

**THE NEW
JOURNAL OF
STUDENT
RESEARCH
ABSTRACTS**

VOLUME 26
2021

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THE NEW JOURNAL OF STUDENT RESEARCH ABSTRACTS

Editor

STEVEN B. OPPENHEIMER, Ph.D.
Professor Emeritus of Biology,
California State University, Northridge

Marking 26 Years of Student Science Research!

The New Journal of Student Research Abstracts **2021 / Volume XXVI**
An Annual Journal for Young Investigators and Their Teachers

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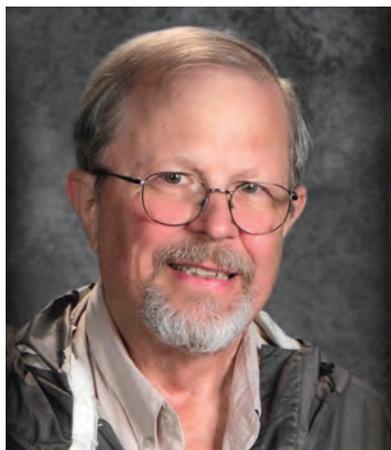
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IN MEMORIAM

Greg Zem
1948–2021

The 2021 issue of *The New Journal of Student Research Abstracts* is dedicated to the memory of **Greg Zem** (December 13, 1948–June 25, 2021). Greg, a CSUN alumnus who taught at Ernest Lawrence Gifted/Highly Gifted Magnet (middle school), was one of the first teachers to prominently participate in CSUN's K–12 programs decades ago, including submitting abstracts to the journal. He also worked with CSUN over many years to present nationally reviewed student posters. A recipient of the Dr. Julie Gorchynski K–12 Teacher Research Award and the Amgen Award for Science Teaching Excellence, Greg left a lasting impression on thousands of students as a teacher and mentor. As one former student wrote after Greg's passing, "His science class helped pave the way for my passion in science and I will never forget him."

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Recognition of Some of the Scientist Mentors

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We are very pleased to share with you the 26th annual volume of the New Journal of Student Research Abstracts. Dr. Steven Oppenheimer, Professor Emeritus of Biology at California State University, Northridge, first produced and edited this journal in 1995 to exhibit the talent and promise of aspiring scientists in grades K-12, fostered by their teachers.

The work captured within this journal not only showcases the brilliance of these students, it serves to demonstrate the potential when opportunity and support are provided and encourage others to pursue research and scholarly activity. This early exposure and guidance are vital to the pipeline of our innovators and creators of the future, instilling a sense of inquiry and discovery that will benefit these students throughout their educational journeys.

Engaging students in scientific discovery also serves to advance our campus' guiding principles of diversity, equity, inclusion and belonging. By integrating and celebrating the work of these young scientists from all backgrounds early and often we are helping to create a more diverse and equitable STEM workforce that will be truly representative of the rich fabric of diversity in Los Angeles, California and the United States.

The recent announcement of the Global HSI Equity Innovation Hub, which will be housed at CSUN, also serves to exemplify the criticality of the research and innovation pipeline. The Equity Hub is a physical and aspirational space that will bring together the greatest minds from around the California State University system, and the country, to actualize equity in STEM education with a focus on students from historically underserved communities. It will serve to accelerate educational equity in innovation nationally to enable human potential.

This issue is dedicated to the memory of a CSUN alumnus and prolific science-teacher Greg Zem who, throughout the course of his decades-long career, guided the work of thousands of young scientists, many of whom had work included in this journal. We honor Greg's memory and thank him for the thousands of lives he transformed throughout his career.

We thank Dr. Oppenheimer for his continued dedication to the students of CSUN and Los Angeles more broadly. We are tremendously proud of the work included in this journal and are thankful to the CSUN faculty and staff as well as the many students and teachers who live this work every day.



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Honoring a Great Mentor and Donor

JULIE GORCHYNSKI, M.D.
Professor

IN HER WORDS

As Professor and Research Director in emergency medicine, my interest in research and education began during my graduate studies at California State University, Northridge (CSUN), in biology as a master's student under the supervision of Steven B. Oppenheimer, Ph.D.

I received two bachelor's degrees at CSUN, in public health and biology. During the master's program I taught CSUN biology laboratory courses to undergraduate students. My mentoring of students began during this time and continued through my medical training. After obtaining a master's degree in 1987, I went to medical school at Creighton University School of Medicine in Omaha, Nebraska. I returned to California in 1991, where I completed my specialty residency training in emergency medicine at Loma Linda University Medical Center in 1994.

As an academic faculty for the past 20+ years, I have mentored hundreds of high school, undergraduate premedical, and preprofessional health students, medical students, and residents. Since 2011, selected graduate students in the master's program in the Center for Cancer and Developmental Biology at CSUN receive a Julie Gorchynski, M.D., MSc Research Scholarship Award for research supplies to advance graduate student research. Most recipients are now in post-graduate Ph.D., M.D., dental, and law programs.



