

Apart, but not alone.



**Mathworks
2020-2021
Annual Report**



"I enjoyed study group the most. I am so grateful for my campers, for making my summer amazing even during quarantine. I think meeting up with my campers before camp started allowed for the first actual study group session to be more comfortable for all of us."

- HSMC Study Group

From the Director

Dear Colleagues, Friends, and Supporters,

The last two years have been quite a challenge for everyone—I hope you are all staying well. In this report, we describe the many programs Mathworks has offered, and how we have used this time to continue developing a new generation of leaders in Science, Technology, Engineering, and Mathematics (STEM).

The three pillars of Mathworks are Summer Math Camps, Teacher Professional Development (PD), and Curriculum Research and Development. Although we had to cancel our commuter Junior Summer Math Camp (JSMC), we nonetheless reached out to our largest group of participants ever to offer free seminars that excited the participants with applications of mathematics in different areas. We also worked with our Master Teachers and graduate students to develop new activities and resources for future camps, and new teacher PD resources to use in future summers. We replaced our residential JSMC with a virtual camp that had our largest group of students ever. Similarly, our Honors Summer Math Camp (HSMC) was expanded with the largest group of students and counselors we have ever had. More details about each of these programs are included in this report of activities for the past two years. Thanks to the generous support of our donors—including grants from H-E-B, the American Mathematical Society Epsilon fund, the Harman-Mayes-Sooch Foundation, and the Mathworks Endowments established by our Mathworks Steering Committee, alumni, and friends, we were able to ensure that all students could attend these programs regardless of their financial situations.

We provided training and support to teachers in McAllen at Brown Middle School to offer their own JSMCs using our Math Camp-in-a-Box materials. We also began an exciting program using the state adopted *Math Explorations* Curriculum in partnership with IDEA Public Charter School in McAllen that will prepare a group of students that has over 90% Hispanic and economically disadvantaged students for success in algebra by 8th grade or earlier. This program was made possible by generous support from the Harman-Mayes-Sooch Family Fund, and can be a model for what all students can achieve when they are provided outstanding teaching and support.

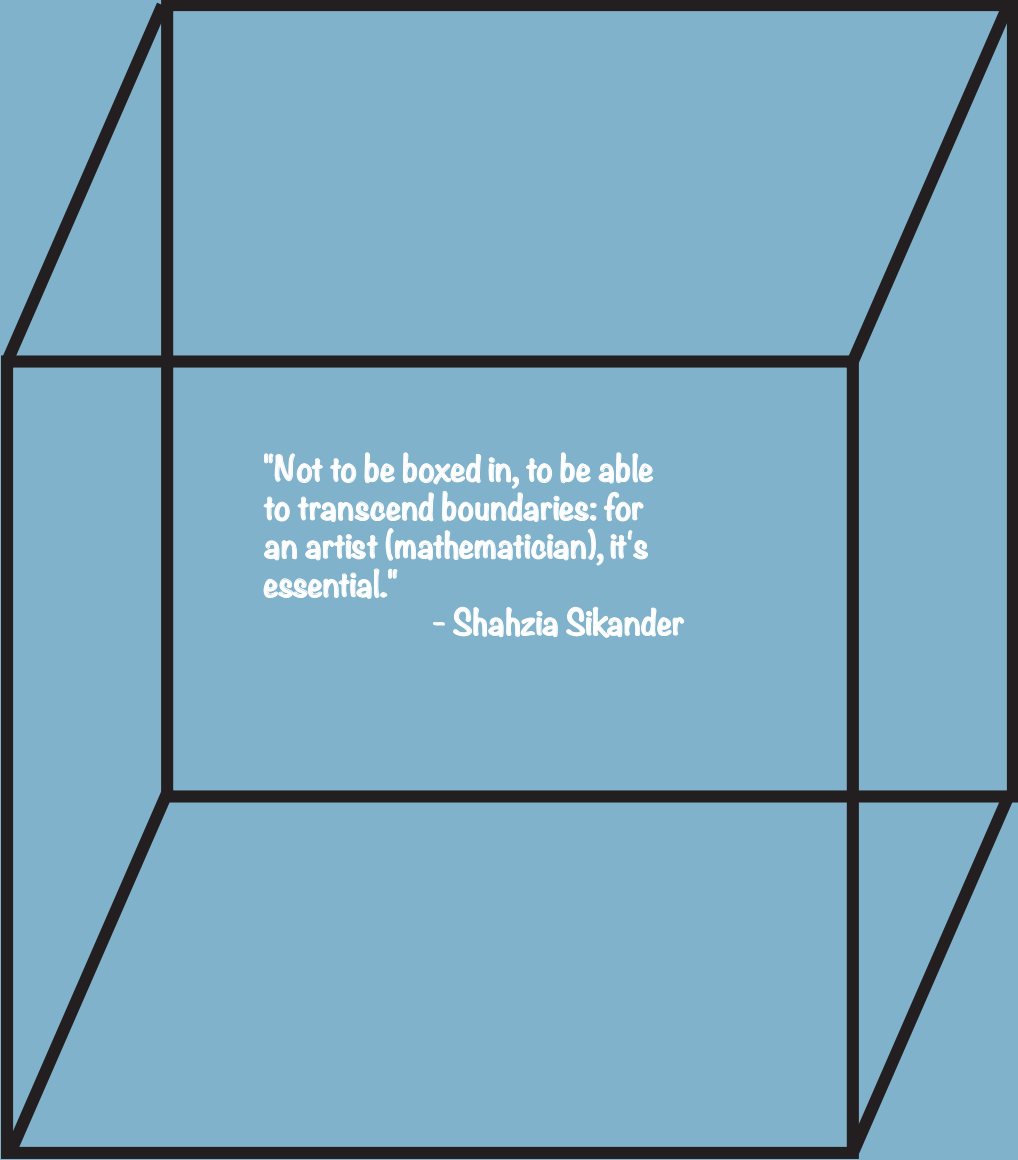
We look forward to returning to in-person camps this coming year with applications going online on Jan. 1, 2022 as usual. We are now working to engage all of our alumni and friends in a vibrant online community where we can share resources and ideas with one another. We invite you all to share your own ideas and to explore the many different programs that Mathworks offers for your families and friends.

With warmest best regards,



Max Warshauer,
Mathworks Director
Regents Professor of Mathematics





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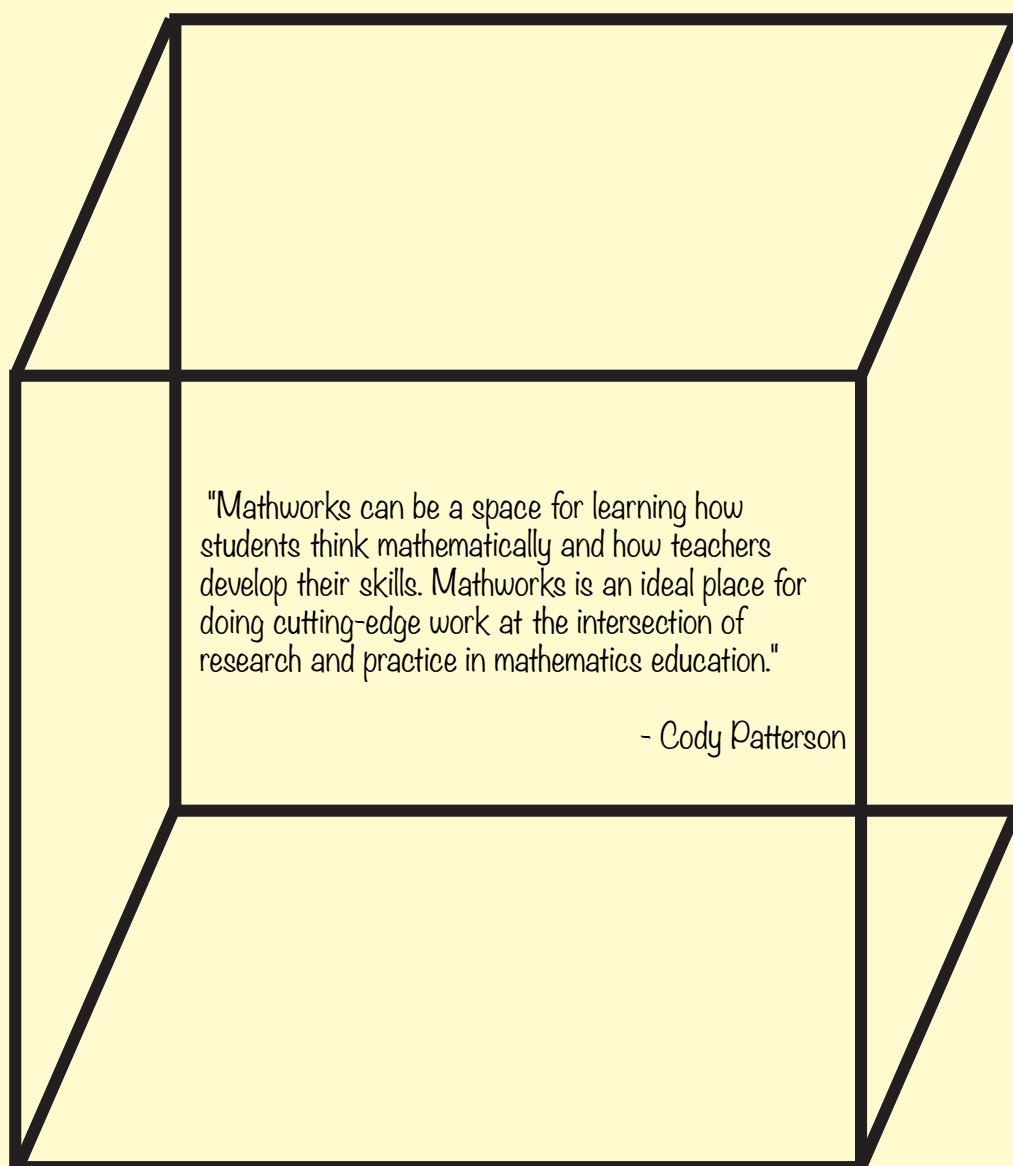
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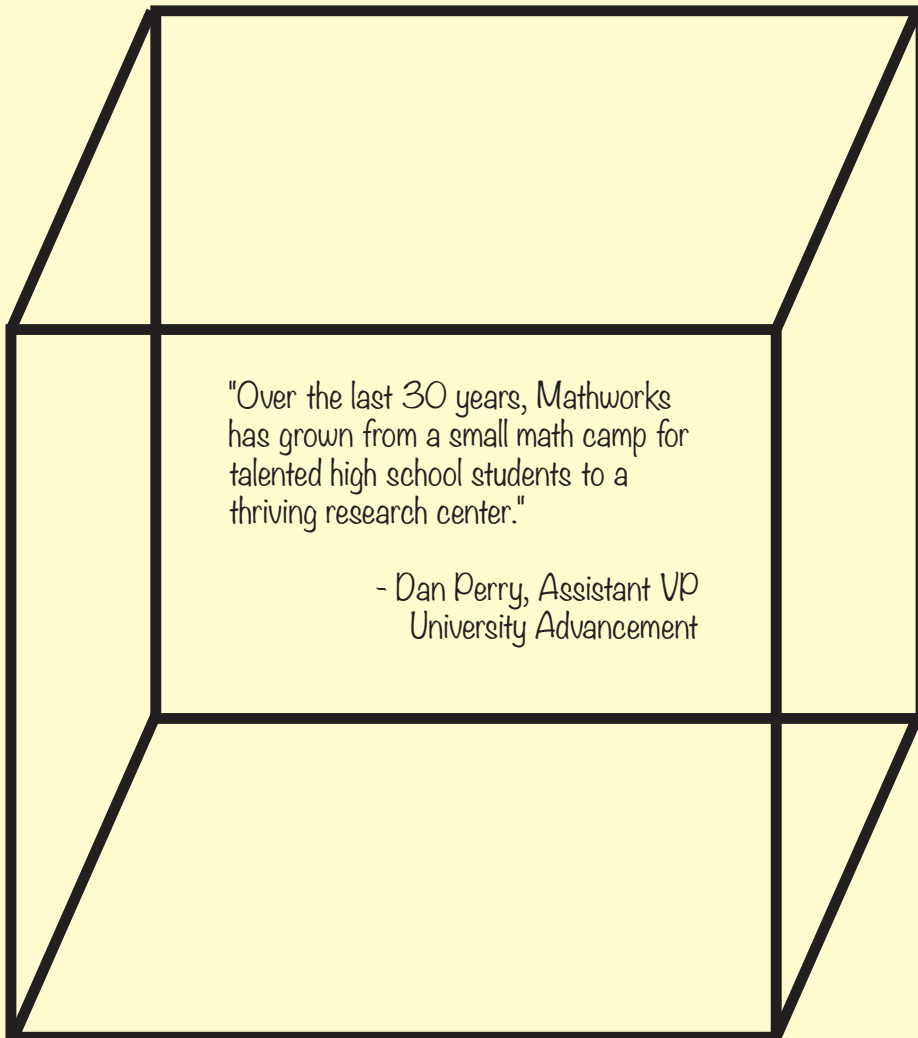
Mathworks Mission

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

Our mission is to research and develop model programs and self-sustaining learning communities that engage K-16 students from all backgrounds in doing mathematics at a high level.

