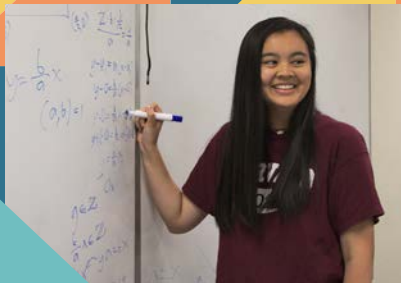


MATHWORKS

Breaking Barriers:
Patterns for Success



2018
Annual Report

TEXAS
STATE
UNIVERSITY
The rising STAR of Texas

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Quotes from
2018 Junior Summer Math Camp students

"I'm 10 years old. This year, I learned about coordinate planes. I learned how to add, subtract, and multiply positive and negative numbers. And we learned about fractions."

"At my school, we don't usually present (our work), we usually do our own work but at math camp we present, we share our ideas, we share our supplies and we help each other a lot."

From the Director

Dear Friends,

We are excited to be celebrating the 30-year anniversary of Mathworks. Beginning with a small summer camp of 12 students in 1990, Mathworks has grown to be a thriving center for researching and developing new ideas in teaching and learning mathematics. The three pillars of Mathworks are summer camps for middle and high school students, teacher professional development (PD) for pre-service and in-service teachers, and curriculum development of materials that teachers can use in their classrooms. Underlying each of these efforts is research that is integrated into our Math Education Ph.D. program that is one of the leading programs in the country.

Our annual report has descriptions of each of the pillars, and highlights some of the research associated with the camps and teacher PD. As part of our 30-year anniversary celebration, we are focused on completing the Mathworks Legacy Campaign of raising \$6 million to sustain and enhance all of our programs. The projects below will complete this campaign:

- Scholarships for the Honors and Junior Summer Math Camps

- Scholarships for the Mathworks Fellows Program

- Support for the Mathworks Graduate Research Program

- Named Professor position for Mathworks
- \$ 500,000

\$ 500,000

\$ 500,000

\$ 750,000

This summer, we are planning a special alumni weekend during the Honors Summer Math Camp. More details about this will be forthcoming. I hope to see you again during the summer, or in April during special events we are planning associated with Math Awareness month.

All best wishes for a happy, healthy holidays and new year,

Max

Max Warshauer
Director of Mathworks
Regents Professor of Mathematics

Mathworks
2018 Annual Report
Breaking Barriers:
Patterns for Success

MISSION
Mathworks is a center for innovation in mathematics education at Texas State University. Our mission is to research and develop model programs and self-sustaining learning communities that engage K-12 students from all backgrounds in doing mathematics at a high level.

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Hiroko Warshauer, Research Coordinator
Patricia Amende, Business Manager
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Mathworks

Mission

Mathworks is a center for innovation in mathematics education at Texas State University. Our mission is to research and develop model programs and self-sustaining learning communities that engage K-12 students from all backgrounds in doing mathematics at a high level.



Curriculum



Camps



Teacher PD



Research

Three Pillars with a Research Foundation

Mathworks performs its mission of engaging students from all backgrounds in doing mathematics at a high level by offering three core programs supported and informed by research. Beginning with summer math camps for elementary to high school students, we develop problem solvers who are unafraid of new challenges. Students learn to think deeply and work collaboratively with others. This concept extends into middle school curriculum and professional development for in-service and pre-service teachers. The element that ties everything together is research about new and innovative ways of teaching, and research opportunities for undergraduate and graduate students interested in mathematics education.

Advancing the Strategic Plan

Mathworks initiatives include:

- Supporting and sustaining the Mathworks Fellows Program that provides undergraduates with an early introduction to teaching
- Providing fellowships to graduate Research Assistants who work with Mathworks on curriculum development, teaching, and learning mathematics.
- Developing a named Professor position to support research and sustained excellence

Celebrating 30 Years of Success

These Mathworks initiatives will sustain and enhance Mathworks core programs--

- Summer math camps for K-12 students
- Teacher Professional Development for pre-service and in-service teachers
- Curriculum Development of new and innovative methods of teaching