I also have been involved in clinical emergency medicine, research, and education since 1991 in California at Loma Linda University Medical Center and at the University of California, Irvine, Medical Center, as well as in Texas at Texas A&M and the San Antonio UT Health Science Centers. I have been an invited speaker for local, state, national, and international emergency medicine conferences, where I had also been selected to present my research. I have numerous publications in medical journals for my clinical research in emergency medicine. One of my numerous awards in research includes a Certificate of Recognition from the National Science Foundation and Research Director Program awarded to me by Dr. Oppenheimer, NSF/U.S. Presidential Award recipient, Director for Cancer and Developmental Biology. This certificate was signed by Dr. Oppenheimer and by the late Francis H.C. Crick, Nobel Laureate, Honorary Project Chair.

Many of the students I have mentored in the past 20 years have entered into professional postgraduate training in medical, dental, veterinary, pharmacy, nursing, physical therapy, law, and Ph.D. programs.

It has been said that "as a teacher, it isn't someone who teaches something, but someone who inspires the student to give of their best in order to discover what they already know."

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ABOUT THE EDITOR

Steven B. Oppenheimer, Professor Emeritus of Biology, received his Ph.D. degree from Johns Hopkins University and is currently Director of the Center for Cancer and Developmental Biology at California State University, Northridge. He is author or co-author, mostly with his Cal State students, of more than 300 published papers, abstracts, letters, books, and national presentations; was awarded over \$7 million in research and science education grants serving as Principal Investigator; and served on National Institutes of Health and National Science Foundation grant review panels.

In addition, he serves on the editorial board and is editor for the United States, Canada, and South America of the more than 60-year-old international journal *ACTA Histochemica*, published by Elsevier. He is recipient of 26 distinguished teaching awards, distinguished research awards, outstanding professor awards, and other honors from local, statewide, and national organizations. In 1984, he was named statewide Trustees Outstanding Professor of the California State University system (the system's highest honor), and in 1992 he was elected Fellow of the American Association for the Advancement of Science (AAAS). The AAAS defines a Fellow as "a member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished." He is a recipient of a U.S. Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.



Dr. Oppenheimer thanks the following organizations for funding his student-involved research programs: National Institutes of Health, National Institute of General Medical Sciences SCORE, RISE, and MARC programs, the Joseph Drown Foundation, the Sidney Stern Memorial Trust, the National Science Foundation, and California Science Project.

The editor also wishes to thank Van Nuys Airport for its past support of the journal, helping give wings to students' educational dreams!

Editor's e-mail address: steven.oppenheimer@csun.edu

Editor's program websites:

www.csun.edu/biology/faculty/oppenheimer.htm

www.youtube.com/watch?v=JQCd5NIFVoQ

www.youtube.com/watch?v=KmlN6DHW3nQ

ABOUT THE ASSOCIATE EDITORS

Helen H. Chun received her Ph.D. and was a postdoctoral researcher at the University of California, Los Angeles. She currently is an Associate Professor in the Biology Department at California State University, Dominguez Hills. Her research interest is in the cellular response to radiation exposure, particularly in the stimulation of DNA repair and cell death. In addition to her work with Dr. Oppenheimer and *The New Journal of Student Research Abstracts*, Dr. Chun is involved in various collaborations with the College of Education (CSU Dominguez Hills) to enhance STEM instruction in K-12 and undergraduate education.

Mindy Berman, owner of Mindy F. Berman Communications, has 35 years of experience in public relations and marketing communications. She has coordinated numerous successful communications and educational programs, and — bringing organizations the "write stuff" — also has written and edited all types of materials. This work includes authoring a book titled *Celebrate Pasadena's Vision: 100 Years of Community-Owned Power*, and editing *The New Journal of Student Research Abstracts* since 2006. She earned her bachelor's degree in journalism from CSUN and her MBA from Pepperdine University, and previously taught public relations and writing courses at UCLA Extension, CSUN, and Woodbury University. www.mfbcommunications.com

ABOUT THE DESIGNER

Alvalyn Lundgren has designed and art directed *The New Journal of Student Research Abstracts* since 2006. As the founder of Alvalyn Creative, a strategic design and branding consultancy, she assists businesses and organizations in building their influence platforms through brand strategy. Among her design awards are two for *The New Journal of Student Research Abstracts*. She was an undergrad at CSUN and completed her degree at Art Center College of Design in Pasadena, CA. In addition to her design practice, she teaches at Art Center College of Design, Otis College of Art and Design, and UCLA Extension. www.alvalyncreative.com

ABOUT THE ACQUISITIONS EDITOR

The journal's Acquisitions Editor, **Terri Miller**, retired in 2016 after teaching middle school in the Los Angeles Unified School District for nearly three decades. She consistently involved her students in hands-on research that was published in this journal and presented at poster symposia, and now is very pleased to continue promoting science education by recruiting additional teachers to contribute student abstracts. Among her many accomplishments over the years, Terri received the Julie Gorchynski, M.D., Center for Cancer and Developmental Biology K-12 Teacher Research Award for the journal for 2014-15. In addition, several of her students earned first place in the 2013 U.S.-China Space Science Education Project, a pioneering international program.