The three pillars of Mathworks are summer math camps for middle and high school students, research and development of curriculum, and teacher professional development. These three pillars provide a foundation for all of the Mathworks programs, and a setting for conducting exciting research about the teaching and learning of mathematics.

Leadership Team



LEADERSHIP COUNCIL

Max Warshauer
Hiroko Warshauer
Cody Patterson
William Boney
Tim Chase
Eugene Curtin
Jian Shen
Susan Morey

TEXAS STATE UNIVERSITY

Denise Trauth, President
Gene Bourgeois, Provost
Christine Hailey, Dean, College
of Science & Engineering
Susan Morey, Chair, Department
of Mathematics

MATHWORKS STEERING COMMITTEE

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Howard Falkenberg
Jeff Kodosky
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Mathworks Guiding Principles

Doing Mathematics

Doing mathematics is about making sense of and thinking deeply about fundamental concepts. Students should learn to “think deeply of simple things,” (Arnold Ross). Students need to:

- 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

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

Persistence

Classroom Culture

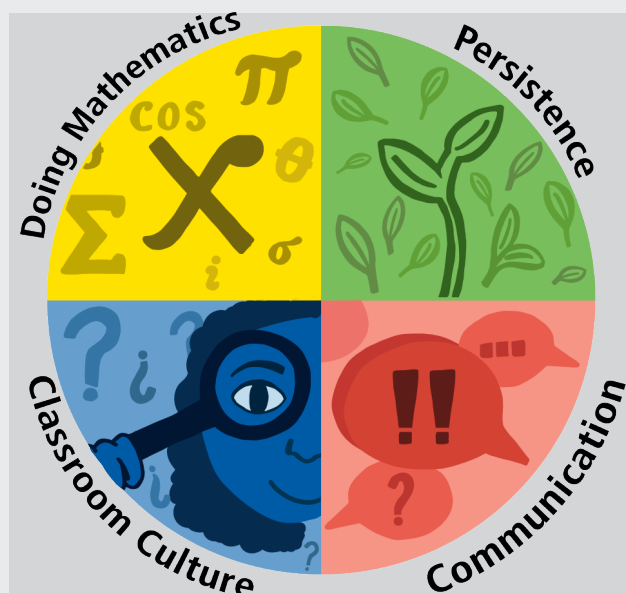
Teachers need to establish a classroom culture that develops students' curiosity and imagination. The keys to establishing this culture are to:

- 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

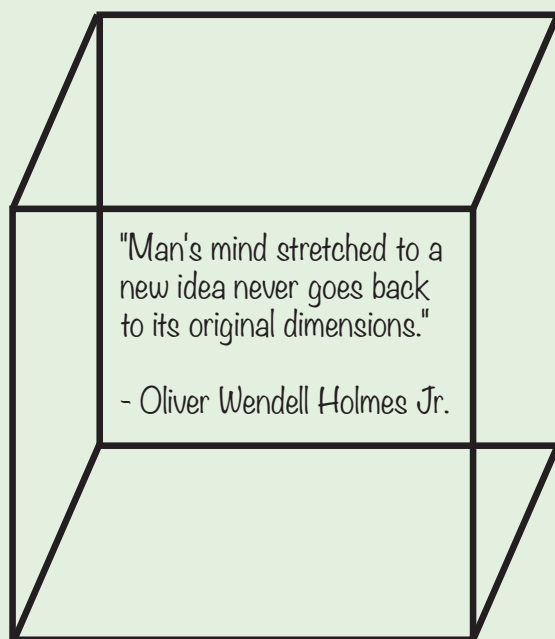
Communication between students and teachers is critical for learning. To facilitate this, teachers should:

- 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

Communication



FUNCTIONS



Max Warshauer, "A Superhero of Mathematics"

On August 5, 2021, Mathematical Association of America (MAA) president Michael Dorff delivered his Retiring Presidential Address, "Who Are the Frodos and Celies of Mathematics?" at MathFest, the summer national meeting of the MAA. In his address Dorff challenged the mathematics profession to recognize members whose greatest contributions to the field are in education, mentoring, and community service. Max Warshauer was named in this talk as one of 24 "Superheroes of Mathematics" for his success in educating over 4,000 young mathematicians through the Honors Summer Math Camp and Junior Summer Math Camp programs.

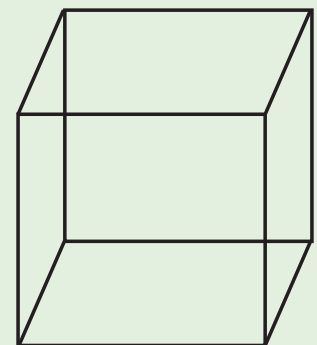
From the citation nominating him for this distinction: *"Max has a skill that I find to be incredibly rare among mathematicians: generating enthusiastic community support, shared purpose, and concerted philanthropic activity large enough to sustain a program without large, recurring infusions of public funding, which are increasingly difficult to secure. His work stems from a deep belief in every student's potential to do mathematics at a high level and his conviction that every student should have opportunities to experience mathematics as a human endeavor full of opportunities for exploration, insight, and joy."*

Math Camp Programs

Texas Mathworks strives to enhance every student's love for mathematics through research-based instruction that makes learning exciting and relevant.

"Mathworks programs are preparing our future leaders so that we can be competitive with the best students in the world."

- Max Warshauer



Junior Summer Math Camp (JSMC)



2020 JSMC

- 2 weeks
- June 8 - 19, 2020
- Program Canceled

2021 JSMC

- 2 weeks
- June 14 - 25, 2021
- Six virtual seminars
- Students: 272

The JSMC is a commuter two-week, multi-level math camp for students in grades 4 - 8. Because of COVID-19, the in-person commuter camp was canceled for summer 2020. However, we used this break to work with our master teachers to develop new activities and resources for future camps. Mathematics Department faculty members, Cody Patterson, Hiroko Warshauer, and Terry McCabe, worked online with 12 master teachers to discuss the Mathworks Guiding Principles: Doing Mathematics, Persistence, Classroom Culture, and Communication, and how these teaching practices are supported in our camps. These principles provide a foundation that we use to build a model math camp environment for learning mathematics at a high level. The participants developed new activities and teaching materials, authored by teachers and faculty for use in future JSMC classes and Professional Development (PD).

While we missed having the students each day during the camp, this time was critically useful for faculty and teachers to reflect on the Mathworks camp curriculum and practices and to develop new methods and resources for future camps.

Due to COVID-19, the in-person commuter JSMC was canceled again in 2021. To provide summer opportunities for local students, Mathworks faculty member Tim Chase, along with the Texas State Math Club, presented six interactive online activities free via Zoom to excite students about different areas in mathematics. Activity topics were geared towards different grade levels and covered a variety of interests. While we missed working with students in person, we are happy to report that the students who attended

our online classes thoroughly enjoyed the activities and enthusiastically participated in the virtual experience.

We had a total of 272 students apply to attend the JSMC activities. Of these students, 66 withdrew to pursue other available summer activities, and the remaining 206 students attended free of charge. The activities were designed for beginning students (Grades 3,4); intermediate students (Grade 5,6) and advanced students (Grades 7,8). Some students attended activities at multiple levels. The average attendance for each class was 69 students. The activity topics were:

1. Math "Magic" Tricks Using Topology (Grades 3,4)
2. Dots and Boxes – An Introduction to Game Theory (Grades 5,6)
3. Fun with Fractals (Grades 7,8)
4. Terrific Tangrams! (Grades 3,4)
5. The Marvelous Mobius Strip (Grades 5,6)
6. Exploring the Tower of Hanoi (Grades 7,8)

Dr. Tim Chase developed and coordinated this program. Tim worked with 5 undergraduate students from the Texas State Math Club who volunteered to help conduct the seminars. The students who attended this program had a wonderful time exploring exciting topics in mathematics. Each of these topics had in-depth mathematics content with the potential for further exploration. We hosted these online activities because we felt that it was important to continue the tradition of hosting activities for local students in our community who wanted to attend the JSMC. The impact on the students can be seen in some of the student comments from their final evaluations of the program:

Student Comments:

"It was also amazing to get to work with other kids who share a love for math. My teacher was also able to explain the problems in ways I could follow easily and understand. I had a lot of fun this summer at Mathworks and hope to come back next year!"

"The lectures were fun. I didn't know math was a part of Magic. I can't wait to show my friends what I learned."

"I learned that fractals are everywhere you look. They are in nature and in art. Before attending, I did not know math was all around me."

"I liked the math talks because I was able to have fun doing math. Sometimes math is boring in school, but these talks showed me that math can be fun."

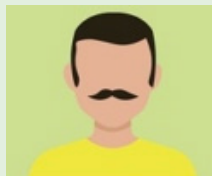
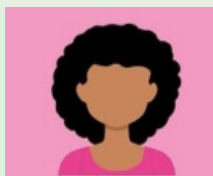
"I now see that math is more than just numbers. Math can be present in games, art, nature, and magic. These presentations showed me that I have more of an interest in math than I thought I did."



Junior Summer Math Camp - Residential (JSMCR)

2020 JSMCR

- 2 weeks - virtual
- June 7 - 19, 2020
- Faculty: 3
- Counselors: 19
- Staff: 3
- Students applied: 161
- Students accepted: 72
36 female, 36 male
- Scholarships: 21 students, \$19,199



Student Comments:

"I really liked the classes! He went through the topics very well which helped me understand it more. He started it off simple, then went through harder questions so that we had a deep understanding of how to solve these problems."

"This camp helped me develop a new way to see math and it got me a bit closer to what I want to become, an architect. This camp was different from others that I've been to for the other camps bore me to death while this camp was engaging and fun."

In early April 2020 we decided to conduct a virtual (online) camp to provide a high-quality environment for students to explore in-depth problem-solving. Despite the new platform and the challenges of conducting camp in a virtual environment, the faculty and counselors went to work to provide a fun environment for middle school students to learn and engage in doing high-level mathematics and share their talents and interests.

Campers "arrived" on Sunday, June 7th for the first virtual meeting with the entire camp. After everyone introduced themselves, the counselors and students met with their fellow campers and prospective study groups. The goal of the JSMCR is to develop young students as creative and critical thinkers. Mathematics faculty members, Eugene Curtin, Jian Shen, and Tim Chase met each morning with the students in Zoom classroom environments to teach topics including number theory, algebra, geometry, counting, logic, and other problem-solving topics. They nurtured students' interests and abilities to pursue higher level mathematics through hands-on instruction and study group interactions. To maintain the fun environment, the students had free time to meet online and enjoy sessions on baking, chess, exercise, calligraphy, scavenger hunts, and a t-shirt design project. The counselors provided support and encouragement in creating a cohesive Math Camp community. The first week ended with a colloquium, *All the Symmetry You Can Buy for Two Dollars*, given by Cody Patterson. He engaged the students in exploring problems together. The second week concluded with a talent show where the students showcased various musical talents and other skills.





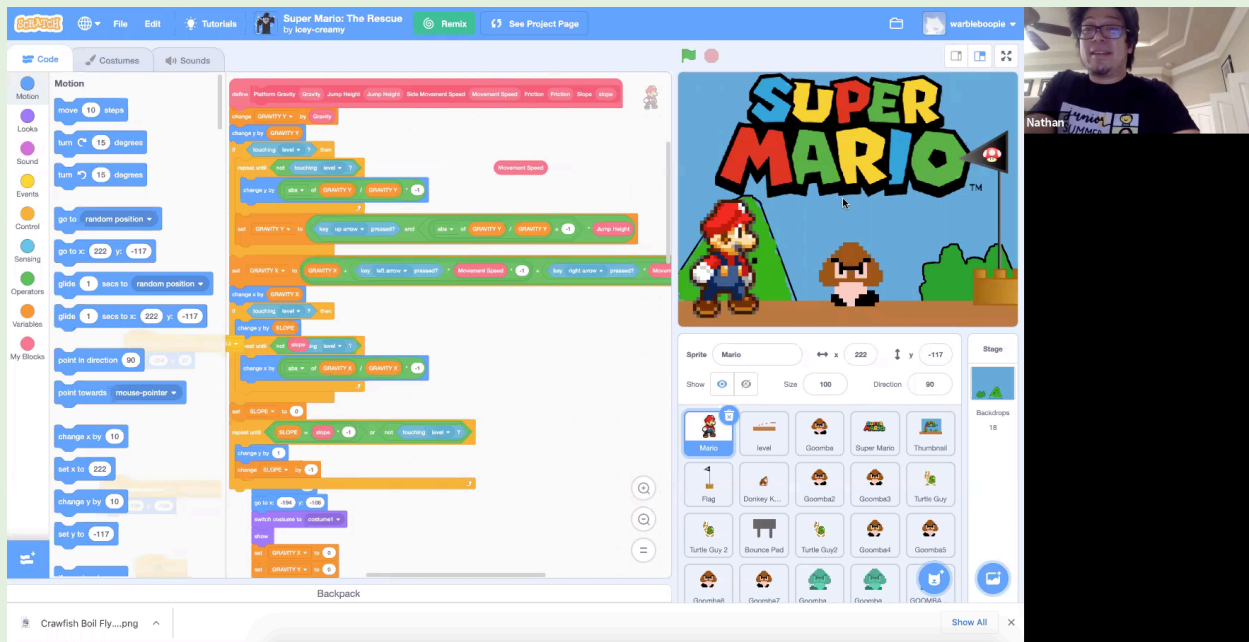
2021 JSMCR

- 2 weeks - virtual
- June 13 - 25, 2021
- Faculty: 3
- Counselors: 22
- Staff: 3
- Students applied: 134
- Students accepted: 85
42 female, 43 male
- Scholarships Awarded: \$26,000



Due to COVID-19, Mathworks again decided to conduct the 2021 JSMCR virtually while continuing to provide a high-quality environment for students to explore in-depth problem-solving. The JSMCR provided a fun environment for middle school students to learn, explore, and engage in high-level mathematics and share other talents and interests.

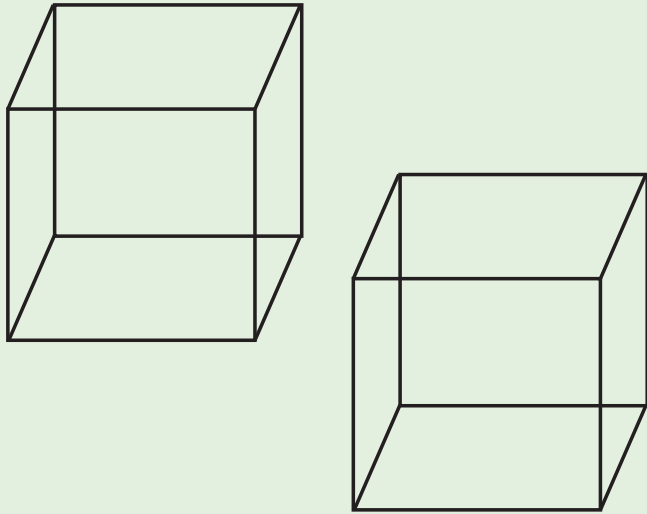
Campers began the JSMCR on Sunday, June 13th with a virtual orientation. Faculty and staff introductions allowed campers and counselors to meet over Zoom in breakout rooms with their study groups. During this time, study group members introduced themselves and began to foster the learning community that would flourish throughout the remainder of camp. Max then described how camp would be conducted online and shared the camp goal to help develop young students into creative problem solvers and critical thinkers. He also answered any questions that the students had, such as what free time activities were being planned.



Mathematics faculty members Eugene Curtin, Jian Shen, and Tim Chase met each morning and afternoon with students via Zoom to teach algebra, number theory, geometry, counting, logic, and other problem-solving topics. The faculty provided a fun and interactive environment while helping students build confidence in solving higher-level math problems. During camp, counselors supported a fun environment during free time by offering interactive activities such as word pattern games, Minecraft, card games, Codenames, Sporcle, baking, painting, and Tetris. A greater emphasis was placed on these online social activities this summer because feedback from our 2020 camps indicated that students missed some of the camaraderie that naturally occurs in an in-person camp.

The first week of camp concluded with a colloquium given by Nathan Warshauer, who is a math camp alum, MIT graduate, and software engineer at Electronic Arts, one of the largest game companies in the world. Nathan provided insights about how mathematics applies to video game development and the importance of working together like we do in our daily study groups. The second week concluded with a talent show where the students showcased their various talents, including songs, music, and humor.





Mathworks Math Contest

Mathworks continued to conduct the annual Mathworks Math Contest (MMC) for middle school students to explore mathematics and be challenged by high-level problems.

The MMC is a 15 question test that is proctored by math teachers and coaches. During the pandemic, parents were allowed to proctor the exam as well. The exam is a rigorous set of problems designed to help Mathworks identify students who might enjoy participating in the JSMCR program. All MMC participants are encouraged to apply to the JSMCR. The MMC problems provide a beginning point for classes taught by math camp faculty during the JSMCR.

In the past, the MMC top performing students represented the United States in the Primary Math World Contest (PMWC) in Hong Kong. For many years the Mathworks teams have earned distinction including both the overall champion recognition and the Po Leung Kuk Cup as the top non-Asian team. Due to COVID-19, the PMWC was canceled for the second year in a row.

2019 MMC

- 483 students took the test.
- 32% Female; 68% Male
- 0.2% scored 15 out of 15
- 11.4% scored 6 out of 15

2020 MMC

- 300 Students took the test.
- 34% Female; 65% Male, 1% Unspecified
- 0.3% scored 14 out of 15
- 14.7% scored 6 out of 15

JSMCR Student Comments

"JSMC has made me become a better mathematician and helped me make friends...it has helped my public speaking, explaining and courage skills. Additionally, study group was very fun and special, as we could seek help from our counselor and peers. During the first study group, I was only able to solve around three problems. However, each study group I was able to solve more and more. Overall, I feel a lot more motivated to study math."

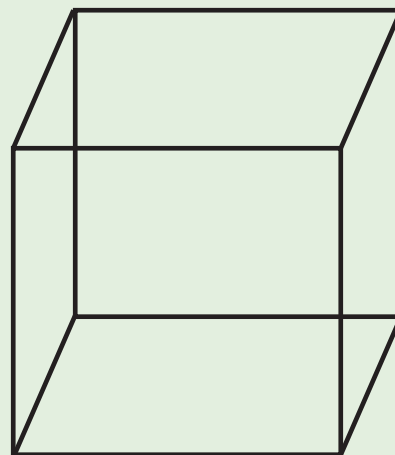
"This camp was different from other camps, because it wasn't about just a very traditional take on math but explores the different and often more interesting facets of less-explored subjects."

"Before camp started, I had lost a lot of motivation to do math, something that had once felt rewarding. However, once I started camp, I saw the reason I had loved it in the first place. Immersing myself back in the world of math from this camp was something that truly reinvigorated me... The rigorous curriculum and schedule of this camp is so unlike any other camp I've attended. The study group made it fun and interactive, our lessons in the morning and early afternoon taught me many new points of knowledge, and the activity sessions were a great, unique way to take what I learned and apply it to real world situations... This is a phenomenal, well-organized program and I hope that I will be able to return in the very near future!"

Honors Summer Math Camp (HSMC)

2020 HSMC

- 6 weeks, June 21 - July 31, 2020
- Faculty: 7
- Counselors: 19
- Research Mentors: 9
- Research Projects: 16
- Staff: 4
- Students applied: 287
- High School Students Accepted: 70
 - 32 First-year
 - 27 Second-year
 - 11 Third-year
- Scholarships: 15 students, \$39,000



In 2020, the HSMC was conducted using a virtual platform for an exciting six-week, intensive learning environment for 70 talented students (38 female, 32 male). Using Zoom the students had classes in a virtual classroom, nightly study groups, and free time to meet with faculty, peers, and mentors.

A typical camp day included classes, free time activities, and two-hour nightly study group sessions. First-year students took *Number Theory* taught by Max Warshauer followed by *Honors Seminar* taught by Ellen Couvillion. During *Honors Seminar*, students read *The Five Elements of Effective Thinking* by Mike Starbird and Ed Burger and explored connections to the topics being studied in *Number Theory*. First-year students also learned to program using *Mathematica*, a mathematics programming language, instructed by Don Hazlewood and Carol Hazlewood. The *Mathematica* course allowed students to program the algorithms studied in *Number Theory*, compute examples, and test conjectures. This course helped students learn to use computational tools for research in STEM, which creates a foundation for success for students who return to work on original research projects in the HSMC second-year and third-year programs.

Meanwhile, the returning students worked on research projects in the morning in small groups mentored by faculty from Math and Computer Science. They then took afternoon classes in *Analysis* taught by Tim Chase and Terry McCabe, and *Abstract Algebra* taught by Eugene Curtin. All students attended nightly study groups led by an incredible group of counselors, working in groups of 3 or 4 students. The study groups provided a setting where the students could work together on problem sets from the courses. We had an outstanding group of speakers in 2020 on a wide variety of topics, including:

- June 26 Lisa Lowrance, *My Time at Math Camp and The Five Color Theorem*
- July 3 Mike Starbird, *Doughnuts, Dogs Bones, and Topology*
- July 7 Admiral Bob Inman, *Life Story and the Challenges we Face*
- July 10 Evan Dummit, *Pick's Theorem and Farey Fractions*
- July 17 Kate Melhuish, *A Window into the World of Mathematics Education Research*
- July 18 David Bamberger, *Bamberger Ranch Conservation and Stewardship*
- July 24 Dan Shapiro, *Integer Sequences and Divisibility*
- July 28 HSMC Presentation of Research Projects, Part 1
- July 29 HSMC Presentation of Research Projects, Part 2
- July 31 Lauren Ancel Meyers, *Modeling to Mitigate the COVID-19 Pandemic*

Camp officially ended on July 31 with a talent show. However, counselors, second-year, and third-year students continued to work on the sixteen different original research projects with their faculty mentors into the fall. Read about the research projects in the Research section of this publication.



Student Comments:

"I now feel more confident and prepared to apply these concepts in the future. I was able to find more creative solutions to problems I wouldn't have been able to solve previously... This camp required me to think more thoroughly about the connections between simple concepts...we were taught the different concepts through exploration."

"I really enjoyed HSMC this year... the inclusion of study group is one of the most outstanding parts of the program in relation to other experiences I've had. Study group really helped me bond with people that I might not have gotten to know and also helped me learn the importance of collaboration... Another thing that has made HSMC such a uniquely enriching experience are the educators... Another standout trait of HSMC is the colloquiums, which were all very engaging, fun, and exciting. I learned something from every single one and really felt like they gave me not only more mathematical knowledge and scope but also wisdom about life itself."

"Dr. Meyers may have been the most relevant to me since she talked about modeling viruses which is basically my research project. My favorite activity in the camp was research. At first, it was a little frustrating because we didn't have an exact clear path (sort of hard to find something "new" with COVID). However, Dr. White helped us find a good idea of taking into account spatial movement and is continuing with us after camp. I appreciate his time in helping me and my fellow researchers find something new for COVID."

"Playing social deduction games with my study group quickly became something I looked forward to every day. In lieu of the in person bonding time we would normally have, my group played everything from online One Night Werewolf to Avalon to Spyfall and more. Least favorite part: I miss being in-person and getting to spend 24/7 with all these amazing people. More specifically, I miss the weekend trips."

Honors Summer Math Camp (HSMC)

2021 HSMC

- 5 weeks, June 27 – July 30, 2021
- Faculty: 8
- Counselors: 21
- Research Mentors: 9
- Research Projects: 17
- Staff: 4
- Students applied: 375
- High School Students Accepted: 83
 - 36 First-year
 - 30 Second-year
 - 17 Third-year
- Scholarships Awarded: 12 students, \$19,750

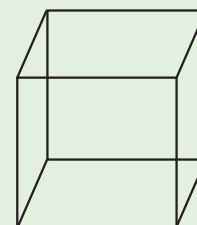
Our counselors included 5 students from MIT, 2 from the University of Texas, 3 graduate students from Texas State; as well as students from the University of Pennsylvania, Johns Hopkins, Stanford, Carnegie Mellon, and several advanced high school students. 18 of these students were math camp alumni who had attended Mathworks camps at least 2 years, and in many cases 5 or more years.

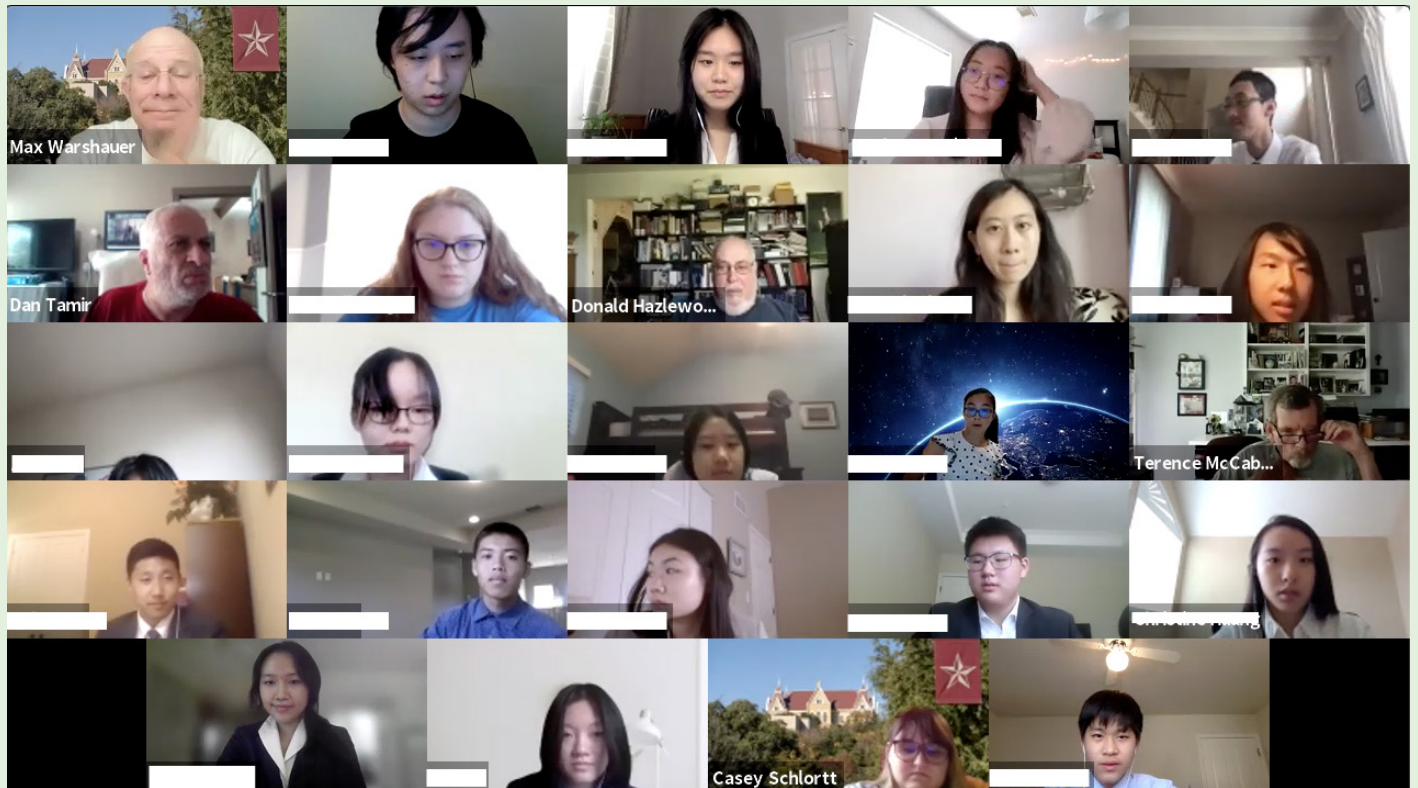
Due to COVID-19 Mathworks also conducted the 2021 HSMC virtually. The HSMC used Zoom and Canvas platforms to create an exciting interactive five-week math camp that immersed students in doing mathematics. Following the same outline from the virtual camp in 2020, the first-year students attended *Number Theory*, *Honors Seminar* and learned programming using the *Mathematica* software.

Second-year and third-year students participated either in *Statistical Learning for Research* with Alex White (and related research problems) or research projects of their choosing in the morning. Second-year students then took an *Analysis* course taught by Tim Chase and Terry McCabe in the afternoon, while third-year students took *Abstract Algebra*, instructed by Eugene Curtin. All camp counselors attended a *Teaching Seminar* conducted by Tim Chase before facilitating nightly sessions with their study groups. Students attended two-hour study group sessions with their designated counselors. These sessions provided an opportunity for students to collaborate and work on problem sets in small groups. Each study group included a counselor and three or four students.

Throughout camp, counselors offered a large variety of free time and weekend activities, including baking, Fishbowl, Chess, Spyfall, Poker, calligraphy, Trivia, and many more. At the end of each week, we had a colloquium featuring a special guest speaker, with topics including:

- July 2 Mike Starbird, *The Art Gallery Theorem*
- July 6 Admiral Bobby Ray Inman, *Life Story and World Affairs*
- July 9 Gail Burrill, *Mathematics is Awesome*
- July 16 Dan Shapiro, *Triangular Reptiles*
- July 23 Lauren Ancel Meyers, *COVID-19 and Pandemics*
- July 30 Nathan Warshauer, *Video Games and Future Directions*
- July 27 HSMC Presentation of Research Projects Part 1
- July 28 HSMC Presentation of Research Projects Part 2





Student Comments:

"The Honors Summer Math Camp was a really great experience... I now feel more confident and prepared to apply these concepts in the future. I was able to find more creative solutions to problems I wouldn't have been able to solve previously... This camp required me to think more thoroughly about the connections between simple concepts...we were taught the different concepts through exploration."

"As a kid who has loved math since I was young, this camp was very fulfilling for me. It was much different than any other math class I've taken and used concepts that I have never used. I went from possibly majoring in math in college to certainly majoring in math."

"Since I was a little kid, I have always been doing math, but I haven't always enjoyed it. HSMC brings satisfaction and enjoyment through mathematics. The environment, the content, and the people all somehow manage to make me simply enjoy everything. Each year I look forward to the summer, and Mathworks camps are the reason why."

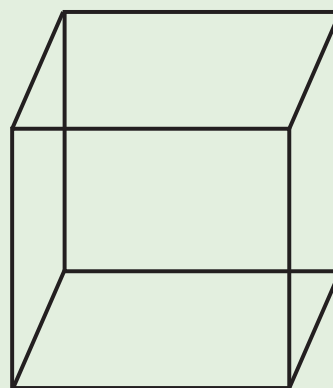
"The Mathworks program was extremely influential – showing me that math can be enjoyable, introducing new ways to think about ideas, and connecting me with a community of amazing people."

HSMC Research Projects

In 2020, 49 high school students worked on 16 original research projects mentored by Texas State Faculty; in 2021, 59 students worked on 17 projects. Although camp has ended, many students participating in research continued to work on their research projects with their faculty mentors. Some of these projects will be submitted for publication and/or entered into science and math competitions.

2020 HSMC Research Projects

- Tableau Stabilization (Jacob D. David, Christopher Wu); Mentor: Suho Oh
- Comparative Analysis of Haplotype Assembly Algorithms (Daphne Han, Pierce W. Lai, Sarah Wei); Mentor: Shuying Sun
- BS Co-Methylation Patterns in Breast Cancer Samples (Flora Cheng, Jael J. Dammann, Christine Tian, Alice L. Zhong); Mentor: Shuying Sun
- Counting Prime Graphs of Finite Solvable Groups (Ishita Goluguri, Eli P. Meyers, Kenta J. Suzuki); Mentor: Thomas Keller
- Generalizing Kirchhoff Laws for Signed Graphs (Amelia Yixin Hu, Skyler J. Johnson, Peter Ye); Mentor: Lucas Rusnak
- An Oriented Hypergraphic approach to Hadamard's Conjecture (Russell A. Li, Eric Yan, Justin Y. Yu); Mentor: Lucas Rusnak
- Simultaneous Compression and Encryption Using Improved Shannon-Fano-Elias Codes (Amy K. Chang, Rebeca De La Garza, Andrew C. Jiang, Aman A. Tewari); Mentor: Dan Tamir
- Score-based Evaluation of Pseudo-Random Number Generators (Ethan Liu, Jonathan C. Liu, Isabella Quan); Mentor: Dan Tamir
- Parametric Representation of Point Clouds Through Interpolation (Susan Janet Hamilton, Alan Lin, Jason S. Wu); Mentor: Dan Tamir
- Computing with Words in Threat Detection Systems (Alicia Y. Lin, Raghav G. Samavedam, Samuel Tian, Richard Z. Zheng); Mentor: Dan Tamir
- Student Definitions of Success at an Informal Math Camp (Angela P. Landry, William Wang); Mentor: Cody Patterson
- Analysis of the Spread of COVID-19 and Impacts of Mitigation Interventions by using Cellular Phone Mobility Data in Jilin, China (Alkiviades Boukas, Sophie T. Cui, Esther M. Lee, Mary M. Lee); Mentor: Alex White
- A Multivariate Analysis of COVID-19 Disparities in 254 Rural vs Urban Counties in Texas using Multiple Linear Regression Models (Amber K. Luo, Charles Sean Sun, Jasmine Wang, Sophia Zhong); Mentor: Alex White
- Poisson Process Analysis of Classroom Observation Data (Jennifer J. Zhang, Annie Z. Zhu); Mentor: Alex White
- Determining Explicit Forms and Relationships between Liouville Manifolds (Alice Shanshan Guo, Naomi Kenyatta, Michelle Xiang); Mentor: Hiro Lee Tanaka
- Graph Balancing for Network Data Analysis (Rachel A. Laing, Allen Z. Wu); Mentor: Jelena Tesic