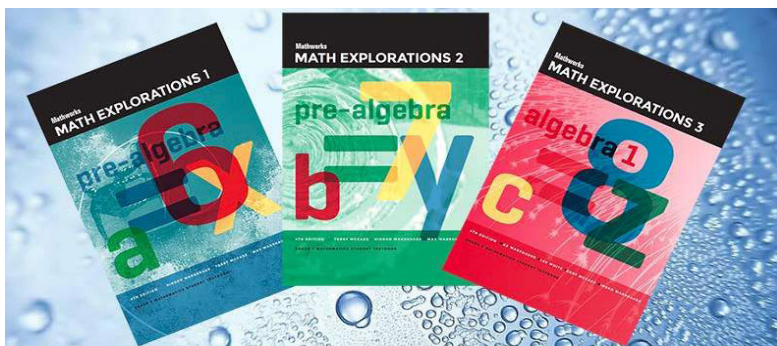
Underlying each of these pillars is research that is integrated into our Ph.D. program in mathematics education. Your help is critical to helping Mathworks develop one of the leading centers for Math Education in the country. As we celebrate our 30th anniversary, Mathworks has grown from a small camp with 12 high school students to a thriving research center that can impact math education throughout the state and nationally. Math camp students have received state, national, and international recognition. Our undergraduates are immersed in a unique hands-on introduction to teaching working with middle school students and master teachers. Our graduate students are pioneering new and innovative methods of teaching, providing a research base for all of the programs that we conduct.

Thank you for your help in making this possible!



Curriculum

Math Explorations Curriculum



"The way the Math Explorations curriculum is put together... this is a really good program and it going to lead the students where they need to go."

-2018 Teacher, Fort Worth

Math Explorations is a series of three textbooks for middle school math that is fully aligned to the Texas Essential Knowledge and Skills (TEKS) for 6th grade, 7th grade, 8th grade, and Algebra I. The textbooks use research from the laboratory of our summer math programs that have been held for the past 29 years.

With this curriculum, young students are engaged in using algebraic ideas that they learned throughout their middle school years. Math Explorations weaves algebra and algebraic ideas together with hands-on, inquiry-based explorations for students working independently and in groups. The curriculum enables students to build on a solid foundation for success in mathematics while preparing them for the STAAR and Texas Algebra 1 End of Course exams.



Excite Students in Summer Math Learning with "Math Camp in a Box"

A school in Austin kicks off the "back to school" season with a one-week camp for in-coming middle schools students using the Mathworks Math Quest Summer Camp Curriculum. This session brings together students from several feeder elementary schools to play games and socialize while learning math skills. During this time, the teachers have an opportunity to see first-hand the academic background of the new students coming to their campus. In this relaxed and fun environment students are encouraged to work together and in groups to solve algebraic problems from the Mathworks Math Quest curriculum. The Math Quest Curriculum offers five levels from beginning concepts in algebra to more advanced problem-solving and discrete math.

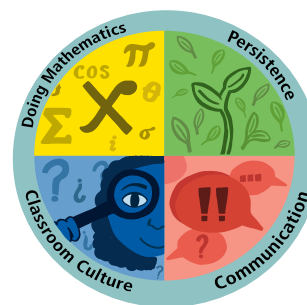
In 2017, with district support to cover, 75 students attended the camp at O Henry Middle School. Building on the 2017 success, they decided to host another camp in 2018, "we didn't know what to expect this year since the district couldn't provide funding; to our surprise, our enrollment went up by 15 students."

About 2 months of reading skills and 2 1/2 months of math skills are lost over a single summer.



Source: <https://www.mathworks.com/summer-learning.html>

Guiding Principles Serve as Foundation for Mathworks Programs!



Research has shown that students' learning success depends on an integrated approach that supports students in each of the domains below. At Mathworks, a center for innovation in mathematics education, our mission is to research and develop model programs and self-sustaining learning communities that engage students from all backgrounds in doing mathematics at a high level. For this reason, the Mathworks Guiding Principles are intentionally woven into every aspect of the Mathworks Programs.

1. Doing mathematics is about making sense of and thinking deeply about fundamental concepts.

Students should:

- "Think deeply of simple things," (Arnold Ross)
- Build on prior knowledge by making connections that follow the flow of ideas from what they previously understood to new ideas being studied
- Promote a deep understanding for why things work using visual models
- Focus on the math problems, not the answers
- Reflect on what they have learned to make sense of the mathematics

2. Persistence is critical to success in problem solving and doing mathematics.

Students need to:

- Develop a "growth mindset," understand and believe that ability can be developed with hard work
- Be willing to take risks and understand that mistakes present opportunities for learning
- Take ownership of their own learning
- Develop confidence to tackle new situations without giving up easily

3. Teachers need to establish a classroom culture that develops students' curiosity and imagination.

The keys to establishing this culture are to:

- Make math interesting, fun and relevant with challenging, well-sequenced problems
- Support students' productive struggle by responding to student questions with appropriate guidance
- Allow sufficient time for learning ideas deeply
- Use techniques to engage all students
- Balance individual and group work; both can be appropriate depending on the task

4. Communication between students and teachers is critical for learning.

To facilitate better communication, teachers should:

- Ask probing questions to develop student understanding, and encourage students to question why things work
- Expect students to present their work and defend their reasoning using precise mathematical language
- Take student attempts seriously, and examine both right and wrong approaches
- Expect students to articulate and explain the key math concepts

Camps

Honors Summer Math Camp (HSMC)

Counting on Success

Attended: 63

Applied: 262

Scholarships: 19%
(full or partial scholarship)

Research: 10
(original research projects mentored by 7 Texas State faculty)

Colloquium Speakers

During the six-week HSMC students attend weekly colloquia given by outstanding scholars, teachers, and leaders. Guest speakers engage the students with real-world applications in their area of expertise and discuss a wide variety of topics.

Students enjoyed an in-depth discussion by Hiro Tanaka, an algebraic topologist, who challenged the students to think deeply by considering the question "Is the Earth Flat?" Students got a new perspective for using math to investigate specific problems.

For a unique perspective of world events, Admiral Robert Inman recapped his 30+ years of service in the US Navy and his additional work with the National Security Agency, Central Intelligence and President's Intelligence Advisory Board. His ability to analyze complex problems has been one of the keys to his success.

The ultimate lesson in perspective was given by Fumiko Futamura, a mathematics professor from Southwestern University, as she presented the concept of anamorphosis. This "stretching of an image" to distort the view depending on the angle is often seen in sidewalk art. From one perspective, you are simply walking across a color of unidentifiable lines, but from the opposite perspective, you appear to be walking over a valley of melting lava. Are you surprised to find mathematics (projective geometry) during a walk down a city street?



Research Projects

Algebraic Topological Methods for the Analysis and Modeling of Protein Data

Crystal Wang, Jason Yuan, Mentor: Dr. Dave Snyder

Utility of Wormlike Micellar Fluids in Enhanced Oil Recovery

Pierce Lai, Michael Li, Sydney Zhou, Mentor: Dr. Young Ju Lee

Correlation between the Tutte Polynomials of Simple Graphs, Bipartite Graphs, and Hypergraphs

Devanshi Gupta, Danika Luo, Michelle Wang, Mentor: Dr. Lucas Rusnak

A Complete Bound on the Chromatic Number and Index of Hypergraphs Through a Generalization of Vizing's Theorem

Jenny Lu, Eric Wu, Amy Zhou, Mentor: Dr. Lucas Rusnak

3D Mesh Generation through Triangle and Curve Algorithms

Naomi Kenyatta, Raymond Suo, Allen Wu, Mentor: Dr. Dan Tamir

Enhancement of the SLAM Algorithm between Two Autonomous Vehicles

Richard Li, Michael Liu, Mahalet Mekonen, Mentor: Dr. Rodion Podorozhny

Construction and Enumeration of Minimal Prime Graphs

Josh Kolenbänder, Elijah Stroud, Selina Wu, Mentor: Dr. Thomas Kellar

An Integrative Evaluation of Statistical Tests for Pseudorandomness to Determine Optimum Randomness Criteria

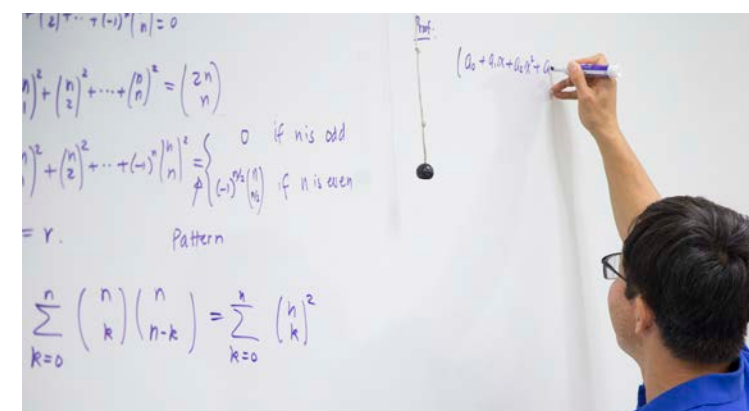
Asha Pereira, Helen Wang, Angela Zhang, Mentor: Dr. Dan Tamir

Verification for the Correctness of Concurrent Data Structures

Turner Bumbary, Amy Hu, Shilpita Mitra-Behura, Mentor: Dr. Rodion Podorozhny

A Generalization of Polygonal Sperner's Lemma to Allow Duplicate Labels

Sarah Wei, Alex Yi, Justin Yu, Mentor: Dr. Suho Oh



"Before coming to HSMC, I viewed mathematics as mostly a competitive activity...I tend to not focus on rigor, but on methods and memorization... Why should I write proofs for basic things such as $n \cdot 0 = 0$? Though I still participate in contests, I have a new-found appreciation for proof-based mathematics, and this type of mindset helped me in classes, aiming to see the bigger picture of everything instead of memorizing specific results."

- 2018 Third-Year HSMC Student

"I found the idea that parallel lines could intersect through the use of projective geometry very interesting, and this seems like a topic that I would want to read more into."

- 2018 First-year HSMC Student



Tubing the San Marcos River

Tubing is just one of the weekend trips and activities the students enjoy during their time at camp.

"I greatly enjoyed the time I had to get to know people as we slowly went up stream."

- 2018 Third-Year HSMC Student

Junior Summer Math Camp - Residential

Counting on Success

Attended: 48

Applied: 144

Scholarships: 25%
(full or partial scholarship)

PMWC Team: 4
Finished in First Place in the International Competition as co-champions for the Po Leung Kuk Cup

Forty-eight middle school students spent two weeks living in dorms on the campus of Texas State University where they were immersed in the excitement of exploring mathematics and higher-level problem solving.

Students learned the importance of collaboration and critical thinking from Texas State math professors Dr. Eugene Curtin and Dr. Jian Shen. During class, students worked on problems and presented their solutions in order to improve their mathematics communication skills. The collaborative learning environment at Junior Summer Math Camp - Residential (JSMCR) helped students understand the importance of teamwork in the field of mathematics.

During daily free time from 3 - 5pm, campers had the opportunity to visit the student recreation center where they could play basketball, run, swim, or attend salsa and yoga classes.

On Friday, campers attended a colloquium given by Dr. Cody Patterson, an HSMC alum who now teaches at the University of Texas at San Antonio. After the colloquium, campers enjoyed a Texas BBQ at the San Marcos Recreation Center.

Weekend Activities

Math isn't the only subject the students learn about during their time at camp. The students tour The Meadows Center and take a glass-bottom boat tour while learning about Spring Lake's ecosystem and biodiversity, the water cycle, and the importance of environmental stewardship. Ask one of the campers about Sunday Simultaneous Chess with Eugene Curtin! He played 20 students all at once.



Mathworks Math Team Finishes First in International Math Competition

In July, after attending the Residential Summer Math Camp (JSMCR) training program, four students flew to Hong Kong to compete at the 2018 Primary Math World Contest (PMWC). The team in 2018 finished as co-champions for the Po Leung Kuk Cup for the 13th time since the first Mathworks team began competing in 2001.

2018 Team (left to right): Hiroko Warshauer (Team Leader, Texas State), Jasmine Wang, Hannah Guan, Edward Xiong, Dylan Yu, and Pat Carreon (Deputy Team Leader, Weslaco ISD).



Quotes from 2018 JSMCR Participants

"Mathworks has broadened my view of what math is about. I learned about new concepts such as Mass Point Geometry and the Alligator Principle. Being home-schooled, and having lived in the Silicon Valley of California for all my life, Mathworks introduced me to people from around the world who share my interest in math. This summer, I enjoyed JSMCR because it fostered an environment of discussion. The teachers and counselors encouraged us to think for ourselves and to maintain a balance between work and fun."

"Of the whole camp, my favorite part was study groups. While still maintaining a relatively competitive environment, it encourage discussion and co-operation. The counselors were friendly and helpful."

For the past three years, I participated in MathCounts... Going to this camp, I was nervous that it might be out of my depth, but I quickly acclimated. My newly made friends and I absorbed the concepts. I learned more information through-out camp these last two weeks than the past two years."

"Mathworks math camp was really an amazing experience. We got to learn high-level math with fellow classmates. The fact that we presented each day meant that we were really able to understand the questions."

"This camp had a strong effect on me overall. Before this camp, I was decent as math. Now, I feel like I am much better and more comfortable with math problems. I also know how to approach problems and am more persistent and strategic in solving them. Now when I see challenging problems, I don't shy away from them like I used to. Instead, I spend more time thinking about an intelligent way to tackle the problem. This change happened because I was taught how to deal with difficulties more than a bunch of theorems and formulas."

"I have found the residential part of camp to be an immense factor of my learning and social-emotional communication with peers and counselors."
-9th Grade student, Kyle



Junior Summer Math Camp



Counting on Success

Attended: 179

Applied: 262

Scholarships: 68%
(received a full scholarship)

Math Interest: 84.1%
(reported positive change in math interest after attending camp)

Fellows: 22

Five Levels to Challenge Young Minds

Students in grades 4 - 8 build a strong foundation in mathematics as they move from Level 1 to Level 5 in the Junior Summer Math Camp program. This two-week, half-day camp is held annually in early June and attracts students from the local area.

Beginning in the 4th grade, students are introduced to algebraic concepts in Level 1 as they explore integers using the number line and modeling problems algebraically. Students in Level 2 learn about patterns, graphs, functions and fractions, while students in Level 3 learn about area, perimeter, line, slope and intercepts as well as the Pythagorean Theorem. Students in Level 1 - 3 are learning middle school Texas Essential Knowledge and Skills for Mathematics (TEKS).

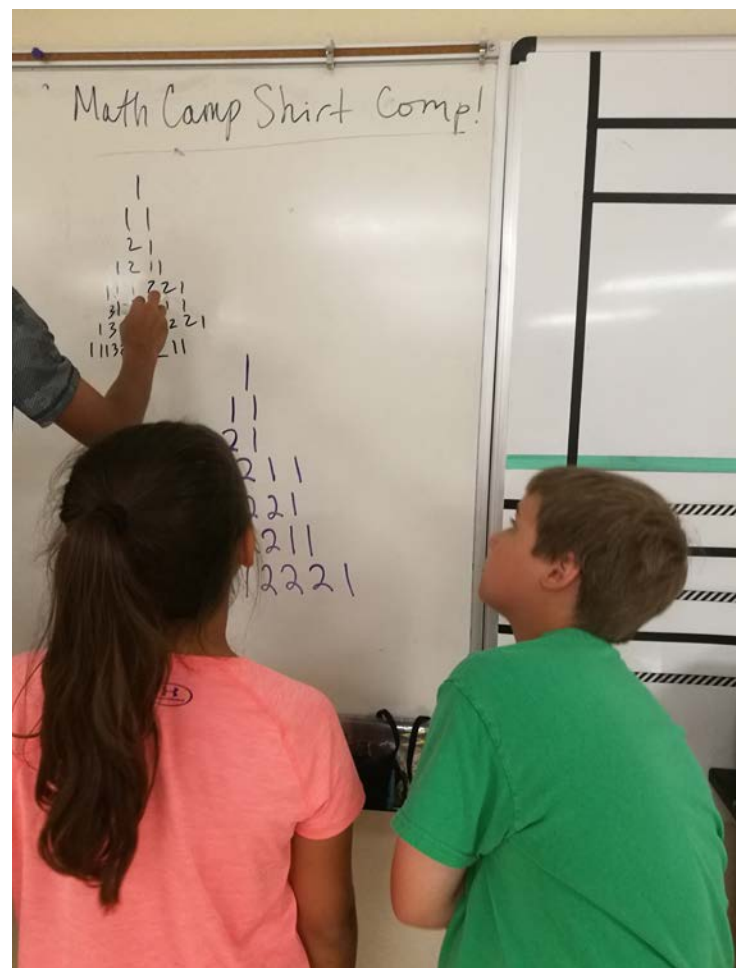
Level 4 focuses on combinatorics and probability while Level 5 tackles logic strategies, number theory, and problem solving.

"Math camp has made math much more fun for me. Math camp gives a good example of what math truly is!"

Unlocking life's mysteries start by understanding simple patterns.

Patterns and sequencing form the foundation for life. Like the pattern these students are learning in Level 3 of the Junior Summer Math Camp class.

"I have come to this camp for the past 3 years and have learned so much about math. It is different from the experience I have at school because I actually learn stuff and I am being challenged. I really enjoy it."



Professional Development



In-service Teachers

The Mathworks Summer Teacher Professional Development program prepares teachers to engage students of all socioeconomic backgrounds in doing mathematics at a high level. This program provides teacher professional development, equipping middle school teachers with the mathematical background and leadership training needed to give all students the opportunity to build a strong foundation for success in mathematics.

"Observing camp classes (taught) me to see how to allow sufficient time for ideas to truly sink in and make sense for all students. I saw the importance of student discussion, and how students built up their mathematical efficacy." -2018 PD Teacher

"Students are being taught in an appropriate way to promote learning. They are in a safe place to take risks with difficult material and ideas all while having fun!" -2018 Master Teacher, 15 year veteran



The dates for 2019 are June 10 - 21. This immersive two-week professional development program is conducted each summer in San Marcos in early June, coinciding with the Junior Summer Math Camp (JSMC). In the morning, participants are part of the half-day JSMC. In the afternoon, teachers participate in a class covering research-based mathematics pedagogy and engaging math activities. A total of 45 hours of Professional Continuing Education hours is awarded, approved by the State Board for Educator Certification (SBEC).

Pre-service Teachers



"I think something that is an important characteristic is never giving up!" -2018 Mathworks Fellow

Twenty-two undergraduate students from a variety of majors worked as Mathworks Fellows during the JSMC. Fifteen of these students are seeking teacher certification, majoring in fields from Mathematics, Applied Mathematics, Physics, Education and History. Each of the 11 JSMC classes had two Mathworks Fellows assisting the master teachers in class. In the afternoons, the Fellows reflected on the morning camp with the master teacher and prepared for the next day's camp. The Fellows then met with Dr. Hiroko Warshauer in a seminar to further discuss the Mathworks Guiding Principles and how these came to life in the camp. This program creates small learning communities of students, teachers, and faculty while giving undergraduates the opportunity to gain classroom experience and work with students.



"I noticed productive struggle a lot more now and highly value it in a classroom setting. It is very beneficial for students to struggle and learn from that struggle. I was able to learn a lot about how I should ask questions in my future classroom and what kind of language to use with students. I also gained lots of helpful tricks of how to run my classroom."

- 2018 Fellow, Majoring in Education - Math/Science Grades 4 - 8

Research & Publications

Graduate Student & Research Opportunities



"My favorite thing was writing and implementing activities that extended the book material to let the students express their curiosity while exploring advanced math topics. "Math camp taught me to really listen and think about student responses because their answer had to come from somewhere. Exploring the origin of the idea can lead to so much insight for the class."

- 2018 Master Teacher, Mathematics Lecturer



"I can say with absolute certainty that I owe my success in my studies, many accomplishments in research, and a successful career in academia almost entirely to my experience at Mathworks. The training I received at Mathworks as a doctoral student was invaluable! Graduate students are encouraged by Mathworks faculty to pursue the area of their interest when doing research. My dissertation resulted from the interests I developed at Mathworks working on various research projects. The sheer diversity of experiences I had at Mathworks was extraordinary – teaching at math camp, participating in teacher professional development, publishing articles, presenting at conferences, developing curriculum, learning about various techniques of data collection and data analysis and the list goes on! As a recent faculty, I can now see how rare it is for any graduate student to get so many opportunities in different aspects of mathematics education (student learning, teacher education, informal math programs such as math camps, and curriculum development) from the very beginning of their doctoral studies. I believe Mathworks provides a great setting for graduate students to pursue their research and dissertation. I couldn't have completed my dissertation without the invaluable mentorship and encouragement of the Mathworks faculty throughout my doctoral studies."

-Nama Namakshi

Publications and conference papers in 2018.

Publications:

Three articles in issues of the journal Mathematics Teaching in the Middle School during the 2018 year. Published by the National Council of Teachers of Mathematics with a readership over 38,000, the articles were based on activities implemented at the JSMC in past summers.

- "Abacus Interactive" by Robinson, Cui, Warshauer, H., & Koehne appeared in March
- "Tortoise and the Hare: Investigating Rates" by Namakshi, Warshauer, H., Bhattacharyya, Koehne, and Warshauer, M. appeared in May
- "Collaboratively engaging with GCFs and LCMs" by Robinson, Cui, Warshauer, H., & Koehne in September. The 2018 graduate students have drafted three new manuscripts and are preparing them for submission.

Conferences:

- Annual Meeting of the American Educational Research Association (AERA) in Toronto, Canada. Two graduate students Christina Koehne and Katty Zied will join Hiroko and Cody at the next April to present findings on a research study of professional development conducted at the JSMC.
- Annual Psychology of Mathematics Education North America Chapter (PMENA). Graduate student Michael Hicks will co-present with Max and Hiroko at the in November to share findings on how HSMC contributes to the development of mathematics identity, competence, and sense of belonging.

