FRESHMAN SUMMER RESEARCH INSTITUTE

SUMMER 2020

CALTECH CENTER FOR INCLUSION & DIVERSITY
In March of 2020, colleges across the country and more than 1,100 colleges and universities in all 50 states cancelled in-person classes or shifted to remote instruction due to the escalating spread of the COVID-19 pandemic and public health concerns. In April, with over three dozen incoming first-year Caltech students having already applied to the Freshman Summer Research Institute (FSRI), Caltech moved the traditionally residential research experience to a remote platform to ensure student safety.

In redesigning the FSRI experiential learning curriculum, the Caltech Center for Inclusion and Diversity (CCID) quickly engaged in efforts to further the reach of the FSRI program while maintaining the research and math core components of FSRI. With the experience and collaborative efforts of Mike Vicic (PhD ’99), lab course instructor for chemistry and chemical engineering, the FSRI team supported FSRI research mentors in adapting their research into projects that could be done safely from FSRI students’ homes.

Additionally, the FSRI team worked with Justin Bois (PhD ’07), Caltech teaching biology and biological engineering professor, to run a three-week computer programming Python boot camp. The boot camp allowed students to engage in practical programming skills while also enabling students to participate in data analysis related to their research projects.

FSRI Math Lecturer Robert Pelayo (PhD ’07) created a program that gave the FSRI students a two-week head start on Math 0. The students participated in a two-hour math boot camp four days a week that featured prerecorded math lectures on video, allowing them to learn at their own pace. The students also participated in the iPad loaner program, giving FSRI students the flexibility and technology to engage and collaborate on math problem sets from disparate locations and time zones with their research mentors.

Throughout the program, the FSRI Student Life team led community-building activities through group engagement initiatives and hosted discussions, as well as a number of online games. The integration of orientation and academic support ensured an engaged transition from high school to college while building a strong academic foundation. While remote, the FSRI team worked collaboratively with our community and institute partners to create an innovative academic and student success-based program to support underrepresented students from diverse backgrounds.
The Freshman Summer Research Institute (FSRI) is designed to introduce incoming underrepresented and underserved freshmen students to Caltech’s research and math curriculum, culture and college life, and academic and student support services. The objective of the program is to create a “learning community” for students where they can develop the academic and social skills necessary to achieve academic excellence during their freshman year.

This fully-funded program offers each participant:
- A 5-week summer research assignment
- A 4-week math-intensive course
- A 3-week computer programming bootcamp
- Opportunities to learn and engage in first-year student programming and Caltech culture

FSRI STUDENT PARTICIPANTS

The FSRI five-week program attracts highly motivated students from populations traditionally underrepresented in science and mathematics. The program looks at various identities including race, ethnicity, socioeconomic status, and gender identity to determine eligibility. We also consider the students’ high school preparation and their previous exposure to math and research.

“I learned that teamwork is a slow start but a strong finish. It is necessary and encouraging to have people support you and work with you, but you need to take that first step to reach out.”
With the ongoing directive of the FSRI program to create a technical research experience for student participants, Mike Vicic, lab course instructor for chemistry and chemical engineering, designed opportunities to engage in practical strategies for developing and transitioning lab-based research to remote environments. Professor Vicic became a primary fixture in the 2020 FSRI collaborative as a direct mentor in supporting individual graduate student, postdoctoral scholar, staff scientist, and faculty research mentors. Professor Vicic also led weekly best-practice sessions to provide ongoing support to the research mentors.

During the 2020 program, FSRI participants had the opportunity to work on engaging research projects with their mentors, and connected with other postdoctoral fellows, graduate students, and undergraduate students who worked in Caltech and JPL laboratories remotely during the summer. FSRI participants attended online group meetings, presented their findings, and learned about the ongoing work of their assigned research group. In addition to technical skill building, the FSRI participants learned important skills on how to collaborate in a lab setting and presented their research to colleagues and peers, resulting in 96% of FSRI participants reporting that their experience was effective in introducing them to research at Caltech.

"I enjoyed the hands-on portion, it was very interesting to see how the research applied to a real-life concept. My mentor was extremely helpful in setting up the experiment along with sending the materials. I also enjoyed the research especially during moments of revelations, noticing how tiny steps compose to a larger project."
"I enjoyed getting to know more about the field that I hope to study. My research mentors were incredibly helpful and always there for me, not only teaching me new methods regarding my project, but also answering questions describing the work that they do and interesting observations that they have found via their research."

FSRI STUDENT RESEARCH AREAS

The 2020 FSRI cohort had a team of twenty-eight faculty, JPL staff, postdoctoral scholar, and graduate student research mentors.