2021 HSMC Research Projects

- Stanley's Conjecture for Triconed Graphs (Jacob David, Pierce Lai, Christopher Wu);
Mentor: Suho Oh
- Studies on Spatio-Temporal Patterns of COVID-19 Pandemic in United States using DMD (Amy Chang, Katie Murphy, Ayush Suresh, Richard Zheng); Mentor: Young Ju Lee
- How Novices Summarize and Explain the Key Ideas of Analysis Proofs (Angela Landry, Mary Lee); Mentor: Kate Melhuish and Michael Hicks
- Using Process Mining Techniques on Classroom Data (Sabrina Hu, Bibiane Kan, Hanna Kenyatta, Reiyah Jacobs, Juhi Pandit, Aaron Piando, Cynthia Zhang);
Mentor: Kate Melhuish
- Minimal Prime Graphs of Solvable Groups: Properties, Size Bounds, and Generalizations (Jael Dammann, Ethan Liu, Christopher Qiu, Devan Shah); Mentor: Thomas Keller
- Exploration of Topological Implications of Asymmetric 2 -Colorings of Graphs (Rebeca De La Garza, Alicia Lin, Klarissa Tey); Mentor: Tim Chase
- An Exploration of the Jones Polynomial in Knot Theory (Zaina Ali, Corona Chen, Sophie Cui, Jasmine Wang); Mentor: Tim Chase
- Generalizations of the Tutte Polynomial (Alice Guo, Andy Jiang, Oliver Kahn, Rich Wang);
Mentor: Lucas Rusnak
- Scientific Workflows (Jonathan Liu, Samuel Salter); Mentor: Rodion Podorozhny
- Generalizing Kirchhoff Laws for Hypergraphs (Amy Guan, Skyler Johnson, Jennifer Yan, Peter Ye); Mentor: Lucas Rusnak
- Improving Shannon-Fano-Elias Rate and Encryption Resilience (Jeffrey Liu, Charles Sun);
Mentor: Dan Tamir
- From 3D Point Cloud To Parametric Representation (Nikola Cao, Sophia Zhong, William Wang); Mentor: Dan Tamir
- The Utility of Distributed Ledger Technologies in Management and Integrity Validation for Big Data Applications (Alissa Shen, Samuel Tian, Ethan Yang, Dylan Yu);
Mentor: Dan Tamir
- Chess Rating Prediction (Evan Lai, August Warshauer); Mentor: Alex White
- Analyzing Trends in Spotify Data Using Multivariable Data Science (Christine Huang, Bibiane Kan, Hanna Kenyatta, Tina Li, Michelle Xiang); Mentor: Alex White
- What Online Behaviors Best Predict Academic Performance? (Sabrina Hu, Reiyah Jacobs, Cynthia Zhang, Jennifer Zhang); Mentor: Alex White
- Effects of Diet on COVID-19 Deaths (Michelle Chen, Flora Cheng, Aaron Guo, Alice Zhong);
Mentor: Alex White

Mathworks Curriculum

Free Curriculum Available During Covid-19

As the news about the COVID-19 pandemic spread, many schools decided to move the remaining 2020 spring semester to online instruction. When the shift took place, Mathworks decided to provide parents and teachers the opportunity to use the Mathworks curriculum products for free.

As a result, 516 products were downloaded as parents and teachers scrambled to find quality math products for their students. The majority of recipients of the free curriculum reside in Texas. However, nearly 20 percent of the individuals were from outside of Texas, some even from outside the United States.

2020 Curriculum Sales	
<i>Math Explorations</i>	\$17,641
<i>Math Quest</i>	\$ 665
Total Sales	\$20,587

2021 Curriculum Sales	
<i>Math Explorations</i>	\$10,806
<i>Math Quest</i>	\$ 1,600
Total Sales	\$12,406

Math Quest Camp Curriculum

From a first-year program that introduces students to beginning concepts in algebra through play-acting and drama (dramathics), to a more advanced program in problem solving and discrete math, students enjoy exploring problems together and share in the excitement of mathematical exploration and discovery.

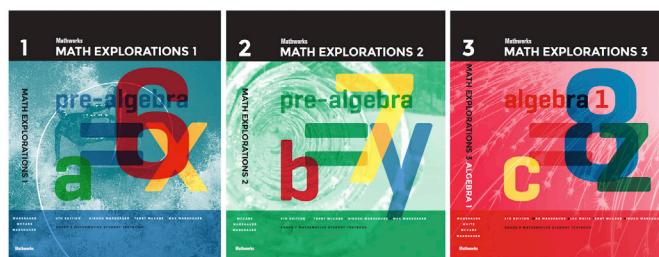
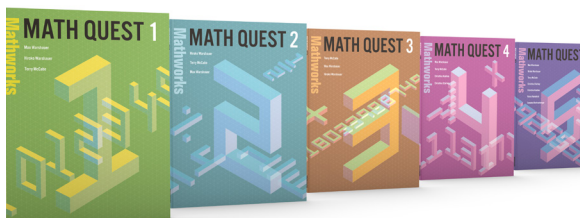
The *Math Quest* Curriculum has been used during the Junior Summer Math Camp for the past 25 years. With years of research associated about best practices and the model program, this curriculum ultimately became the foundation for the Texas State adopted *Math Explorations* Curriculum.

"The math problems are more challenging but they make it easier to learn."

- Former Math Quest Level 4 Student

"My name is Zachary. 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."

- Former Math Quest Level 2 Student



Math Explorations Academic Year Curriculum

Math Explorations (Texas State adopted curriculum for middle schools) is a series of three textbooks that cover the Texas Essential Knowledge and Skills (TEKS) for 6th grade, 7th grade, 8th grade, and Algebra I. The textbooks integrate research from the laboratory of our summer math programs that have been held for more than 25 years.

With this curriculum, young students are engaged in using algebraic ideas which are built upon 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.

Academic Year Program (AYP)

With resources made available from the canceled JSMCH program, funds were allocated to the AYP and to support a new JSMC at Brown Middle School in McAllen, Texas. The remaining funds have been encumbered to support the AYP during the coming academic year, designated as salary for a remote teacher. The AYP is offered free to all participants with funding provided by the Harman-Mayes-Sooch Family Fund (HMS). Our partner school district is providing support for an in-class co-teacher, and administrative support for students and parents.

The AYP was designed to prepare all students for success in algebra and higher-level mathematics. This is a new initiative that is made possible by the HMS Family Fund and links the state-adopted *Math Explorations (ME)* curriculum to a program conducted under the auspices of Mathworks. There were several steps in putting this program together:

Step 1: Identify a lead teacher

We needed to find a talented master teacher to build a scope and sequence that provides a guide for the pacing when teaching the *Math Explorations (ME)* curriculum. We also needed to develop benchmark tests that would give schools confidence that *ME* would enable their students to do well on the statewide State of Texas Assessments of Academic Readiness (STAAR) achievement tests by which school districts are judged.

In the spring semester, we found an incredible teacher to work with, Shamaa Lakshmanan. Shamaa was a past chair of the Mathematics Department at the Ann Richards School for Young Women Leaders in Austin, and before that, a mathematics teacher at the Kealing Magnet School in Austin. She has experience teaching grades 6-12. Our plan is to offer a three-year program that will prepare all of the students in the cohort to work through Algebra I by the end of 7th or 8th grade.

Step 2: Program preparations

Master teacher develops support materials to use when teaching *ME*. *ME* is a Texas state-adopted curriculum aligned with the Texas Essential Knowledge and Skills (TEKS). Based on teacher feedback, we developed support materials to assist teachers in addressing the learning goals in the Texas Essential Knowledge and Skills (TEKS) as well as the Common Core state Standards (CCSS). Shamaa developed the following resources:

- A TEKS/CCSS alignment chart. This chart allows the viewer to quickly see what TEKS/CCSS are covered in each of the different *Math Exploration* volumes, as well as in which specific chapter they are found.
- STAAR-aligned daily exit tickets that correlate with each section of the *Math Explorations* curriculum.
- STAAR/CCSS aligned Benchmarks for both 6th and 7th grade.
- Chapter Tests for both *ME 1* and *ME 2*
- *ME 1* Digital Notebook. In lieu of the paper workbook, students can complete activities through Google Slides, where their work is accessible to the teacher.

Step 3: Identify a school partner

Identify a partner school to work with their students, administrators, teachers, and parents.

In the spring semester we identified a wonderfully supportive public charter school, IDEA public school in McAllen. We knew about IDEA since their past principal, Jose DeLeon attended the HSMC as a high school student in 1994. Jose was a migrant worker and an incredible student. After attending the HSMC, Jose continued his education at MIT, and then decided to return to the Rio Grande Valley to work in education. Two of his children also attended Mathworks camps, and several of the IDEA students had previously attended our JSMCR when it was in-person.

Terry McCabe (retired Math Professor), Max Warshauer and Shamaa Lakshmanan visited IDEA in the spring to meet with their students, parents, teachers, and administrators. With the IDEA administration, we formulated a plan to recruit a cohort of students for a three-year pilot program. The students will be introduced to algebraic ideas in *ME 1* and *ME 2* curriculum in the first and second years, and then complete Algebra I in the third year or earlier. The program will be taught online by Shamaa, assisted by a designated teacher from IDEA in McAllen. In year 2, Shamaa will work with another teacher, while her co-teacher from year 1 will begin a second cohort.

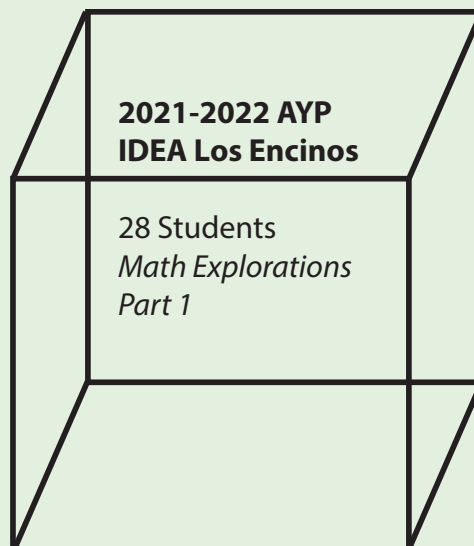
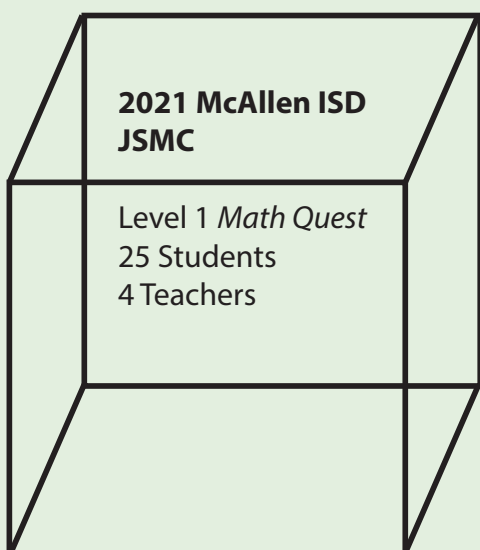
Step 4: Offer the Program

Shamaa described the program at IDEA as follows:

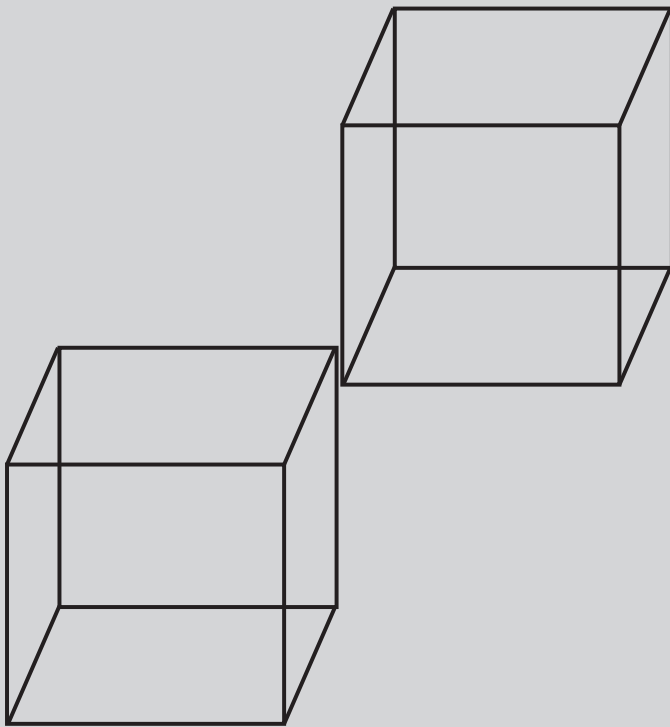
“Currently, I am piloting ME 1 with a 6th grade class in McAllen at IDEA Los Encinos. IDEA Los Encinos is a 6-8 charter school where 95% of students are on free and reduced lunch. My class is composed of 28 Hispanic students, 14 boys, 14 girls. Of the initial 28, 15 students requested to be a part of the pilot program. 3 out of the 28 passed last year’s STAAR exam, while 15 of the students are first year US students. The year has started off well, the students are responding to the curriculum, but there have been several challenges, namely Covid. Within the first week of school, 10 students are absent/quarantining. Students are unable to get up and move around the classroom which does not allow many of the full body explorations that the ME curriculum provides. For example, I was unable to have the students engage in the United we Stand activity since they were unable to get up out of their seats. Along the same lines, collaborative work is limited to partner work. One of the many powerful practices within the Mathworks curriculum is the ability to collaborate in groups of 4 to talk about and explore mathematical topics. Nevertheless, both the teacher on the ground, Mr. David Coddington, and I are pleased with the students’ participation and engagement with the curriculum and we have both been amazed and excited to hear students’ observations and thinking. I will be giving the students a short survey soon to get their feedback on how they are enjoying this method of Math learning.”

This is one of the most exciting programs we have ever undertaken, since it can show that ALL students are capable of succeeding in algebra by the 8th grade or earlier. We have built a replicable model and the resources to take the program to scale. We are also planning to invite many of the cohort students to attend our JSMCR next summer where they will get even more experience doing higher-level math problem solving. In short, the AYP provides opportunities to build a statewide network of camps and academic year programs that will reach out to and include disadvantaged students who have not had the opportunities that these programs provide.

The AYP and summer math camps have been supported by this grant from HMS, which is paying for the AYP teacher salary as well as for books and supplies for the students. We hope that HMS will be able to continue support of this program in future years.



Professional Development



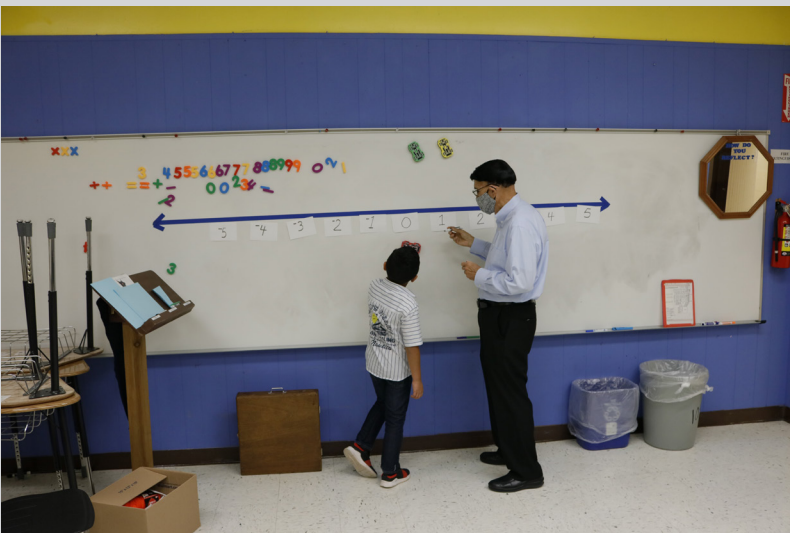
The Mathworks Summer Teacher Professional Development (PD) program prepares teachers to engage students of all backgrounds in doing mathematics at a high level. This PD equips elementary and middle school teachers with the mathematical background and teaching tool to give all students the foundation needed to succeed in algebra and higher-level mathematics.

Typically the program runs in conjunction with the Junior Summer Math Camp commuter program (a two-week, multi-level math camp for students in grades 4 - 8. Because of COVID-19, this camp was canceled for summer 2020. Although the students did not get to attend, Mathematics Department faculty members Cody Patterson, Hiroko Warshauer, and Terry McCabe worked online with 12 master teachers to discuss the Mathworks Guiding Principles: Doing Mathematics, Persistence, Classroom Culture and Communication, and how these teaching practices are supported in our camps by our curriculum and the teachers. These principles provide a foundation that we use to develop a model math camp environment for learning mathematics at a high level. The project resulted in written material, authored by teachers and faculty for use in future JSMCH classes and teacher professional development.

Outreach

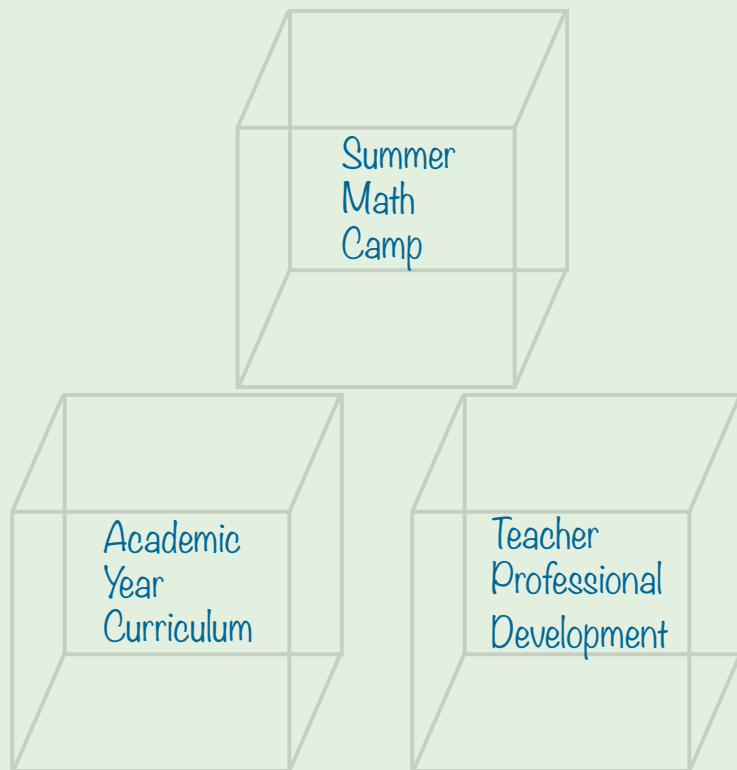
Focusing on the Mathworks Mission: McAllen ISD

Replicating the success of the camps, curriculum, and professional development in the central Texas area, Mathworks partnered with McAllen ISD to support their goals.



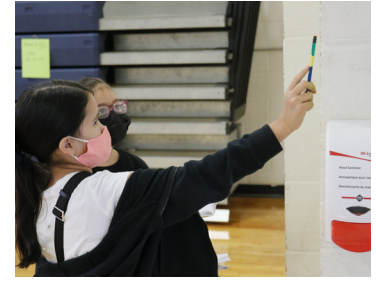
Professional Development for McAllen ISD Teachers

Mathworks provided the McAllen JSMC teachers a week-long Professional Development workshop conducted by Melissa Freese, a master teacher at the San Marcos JSMC for over 12 years. Melissa used the Mathworks Professional Learning Resource (PLR), developed by master teachers and Mathworks faculty, and the *Math Quest* Level 1 curriculum to prepare the McAllen teachers for their two week JSMC. Melissa reflected that while being in person would have been better, the zooming with the camp staff at McAllen was enjoyable and effective. She was able to demonstrate the models and have good discussions about the how's and why's of the curriculum.



Junior Summer Math Camp (JSMC)

Mathworks provided resources and training for four teachers from Brown Middle School in McAllen, Texas to conduct a new Half-Day Mathworks Junior Summer Math Camp. This Brown JSMC had 25 elementary students who will be attending Brown next year. *Math Quest* Level 1 curriculum was used during the two-week half day program. Brown Middle School hopes to recruit more campers and teachers next year and add the Level 2 curriculum to their program.



Student Quotes:

"When I first heard that I was going to go to Math camp I felt really excited because I was going to have better math skills."

"My favorite part of camp was all the activities, we learned in different ways rather than just writing on paper."

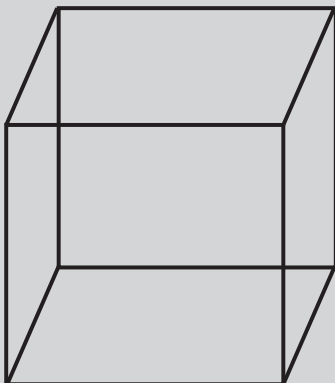
"Camp was very fun, I learned about number lines and absolute value."



Research

"Mathworks bridges our legacy as a teacher's college and our vision to become a national research university."

- Dr. Dan Perry, Assistant VP
University Advancement



In 2020, six Texas State graduate students in either the PhD program in mathematics education or a MS program in mathematics (Justin Eccles, Lino Guajardo, Christina Koehne, Josephine Reynes, Jacob Shapiro, and Holly Zolt) worked online with Hiroko Warshauer to develop activities and resources that build on the state-adopted school Mathworks curriculum-*Math Explorations*; our *Math Quest* camp workbooks, and our *Math Reader* and *Math Explorer* publications with problems, activities, and articles for elementary and middle school students.

The new activities developed by graduate students were implemented in the 2021 JSMC coordinated with related research studies that investigate the effectiveness of tasks, student engagement, and teaching practices. Max and Hiroko were on Developmental Leave in 2020 to continue this work, while piloting and researching the ways that our students can use these out-of-class resources.

By reviewing Mathworks articles from *Math Reader* and *Math Explorations* magazines (1998-2006), we were able to select 20 articles to further develop. These articles were used to develop research and practitioner articles related to content and develop activities related to the articles. We then designed a plan to pilot the activity and developed research questions that connected to the JSMC curriculum. These materials were then implemented in the summer 2021.

The JSMCR provided an ideal setting for our graduate students in mathematics education and mathematics to interact with middle school students and learn about teaching, learning, and curriculum. In 2021, two doctoral students in mathematics education and one master's student in mathematics designed activities for middle school students,



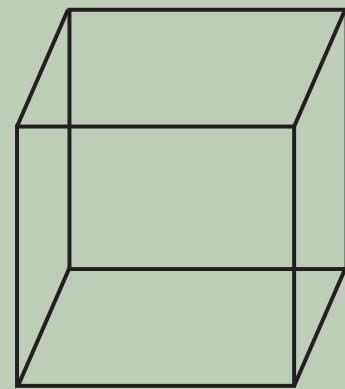
Graduate Student Research Projects

"Before actually doing a project in math ed, I always assumed that I wanted to be on the cognitive side of it because I liked the question why and I liked knowing how students thought. This project helped me see what that would look like in practicality."

- Graduate student working on PhD in Math Education

trained counselors to implement the activities in JSMCR, and gathered research data from the implementation of these activities. A total of 12 activities relating mathematics to other fields such as art, astronomy, medicine, and music were implemented by our three graduate students and 22 counselors for the JSMCR students. The 22 counselors each worked with a study group of 3-4 students in the evening for two hours daily.

One of the activities, Math and Origami, co-written by one of our graduate students, Holly Zolt, and Hiroko Warshauer is a finalist in the Rosenthal Prize for Innovation and Inspiration in Math Teaching sponsored by the National Museum of Mathematics (MoMath) in New York City. We submitted our activity to the final round of the competition and additionally will publish the 12 activities as a mathematics enrichment resource for students, teachers, and parents.



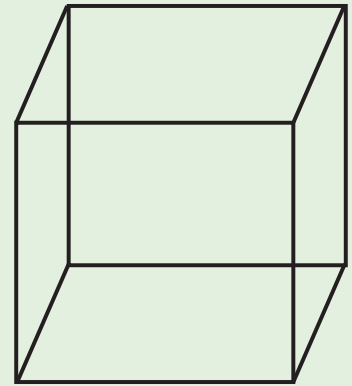
Student Comments

"I liked the puzzle, even though it was difficult. It was fun to talk through and fun to solve."

"I liked experimenting with stars with groupmates."



Texas State professor uses math models to make inroads against COVID-19



Taking on COVID-19 has entailed a 3-pronged approach from Alex White, a professor of mathematics education and the Assistant Chair of the Mathematics Department at Texas State University.

White has teamed up with both Mathworks, a center for innovation in mathematics at Texas State, and Lauren Ancel Meyers, a professor of integrative biology at the University of Texas at Austin, to put some new math models to work. A research group headed by Meyers has been using those models for several years to predict the spread of diseases. Meyers' mathematical models use graph theory to model how disease spreads through a contact network, data from public health officials in the U.S. and Canada and computer simulations to design optimal control measures of diseases.

One aim is to determine: Who should receive vaccines when the supplies of the vaccine are insufficient? Which mitigation strategies are the most effective? The overall project is designed to study and develop models, and use simulations to determine optimal control measures.

COVID-19 has thrown a batch of new elements into the equations.

"A lot of the techniques we have still apply for COVID, but specific parameters we include were uncertain due to uncertainty in the testing," White said. "The data gets better over time."

An even more difficult component of countering COVID is the differences in the way the virus presents itself compared to other diseases. Typically, an infected person displays symptoms before a person they transmits a virus to. However, COVID-19 requires a different analysis.

"Your thoughts about how a disease should behave and the parameters you put on it don't apply," White said. "The time gap between the infector and infectee showing symptoms is usually positive. In this disease, a percentage of that is negative. Even though Person X infects Person Y, X might show symptoms after Y." This revelation is one of the puzzles posed by COVID-19. "You typically have a signal with other diseases that a person might have the disease," White said. "Here, the signal is not always present."

One benefit of the challenging questions posed by COVID-19 is that students have received ample opportunities to contribute to the discussions. High school students who attended the Honors Summer Math Camp at Texas State worked on two related projects. The first project involved looking at and understanding the relationship among counties throughout Texas regarding the rate of spread in urban and rural counties. "The initial spread was focused mostly on urban areas, but there has been spread to rural areas," White said.

The second project involved analyzing data from a second outbreak in China. A response in February and in March may have knocked the disease down, but how did cell phone data registering mobility relate to the second outbreak?

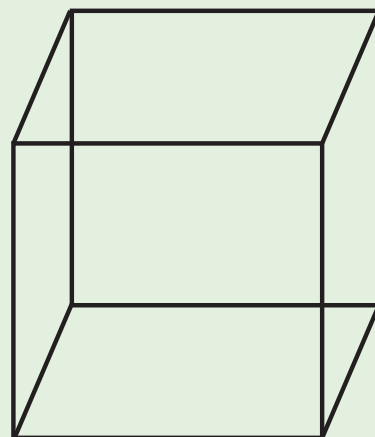
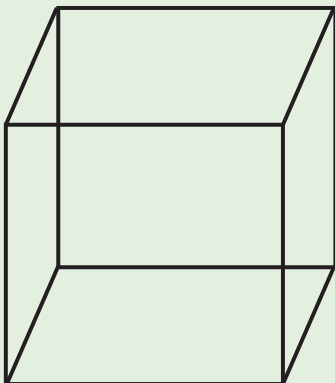
Students in the HSMC were able to participate in 30-minute Zoom meetings. That gave them the chance to hear from modelers with the Columbia School of Medicine, Northwestern University, UCLA and modelers from South Africa and England.

“They are top researchers in the modeling field,” White said. “They are the people the Centers for Disease Control and Prevention reach out to.”

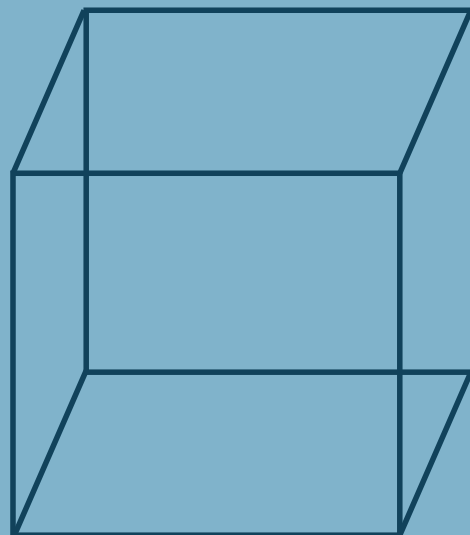
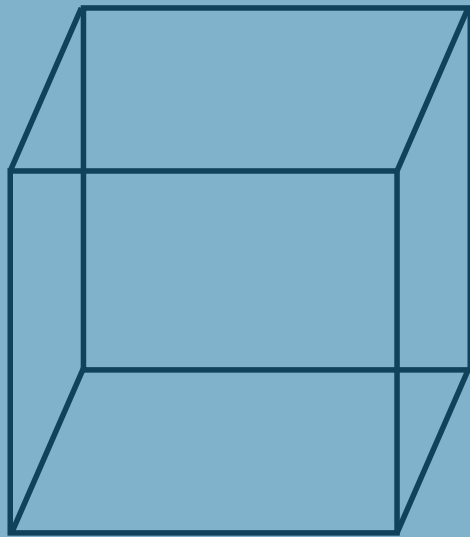
The group efforts by the HSMC participants and their ability to hear from modelers throughout the world provided many benefits to White. “These students are extremely hard working and academically oriented,” White said. “They ask excellent questions and make me as a researcher think more deeply about questions. It helps me to hear their different perspectives and how these problems affect them. It’s a pleasure to work with those students – you give them a problem and they come back with ideas.”

A personal motivation for the high school students to jump in and assist revolves around the modelers looking at the impact of opening schools or not opening. “We got to hear from students in Texas, Pennsylvania and California,” White said.

Within that U.S. effort, there is the collaboration between White, his peers in Texas State's mathematics department and Meyers’ group at UT-Austin. “The research I have been doing with students (at Texas State) is funded internally, but we are also taking advantage of the resources Dr. Meyers has.”

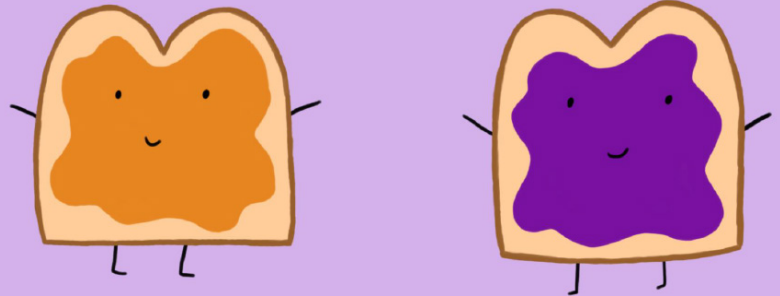


Financial



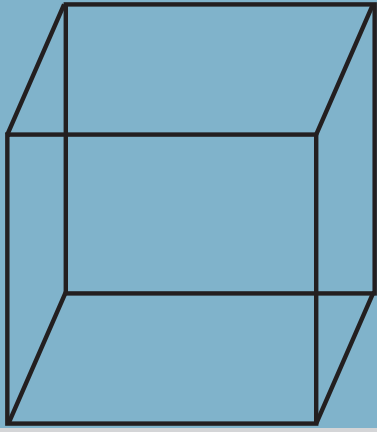
Donor Appreciation

Apart... but not alone.



Another year has passed and we are reflecting on the generosity of our donors. During this time of continued virtual camp programs, we recognize that their donations have sustained Mathworks. As the Mathworks student-drawn art above reflects, we are apart but not alone. And we all agree that we are better together, just like peanut butter and jelly. Thank you all for your support. We are especially thankful for the donations from individuals, businesses, partners, and alumni, including:

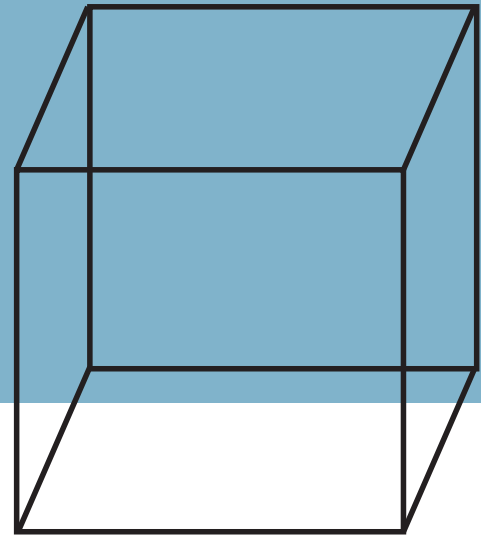
- American Math Society Epsilon Fund
- Sarah and Ernest Butler
- Herb Carter
- Jeff and Gail Kodosky
- KLE Foundation
- RGK Foundation
- Harman-Mayes-Sooch Family Fund
- H-E-B Tournament of Champions
- Mathworks Alumni



Funding and Support

“Not everything that counts can be counted, and
not everything that can be counted counts.”
- Albert Einstein

"No one has ever become
poor by giving."
-Anne Frank



Corporate and Foundation Gifts

- American Math Society Epsilon Fund
- Sarah and Ernest Butler
- Herb Carter
- Jeff and Gail Kodosky
- KLE Foundation
- RGK Foundation
- Harman-Mayes Sooch Family Fund
- H-E-B Tournament of Champions
- Mathworks Alumni

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Zhixiong Jiang

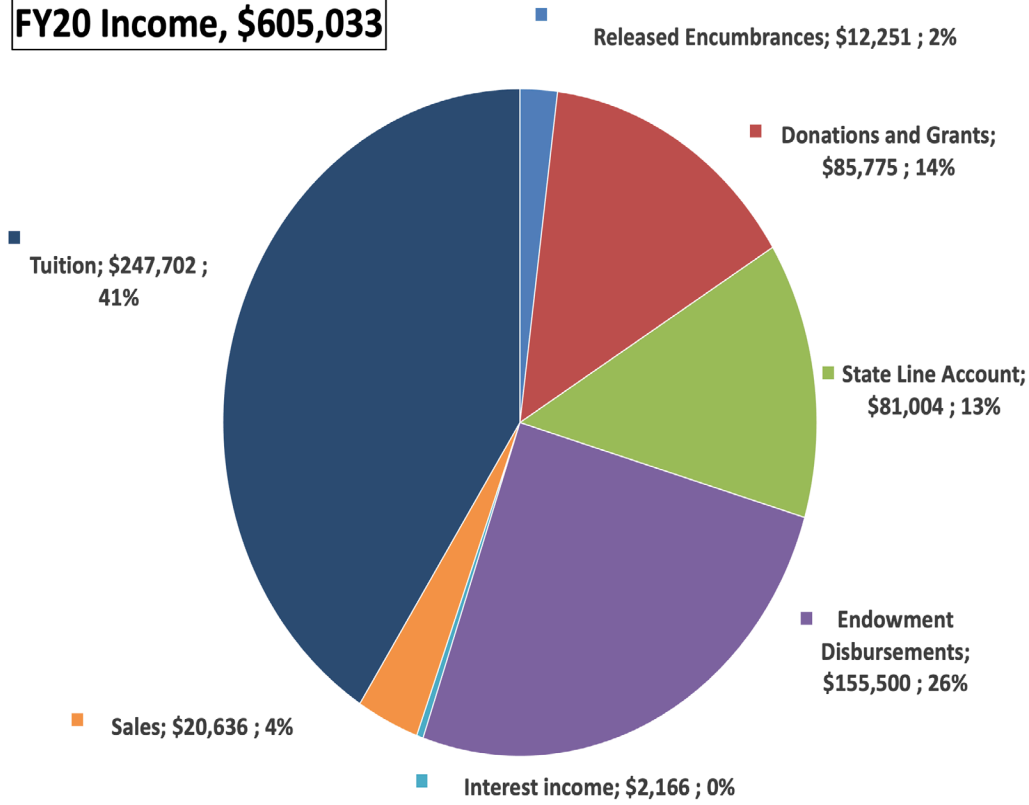
Donghui Kan
Regina Lefkowitz
Xiao Li
Kaitlin E. McClymont
Moriah Momsen
Richarda Momsen
Cody Patterson
Judith Rockman
Hiroko Warshauer
Max Warshauer
Maja Wichrowska
Yongming Zhu

Financial Report 2020

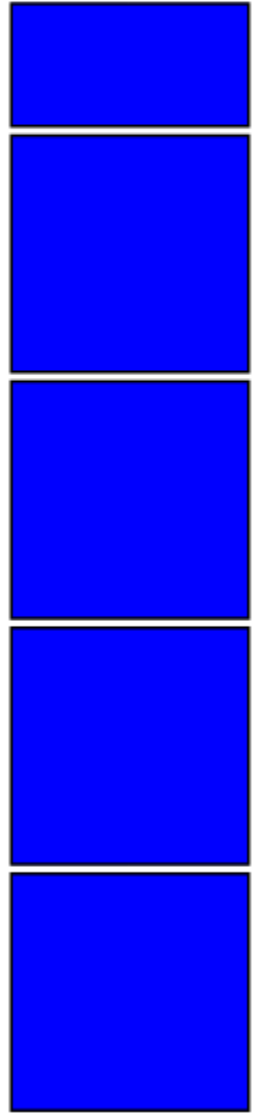
"Being surrounded by people who shared my passion and curiosity for mathematics everyday, allowed me to be who I truly was. Before camp I lived behind a mask, scared of being judged or ridiculed by my classmates. But now, I have found a community that shares and accepts my excitement for mathematics. I began taking pride in my mathematical abilities and day by day the facade I built for myself started fading."

-First-Year Student

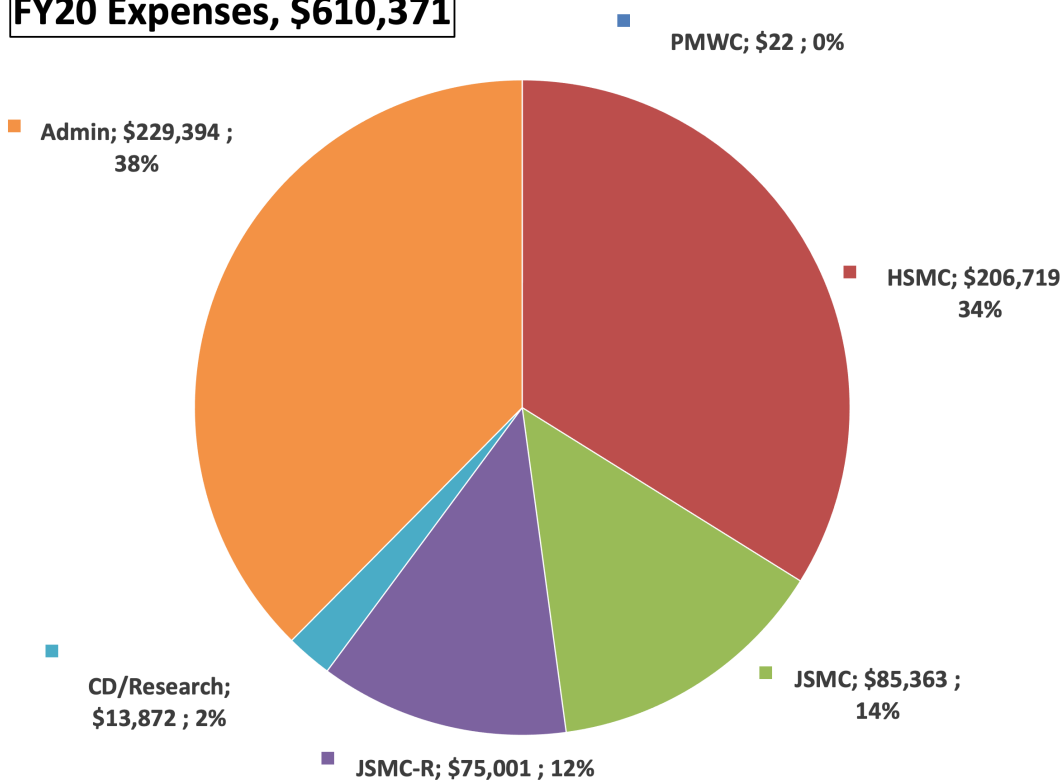
FY20 Income, \$605,033



2020
Endowment
balance increased
to 4.58 M.



FY20 Expenses, \$610,371

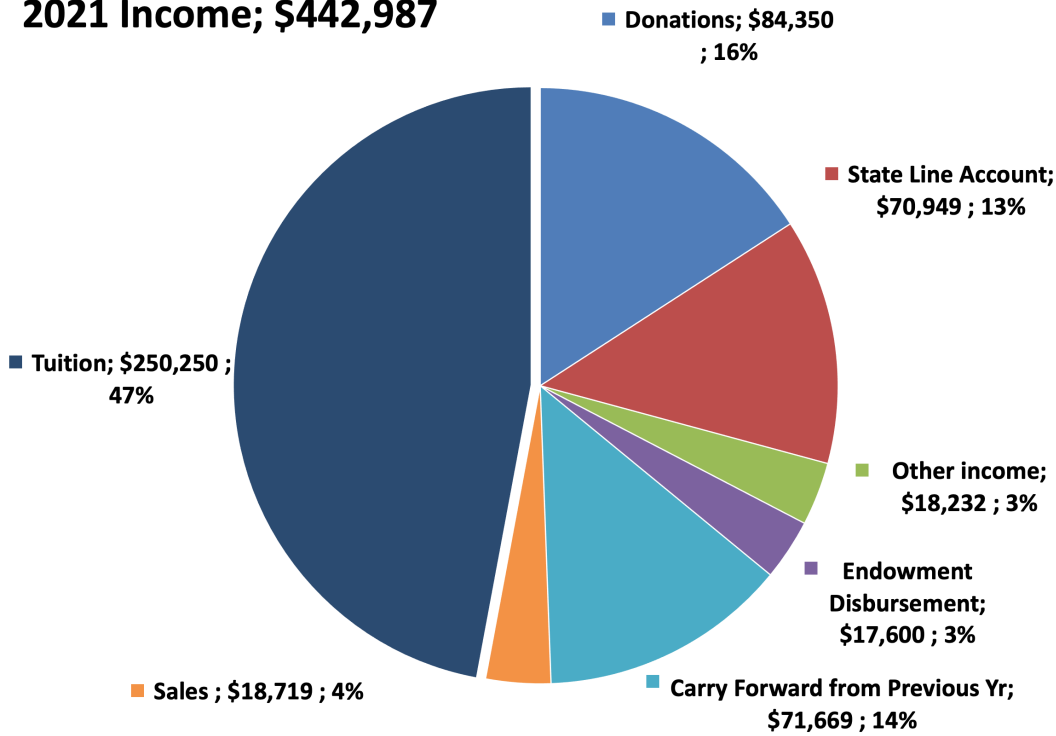


Financial Report 2021

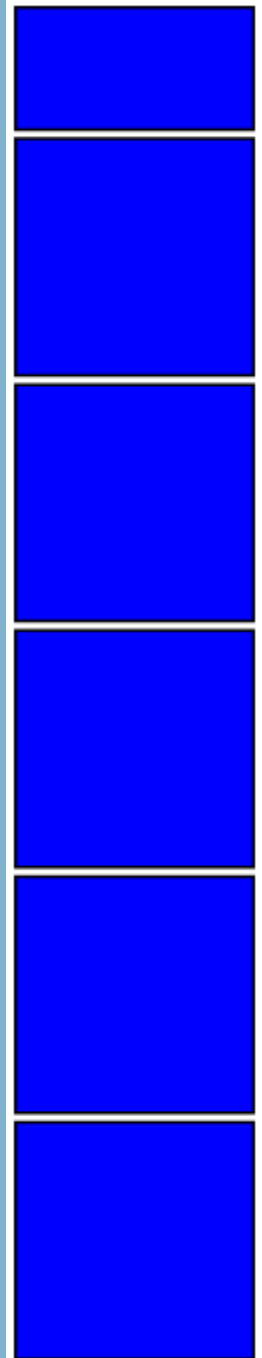
"HSMC has truly allowed me to find another family I belong to, make new friends, all while challenging my math skills and expanding my problem solving skills."

-First-Year Student

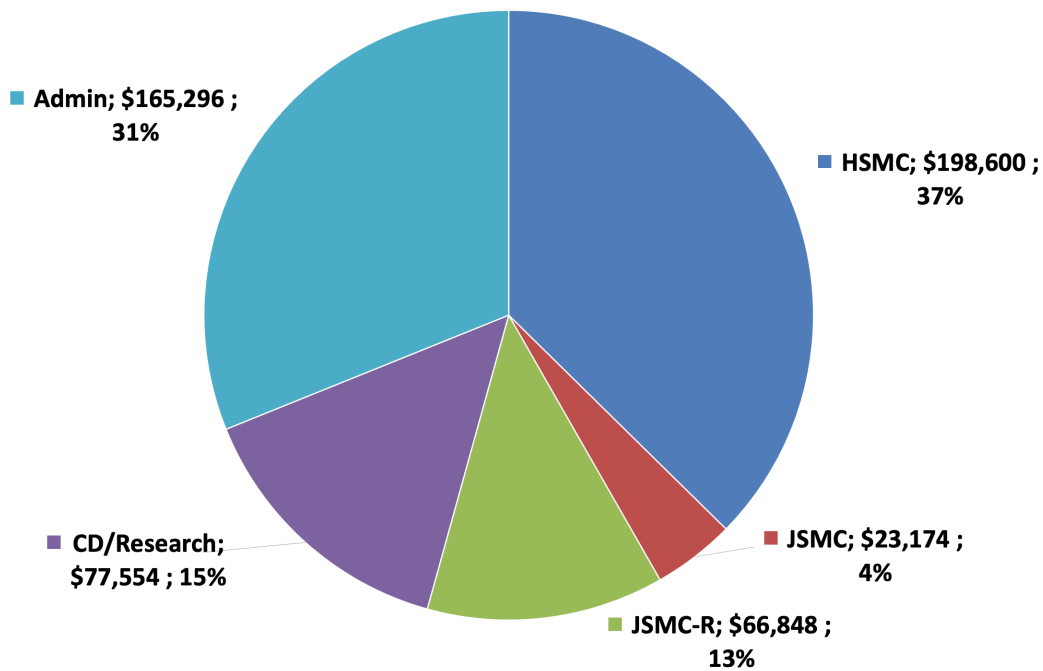
2021 Income; \$442,987



2021 Endowment balance increased to 5.6 M.



2021 Expenses; \$531,471



Future

"The emphasis on understanding the most basic levels of math, and understanding it deeply has also been incredibly helpful, and this method of thinking can be applied to so many other types of problems. This camp has helped me to think more deeply about problems and try different methods of analysis. In the future, I hope to apply this mindset and the methods I learned to solve other problems, not just math problems but perhaps societal problems more creatively through social entrepreneurship."

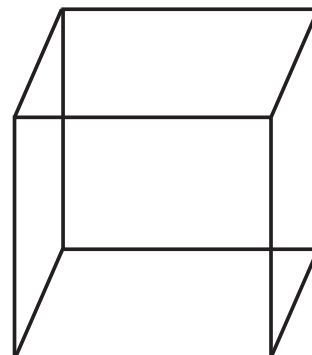
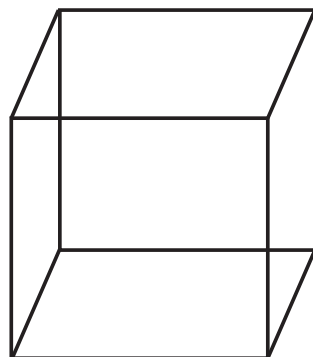
- First-Year Student

Where does Mathworks go from here?

*"We want to sustain the Mathworks legacy for future generations."
- Max Warshauer*

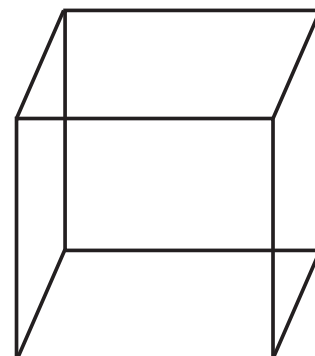
"The Future depends on what we do in the Present."

-Mahatma Gandhi



"Before this camp I had a very fixed mindset. If I didn't know I wouldn't ask about it because of the risk of sounding stupid and now I am not afraid to ask the question that will help me learn about new things. This camp has helped me to accept failure. Not as a bad thing but as a teacher."

- First-Year Student



"I really liked going to office hours and assisting the first years with number theory, mostly because it was nice to get to know them and see what they're working on and also sometimes they'd ask questions about how in person camp would be like and it would be fun to tell them all the cool things about HSMC in person! I also enjoyed refreshing my knowledge of number theory, especially since I am wanting to be a first-year counselor next year at HSMC!"

- Third-Year Student

"Next year I hope to return to HSMC as a second year (hopefully it's in person next time) and conduct my own research project; but I do not only wish to be a student in this program. Throughout my time at camp the idea of becoming a counselor and helping the next generation of campers grow and succeed has evolved into a goal I yearn to achieve."

- First-Year Student

Apart, but not alone.

Thinking
outside
the box

Mathworks

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.

512-245-3439 | mathworks@txstate.edu
www.txstate.edu/mathworks
facebook.com/mathworkstxstate