

**2022-2023 Science for All Outreach Program
Annual Report
8/21/2023**

In 2022-2023, UMN Science for All (SFA) worked with **three Minneapolis and St. Paul middle and high schools to conduct 18 visits** with hands-on science experiments focused on teaching scientific-method-focused inquiry. A summary of participants and experiments conducted can be found below (**Table 1**). We were able to continue our partnerships with Heritage STEM Academy, Murray Middle School, and Andersen Middle School, where **we worked with 98 students in Grades 6-9** throughout the year. The experiments this year covered broad topics including atmospheric science, fluid flow, electromagnetism, enzymes, and much more. The school visits consisted of a pre- and post-evaluation, brief background of the topic, and the majority of time was spent doing the experiments. All visits over the 2022-2023 year were held in-person with graduate students visiting the classrooms roughly every month from October to April. In May, the students visited the UMN campus for a full day of experiments. Each visit had **a student:mentor ratio of less than 4:1**, allowing all students to receive significant engagement during the lesson. For more information about the experiments completed this year visit the SFA blog, sfa.cems.umn.edu/blog.

Table 1: 2022-2023 SFA Participants and Experiments

School	Students	UMN Volunteers	Experiments Conducted
Heritage STEM Academy	30	28	Material Mechanics & Deformation
2.5 hour visits			Mixtures and Solutions: Slime
9th grade students			Intro to Polymers
Location: Minneapolis (Midtown)			Gravity and Forces: Popsicle Bridges
			Energy Conservation: Balloon Powered Cars
			Electrochemistry: Cola Battery
Murray Middle School	38	22	Surface Tension & Capillary Action
50 minute visits			Heat Transfer
6th - 8th grade students			DNA and Mutations
Location: St. Paul			Intro to Polymers: Synthesizing Nylon
			Magnetism and Electromagnetism
			Elemental Emission Spectra: Flame Test
Andersen Community School	30	18	Central Dogma of Biology: Strawberry DNA Extraction

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40 minute visits			Mixtures and Fluids: Oobleck
8th grade students			Energy Storage: Lemon Battery
Location: Minneapolis (Midtown)			Weather Patterns: Cloud in a Bottle
			Piezoelectric Materials
			Logic Gates and Computers

This year, SFA had graduate students from Biomedical Engineering (BME), Chemical Engineering and Materials Science (CEMS), Chemistry (CHEM), Electrical and Computer Engineering (ECE), Neuroscience, and other UMN departments. Building upon its **effort to recruit graduate students from a range of different departments**, SFA was able to retain and expand involvement from ECE and add members from Earth and Environmental Sciences (ESCI), Mechanical Engineering (ME), and Physics (PHYS). In 2022-2023, SFA had 68 active graduate students mentors, not including team leads and co-presidents (**see Table 2**).

Based on feedback from our funding sources, **SFA expanded our efforts to tie the in-class experiments to careers, STEM education paths, and real-life connections.** This effort was achieved by including real-life examples in the experiment introduction slides, incorporating more experiments that relate to current state-of-the-art science, and having more intentional discussions during the small group experiments. **We continued to assess learning of the scientific concepts from the experiments through pre- and post-experiment assessments.** These assessments were a combination of multiple choice and short answer questions with the same wording before and after the experiment. This year, response rate on these assessments was low, partly due to shortened visit times at some of our schools which led mentors to prioritize lesson time and engagement over the quizzes. However, in recent years, we have seen an **overall improvement of ~15% increase in correct answers with a ~70% correct answer rate** after the lessons and experiments, determined from 150-200 surveys in each case. In the upcoming year, SFA plans to evaluate the effectiveness of the assessments throughout the year, adjust difficulty based on students' understanding, and expand analysis to include question-level evaluation of learning. In addition to gauging learning of participating students, the assessments also encourage graduate students to develop clear learning objectives for each experiment. During this Spring, we also tried out another method of assessing impact in which we recorded short video interviews of students discussing what they learned from a lesson. We hope to expand upon this medium of learning assessment in the coming year. **SFA is dedicated to self-evaluating impact and improving our methods wherever possible.**

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Figure 1: Various pictures from the end-of-year field trip. Top left: studying rates of diffusion in various liquids. Bottom left: studying rates of diffusion using different filters. Right: group picture with students from Andersen Middle School.

At the end of the academic year, **SFA hosted all of our students on the UMN campus to conduct more elaborate experiments and see real laboratory spaces.** All three schools attended this field trip over three days in May 2023. This year, SFA had two experiments during the field trip: Diffusion & Convection and Enzyme Catalysis (**Figure 1**). The Diffusion & Convection experiment was completed in the Valspar Materials Characterization Lab and was accompanied by a tour of Professor Aditya Bhan's lab. The lab tour gave students the opportunity to learn more about some of the research being conducted in CEMS and see what working in a lab entails. Following the lab tour, the Enzyme Catalysis experiment was conducted in the chemistry teaching lab in Smith Hall. This allowed the visiting students to see the lab space and equipment used in undergraduate chemistry classes at UMN. Lunch was preceded by a tour of Professor Marc Hillmyer's lab. During lunch, professors from CEMS (Professors Ben Hackel and Kim Kosto) stopped by to talk to the students about college and career paths. After lunch we held liquid nitrogen experiments demonstrating the effects of temperature on air pressure, malleability of different materials, and superconductivity. We concluded the field trip by making liquid nitrogen ice cream for the students and volunteers.

Continued funding has allowed SFA to keep growing and expanding the number of schools and classrooms we are able to visit for in-person experiments. Part of these expenditures included a charter bus to transport the Andersen Middle School students and teachers to UMN for the May field trip after their school-organized bus was canceled. The

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funds also allowed us to design new experiments to keep up with the ever advancing science instruction for middle and high schools. **We are extremely grateful for our financial and institutional support over the past year. Without the support, this program would not be possible.**

In the upcoming year, SFA plans to maintain connections with the schools we partnered with this year and possibly initiate partnerships with new schools. We **aim to maintain and expand the broad reach of our program** and continue to improve upon the quality of our experiments. SFA hopes to **deepen our impact on middle and high school students** and connect our experiments to career paths and scientific programs for continuing education.

Best,

SFA 2022-2023 Leadership Team

Rohan Chakraborty, *Co-President*

Maya Ramamurthy, *Co-President*

Andrew Johannesen and Clara Kirvold, *Andersen Community School Team Leads*

Daniel Krajovic, *Murray Middle School Team Lead*

Mayank Tanwar and Matthew Lawler, *Heritage STEM Academy Team Leads*

Kristine Loh, *Webmaster*

Ela Engen, *Treasurer*

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Table 2: 2022-2023 SFA Members

Name	Dept.	Name	Dept.	Name	Dept.	Name	Dept.
Adaire Nehring	ESCI	Emma Pettit	CEMS	Maggie Kumler	CHEM	Zach Gdowski	CEMS
Akanksha Akanksha	CHEM	Eric Rachita	CEMS	Michael Gresh-Sill	CEMS	Zachary McAllister	CEMS
Alison Block	CHEM	Erin Maines	CEMS	Michael Harris	CHEM		
Alison Harpel	CEMS	Gautam Hegde	PHYS	Michael Leyden	CEMS		
Ally Jacoby	ESCI	Geethaanjali Mohan	CEMS	Molly Vittengl	CSE		
Ashutosh Nehete	CEMS	Grant Larson	CHEM	Murphi Williams	CHEM		
Barath Tirumuruhan	CEMS	Hanchu Wang	CEMS	Nathan Sidhu	CEMS		
Betty Liu	CEMS	Huzefa Husain	BME	Neal Duong	BME		
Brian Bayer	CEMS	Janani Narayan	CEMS	Nikhil Sethia	CEMS		
Camila Perales	CHEM	Jesse Canavan	CEMS	Ninad Mhatre	CEMS		
Chris Carchi	BME	Joanna White	CEMS	Parth Bhide	CEMS		
Clara Kirkvold	CHEM	Joe Vallin	CEMS	Ritu Shah	BME		
Clare Froehlich	CEMS	Kaavya Nimmakayala	CEMS	Rowan Matney	CHEM		
Cooper Gray	ME	Katie Vopat	BME	Sameer Swain	ECE		
Diana Zhang	CEMS	Kaylee Barr	CEMS	Tessa Burrows	BME		
Dzifa Kwaku	BME	Kaylie Richard	CEMS	Tushar Rathi	CEMS		
Eli Kipp	CEMS	Lexi Leali	PHYS	Victoria Jones	CEMS		
Elizabeth Apiche	CHEM	Luna Zhang	BME	Will Benoit	CSE		
Emily Hoffmann	BME	Madison Seefeld	BME	Yeena Ng	ECE		
Emily Lecy	Neurosci	Maggie Chiu	BME	Zach Cresswell	CEMS		