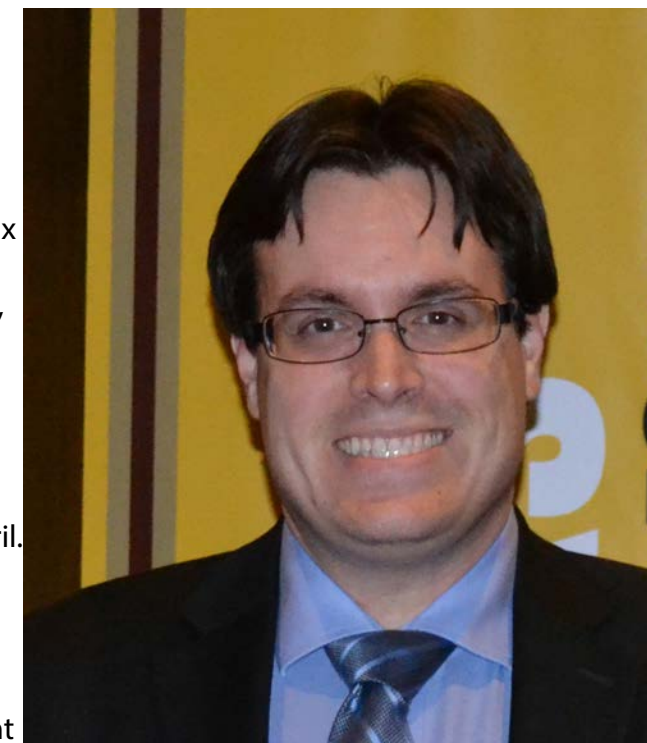
Collaborative Research

Cody Patterson, a former HSMC student and now a mathematics education faculty at UTSA collaborates with Texas State graduate students and Mathworks faculty to work on research in the JSMC and HSMC settings.

Joining with Mathworks faculty, Hiroko Warshauer, Max Warshauer, and Terry McCabe, and graduate students in mathematics education including Christina Koehne, Katty Zied, Xiaowen Cui, and Sonalee Bhattacharyya, the team is examining professional development of pre-service and in-service teachers – what a mix of participants offers. Their work will be presented at the 2019 Annual Meeting of the American Educational Research Association (AERA) in Toronto, Canada in April.

Cody has also used the HSMC setting to study peer mentors' criteria for proof validity and how these criteria may differ from those of professional mathematicians. Working with Texas State PhD student Xiaowen Cui, they presented their research at the 2017 Conference on Research in Undergraduate Mathematics Education (RUME).

Currently, Cody is working with two Texas State MS students in mathematics, Lino Guajardo and Maria Tomasso, to examine how peer mentors support students in learning about proofs. They will present their work at the 2019 RUME Conference.



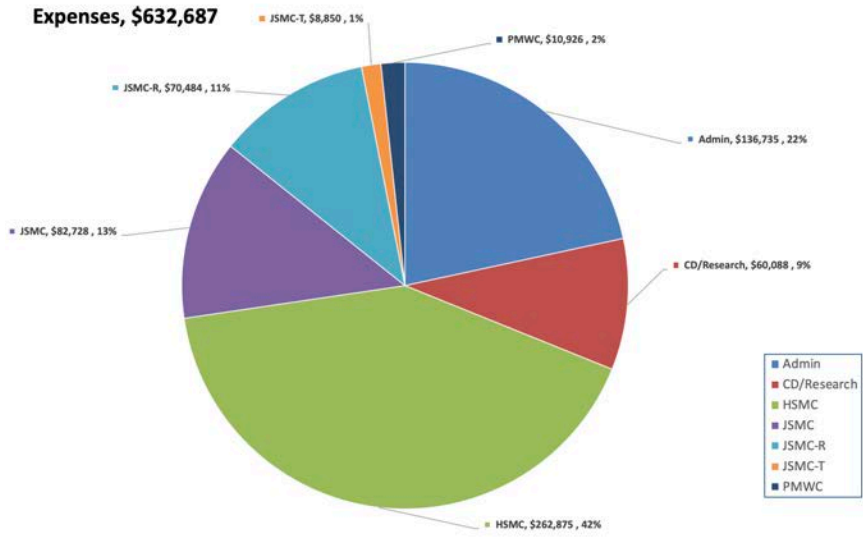
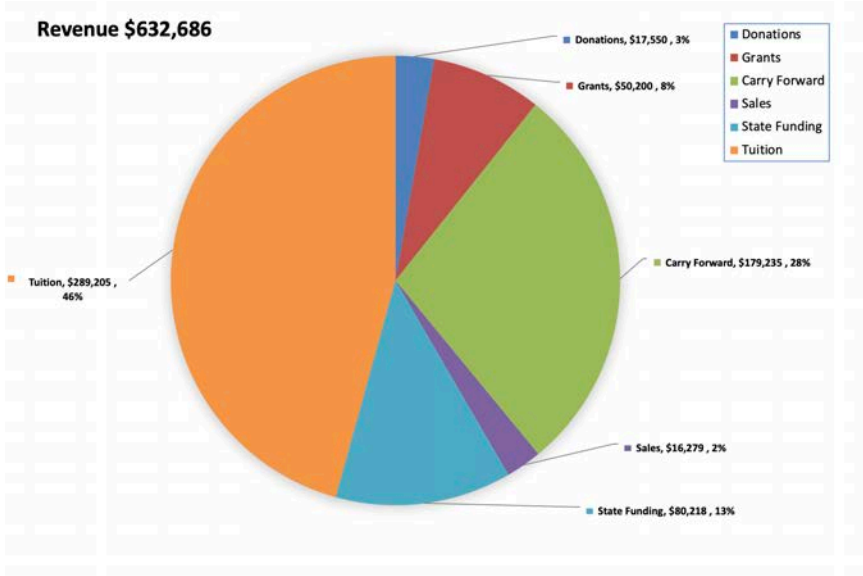
"This year the camp reminded me about the core of algebraic thinking which many of my college students have forgotten by that point in their education. This reminder of a time in a child's mind before algebra will improve my day-to-day teaching by allowing me to encourage a conceptualization of algebraic expression and equations. "

-2018 Texas State University Mathematics Lecturer, JSMC Master Teacher

"As a teacher, it is great to hear how the lesson was perceived by other observers. That unique perspective is rarely found in a typical classroom."

- 2018 Master Teacher

Finances FY18



Counting on Success

- 63 HSMC Students
- 17 HSMC Counselors
- 7 HSMC Research Mentors
- 10 HSMC Research Projects
- 48 JSMCR Students
- 12 JSMCR Counselors
- 175 JSMCH Students
- 22 Undergraduate Fellows
- 6 Graduate Research Assistants
- \$4.3 Million Total Mathworks Endowment**
- \$119K Scholarships Awarded**

True to the Mathworks record for success, 2018 marked another year of outstanding performance.

As our community grows, so does our impact. Thanks to generous donations both today and in years past, we are able to celebrate 29 years of high quality math education and research.

The commitment to sustaining this program continues to grow as we begin planning for the 30 year anniversary for Mathworks. Our partnerships mean more to us than ever as we plan and look to the future.

Moving toward a self-sustaining program remains a top priority as we move into the future. We wish to celebrate the combined gifts of nearly \$100K toward the endowment for the future.

Our Partners

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Herb Carter Endowed Scholarship
HSMC Alumni Partners
KLE Foundation
Kodosky Foundation
Mathworks Development
RGK Foundation

"Study group was great! There were people you could bounce ideas off of, people to joke around with, and we all had a great time solving problems. I have learned different math concepts but I have also learned a better way to learn things. My counselor taught me that the best way to learn was through doing."

-2018 JSMCR Student

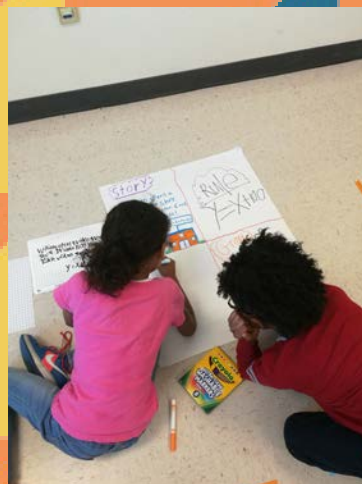
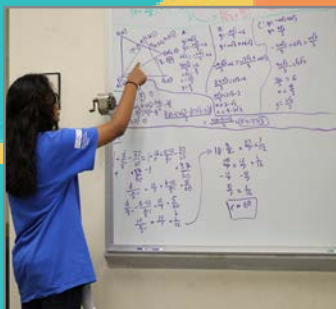
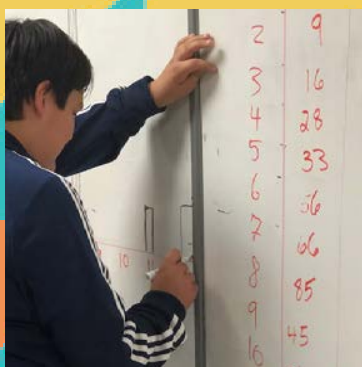


Our deepest thanks...

Mathworks is pleased to recognize donors who make it possible for us to provide high quality mathematics education and programs to students from all socio-economic backgrounds.

Thanks to the passion and commitment of you and your fellow donors the fiscal year ended with \$67,750 in donations and grants.

Large or small, your gift directly benefits the students and teachers that attend these outstanding programs and furthers research in math education.



Mathworks at Texas State University

Mathworks is a center for innovation in mathematics education at Texas State University.

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