ABOUT THE SPONSOR

California State University, Northridge, has been ranked by the National Science Foundation in the Top 15 (sometimes No. 1) of over 500 similar universities in numbers of its science and social science graduates who go on to achieve doctoral degrees.

CSUN Science was ranked No. 1 in North America in the largest percentage increase in publications in high-impact journals 2012-2015 by Nature Index:
www.csun.edu/science-mathematics

ABOUT THE JOURNAL AND ABSTRACTS

The New Journal of Student Research Abstracts is published yearly in the fall. Continued publication is always dependent on funding. The journal is intended to serve as:

- 1] a vehicle to honor young investigators and their teachers by showcasing their work, motivating them to continue their involvement in research science;
- 2] a sourcebook for both students and teachers who are looking for ideas for research projects; and
- 3] a volume to disseminate student research discoveries.

Many abstracts included in the journal demonstrate good science, i.e., clear introductions describing a hypothesis to be tested, appropriate methods and data analysis, results and conclusion statements, and – most important – sufficient numbers of appropriate control and experimental samples and repetitions of experiments. Some are idea abstracts, and some are abstracts of library or Internet research projects.

Abstracts are reviewed by the teachers and the journal editors, and may be edited for clarification or grammar corrections. Although the journal editors delete very poor abstracts from the publication, some abstracts herein are quite flawed, and some lack at least one component of a good science experiment. Including some of these abstracts helps make this journal very useful for classes to learn what makes for a good experiment and a good abstract versus a not-so-good experiment and a not-so-good abstract.

Some of the abstracts are experimental plans instead of completed projects. This is especially true in the case of long-term, sophisticated research programs that require extensive setup and planning. The journal encourages abstracts on the planning and progress of such projects.

The journal editor continues to reserve the right not to publish those abstracts that are seriously flawed. The journal does not notify authors if their abstracts have been deleted. **Please note that any abstract that involves harming vertebrate animals (including humans) will not be published in this journal. In addition, students and teachers must ensure that experiments are conducted using necessary safety measures as appropriate.**

Any opinions, findings, and conclusions or recommendations are those of the individual authors of the abstracts presented in the journal, and do not necessarily reflect the views of California State University, Northridge, other contributing organizations and individuals, or the journal staff.

SUBMISSION OF ABSTRACTS

Any science teacher may submit student abstracts following the format used with the abstracts in this volume. After the title, followed by student-author name(s) and teacher name (teacher), school and school street address, city, state, and ZIP Code, abstracts should begin with the purpose of the study, followed by how it was done, and then the results and conclusions.

All abstracts should be typed in **11-point Arial font**, error-free. Messy abstracts and those not following proper format may be discarded. The journal is not responsible for any abstracts received or for publication errors. The journal does not acknowledge receipt of abstracts and there is no guarantee that they will be published or that the journal will be published in any given year.

Only teachers may submit their students' abstracts to the journal. Teachers must submit each abstract as a **Word document** to steven.oppenheimer@csun.edu. Abstracts not submitted electronically or not following the other guidelines provided herein may be discarded without notice.

The deadline for receipt of abstracts for each annual volume is June 1, but an issue may be closed at an earlier date. Publication is scheduled for each fall. Submitted abstracts are not returned to authors, so students and teachers are advised to keep a copy of all submitted materials. The only confirmation that abstracts will be published is if they appear in print.



FROM THE EDITOR

A Golden Opportunity for Underrepresented Science Students Interested in Careers in Biomedical Research

To those underrepresented science students who select California State University, Northridge (CSUN), for your college experience: We have a golden opportunity for you. If you are a U.S. citizen or permanent resident and if you are possibly interested in a Ph.D. degree in biomedical science, you can apply for distinguished programs funded by the National Institutes of Health (Maria Elena Zavala, Director). These programs will open many doors and will pay you thousands of dollars to do research while a student at CSUN. We thank the National Institutes of Health, National Institute of General Medical Sciences MORE program for distinguished support for these student opportunities. *(Note that programs are dependent on yearly funding.)*

For more information, contact Steven Oppenheimer at steven.oppenheimer@csun.edu.

CONGRATULATIONS TO A PRESIDENTIAL AWARD WINNER!

In 2019, CSUN alumna Dominique Evans-Bye, whose students regularly submit outstanding abstracts to The New Journal of Student Research Abstracts, received the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) – the highest U.S. government honor for mentors who work to expand science, technology, engineering, and mathematics (STEM) talent.

The National Science Foundation (which administers the Excellence Awards in Science and Engineering, including PAESMEM) selected Dominique from among thousands of Presidential Award recipients to share insights into supporting student research as part of a webinar for program alumni. Dominique chose Dr. Steven Oppenheimer, CSUN Professor Emeritus of Biology and journal Editor-in-Chief, as a co-presenter based on his contributions to her success.

Dominique currently teaches “Byeology,” AP Environmental Science, and Geographic Information Science classes at Anderson W. Clark Magnet High School (in the Glendale Unified School District). