability theorems; and the card games SET and Spot It!.

"I think the girls thought it was really cool that they were learning college-level math, and it added to this notion that they were capable of enjoying and being successful in math. Just having multiple role models around them who are excited about STEM fields and seeing real-life examples of women in math-related careers will make a positive impact on their futures," Bennett said.

The program incorporated mathematics activities that suited all ages, with activities that can be used with first-graders (such as map colorability) as an introduction to validating claims and finding counterexamples, all the way to collegiate mathematics concepts. Other activities relied on middle-level understanding, such as proportional reasoning (finding the height of the Sheldon Museum person).

Bennett said she hopes the camp allowed the students to see "a 'mathematician' doesn't have to look or think one particular way."

– Tori Pedersen, senior, agricultural leadership, education, and communication

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MATH ED RESEARCH: Multiple 'change levers'

LINDSAY AUGUSTYN | UNL CSMCE

As a society, we spend immense resources on improving education by addressing *problems of practice*, which are complex issues of teaching and learning that result in inequitable outcomes and inadequate student understanding. Much of current mathematics education research is geared toward figuring out ways to address these problems effectively, engaging in *applied* mathematics education research.

RECOGNIZING PROBLEMS OF PRACTICE

Problems of practice arise from interactions among complex systems involving:

- students;
- instructors;
- mathematics content, curriculum, and assessment;
- department and university cultures and value of educational improvements;
- beliefs about mathematics, teaching, and learning;
- policies that impact teaching and learning;
- course coordination structures; and
- instructor communities of practice.

Like issues of climate change and health care, solving these problems of practice is anything but straightforward — given the complexity of these problems of practice, any progress made to solve them needs to be multi-faceted: *An n-dimensional problem (n>2) cannot be solved with a 1- or 2-dimensional solution.* Mathematics education research supports the field in understanding these complex systems better and identifying ways we can make progress toward improved educational outcomes.

The University of Nebraska–Lincoln Department of Mathematics has helped the field address complex educational problems by studying one or multiple *levers of change* (methods of causing something to happen) to examine the ways in which students learn and educators teach mathematics. The group specializes in research at the postsecondary level, including research on mathematics teacher education, and institutional change to support instructor use of active learning.

Two leaders of the department's math education group, Research Professor Wendy Smith and Milton Mohr Associate Professor Yvonne Lai, have been successful in obtaining a large number of external grants and have cultivated collaborative relationships with colleagues at many institutions. These grants increase the opportunities for other faculty in the department, as well as mathematics graduate students and postdoctoral faculty, to participate in education research. Smith has acted as principal investigator or co-principal investigator of over 20 externally funded grants and four internally funded grants. In the 2020–2021 academic year alone, funding from a subset of these grants partially supported 10 graduate students within the mathematics department.

The MODULE(S^2) grant, led by Lai, focuses on curriculum and professional development as change levers. The grant designed curricula in geometry, statistics, modeling, and algebra that have been used by faculty across the nation to improve future secondary mathematics teachers' knowledge for teaching. Along with providing curricula, the project supports faculty through professional development.

Amy Bennett, who joined the department as postdoctoral faculty in 2020, is also interested in teacher preparation. As a graduate student at the University of Arizona, Bennett explored how in-service teachers and students drew on their cultural funds of knowledge while designing and solving realistic mathematics tasks in grades 3–12. Her research team found that designing culturally relevant, community-based tasks can be challenging. Bennett's research team collaborated with teachers to develop professional development resources to support teachers in designing such tasks. Bennett's current work at UNL extends this research with pre-service teachers, with a focus on how mathematical modeling can be used to teach about equity. Bennett is also interested in issues of equity in courses such as Math 325: Elementary Analysis.

A grant focused on active learning efforts, the SEMINAL grant from the National Science Foundation, investigates how multiple change levers impact the implementation and sustainability of active learning in Pre-calculus and Calculus courses. SEMINAL involves Smith, Associate Professor of Practice Nathan Wakefield, and Professor Allan Donsig as UNL's principal investigators plus dozens of other researchers at the collaborative SEMINAL institutions.

Key findings from the first phase of the project were recently published by the American Mathematical Society

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in the book "Transformational Change Efforts: Student Engagement in Mathematics through an Institutional Network for Active Learning." Research from the SEMINAL grant also benefited the aims of UNL's First Year Math Task Force to support a large population of graduate student instructors to teach active learning classrooms effectively.

"Math education research is vital to both improving the department's own instruction and preparing our graduate students to be outstanding innovative instructors — not only here at UNL, but also after they graduate," said Donsig, vice chair of mathematics.

A key element to the success of efforts at UNL to improve its instruction has been tghe development of a *community of practice*. In UNL's first year mathematics program, the community of practice largely consists of graduate student instructors, with a few adjunct instructors, course conveners, and faculty. It is sustained in great part due to efforts by Wakefield and Assistant Professor of Practice Josh Brummer. The practice of the community centers on active learning in Pre-calculus and Calculus courses, and a central component has been a "wiki" (an online content management system) where course materials are stored in a format in which all instructors can contribute suggested revisions. The department supports graduate student instructors' enhanced participation in this community of practice by explicitly offering ways for them to act as leaders in the instruction of these courses: They are involved in overseeing these courses (e.g., as associate conveners), contribute to lesson plans and task development, and often are involved in/initiate course reforms (e.g., the open education resources).

Recent research has examined the department's response to the pandemic and its impact on this community of practice. Current and former graduate students have been working alongside Smith, Wakefield, and Donsig on this research, including: Karina Uhing, who was Lai's and Wakefield's Ph.D. student and is now a member of the mathematics faculty at the University of Nebraska at Omaha; Rachel Funk, who is a current Ph.D. mathematics student hired as a research scientist by the Center for Science, Mathematics, and Computer Education to strengthen math education research at UNL; and current mathematics graduate student Brittany Johnson.

Funk and Uhing, along with Sally Ahrens, formerly of UNL, submitted a paper to the Research in Undergraduate Mathematics (RUME) conference on the impacts of the pandemic on the community of practice of instructors of first year mathematics courses at UNL in Spring 2020, based on interview data from several graduate student instructors and faculty involved in coordination efforts. They found communication had become more scheduled and less impromptu, and the lack of convenient ways to communicate meant that some people were less likely to seek advice unless they felt they had to. With the transition to asynchronous courses, some graduate students also felt more like content managers than teachers. However, the regular, weekly formal communication in coordination meetings and emails sustained the sense of support in the community of practice. Many of the graduate students who acted as coordinators or conveners expressed that they continued to have quite a bit of say in the direction of the courses. In addition, many graduate students reported thinking differently about equity issues than they had in the past. Additional research will be conducted this Spring 2022 to examine the evolution of the community of practice since Spring 2020.

This community of practice intersects with the classroom community, which includes students, learning assistants, and instructors. Research into the learning assistant program at UNL, involving Brummer and Funk, focuses on how learning assistants support students and instructors within a coordinated, active learning system, and the impacts of professional development and departmental norms on the work of learning assistants. One goal of this research is to understand how learning assistants may impact a student's sense of belonging in the classroom — which is critical to providing equitable learning experiences for students.

Lai and Wakefield also started MEDS, a mathematics education seminar, in 2017 to support mathematics education graduate students in planning and conducting research.

While much research has focused on the post-secondary level, Smith leads several projects that focus on research in K–12 STEM education. With her National Science Foundation Robert Noyce Teacher Scholarship research grant T-LEAD, Smith (along with Funk) focuses on one key lever to sustainable change efforts — effective leadership. T-LEAD explores how nine Noyce Master Teaching Fellowship programs develop and support teachers in STEM disciplines to be leaders both in their classroom and outside their classroom context. The assumption of T-LEAD is that to make institutional or systemic change at the K–12 level, teachers should be positioned as leaders.

By studying multiple change levers and their impact on education at various grade levels, researchers at UNL can work to sustain as well as improve the teaching of mathematics to support equitable learning outcomes.

– Rachel Funk and Lindsay Augustyn

LEVERS TO LEVERAGE

We consider this problem in terms of a metaphor, **"levers for change."** Why levers? In mechanics, a lever is a simple machine used to move an object at one location by applying a force somewhere else. By working at a distance, a lever acts to magnify the applied force. Metaphorically, then, a lever is a means to achieving an end, a method of persuading or causing something to happen. When we try something and see that it is working, we have gained leverage on the problem.

– From "Levers for Change: An Assessment of Progress on Changing STEM Instruction"

Identifying more inclusive instruction

The Department of Mathematics's commitment to open education resources (OER), led by Professor and Vice Chair Allan Donsig, offers the opportunity to further modify the department's curriculum and address issues of increased Drop, Fail, Withdraw (DFW) rates among students of color at the University of Nebraska–Lincoln.

Michelle Homp

Kaitlin Tademy

Associate Professor of Practice Michelle Homp, the faculty convener for Math 203: Contemporary Mathematics, Nebraska's liberal arts mathematics course, received grant funds in 2021 to research how to change this course in ways that will encourage underrepresented minorities to see improved success and minimize achievement gaps.

OER Seed Grants (formerly Kelly Grants) from the UNL Center for Transformative Teaching support the pedagogical innovations and course redesigns resulting from the adoption, adaptation, or authoring of OER.

The DFW rate for all students students registered for Math 203 or Math 203J, a special section for journalism students, in 2019–2020, was 16%, which compares well with other first- and second-year mathematics courses. However, there were significant differences in terms of race and ethnicity. The DFW rate for White students in Math 203 was 13.6%, compared with 100% of the American Indian students, 31.3% of the Black students, and 29% of the Hispanic students.

This seed grant allowed for the process of change to begin with focus groups to assess aspects of math instruction in first-year math courses that may need to be changed.

In Spring 2021, a research team led by graduate student Kaitlin Tademy interviewed focus groups of Math 100A and Math 203 students who identified as students of color and/or first-generation college students. The data gathered from these focus groups was then analyzed to get a better sense of the Math 100A and Math 203 experience for these students.

Tademy presented recommendations, inspired by the students' responses, for inclusive instruction to the department in August. Suggestions for implementation included: asking students about themselves and taking an interest in who they are outside of class; establishing ways for students to make connections with their peers; providing structure to group-time that encourages and supports productive collaboration between students; being aware of what resources students have and finding creative ways to inform and remind them of those resources; and encouraging students to do assignments at times that make the assignments most beneficial to them.

"Instructors need to carefully and intentionally create and maintain a welcoming and safe environment for students," Tademy said. "They should share with students what kind of classroom environment they hope to create. Ask students to share their expectations and goals for the semester — then share yours."

In Summer 2019, Homp led the department's creation of an OER textbook and companion classroom materials for Math 203. However, Homp determined that nearly all of the content in the curriculum of Math 203 was attributed to White, male mathematicians of Northern European descent.

With the help of graduate students Andrew Quaisley and Ash DeClerk, Homp identified existing topics in Math 203 where relevant mathematics developed by underrepresented groups can be incorporated, and they researched mathematical topics with major contributions by people of color and how these concepts are being used in modern society.

Examples of topics Homp has introduced into Math 203 are the basic principles of epidemiology and the mathematics of gerrymandering. There are numerous mathematicians from traditionally underrepresented groups that conduct research in these areas. The revised course materials bring these researchers to the forefront by featuring their research and the connections between their work and the content taught in the course. The OER has been updated to accommodate these changes, and the content has been fully integrated into the course materials.

In addition, the Office of Academic Success and Intercultural Services (OASIS) joined forces with Mathematics to hire Math 203 tutors as part of the Study Studio tutoring program at the Jackie Gaughan Multicultural Center.

Since all Pre-calculus courses at Nebraska are using OERs, revising curriculum is an ongoing process. Successful changes made in Math 203 may be replicated in other courses, resulting in widespread improvement in the mathematical achievement of underrepresented students.

"My goal for Math 203 is to make curricular changes that will help traditionally underrepresented students to see themselves as part of the culture of mathematics, as individuals capable of mathematical success, and as being contributors to a body of the mathematical knowledge that is fundamental to the society in which we live today," Homp said.

– Lindsay Augustyn

MASTERY GRADING

Graduate students Emily McMillon (see page 23) and George Nasr (who graduated with his Ph.D. in 2021) wrote the blog "Mastery Grading for Future Elementary School Teachers," for the AMS, posted online Feb. 26. Mastery grading is a grading scheme in which students are expected to show complete understanding of subjects, but are given multiple opportunities throughout the semester to show that understanding. McMillon and Nasr reimagined the grading scheme for Math 301: Geometry Matters and implemented it in Spring 2020, with great success. For more detail, see the blog post at: ***https://bit.ly/3CrwysM***

COURTESY PHOTO

Alumna Julia Read-LaBelle and her husband, Pete, enjoy a trip to the Grand Tetons. Read-LaBelle (BS '83), has worked at Nike for 22 years.

JULIA READ-LABELLE: Roles at Nike beget new experiences

Mathematics and customer service cooperate as a balancing act.

Julia Read-LaBelle, in her role as global supply and inventory analyst at Nike, uses her background in mathematics to make sure the products that customers want are available to them when they need them.

"Optimization means to have the right product in the right marketplace to satisfy our consumer," Read-LaBelle said. "It's a balance of not growing inventory too much — excess that would need to be liquidated — but ensuring the consumer is happy — can get the product in their size timely."

During her 22 years at Nike, Read-LaBelle has woven together experiences working in areas from the database and warehouse lead to director of sustainable audit, seeing and analyzing the company's business practices from different vantage points. Now, she decides how to best coordinate inventory supply with Nike's worldwide supply chain partners, considering environmental sustainability and balancing consumer demand with cost reduction measures.

After earning a Bachelor of Science in mathematics from the University of Nebraska–Lincoln in 1983, Read-LaBelle first worked for Texas Instruments with signal processing algorithms for seven years. She enjoyed being able to use both her math and computer science skills in programming and testing algorithms. She also returned to school during this time, as a part-time graduate student, taking two evening courses per semester. She completed her Master of Science in applied mathematics from the University of Texas at Dallas in 1988. Texas Instruments both helped pay for tuition, and her supervisor gave her the flexibility to schedule work travel around classes, or her supervisor would travel in her place.

Read-LaBelle recalls that she was inspired to continue her education by co-workers who had obtained their master's and doctoral degrees. She even

READ-LABELLE { PAGE 12 }

CONRAD 'CONNIE' RENNEMANN JR.: Husker by luck gives back for 64 years

Alumnus Conrad "Connie" Rennemann Jr. of Dayton, Ohio, has made annual gifts to the College of Arts and Sciences Department of Mathematics at UNL since 1957, starting just six years after completing his studies. He received bachelor's and master's degrees from Nebraska, majoring in chemistry and mathematics and mathematics and physics respectively.

Connie met his wife, Annette (Luebbers) Rennemann, a dietetics major, at the university. She came to the university from Iowa but was born in Osmond, Nebraska. They married in 1952 and had a son, Ed, and a daughter, Ann. Annette died in 2011; the Rennemanns were married for 59 years.

In 1999, the couple established the Rennemann/Luebbers Scholarship in Mathematics at the University of Nebraska Foundation to provide annual tuition aid to students who live outside of Nebraska who wish to study mathematics at UNL. We asked Connie Rennemann about his time at Nebraska, his career and giving back.

You must have felt that the University of Nebraska was a good fit as you have a bachelor's and a master's degree from UNL. Why did you decide to attend Nebraska?

Well, it was a consequence of World War II. I was born and raised in Mount Vernon, New York, and graduated from high school in 1946. I thought I was going into the army, but they stopped drafting about the time I graduated, and I had not applied for college. So, all the eastern schools were flooded with GIs coming back from the war. I started applying further away, and Nebraska was one of the schools I was accepted at. And frankly, I liked their catalog better than any other school. So, I climbed on a train and headed to Nebraska.

You have supported the Department of Mathematics since 1957. This has helped provide it stable support over the years. What interested you in giving, and why have you kept it up?

Annette and I visited Lincoln in 1999 and met with the math department chair to discuss the needs of the department. It turned out he was interested in attracting out-of-state students, and we agreed to set up a scholarship for out-of-state students. I just felt that I gained an awful lot from the school and the math department, and I should give something back.

What are some of your favorite memories of your time at Nebraska?

I was a baritone horn player in high school and earlier for a lot of years, so I went to talk to Don Lentz who was the director of bands. I gave him a little demonstration of playing, and he said, "You're in." So, I started playing in the Cornhusker Marching Band and the concert band for five years. I was the first-chair baritone horn player, and that was a very pleasant experience I enjoyed very much.

COURTESY PHOTO

Alumni Conrad "Connie" Rennemann Jr. and his wife, Annette (Luebbers).

And what memories do you have of your time studying in the Department of Mathematics?

I started out studying chemical engineering, but after roughly the first year I decided that an engineer wasn't me, and I switched to chemistry and math as a double major. The first important memory was when I was a first semester sophomore. Professor Edwin Halfar asked if I would like to grade papers, and I said, sure. So, that was the start of a relationship with the math department through the years. I worked for a number of professors. Eventually, I was working for Dr. Miguel Basoco, the chair of the department. I appreciated the opportunities and the treatment that I received. The reason I wanted to fund a scholarship was because I appreciated what this department had done for me and what the people had done in helping me.

What are some highlights of your career after completing your studies at Nebraska?

When I graduated, I went to work for what is now NASA. They hired me as an aeronautical research scientist, and I worked on theoretical aerodynamics. I was with a small group, and it was a good foundation and learning experience.

Then, in 1955 I started looking for another position. I accepted one with the Republic Aviation Corporation in Long Island, New York, where I worked for about 23 years. Mostly, in the early days there, I was still in aerodynamics. I then started an operations research sister organization, which I ran. In 1961 the company sent me to Harvard Business School for 16 weeks, and eventually I was head of new business for

RENNEMANN { PAGE 13 }

READ-LABELLE { FROM PAGE 10 }

utilized the help of a co-worker's spouse as a tutor for her real analysis course.

"That first job after college taught me to have confidence in your skills, such as presenting your research and being ready for questions, and to build relationships with your colleagues on a personal level. It makes work much more fun," she said. "It's also important to know when to move onto something new if you are not growing or learning."

Read-LaBelle's time at UNL also helped to prepare her for a future career using mathematics. Looking back, she cites Honors Calculus and Differential Equations as two of her favorite courses.

"Everyone told me differential equations was terribly hard, but I found it so logical and loved it," she said, adding that during calculus she also met two of her closest friends.

A highlight of her undergraduate years was when she was given a teaching assistant position. While intimidating, the experience built her confidence.

"On my first day, some students asked me to work a problem not on the syllabus, testing me," Read-LaBelle said. "I worked it out in front of them, and they never questioned me again."

Before joining Nike, Read-LaBelle spent three years at Nationwide Insurance, where she analyzed the customer base to better predict loss. At the time, she said, there was unreliable information about what factors led to a higher risk customer, so Read-LaBelle used scientific data to look at the problem.

"My job as a data analyst was to use analytics to provide a fact-based risk analysis. Some of the complexity was pulling together data from varying systems. I had to learn new tools like SQL and SAS. But, the problem-solving skills from mathematics and the programming fundamentals that I received from UNL helped me learn new skills quickly and find a successful approach in how to combine different data to answer business questions," Read-LaBelle said.

Process improvement, automation, and analytics are the guiding forces for Read-LaBelle and her team today at Nike.

In her recent work, supply chain challenges associated with COVID-19 have initiated new questions to answer. These challenges have sped up innovations and approaches to "ways of doing," she said. As part of its commitment to the community, Nike engineers at the airbag manufacturing site in Oregon were able to produce face masks for local medical teams in just two months' time, using raw materials and machinery that were available.

"Sustainability continues to gain momentum, from powering our distribution centers with clean energy, using less toxic chemicals in creating products, to finding ways to reuse waste materials and creating products with sustainability in mind," Read-LaBelle added.

The travel that work requires also affords her exposure to try new activities, gain new experiences, and broaden her knowledge. The benefits of working at Nike extended to her family and friends over the past two decades, as well.

"Nike offered my family their own unique experiences: training with the USA women's soccer coach, testing out equipment, inspirational events with talented athletes, swimming lessons, tennis lessons," Read-LaBelle said. "One of my friends even ended up playing pool with Michael Jordan — right place, right time. I happened to be in the locker room after a run when the whole USA women's soccer team came in from practicing on our fields. It's a unique place to work!"

Originally from Sleepy Eye, Minnesota, Read-LaBelle and her husband, Pete, an electrical engineer, live in Beaverton, Oregon, and have two children, Alex, who is a mechanical engineer, and Kelsey, a marketing director.

"I enjoy traveling. My favorite spot is the one I have not been to yet. I love experiencing the language, culture, art, and outdoor beauty across the world," Read-LaBelle said. "We love the outdoors through camping, snow shoeing, hiking, biking, paddle boarding, or even a nice outdoor concert. Oregon is the perfect location since you have so much variety."

Growing up in Minnesota, then Iowa, Illinois, Florida, and Nebraska, Read-LaBelle said there was not a time she can remember when she did not love math and problem solving. She credits the help of teachers who fostered her love of math and encouraged her to compete in math competitions — in which she excelled — to affirm her skills in math. Seeing the examples of her mother and father — who obtained their college degrees in teaching and agriculture, respectively, and went on to work in different sectors of business — and having their encouragement in STEM propelled Read-LaBelle on her path.

For students looking at careers with Nike, Read-LaBelle has a few inside tips: The summer internship program is an excellent way to showcase your skills and develop relationships, and make sure at an interview you have your favorite Nike footwear or apparel on — "and not a competitor's! It is noticed, and a great way to start a conversation."

– Stephanie Vendetti

JULIA'S GUIDE TO SUCCESS

1. Never stop learning.
2. Take time to explore new things to keep life interesting.
3. Don't worry about making mistakes; just learn from them.
4. Believe in yourself. Period.

'MATH NEWS' SUBSCRIPTION

If you would prefer to get this newsletter in your inbox instead of your mailbox, sign up online at **https://math.unl.edu/friends**. To remove yourself from the printed mailing list in the future, email us at **nebraskamath@unl.edu**.

RENNEMANN
{ FROM PAGE 11 }

the company, then assistant to the president, then vice president, director of administration and so forth.

In 1978 I accepted a position in Tennessee with an engineering company that was a principal contractor for the government at a government test facility. I was vice president of the company, and we had about 3,000 employees. I became deputy general manager and, ultimately, was chief operating officer and executive vice president when I retired in 1991.

When you graduated you probably didn't imagine you'd be a business executive and lead companies?

No, no. I was always a one-step-at-a-time type of person. Do your job, try to do it as well as you can, and things will fall in place for you.

Would you say the university prepared you for success in your career?

Oh, definitely. It helped not so much with the detailed knowledge as it did with the training to think and to analyze problems and so forth. That was key. In the early years, I was heavily using mathematics, so the training in math helped a lot. The future required less technical knowledge, put it that way.

Is there anything else you'd like to share?

I learned to play bridge at Nebraska, and it's been a side passion my whole life. I played bridge competitively over the years. When I retired, my wife played with me as partners, and I'm probably currently ranked in about the top 10% of bridge players in the country. It's a challenging game but is something I've enjoyed.

– Robb Crouch, University of Nebraska Foundation

Read this article online at: nufoundation.org/rennemann

CLASS NOTES

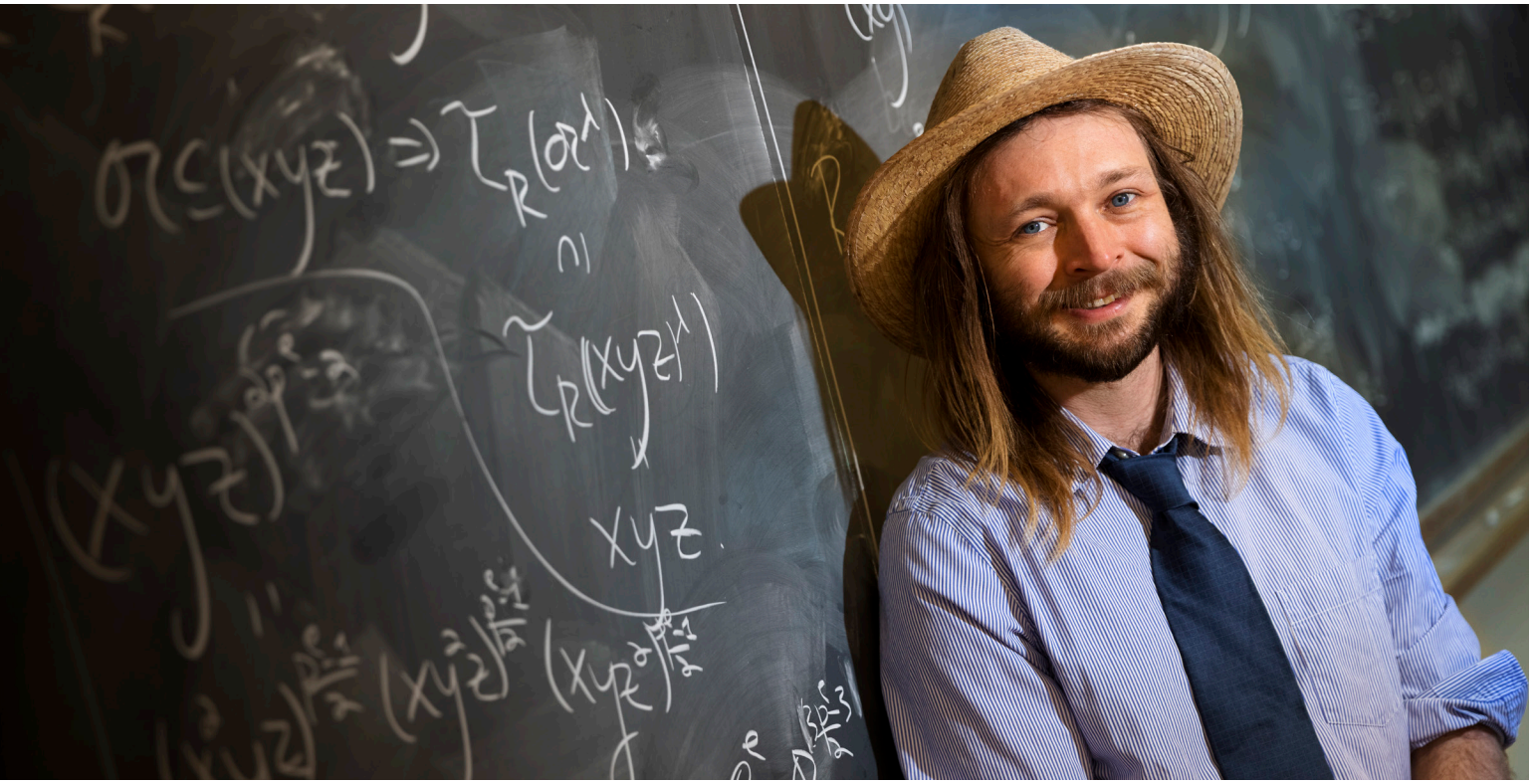
Allison Beemer (Ph.D. '18), an assistant professor of mathematics at the University of Wisconsin-Eau Claire, gave a talk on coding theory to the UNL Math Club on March 18. Her talk, "Coding theory: shielding data from corruption," introduced students to some fundamental concepts in coding theory, including measures of reliability and efficiency and an important class of codes called linear codes. Beemer is an MAA Project NExT fellow and a Math Alliance mentor.

Raegan Higgins (Ph.D. '08), associate professor of mathematics in the Department of Mathematics and Statistics at Texas Tech University, is the recipient of the 2021 Gweneth Humphreys Award from the Association for Women in Mathematics. Higgins's research interests revolve around time scales — particularly oscillation criteria for certain linear and nonlinear second order dynamic equations. She has also studied the impact of professional development on the self-efficacy of middle-school mathematics teachers. At Texas Tech University, Higgins's excellence in teaching and mentoring and her commitment to diversity have consistently shined through. In addition to her formal role as academic advisor for graduate students, she co-founded the Young Women in Mathematics: Fostering Success program in 2013. This initiative led to the formation of an AWM Student Chapter in 2018, which Higgins co-advises. She is also a member of the organizing committee of the Emmy Noether High School Mathematics Day and over the years has given numerous talks, organized workshops, and served as career panelist for the high school and undergraduate students who participate in this annual event. Since 2009, Higgins has served as faculty mentor and mentor cluster leader for Mentor Tech, a program for students from diverse backgrounds at Texas Tech. In 2014, Higgins received a Women in STEAM Award from the Center for the Integration of STEM Education and Research, and in 2020 she was recognized as an integrated scholar for her synergistic activities at the intersection of teaching, service, and research. An alumna of the Enhancing Diversity in Graduate Education (EDGE) program, and one to always give back, Higgins served as EDGE instructor in the years 2014 to 2017 and since 2017 serves as co-director of the program. Higgins also is a co-founder of the Network of Minorities in Mathematical Sciences. Through its website, Mathematically Gifted and Black, the network highlights the contributions and accomplishments of blacks in the mathematical sciences.

Brittney Keel-Mercer (Ph.D., '15) was one of four Area Early Career Research Scientists honored by the USDA's Agricultural Research Service in April 2021. Keel-Mercer, who works with ARS's U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska (Plains Area), was recognized for applying machine learning and novel mathematical modeling to complex livestock genomic analyses. Significant advancements in the livestock genomics and precision agriculture fields were made as the result of Keel-Mercer's work. The early-career awards recognize the achievements of ARS researchers with the agency for seven years or less.

Jason Vitosh (MAT, '06), a math teacher at Falls City High School, was the 2020 winner of the Nebraska Rural Community Schools Association's Outstanding Secondary Teacher of the Year Award.

Send us your news at:
go.unl.edu/mathcareerprofile



CRAIG CHANDLER | UNIVERSITY COMMUNICATION

Jack Jeffries, assistant professor of mathematics at Nebraska, has earned his department's first-ever Faculty Early Career Development Program award from the National Science Foundation. He will use the $400,000, five-year grant to advance his research in commutative algebra.

JACK JEFFRIES: CAREER award

Department earns first NSF Faculty Early Career grant, which Jeffries will use to study singularities

University of Nebraska–Lincoln mathematician Jack Jeffries has received the department's first-ever Faculty Early Career Development Program award from the National Science Foundation.

Jeffries, assistant professor of mathematics, will use the $400,000, five-year grant to advance his research in commutative algebra, a field of abstract algebra that, at its heart, is focused on polynomials in many variables. More specifically, he will study singularities — points at which a mathematical object, or geometrical shape, is not "well-behaved" in some way — using differential operators and p-derivations.

"Systems of polynomial equations are ubiquitous throughout the sciences," Jeffries said. "Singular points are of interest because many standard techniques and algorithms can go haywire at those points."

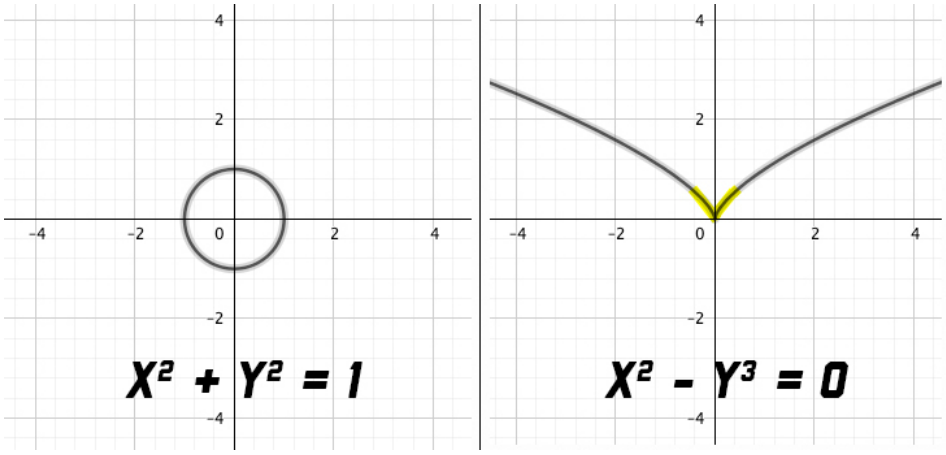
Jeffries focuses on the solution sets of polynomial equations, a particular type of algebraic expression involving variables, coefficients and non-negative exponents. Over the most familiar number systems — real numbers and complex numbers — the solution sets to these types of equations can be visualized geometrically via Cartesian coordinates on the x- and y-axis. Each polynomial equation has a solution set that "cuts out" a geometric shape.

Two simple examples would be the polynomial equations $x^2 + y^2 = 1$ and $x^2 - y^3 = 0$. Each one has a solution set that creates a particular shape. For the first, it would be a circle with a radius of 1 around the origin. For the second, the shape looks a bit like a seagull with its wings spread. See the graphs on page 15.

Jeffries is interested in solution sets that have singularities. Visually, these can be thought of as aberrant points in the shape. The circle resulting from $x^2 + y^2 = 1$ has no singularities; the seagull of $x^2 - y^3 = 0$ does. It's the corner created at the point of origin.

"Looking closer and closer, the circle starts to look flat," Jeffries said. "Whereas the shapes cut out by other equations, like $x^2 - y^3 = 0$, might have a crinkle, crossing or wrinkle. Geometrically, that's the idea of a 'singularity' in a solution set."

Jeffries is also interested in looking at polynomial equations and singularities over more exotic number systems. For example, computer data and arithmetic are built on a



The polynomial equation on the left has a solution set that "cuts out" a circle across the x- and y-axis. With no visual points of "misbehavior," this solution set has no singularities. The polynomial equation on the right has a singularity at the highlighted corner that crosses the (0,0) point.

system of two numbers, zero and one. He aims to develop new tools to study the small-scale behavior of systems of polynomial equations over both familiar number systems and more exotic systems. More specifically, he will study points of singularity using differential operators and p-derivations, which are extrapolations of the concept of "derivative" in calculus to more general settings. He is looking to establish these methods as tools for better understanding singularities.

Nebraska is considered an international leader in the field of commutative algebra and algebraic geometry. With five faculty and 12 doctoral students focused in the area, the university has one of the nation's largest research clusters in these fields.

"Jack's innovative approach to the study of singularities of geometric objects, particularly through his novel use of differential operators, will help keep Nebraska at the forefront of research in commutative algebra and algebraic geometry," said Tom Marley, chair of the mathematics department.

Prior to arriving at Nebraska last year, Jeffries was a faculty member at the Center for Research in Mathematics, known as CIMAT, in Guanajuato, Mexico. As part of his CAREER project's education component, he aims to advance the relationships he established at CIMAT by hosting faculty from Latin America at the university. Beyond just furthering research collaborations, these visits are intended to expose Nebraska's graduate students to an international network of mentors and potentially open doors to postdoctoral opportunities.

Jeffries also envisions these Hispanic mathematicians serving as role models for Nebraska's undergraduate and high school students. One of his goals is to encourage more high school students, particularly members of the Hispanic community, to study mathematics. Toward that end, he will launch a biweekly high school math circle during the academic year. During each session, a university or visiting mathematician will lead students through an activity related to advanced mathematics. To attract Hispanic students, at least one session per semester will be directed in Spanish, and visiting faculty from Latin America will participate as scheduling allows.

Jeffries will make all notes and materials related to the math circle publicly available on a website, enabling others to start a similar group.

He'll also support five graduate students in attending the Pan-American School on Commutative Algebra, a summer school program to be located at the Universidad del Norte in Barranquilla, Colombia; sponsor cross-topical mini-workshops; train graduate students; and continue work on a commutative algebra textbook.

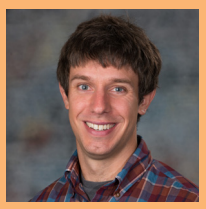
The National Science Foundation's CAREER award supports pre-tenure faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research.

– Tiffany Lee, Research and Economic Development

AWARDS

Judy Walker, Aaron Douglas Professor of Mathematics and associate vice chancellor for faculty and academic affairs, has earned the 2021 Outstanding Achievement Award from the University of Illinois Urbana-Champaign Department of Mathematics for her outstanding professional career and her leadership and contributions to the advancement of mathematics and inclusion. At the national level, Walker serves as a trustee of the American Mathematical Society (AMS) and is currently serving as chair of the AMS Board of Trustees. Additionally, Walker co-founded the Nebraska Conference for Undergraduate Women in Mathematics. It was noted by one of her nominators that she is one of the few individuals that could be called up to serve in leadership roles in each of the AMS, MAA, and AWM. She was named a Fellow of AMS in 2012 and a Fellow of AWM in 2019.

Nathan Wakefield, associate professor of practice, earned a College Distinguished Teaching Award in 2021. This award honors faculty in the College of Arts and Sciences with a record of consistently excellent teaching.



Alex Zupan, associate professor, joined the latest cohort of Faculty Fellows for Student Success.

RETIREMENTS

Longtime lecturers **Bill Rogge** and **Bob Ruyle** retired in 2021. Look for stories about their adventures in the 2022 edition of Math News.

Lai receives Don Miller Math Award

COURTESY PHOTO

Yvonne Lai, associate professor in the University of Nebraska–Lincoln Department of Mathematics, is the 2021 recipient of the Don Miller Math Award from the Lincoln Rotary Club #14.

"The Rotary Club is known for its service to the community. I am especially honored to receive the Don Miller award because I view teaching and learning as about developing mathematical communities," Lai said. "I am grateful for the consistent, enthusiastic support from the mathematics department. And I am grateful to teachers in Lincoln Public Schools for welcoming me into their classrooms and into the Lincoln Math Teachers' Circle, so that I can learn from them what it means to nurture mathematical communities."

Each year since 1992, Lincoln Rotary Club #14 proudly presents the Donald W. Miller Math Recognition Award, recognizing outstanding mathematics educators in the Lincoln area. The club endowed this award in honor of former member, past club president (1986–87) and Rotary leader, Donald W. Miller, a University of Nebraska–Lincoln professor emeritus in the Department of Mathematics.

Lai's NSF grant studies learning progressions

Associate Professor Yvonne Lai is co-principal investigator for a new National Science Foundation grant, Investigating the Role of Collaboration in the Development of Student Ideas Using a Learning Progression for the Function Concept. ETS is the lead institution with a subaward to UNL, the Algebra Project, and the Young People's Project.

Over this four-year project, the team will address questions about how collaborative problem solving, learning progressions, and facilitation interact in the development of students' mathematical learning in grades 9 through 12. The work affords an opportunity to advance equitable access to high-quality education for all students.

Learn more at:

https://bit.ly/3FUUlDM

ROWLEE LECTURE: Kicks off KUMUNU-ISU PDE conference

The KUMUNU-ISU Conference on PDE, Dynamical Systems, and Applications (named for its participating institutions: the University of Kansas, University of Missouri–Columbia, University of Nebraska–Lincoln, and Iowa State University) takes place annually in the Great Plains region. The KUMUNU-ISU 2021 Meeting was held at UNL from Oct. 23-24, in conjunction with the Howard Rowlee Lecture on Oct. 22.

KUMUNU-ISU 2021 brought together eminent and junior researchers to discuss recent advances in the theoretical and numerical analysis of nonlinear partial differential equations (PDEs). There were 40 in-person conference participants. Plenary speakers were Professor Michael Renardy of Virginia Tech and Professor Edriss Titi of Texas A&M University and the University of Cambridge.

Titi gave the Rowlee Lecture, "Mathematics of Turbulent Flows: A Million-Dollar Problem," described as: Controlling and identifying the onset of turbulence has a great economic and industrial impact, ranging from reducing the drag on cars and commercial airplanes to better design of fuel engines and weather predictions. It is widely accepted that turbulent flows are governed by the Navier-Stokes equations. Whether the solutions to the three-dimensional Navier-Stokes equations remain smooth, indefinitely in time, is one of the most challenging mathematical problems. The Clay Institute of Mathematics identified it as one of the seven most outstanding Millennium Problems in mathematics and set a $1 million prize for solving it.

NEW GRANTS

Amy Bennett, Promoting Equity through Mathematical Modeling for Prospective Teachers, UNL Center for Transformative Teaching

Mikil Foss and **Petronela Radu**, Nonlocality in Continuum Mechanics, Population Dynamics, and Neural Networks, NSF; Internship Supplement, Hayley Olson, NSF; Internship Supplement, Anh Vo, NSF

Eloísa Grifo, Symbolic Powers and p-Derivations, NSF

Michelle Homp, Instructional Improvement, OER Seed Grant, UNL Center for Transformative Teaching

Jack Jeffries, CAREER: Differential Operators and p-Derivations in Commutative Algebra, NSF

Yvonne Lai, Investigating the Role of Collaboration on the Development of Student Ideas using a Learning Progression for the Function Concept, NSF (subaward from ETS)

Alexandra Seceleanu, Symbolic Powers and Lefschetz Properties: Geometric and Homological Aspects, NSF

Wendy Smith, Conference Award, Transforming Secondary Mathematics Teacher Preparation: Focus on Recruitment and Equity, NSF

Nathan Wakefield, University of Nebraska ITS Inclusive Access and Open Educational Resources (OER) Program

AMS FELLOW: Brian Harbourne

Brian Harbourne, Willa Cather Professor in the Department of Mathematics, was named a Fellow of the American Mathematical Society for contributions to algebraic geometry and commutative algebra, and for mathematical exposition. Harbourne is one of 45 mathematical scientists from around the world who have been named Fellows of AMS for 2022, the program's tenth year.

This designation recognizes AMS members "who have made outstanding contributions to the creation, exposition, advancement, communication, and utilization of mathematics." Fellows present a public face of excellence in mathematics, elect new fellows, and advise the AMS president and council on public matters.

Harbourne joined Nebraska in 1986. He is an internationally recognized leader in algebraic geometry and commutative algebra, responsible for path-breaking research in both fields. He has supervised six graduate student Ph.D. theses so far. In addition, he received the College of Arts and Sciences Distinguished Teaching Award in 1992 and the Hazel R. McClymont Distinguished Teaching Fellowship in 2013. He also has served multiple times on the departmental Executive Committee, served as Graduate Committee Chair in the late '90s and has chaired both the department's Computer and Teaching Advisory committees.

His papers have appeared in top journals in mathematics, such as Advances in Mathematics, Compositio Mathematica, the Duke Math Journal, the Journal of Algebraic Geometry and the Journal für die reine und angewandte Mathematik.

He is well known for developing a version of the still open Segre-Harbourne-Gimigliano-Hirschowitz Conjecture and, more recently, for his collaborative work, including proposing the Harbourne-Huneke Containment Conjecture and introducing new concepts such as resurgences, H-constants and unexpected hypersurfaces.

The complete list of the AMS Fellows Class of 2022 can be viewed at ***https://www.ams.org***.

IN MEMORIAM: David L. Skoug

David L. Skoug, 83, of Lincoln, passed away March 25, 2021. Skoug was retired chair of and a longtime professor in the Department of Mathematics and Statistics at the University of Nebraska–Lincoln. Born Dec. 31, 1937, in Rice Lake, Wisconsin, to Henry and Grace (Hanson) Skoug.

Skoug retired from UNL at the end of the 2011 calendar year. He was a member of the department since 1966, when he joined the faculty after graduating with his Ph.D. from the University of Minnesota. He served as chair of the department from 1975 to 1983. Skoug published extensively, with around 90 published research papers by 2012 in the general area of integration in function spaces, particularly Wiener and Feynman integrals. This is an area in which he was internationally known, with particularly close connections to many mathematicians in Korea.

In addition to his research and major service contributions to the department, Skoug's teaching was recognized by a Chancellor's Distinguished Teaching Award and an MAA Sectional Distinguished Teaching Award. He was been very active as a member of the board of directors of the Rocky Mountain Mathematics Consortium and in the MAA, serving as sectional governor from 1984 to 1987.

He enjoyed hiking in the Rocky Mountains and Yellowstone National Park and playing handball for many years.

Family members include his beloved wife of 59 years Muriel; and devoted daughters Ruth Skoug (Peter Ebey) and Kathryn (Russ) Pearlman.

IN MEMORIAM: Buren 'Skip' Thomas

Buren "Skip" Thomas, 82, of Lincoln, died June 26, 2021. Thomas was born Sept. 17, 1938, in Cowles, Nebraska, to Glen and Bertha Thomas.

He taught in the mathematics department at Lincoln Northeast High School (LNE) from 1964 to 1998. He was department chair for most of those years. Thomas then went on to teach as a faculty member in the Department of Mathematics at the University of Nebraska–Lincoln from 1998 to 2008. From the mid-'70s until his retirement from Lincoln Public Schools he taught night classes every year. His leadership in mathematics teaching was exceptional, and he believed that all mathematics teachers should be involved at the local, state, and national levels. He demonstrated by doing all of these and encouraging his LNE mathematics department to do the same.

Thomas's honors earned include the Scottish Rite Distinguished Teacher of the Year (1972) and the Presidential Award for Excellence in Mathematics and Science Teaching (1983). He was a former president of the Nebraska Association of Teachers of Mathematics. Thomas also served on many National Council of Mathematics Teachers committees and as a board member.

PROMOTIONS

Christine Kelley has been promoted to full professor of mathematics.

Kevin Gonzales has been promoted to assistant professor of practice.

POSTDOCS

Tejfol Pllaha is a postdoctoral faculty in the Department of Mathematics. He earned his Ph.D. in mathematics from the University of Kentucky in 2019 under the supervision of Heide Gluesing-Luerssen. Before joining UNL, he was a postdoctoral researcher at Aalto University in Helsinki, Finland. His research interests revolve around applied algebra, with special focus on 5G wireless communication and quantum computation.

Chayu Yang, whose hometown is in Sichuan, China, is currently a postdoc in mathematics and is serving as a Putnam Exam Coordinator. Yang earned his Ph.D. in computational and applied mathematics from the University of Tennessee at Chattanooga, and then he was a visiting assistant professor at the University of Florida. His work mainly focuses on the area of mathematical biology, especially epidemiology.

LEWIS { FROM PAGE 1 }

improving mathematics education, and serving the department in myriad ways. Over the last half century, Lewis has laid the foundation for the department to flourish for decades to come.

A native Louisianan, Lewis received his bachelor's degree and Ph.D. from Louisiana State University. His dissertation was in the field commutative algebra and written under the direction of Jack Ohm. Nebraska was his first and only job; although, he did spend four years working at the National Science Foundation in Washington, D.C.

For the 1987–1988 academic year, Lewis served as president of the Faculty Senate. In this capacity, he lobbied university leaders, the Nebraska Legislature, and the Board of Regents to push for a major increase in faculty salaries, which lagged far behind their peers. This success was one of the earliest of Lewis's many signature achievements.

In 1988, Lewis was named chair of the department, a position he held for 15 years, the longest tenure of any chair since Albert Candy served 17 years as chair from 1917–1934. It would be difficult to overstate the impact Lewis had on the department during this period. Lewis has made the department a more supportive place for both faculty and students. For most of the 1970s and '80s, the department had precisely one woman faculty member (Professor Emerita Sylvia Wiegand). Lewis recognized a basic reality and used it to the department's advantage: many women who earn Ph.Ds. in mathematics have partners who are also Ph.D. mathematicians. Departments and institutions that are open to hiring dual career couples would have a leg up on hiring and retaining outstanding women faculty over those that are not.

During Lewis's tenure as chair, the department added three dual career couples, all of whom are still members of our faculty, and Lewis hired several new faculty, 11 of whom are still on the faculty today.

"Jim's impact on the mathematics department is unparalleled and long-lasting," said Judy Walker, associate vice chancellor for faculty and academic affairs and Aaron Douglas Professor of Mathematics. "During his time as chair, he transformed the culture of the department from one which granted no Ph.Ds. to women in the 1980s to one that was recognized with a 1998 Presidential Award for its success with female graduate students. To this day — almost 20 years after Jim's term as chair ended — the department still has a national reputation for offering a graduate program where women can and do succeed at a rate far above the national average."

While there is still work to be done, the department now has eight women with tenure in Mathematics and three more faculty who have partial appointments, a vast improvement from where we were 30 years ago — due in large part to the leadership and priorities set by Lewis.

Similarly, Lewis found it alarming that of the 23 students who received a Ph.D. from the department in the 1980s, none of them was a woman. He set out to make our graduate program more welcoming and supportive for women— and by extension, for all students. In the succeeding decades the number of students receiving Ph.Ds. from the department greatly increased, and the percentage of them going to women dramatically so. This past summer, the department awarded its 100th Ph.D. degree to a trio of women (see page 1).

In 1998, in recognition of these efforts, the department became the first mathematics department to receive the Presidential Award for Science, Mathematics, and Engineering Mentoring. Around the same time, Lewis was honored with two individual awards: the Chancellor's Commission on the Status of Women Award in 1996 and the Lincoln-Lancaster Women's Commission Erasmus Correll Award in 1997.

A constant throughout Lewis's career has been his commitment to excellence in teaching, not just personally in his own classes, but as chair and as a national leader in the mathematical community. His goal for the department was for it to be a national model of a research university where outstanding teaching is valued as highly as outstanding research — and excels at both. In the 1990s, among other things, he urged the department to adopt new teaching practices in calculus, which called for more collaborative

learning and a revamped curriculum, leading to a significant improvement in Nebraska's success rates in these courses. In 1998, Mathematics became only the third department at UNL to win the University of Nebraska System-Wide Department Teaching Award. In 2003, Lewis was elected to the UNL Academy of Distinguished Teachers and received the University System-wide Outstanding Teaching and Instructional Creativity Award.

"Many students and faculty will cite Jim's mentorship as invaluable. I am certain that I would not have the career I have if Jim had not hired me as an assistant professor 25 years ago. The fact that so many mathematicians with Nebraska ties have become national leaders in the profession is surely due to his influence," Walker said.

In 2002, Lewis was named director of the Center for Science, Mathematics, and Computer Education (CSMCE), and, in 2003, he stepped down as department chair to focus more of his energy on CSMCE activities. The mission Lewis crafted for the CSMCE is to support UNL faculty engaged in educational activities focused on improving the teaching and learning of science, technology, engineering and mathematics (STEM) at both the PK–12 and collegiate levels. Lewis has been a principal investigator or co-principal investigator for over $41 million in externally funded projects, most aimed at mathematics teacher professional development and involving partnerships across departments and institutions.

Lewis was highly involved in the Conference Board of Mathematical Sciences publications *Mathematical Education of Teachers I* and *II* (2001 and chairing the writing team in 2012, respectively). Lewis then led two large Math Science Partnership projects from NSF to provide extensive professional development for K–12 mathematics teachers, including Math in the Middle (for grades 4–9 teachers) and NebraskaMATH, which had components for elementary mathematics specialists (K–3), algebra teachers (grades 8–10), and novice secondary teachers. These large projects were followed by a NSF Robert Noyce Scholarship Program Teaching Fellowship and Master Teaching Fellowship grant designed to recruit outstanding candidates to become mathematics teachers in high-need schools or support mathematics leaders in high-need Nebraska schools.

Even while seeking external grants to get teacher professional development programs launched, Lewis has constantly thought ahead to how to sustain such programs beyond the end of grant funding. In 2008, Lewis led the launch of the Nebraska Math and Science Summer Institutes (NMSSI). Featuring summer in-person and online courses for K–12 STEM teachers, this program has grown to include hundreds of teachers each summer, some years comprising nearly one-quarter of all summer graduate credit hours at UNL. Combined with master's degree programs for teachers in the Departments of Mathematics (Master of Arts for Teachers) and Teaching, Learning, and Teacher Education (Master of Arts), over 500 teachers have received a mathematics-focused master's degree in the past two decades, all related to grant-funded programs and the NMSSI.

From 2015–2018, Lewis served in the Education and Human Resources Directorate of the NSF, first as deputy assistant director and later as acting assistant director. Upon his return to Nebraska in late 2018, Lewis — never one to rest — immediately led the effort to secure a multi-institutional $3.5 million grant from the NSF, called STEM CONNECT, which awards scholarships and mentoring to academically talented, low-income students with interest in careers in mathematics or computer science, aiming to promote diversity within those disciplines (see page 24). In addition to his appointments as mathematics professor and director of the CSMCE, Lewis was named director of STEM education research initiatives for the Office of Research and Economic Development.

It is likely that no other faculty member in our department's history has received more awards and honors, both local and national, than Lewis. In 2009, he received the Louise Pound-George Howard Distinguished Career Award and in the same year earned his named professorship, the Aaron Douglas Professor of Mathematics. The following year, he was named the Nebraska Professor of the Year by the Carnegie Foundation for the Advancement of Teaching. In 2015 he received two national honors: the American Mathematical Society's Award for Impact on the Teaching and Learning of Mathematics and the Mathematical Association of America's Gung and Hu Award. He is also an elected Fellow of both the American Association for the Advancement of Science and the American Mathematical Society.

GRACE KOVAR | UNL SENIOR, JOURNALISM

Jim Lewis (center) visits with Bob Wilhelm, Nebraska's vice chancellor for research and economic development (left) and Matt Larson, associate superintendent for instruction at Lincoln Public Schools (right), on Nov. 18.

"I had the good fortune to follow Jim as chair of a department that he shaped," said John Meakin, professor emeritus and chair from 2004–2011. "In many ways, the Department of Mathematics owes to Jim its broadly accepted reputation as a national model among research mathematics departments, in which excellence in its mission is expected and is commonplace. His impact on the culture and intellectual life of this department is enormous. On many occasions throughout his professional life, Jim has exhibited extraordinary insight into what is possible, and an extraordinary capacity to motivate people to carry out his vision."

– Tom Marley

Those who want to join me in thanking Jim for his service can donate to the Jim and Doris Lewis Fund, the Emeritus Faculty Fellowship Fund, or the Math Teachers for the 21st Century Fund. Readers who want to share a memory of Jim can submit a class note at ***https://go.unl.edu/mathcareerprofile****.*

COLUMN: 'Please, do tell,' finds Lai, in teaching students proofs

By Yvonne Lai, associate professor

"Be a guide on the side, not a sage on the stage." "Ask, don't tell." "Math is not a spectator sport." "Lecturing is educational malpractice." These slogans rally some mathematicians to teach classes that feature "active learning," where lecturing is eschewed for student participation. Yet as much as I believe that students must do math to learn math, I also find blanket statements to be more about bandwagons than considered reflection on teaching.

In this column, I urge us to think through the math we offer students and how we set up students to learn. Although I draw primarily from my experiences teaching proofs in abstract algebra and real analysis, the scenarios extend to other topics in first year undergraduate education and beyond.

Showing and telling the public and private spaces

If you have ever taught real analysis, you have seen students struggle. The nested quantifiers, new proof structures, and abstraction can feel like an avalanche. Those students who succeed find new mathematical doors to measure theory, topology, and more. Many students don't though, and instead experience real analysis as an exercise in frustration and a message that they cannot do mathematics. The rewards of real analysis may be rich, but most emerge poor.

When I first taught real analysis proofs, such as proving the divergence or convergence of a sequence, I emphasized conceptual understanding and lots of hands-on activities on the definition of a limit. Many students claimed that after these activities, limits made more sense than they did in Calculus. Yet they were not able to write proofs. They were unable to connect scratch work with ϵ and N to writing a clean argument that a sequence converged or diverged. Consequently, some saw no use in the scratch work at all. I encouraged, begged, and pleaded with my students to go through the scratch work, to no avail.

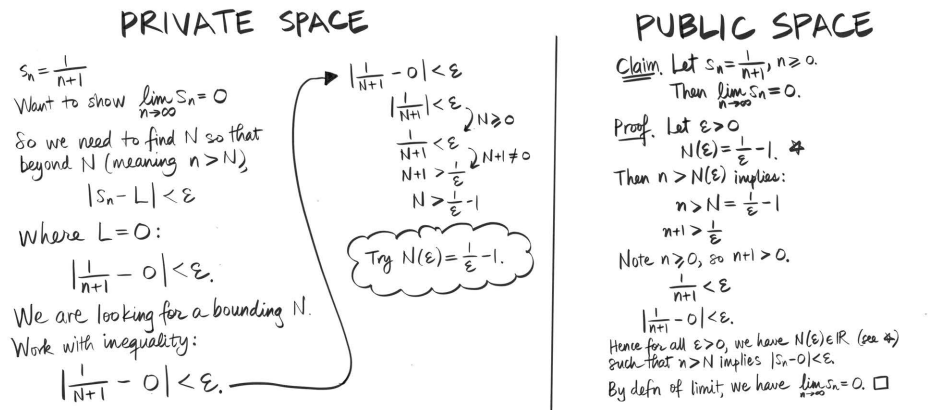


Figure 1. Boardwork that shows public and private spaces for a convergence proof.

Then I encountered Manya Raman Sundstrom's dissertation, on proof and justification in university calculus, where she used "public " and "private" to distinguish scratch work from the proof one might see in a textbook or perfect problem set write-up (2002). I was inclined initially to dismiss the terminology — after all, "scratch work" suited me just fine, and I heard plenty of others use it — but there was something about the new terms that stuck with me. In any case, my students never seemed to benefit from talk of "scratch work." Something else was needed.

I developed a little talk about "private space" and "public space," likening "private space" to the things you do but don't show, such as trying on different outfits or practicing your smile before a promising job interview. You're just going to show a charming, enthusiastic smile to an interviewer, and that's the "public space."

This spiel got students' attention. Even more promising, I noticed that they referenced "private" and "public" voluntarily — an improvement over their de facto embargo of the term "scratch work." But this talk alone didn't help connect the private mathematics, or scratch work, to the final write-up, or public mathematics.

I began wondering what it would take to teach the interplay of public and private mathematics. What if I simulated my own private work and its connection to the public proof? I did so. The result was the most success that I have ever had teaching proofs in real analysis. For the first time, I saw students go from doing proofs of $\lim_{n\to\infty}\frac{1}{n+1}=0, n\in\mathbb{N}$ in class to proving in homework that $\lim_{n\to\infty}\frac{-3n^3-\frac{2}{5}n+2}{5n^3-n}=-\frac{3}{5}, n\in\mathbb{N}$. For those that did not prove the latter, feedback seemed to make sense; when I asked students to revise the proof, most students only needed one or two more tries. On the midterm, the vast majority of students aced a similar limit proof.

Later, on the first day of ϵ-δ proofs, I once again modeled private work and how it translated to public proof, for a proof of the continuity of $f + g$ given the continuity of f and g, and then $-3g$ given the continuity of g. I asked students to prove $Af + Bg$ given the continuity of f and g at their seats. When I walked around, I saw many correct proofs written so well they could have appeared in a textbook. Even more remarkably, many proved the continuity of f^2 given the continuity of f. I should mention that at UNL, this is a first course in real analysis, taken by

math majors and some math minors — the majority of whom do not go on to graduate school in mathematics.

I made a special effort to show the connection between private and public spaces, by designating one board "private space" and another board "public space." I walked through scratch work and gave a rationale for each step. Then, and crucially, I walked over to the public space, and, as I wrote each step in the final proof, explained where in the private space the step came from. Figure 1 (see page 20) shows the dual board work.

For instance, when proving that $\lim_{n\to\infty} s_n = 0$, where $s_n = \frac{1}{n+1}, n \geq 0$, the claim comes from the problem statement. The statement $N(\epsilon) = \frac{1}{\epsilon} - 1$ is the result of the private space. Showing deductions from $n > N$ will sometimes but not always resemble private computations. Altogether, these inferences show that for all $\epsilon > 0$ there is an N such that $n > N$ implies that s_n is closer than ϵ to 0, and hence the limit is 0.

After the success of this approach with convergence proofs, I asked students to find divergence proofs without modeling a similar process in class — only to have many turn in muddled work. Once I modeled divergence proofs in this way, the majority were able to write divergence proofs. However, I did not want to have to model every possible kind of proof — an impossible task in any case. And so, I decided to find a time to model the process of proving that something satisfies the negation of a definition. I found this opportunity in the unit on continuity and discontinuity. We rehashed divergence proofs, and discussed how divergence proofs were an example of proving that an object satisfies the negation a definition. Then I asked students to brainstorm how to prove that a function was discontinuous. After we generated a method in class, we talked about how the process of finding a structure for proving discontinuity paralleled that of proving divergence. I assigned both proofs of continuity and discontinuity for homework, and did not model a private-to-public space process for discontinuity proofs. Students generally succeeded at writing both continuity and discontinuity proofs.

Convergence proofs and limit proofs are a new mathematical language, compared to the proofs students are likely to have seen previously. When teaching a new mathematical language, we must be utterly transparent about the process of mathematics from beginning to end. This can include taking class time to walk through how private work leads to public proof, as unnatural as this may seem to do in front of a room of students. The time that one takes to do so can save more time later, as well as open doors to more students about how mathematics works.

Transparency with proof structures

One critique of the show-and-tell of public and private space is that they may reduce proofs to procedures, and therefore further the idea that math is about formulas rather than reasoning. I believe that one potential way to counter this effect, and to promote proofs as a genre of communication that makes sense, is discussing where proof structures come from and why they work.

For instance, in real analysis, the structure of a convergence proof comes from the definition of convergence. Because the definition specifies, "For every $\epsilon > 0$, there exists an N such that $n > N$ implies ... ", we can think of N as a function of ϵ, and we must find $N(\epsilon)$ that $n > N(\epsilon)$ leads to the desired inequality to show convergence. In practice, when teaching this, I write the definition on the board, and then I write the first few lines and the last few lines of a proof, and ask students to think individually, then share with a partner, why this proof structure would actually show that a sequence is convergent. We then discussed the connection as a whole class, underscoring the point that definitions come with criteria, and the proof is about establishing those criteria. After a similar process with ϵ-δ proofs, a student — who had failed the course two times before enrolling in my course — practically ran up to me after class, her face beaming. She said, "This is the first time that these proofs have made sense." Three weeks later, she received one of the highest marks on the midterm assessing performance on these proofs.

Looking back, I found joy in the "magic tricks" that my professors pulled in my undergraduate classes because the idea of algebraic wishing had been patiently explained to me by my father in middle school and high school. In other words, I already had access to a firm conviction that math could and should make sense, because someone had already been transparent with me about how certain proofs worked. Talk of "magic" was fun only because I knew it wasn't really magic.

Moving beyond magic tricks

In mathematics, slogans and magic tricks come in the form of phrases such as "just use the definition," "write down what you know," or "show your work." These phrases each point to a helpful idea, but the phrases alone can't teach the ideas. Instead, students need experiences to help them make sense of these phrases and see how different instantiations of these phrases can fit together in a whole. When instructors attend to students' work and hear how students talk, then, using these observations over time, they can refine the feedback they offer, problems they assign, and explanations they give.

In teaching, slogans and magic tricks come in the form of phrases like "student-centered" and "instructor-centered." These phrases can mean something, but the phrases themselves don't communicate much. Just because students have done math in class or have talked to one another about math doesn't mean that they have learned math. On the other hand, without having students do math in front of us, be it by themselves or with a group, it's hard to tell what they are learning, and whether we should be changing our plans. Some of the most important tools we have, as instructors, are our eyes and ears. Whatever our goals for students are, our students can teach us what they know. When we look and listen, and identify ideas and practices to make more transparent, we can become better teachers.

– The complete version of this column appeared in the Sept/Oct 2021 edition of the AWM Newsletter.

Two earn NSF Graduate Research Fellowships

Six University of Nebraska–Lincoln students and alumni have received 2021 Graduate Research Fellowships from the National Science Foundation, including two from the Nebraska Department of Mathematics.

The program helps ensure the quality, vitality, and diversity of the scientific and engineering workforce by recognizing and supporting outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics education. The program provides three years of support for recipients' graduate education.

Nebraska's honorees are Diego Galvan, a senior mathematics major; Grayson Minnick, a graduate student in mechanical engineering and applied mechanics; and Molly Creagar, a graduate student in mathematics.

Molly Creager

Diego Galvan

Anastasia Madsen, a graduate student in biological sciences, received an honorable mention.

Three Nebraska alumni who are pursuing graduate degrees at other universities also received fellowships: Ryan Regan and Maureen Winter, both studying mechanical engineering at Purdue University, and Claire Richardson, who is studying geological sciences at Arizona State University.

DIVERSITY FELLOWSHIP

Graduate student Kirsten Morris joined the department this fall with a Graduate Fellowship for STEM Diversity. Formerly known as the National Physical Science Consortium, GFSD is a partnership between government agencies and labs, industry, and higher education. GFSD's goal is to increase the number of U.S. citizens with graduate degrees in STEM fields, emphasizing recruitment of a diverse applicant pool. Morris earned an MA from the University of Georgia and a BS from Georgia College & State University, both in mathematics.

Haight gift supports first graduate intern

The first graduate student internship supported by funds from the estate of Ernie Haight occurred over the summer of 2021.

Third-year mathematics graduate student Meraiah Martinez built upon the work she did in the winter of 2020 at Lincoln-based company Ocuvera, under the direction of Nebraska mathematics Ph.D. alumni Josh Brown Kramer.

Following Haight's death in 2018, he provided a $208,000 estate gift to the University of Nebraska Foundation to support the Department of Mathematics Emeritus Faculty Fund. The annual income from the Haight gift funds a graduate student internship in industry or a research lab.

"Internships are important professional development activities for graduate students in mathematics, and the Haight internship fund provides a great opportunity for students in our graduate program," said Susan Hermiller, Willa Cather Professor of Mathematics and prior graduate chair.

Martinez worked on two projects during her summer internship at Ocuvera. First, she finished her winter project of creating a machine-learning model that would use pictures taken with an older camera and make them look as if they were taken with the newer cameras. Second, she took 3D images and gave them points in 3D space.

"I created a 3D scene of a hospital room, for the computer to categorize where people were and the chairs were — essentially, to find the various objects in the room," Martinez said. "This was based in machine learning, to make the computer do all of the categorization for me."

Martinez also worked with Lucas Sabalka, who earned his bachelor's at UNL in mathematics, and Ben Rush, along with the computer vision team. While she had to work remotely in the winter, she was able to come to the office over the summer: "It was nice being welcomed into the community there and to have the ability to just turn around and ask someone a question."

She said some linear algebra background is needed to do this machine-learning work, in particular an understanding of matrices.

"This experience gave me confidence in my ability to learn new concepts independently, as well as how to apply them," Martinez said. "I learned a lot from asking questions and reading through a variety of papers."

STUDENT PROFILE: Michael Pieper

Michael Pieper, an undergraduate math student from Omaha, charted his own path in college.

During his time at the University of Nebraska–Lincoln, Pieper, a philosophy and mathematics double major, has conducted research on campus, brought accomplished mathematicians to the university to speak to students, and taken graduate-level courses to deepen his understanding of the world of mathematics.

For his research, Pieper works in collaboration with Associate Professor of Mathematics Mikil Foss, studying whether the Lavrentiev Phenomenon occurs in nonlocal optimization problems. This study examines the intersection between these two phenomena.

As a prospective graduate student, Pieper has embraced eagerly the challenge of taking graduate classes as an undergraduate. He shared that his graduate courses have allowed him to draw connections between his philosophy and math majors, as these upper-level courses often require critical analysis of mathematics concepts.

"I love math mostly because it is one of our best tools for understanding the world," Pieper said. "I have found that the more math you know, the better you can explain how things work. And there's a certain sort of satisfaction that comes from solving a hard math problem that you don't always get in other fields."

One of the most influential aspects of Pieper's collegiate career was his involvement in the UNL Math Club. He shared that this experience connected him to intelligent, accomplished people on campus that pushed him to grow.

Motivated by his experience with the Math Club, Pieper decided to reinvest in other students by taking on a leadership role in the club.

"I wanted to help the club do for other students what it did for me," Pieper said.

Pieper organized a number of events for students to attend that covered a range of topics, such as fluid dynamics and its tie to the movie industry, coding theory, LaTeX, and graduate school.

"Overall, the club tries to get people excited about math and provide students with the tools they need to succeed as students and as professionals," Pieper said.

In the future, Pieper said, he hopes to pursue a graduate degree and have the opportunity to teach math to students: "I've been very fortunate and stumbled into some great opportunities, so I'm looking forward to a chance to give back to the world in some way. And, I think great teachers play a huge role in moving the world forward."

– Tori Pedersen, senior, agricultural leadership, education and communication (ALEC)

TELL US ABOUT YOUR FAVORITE PROFESSOR OR CLUB AT NEBRASKA! TAG @UNLMATHEMATICS ON INSTAGRAM, FB, OR TWITTER!

GET TO KNOW GRADUATE STUDENT:

EMILY MCMILLON

Where are you from?
I am from Lumberton, Texas. It's about two hours east of Houston.

What is your research area of interest?
I work in coding theory (or, more broadly, applied discrete mathematics).

What is the best advice you have been given regarding graduate school or your career?
It's OK to ask for help, and if someone offers to help you, it's OK to say yes. Let's say that again: *It's OK to ask for and receive help.* This feels like it should be obvious, but sometimes it isn't. When I was an undergraduate, I never asked anyone for help because I was so scared of inconveniencing people. Turns out, people like helping other people! That was a revelation, and it led me to talk to my professors, which is how I ended up in graduate school.

What is a goal you have accomplished as a Husker?
I mean, I'm on track to earn my Ph.D. So that's a pretty big accomplishment. There were a lot of times (especially during my first two years) when I didn't think I would make it.

What types of jobs are you interested in pursuing after graduation?
My long-term goal is to remain in academia. Ideally, my career will involve a balance of research, teaching, and mentoring. Currently, I am applying to both postdoctoral and tenure-track positions.

What do you hope to cross off your "bucket list" in the next few years?
On a personal note, I would like to travel. I've never been out of the country. I had planned to go to Europe in summer of 2020, but that didn't go as planned. Professionally, I would like to find a way to incorporate more topology into my coding theory research. What I've done so far has mostly been graph-theoretic, and while I enjoy it, I am interested in lots of things! I would also like to become more involved in the math education research community. In particular, I think there is a lot of interesting research to be done on graduate mathematics education (see page 9 for more on my AMS blog with George Nasr on mastery grading).

STEM CONNECT PROFILE: Cleve Young

GRACE KOVAR | UNL SENIOR, JOURNALISM

Third-year UNL student Cleve Young is majoring in mathematics and minoring in statistics. Young transferred to Nebraska from Wayne State College in 2020.

Before joining the STEM CONNECT program, Cleve Young encountered few opportunities to explore programming or research. Now, as a third-year student majoring in mathematics and minoring in statistics, Young said the support offered by faculty at the University of Nebraska–Lincoln made those experiences an easy transition.

Young, who spent his first year at Wayne State College and transferred to UNL in the Summer of 2020 as a sophomore, commutes an hour and 15 minutes to campus each day and is the father of a 7-year-old. As an enrolled member of a Native tribe, Young said he is "extremely proud of my heritage and all that comes with it."

He decided to transfer to UNL after the university expanded the financial support provided through FAFSA.

"I am proud to be a part of a university offering that support," Young said.

Throughout his time in the department and STEM CONNECT program, Young has began assisting with research. His current research is with Yvonne Lai, developing a learning progression for students in underserved communities to create more accessibility to STEM (see grant on page 16).

"The research is looking to measure students' abilities and help communities that typically don't have many STEM opportunities so we are able to reach these students," Young said.

Young said he finds excitement in solving problems and exploring the foundational and conceptual sides of mathematics. He was recruited to STEM CONNECT by Jim Lewis, Aaron Douglas Professor of Mathematics and principal investigator of this National Science Foundation grant.

Thrilled at the opportunity to join a program that offered such strong support to students, Young also shares his commitment to helping other students learn and experience math by working as a teaching assistant and learning assistant for the Department of Mathematics.

Young's favorite STEM course, Modern Algebra, goes beyond applying formulas to a problem, he said, and instead challenges students to really understand why math works the way that it does. "Older students always told me that you haven't done real math until you've done modern algebra," he said.

As far as his future goals, the Decatur, Nebraska, native said he wants to keep his eyes open for as many opportunities as possible until he finds what strikes him as the "right fit." His passion lies in exploring math, and until he finds one area he wants to hone in on, he wants to explore it all.

"There's so many options," he said, "I could go into finance, actuarial science, math education. I'm always learning of new opportunities."

– Tori Pedersen, senior, ALEC

2021 SCHOLARS

The following students joined STEM CONNECT in 2021 (high school in parentheses after hometown; Nebraska unless otherwise noted):

University of Nebraska–Lincoln

Lawand Anwer, Erbil, Iraq (Lincoln North Star)

Jayden Carlon, Bellevue (Bellevue East)

Catherine Hozzian, Chicago, IL (Noble Street College Prep)

Gabe Payson, Ashland (Payson Academy)

Zach Reed, Holdrege (Holdrege)

Dennis Startsev, Stavropol, Russia (Stavropol Municipal Educational Institution the High School)

Cleve Young, Decatur (Lyons-Decatur Northeast)

Southeast Community College

Kayla Botsford, Bellevue (Bellevue West)

Demostin Ewougouo, Yaounde, Cameroon (GBHS Buea)

Zach Foyt, Nebraska City (Nebraska City High)

Elsa Johnson, Lincoln (Lincoln Southeast)

Phillipe Musau, KInshasa / Congo, Democratic Republic (Groupe Scolaire Tumba)

Cong Nguyen, Lincoln (Ly Tu Trong, Vietnam)

Evin Rasho, Lincoln (North Star)

Kendra Shreves, Johnson (Johnson-Brock)

Boston Workman, Lincoln (Lincoln High)

Western Nebraska Community College

Joann Jones, Scottsbluff (Angeles University, Philippines)

Justin Rosa, Sallisaw, OK (Muldrow)

Monica Moreno, Gering (Minatare)

Octavious Gonzalez, Scottsbluff (Scottsbluff High)

Quintin Hassel, Minatare (Bayard)

Rosa Linda Acevedo, Torrington, Wyoming (Torrington)

Shelby James, Scottsbluff (Hosanna Christian Academy)

Undergraduate awards

Chair's Prize
Awarded to an outstanding senior mathematics major
Diego Galvan and Andrew Haar

Special Awards
Diego Galvan, NSF Graduate Research Fellowship Program

Andrew Haar, DAAD Fellowship

Chancellor's Scholars
Kushagra Kapil, December 2020
Will Bruening, May 2021
Will Brunner, May 2021
Andrew Haar, May 2021
Amanda Rowley, May 2021

Senior Honors Thesis and Graduated with Distinction (directed by):
Will Brunner (Timothy Gay, Physics & Herman Batelaan, Physics) – May 2021

Allison Cruikshank (Huijing Du, Mathematics & Yawen Guan, Statistics) – May 2021

Diego Galvan (Adam Larios, Mathematics & Petronela Radu, Mathematics) – May 2021

Andrew Harr (Petronela Radu, Mathematics & Adam Larios, Mathematics) – May 2021

Kushagra Kapil (Etsuko Moriyama, Biological Sciences & Jitender Deogun, Computer Science) – December 2020

Jackson Lederer (Martin Centurion, Physics & Herman Batelaan, Physics) – May 2021

Jesse Osborn (Ilya Kravchenko, Physics & Ken Bloom, Physics) – May 2021

Special Scholarships Awards
Note: 67 scholarships were awarded for the 2021–22 academic year.

Dean H and Floreen G Eastman Memorial Scholars
For Nebraska high school graduates
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Joel Stebbins Fund Scholarship
Clay Christenson, Cole Johnson, Angeline Luther, and Garrett Mayer

Renneman/Luebbers Scholarship
Anas Al Balushi, Elena Butler, Ritvik Handa, Garrett Mayer, and David Scalzo

Drusilla Winchester Scholarship
Yashaswi Mehra and Aleah Miller

Ruby Matzke Wittemore Scholarship
Ronit Gandhi

Irwin Dubinsky Memorial Scholars
Morgan Brockner, Clay Christenson, and Yashaswi Mehra

Sylvia and Hans Jeans Mathematics Scholarship
Alexander Cathcart, Cole Johnson, Angeline Luther, Kim Hao Nguyen, Tram Nguyen Gia, Luke Van Drie, Sarah Van Hare, and Cheyenne Warren

Dr. Hubert Schneider Memorial Scholarship
Emma Dover

Linda Bors Mathematics Scholarship
Stephanie Marsh, Kira Mills, and Xin Wu

Bachelor's degrees

August 2020: Emilee Buol, Drew Doyle, Nathan Ghanavati, Jinyu Hu, Yakira McKay, Lucille Melcher, Kyle Pekarek, Huixin Peng, Jonghyun Yoo, Wenjun Yuan, and Geigh Zollicoffer

December 2020: Matous Adamec, Jean Claude Bamute Kamba, Melissa Bowers, Cheng Cheng, Kushagra Kapil, Jared Ladd, Guanzhong Liang, Huanyu Liu, David Maas, Phillip Nguyen, Zhenchang Qi, Wei Qu, Brennan Roberson, Nicholas Verdoni, Carter Walford, Dillon Walker, Zetian Wang, Heng Xu, Xu Yang, and Liyuan Zhang

May 2021: Azaria Ahl, Izzat Bin Ahmad Adly, Ahmed Al-Mazrouai, Jonathan Askey, Hannah Balandran, Taylor Bartek, Xiaoyu Bi, Brandon Blue, Tara Brockman, Will Bruening, Will Brunner, Kenneth Buffo, Zach Cairney, Samuel Carrasco, Chris Carreras, Shen Chang, Allison Cruikshank, Alex Curran, Blake Dvarishkis, Calvin Focht, Diego Galvan, David Garza, Austin Gubbels, Andrew Haar, Christopher Haidvogel, Achintya Handa, Jacob Henderson, Micah Holmes, Parker Janicek, Nicholas Johnson, Scott Jones, Lucas Keester, Jacob Kennedy, Taylor Kissinger, Jackson Lederer, Nicholas Lennon, Siyi Li, Barrett Luci, Zachary Madsen, Henry Mitchell, Nischal Neupane, Nick Nguyen, Dana Nugent, Jesse Osborn, Jesse Osnes, Cameron Peer, Samuel Pierce, Lara Quiring, Bret Reetz, Ryan Reeves, Quinn Reimer, Brennan Rhoadarmer, Ben Rhodes, Amanda Rowley, Josh Schmidt, Michael Schneider, Taylor Schrader, John Slaby, Jane Speier, Will Stokebrand, Nate Thach, Grace Tiernon, Shreeya Vaitla, Treyvor Vice, Zeyu Wang, Colten Welch, Sirui Wen, Reagan Wooden, and Yimeng Zhao

Doctoral degrees

Bukoski, Juliana *Free Semigroupoid Algebras from Categories of Paths*, advised by Allan Donsig

Carlson, Elizabeth *Enhanced Effication of Turbulent Flow Observations: Parameter Recovery, Sensitivity Analysis, Nonlinear Data Assimilation Algorithms, and a Real-World Implementation,* advised by Adam Larios

Funk, Taran *Frobenius and Homological Dimensions of Complexes,* advised by Tom Marley

Hong, Su Ji *On the Realization of Real Schur Roots as Planar Curves*, advised by Tri Lai and Kyoungyong Lee

Hopkins, Eric *N-Fold Matrix Factorizations*, advised by Mark Walker

Hopkins, Erica *Complexes over the Exterior Algebra with Small Homology*, advised by Alexandra Seceleanu and Mark Walker

Huben, Robert *Gauge-Invariant Uniqueness and Reductions of Ordered Groups*, advised by Mark Brittenham and David Pitts

Longo, Vincent *Results on Nonorientable Surfaces for Knots and 2-knots*, advised by Mark Brittenham and Alex Zupan

Martin, Adolfo Amadeus *Curved BGG Correspondence*, advised by Mark Walker

Moeller, Jesse *Results on Goeritz Groups and Farey Trisections*,

AWARDS { PAGE 26 }

GET TO KNOW UNDERGRADUATE:

ANA PODARIU

Where are you from? Omaha, Nebraska

What excites you about math? How broad it is. Every problem, no matter how obscure or seemingly ridiculous it is, has some math dedicated to it.

What has been your favorite math class at UNL? Introduction to Abstract Algebra (Math 310). It was my first proofs course, and I loved seeing all the things I took for granted about algebra with their justifications.

What research have you done as an undergrad? I started working with Dr. Yu Jin on a predator-prey model with a stage-structured pest on the start of my junior year under the UCARE program.

How have you benefited from taking graduate-level courses? Taking a few courses was obviously challenging, but it helped me feel better about graduate school as a future option. The level of difficulty also taught me to be more comfortable with the idea of failure.

What is a goal you have accomplished as a Husker? One goal I set for myself was to keep my scholarships, which required a GPA of 3.5 or higher, and I have, so that's good!

What do you hope to cross off your "bucket list" in the next few years? I hope to publish my first paper and to get into graduate school.

What are you excited about doing after graduation? I'm excited to start graduate school. I hope I will get to explore some math topics I didn't have the background to try in college.

Moeller heads to SpaceX

Jesse Moeller (Ph.D. '21) is now a software engineer for Starlink, SpaceX's low-latency satellite internet company. Moeller is part of the topology team, which is responsible for deciding how satellites connect to users. "Satellites are always moving, and serve users for a limited time before they must serve someone else," Moeller said. A native of Davenport, Iowa, Moeller learned the fundamentals of computer science and modern programming in his free time while pursuing his doctorate in mathematics. His internship at Ocuvera helped solidify his interest in the field. At SpaceX, "everyone wants to see one another succeed," he said.

AWARDS { FROM PAGE 25 }

advised by Mark Brittenham and Alex Zupan

Nasr, George *A Combinatorial Formula for Kazhdan-Lusztig Polynomials of Sparse Paving Matroids*, advised by Jamie Radcliffe

Whittemore, Alyssa *Bootstrap Percolation on Random Geometric Graphs*, advised by Xavier Perez

Master's degrees

MS/MA (through May): Molly Creagar, Matthew Enlow, Abigail Long, April Loyd, Robert Martin, Meraiah Martinez, Sarthak Neupane, Justin Nguyen, Shah Roshan Zamir, Isabel Safarik, Andrew Soto Levins, Kaitlin Tademy, Kathryn Van Etten, Anh Vo, Daniel Welchons

MAT (Aug. 2020-Aug. 2021): Alyssa Baber, Hannah Beck, Allison Brown, Andrew Campbell, Geoff Carnahan, Nicholas Clayburn, Kelsey Cordero, Rosanne Gartner, Kayla Geiger, Keira Johnson, Lori Johnson, Corey Jones, Jim Lynam, Cady Maple, Laura Rademacher, Drew Rische, Hannah Rundle, Lauren Taylor, Kaitlyn Tenski, Alison Timoney, Alison Willis

Graduate program awards & fellowships

Don Miller Award for Outstanding Teaching by a Graduate Student
Emily McMillon

Grace Chisholm Young and William Henry Young Award
Nikola Kuzmanovski

Outstanding Qualifying Exam
Charles Chen

Walter Mientka Teaching Award
Johan Cristobal

Amy Bouska GTA Leadership Award
Matthew Bachmann

Outstanding First-Year Student Award
Jordan Crawford and Maia Wichman

Bill Leavitt Award
Valerie Morris

Lloyd Jackson Award
Frank Zimmitti

Linda Bors Fellowships
Laila Awadalla, Rachel Funk, Jake Kettinger

Ben Carse Nolting Award
Shah Roshan Zamir

2020–2021 Steven Haataja Award for Outstanding Exposition by a Graduate Student
Kathryn Van Etten

Internships and 2021 summer schools

Nicole Buczkowski, Sandia National Lab, summer (virtual)

Molly Creagar, MSGI Program, USACE-ERDC Cold Regions Research and Engineering Lab

Audrey Goodnight, SCAMP, Center for Computing Sciences, summer

Meraiah Martinez, Ocuvera, summer

Nick Meyer, MSRI Summer Graduate School: Gauge Theory in Geometry and Topology, summer (virtual)

Anh Vo, Oakridge National Laboratories, summer (virtual)

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DEPARTMENT OF MATHEMATICS

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New fund honors Professor Mientka

Irene Bjorklund (BS, '69) has established a new scholarship, the Dr. Walter Mientka STEM Scholarship Fund, in honor of her mentor, Professor Mientka, and with sincere gratitude to her parents. This fund encompasses other STEM disciplines in the College of Arts and Sciences in addition to Mathematics. Irene writes:

"Prior to graduating with a Bachelor of Science in mathematics in 1969 from UNL, I was raised on a dry land farm outside of Greeley, Nebraska. I want to thank and acknowledge my parents, Elmer and Elaine Bjorklund, for their commitment and desire to educate their children. Their drive, hard work, and sacrifice allowed all four of us to graduate from college. Without them, I would not have had the opportunity to attend the university and meet such a great teacher, Dr. Walter Mientka. By far, Dr. Mientka was the best instructor that I had throughout my formal education and all the classes I have taken in the business world since. He had the ability to teach rather than lecture, to facilitate learning and make it fun, and to make mathematics exciting. Even in tough upper-level math classes, he could fill the classroom with his enthusiasm and the chalkboard with equations. I will never forget him writing 'W5' on the chalkboard as he proved a theorem. We all asked, 'What is W5?' He explained, 'W5 = Which Was What We Wanted.'

As I continued my education in Lincoln, I wondered where my mathematics degree could take me. I had grown up on a farm and attended a one-room country school and a small high school. I was always good at math, but didn't know how to apply it to a career. When Dr. Mientka became my advisor, we began to explore my options together. Dr. Mientka was willing to invest his time in me. In the summer of 1968, he introduced me to computer science. I took my first programming class that summer, followed by all computer classes my senior year. Following graduation, I worked in the computer business for over 30 years. Very insightful on Dr. Mientka's part, and very fortunate for me!

FUND #: 01155000

When I chaired the Advisory Board for Women in Engineering (WIE) at the University of Washington, they had a saying that a mentor was a $1 million asset. I would have to say that, in my case, that is undervalued by a big percentage. As I look back on my working career, Dr. Mientka's encouragement, inspiration, interest in me, and assistance defining a successful career path culminated into one of the most significant aspects of my life. It is in the spirit of honoring Dr. Mientka's great legacy, that I establish this scholarship in his name."

Donate at: https://nufoundation.org/fund/01155000

Math News is a newsletter published for the Nebraska Department of Mathematics community. To receive Math News via email, please register online at ***https://math.unl.edu/friends***. Comments regarding newsletter content should be sent to Tom Marley (**tmarley1@unl.edu**), Chair, Nebraska Department of Mathematics, 203 Avery Hall, Lincoln, NE, 68588-0130.

Math News is produced and edited by Lindsay Augustyn and Tori Pedersen of the Center for Science, Mathematics, and Computer Education.