- Hope Arnett – Mentor Ayush Pandey, Graduate Student – Control & Dynamical Systems
- Carlos Ayala – Mentors Casey Law, Staff Scientist – Radio Astronomy & Dillon Dong, Graduate Student – Astrophysics
- Kyla Yu-Swanson – Mentor Chang Sub Kim, Postdoctoral Scholar – Jet Propulsion Laboratory
- Angel Wang – Mentor Charles Guan, Graduate Student – Bioengineering
- Daniel Nagles – Mentor Elijah Cole, Graduate Student – Computing and Mathematical Sciences
- Anas Zouhar – Mentor Federico Echenique, Professor of Economics – Humanities and Social Sciences
- Isabella Mendoza – Mentor Gabriella Weiss, Postdoctoral Scholar – Geological and Planetary Sciences
- Sarah Kabboul – Mentor Hossein Salahshoor Pirzoltan, Postdoctoral Scholar – Aerospace
- Vinny Hadley – Mentor Hossein Salahshoor Pirzoltan, Postdoctoral Scholar – Aerospace
- Nathan Campos – Mentor Igor Andreoni, Postdoctoral Scholar – Astronomy
- Beatriz Avila-Rimer – Mentor John Bostick, Postdoctoral Scholar – Biology and Biological Engineering
- Ezra Johnson – Mentor John Bostick, Postdoctoral Scholar – Biology and Biological Engineering
- Angelina Torres – Mentor Juliette Becker, Postdoctoral Scholar – Geological and Planetary Sciences
- Gabriella Twombly – Mentor Juliette Becker, Postdoctoral Scholar – Geological and Planetary Sciences
- Rohan Iyer – Mentor Matthew Levine, Graduate Student – Computing and Mathematical Sciences
- Ian Fowler – Mentor Michael Kuhn, Postdoctoral Scholar – Astronomy
- Bertha Mireles – Mentor Miggy Chuapoco, Graduate Student – Bioengineering
- Julian Peres – Mentor Orland Bateman, Graduate Student – Chemical Engineering
- Turner McNeal Bumbary – Mentor Osa Igbinosun, Postdoctoral Scholar – Jet Propulsion Laboratory
- Zack Lee Dugue – Mentor Osa Igbinosun, Postdoctoral Scholar – Jet Propulsion Laboratory
- Leo Williams – Mentor Patrick Almhjell, Graduate Student – Biochemistry & Molecular Biophysics
- Catherine Ko – Mentor Rachael Kuintzle, Graduate Student – Biochemistry & Molecular Biophysics
- Joseph Mina – Mentor Rhondale Tso, Graduate Student – Physics
- Snigdha Saha – Mentors Sara Beery, Graduate Student – Computing and Mathematical Sciences & Neehar Kondapaneni, Graduate Student – Computation & Neural Systems
- Milan Robinson – Mentor Sean Mullin, Graduate Student – Geological and Planetary Sciences
- Josiah Miller – Mentor Stephen Appert, Mechanical Engineer – LIGO Caltech
- Thomas Cleveland – Mentor Stephen Appert, Mechanical Engineer – LIGO Caltech
- Parul Singh – Mentor Sudip Chakraborty, Postdoctoral Scholar – Jet Propulsion Laboratory
- Sean Chang – Mentor Sudip Chakraborty, Postdoctoral Scholar – Jet Propulsion Laboratory
- Tiba Hamza – Mentor Suzy Beeler, Graduate Student – Biology
- Lily Coffin – Mentor Valère Lambert, Graduate Student – Geophysics
- Gilbert Castro – Mentor Zhongxu Zhai, Postdoctoral Scholar – IPAC
The structure and implementation of the 2020 FSRI Math program was largely shaped by the required remote instruction and the significantly larger student cohort. The asynchronous lectures & assessments and synchronous workshops utilized several electronic platforms that facilitated collaboration and engagement with the content developed and implemented by the FSRI Math Instructor Roberto (Bob) Pelayo. Overall, the FSRI Math program provided the same level of rigorous instruction in a virtual setting with increased student capacity and only relatively small levels of non-participation.

FSRI Math is particularly notable for the breadth of its course content, which stayed consistent as past non-virtual FSRI programs. It includes topics from Math 0, Math 1, and Math 2, all in four weeks:
- Week 1: Foundations & Proofs (Ma0 content)
- Week 2: Analysis of Calculus (Ma1a content)
- Week 3: Linear Algebra (Ma1b content)
- Week 4: Differential Equations (Ma2 content)

The Math Workshop is where much of the collaborative learning occurred. For two hours four days a week, students met virtually using breakout groups with the three FSRI alumni Teaching Assistants (TAs). They were put in groups of three to four and worked on scaffolded problems that were extensions of the lecture content. After working on these problems, every student would have to present some portion of a problem to their broader group. Additionally, students were provided with links to an asynchronous video of the instructor discussing the daily content. This video included video of a “worksheet”, including some key definitions, graphs, and examples, which the instructor filled in as he verbalized strategies and different concepts.

"The math workshops were the most effective way that I absorbed the course material because the problems were very challenging and working through them with my peers forced me to understand the subjects. Office hours were very helpful and usually necessary for me to even complete the homework assignments."

As FSRI Math seeks to follow much of the assessment structure at Caltech during the academic year, students were provided with a total of six homework sets, 1 midterm, and 1 final. The honor code was highlighted, and students were allowed to complete “take home” exams (this is true in non-virtual instruction as well). Submission of all assessment material (HWS, midterm, final) was done using GradeScope and was graded by the three TAs. Office hours were also run before every HW due date and Midterm/Final. These office hours were held using Zoom and were enhanced by the use of iPads/pencils and virtual collaborative whiteboards made available through Caltech Library Services and the Office of the Provost.

The COVID-19 pandemic offered an opportunity for FSRI Math to experiment with different methods of instructional delivery. This required a major redesign of the course and the materials to create intentional exchanges and valuable workshop time. With the ongoing efforts Bob Pelayo, the FSRI Math Team was able to create positive, interaction-based experiences during the academic portion of FSRI.
With the knowledge that the FSRI students would have a remote research experience, the FSRI Team worked to establish a hands-on learning component allowing students to engage in practical data analysis that could be applied to their research projects. To create this online version of the FSRI research component, Justin Bois, a Caltech teaching professor of biology and biological engineering, developed and implemented a three-week computer programming boot camp in the Python language. The FSRI Programming Bootcamp provided an intensive, hands-on, pragmatic introduction to computer programming. FSRI students learned basic concepts, such as data types, control structures, string processing, functions, input/output, etc., while writing code applied to scientific problems and areas of research.

The Programming Bootcamp ran two hours a day, four days a week, for three weeks during the five-week FSRI experience. Before the start of Bootcamp, students attended a troubleshooting session to address installation issues, as well as an introductory lesson to orientate the students to the virtual learning space and meet the Programming Team, consisting of Professor Bois and two FSRI alumni Teaching Assistants. The Programming Bootcamp was conducted through Zoom and recorded for future reference, with private video links emailed to FSRI student participants. The Programming Bootcamp Teaching Assistants held office hours Monday and Wednesday nights to engage students in the lesson information and complete exercises.

Professor Bois’s Programming Bootcamp gave the FSRI student participants a jump-start on their computer science education as well as a way to contribute to data-heavy research projects across the Institute and JPL by assisting with data analysis. At the end of the course, the FSRI students were able to write code and analyze and plot data, leading to 92% of the FSRI students stating that the Programming Bootcamp was a useful learning experience as part of the FSRI program.

“We learned a lot of neat tricks with Python that helped us out with our final presentations, and will hopefully help us for a long time to come! It was great getting to know all the neat tricks we could do with Python.”
STUDENT LIFE

FSRI provides opportunities for incoming first-year students to engage with college-life and campus culture. As FSRI students were geographically separated during Summer 2020, the FSRI Student Life Team made concerted efforts to increase group cohesion and camaraderie. The Student Life Team included CCID staff and four FSRI alumni as student mentors who actively engaged in creating opportunities to connect and learn about life at Caltech, including strategies for success during the first year of college.

The collaborative structure of FSRI Student Life included small group and cohort social experiences, games, and activities, as well as intentional one-on-one interactions with our student mentors. In our assessment of the program, 80% of students expressed that the FSRI Student Mentor events were extremely helpful in creating a community.

Additionally, the students attended regular remote group discussions with campus resources such as the Caltech Registrar, Equity & Title IX Office, the Hixon Writing Center, and Campus Wellness services that include an Occupational Therapist. Additionally, The FSRI students had the opportunity to engage in the weekly Summer Undergraduate Research Fellows (SURF) Seminar Series through the Student-Faculty Programs Office to learn about current research being done at Caltech and JPL.

"My favorite moments were those spent with the student community and with my FSRI mentors. I constantly felt supported by my research mentors, and had fun participating in events with the other students."

Throughout the summer, the Student Life team worked to engage the FSRI participants in bonding activities and created opportunities for shared experiences by sending Caltech “Ready for College” care packages with supplies ranging from astronaut cream to school supplies and tech gear. Students also received the book Why Are All the Black Kids Sitting Together in the Cafeteria: And Other Conversations About Race to encourage students to participate in the CCID summer book club.

Collectively, the 2020 FSRI experience closed with a remote sendoff, including all four branches of the FSRI Team represented. Students had the opportunity to reflect on the experience, research, skills learned, and newly found friendships. The FSRI Team shared favorite stories and highlights from student-created memes to the discovery of hidden talents. With Caltech swag in hand, the cohort-based experience came to a close, beginning college life preparations with an assembly of friends, knowledge, resources, and experiences to ensure student success at Caltech.
67% of students felt that the FSRI program enhanced their interest and skill in STEM.

95% of students would recommend FSRI to future incoming freshman student.

96% of students felt that receiving Math 0 before starting fall term was helpful.

96% of students felt that the fall term midterm and final were reflective of what they learned in FSRI.

83% of students attended office hours with their advisor during the fall term.
SUMMER 2020

FRESHMAN SUMMER RESEARCH INSTITUTE

Thank you to the Twenty-Seven Foundation, the Crossland Student Success Fund, Mason Smith, and the Andelins for their support.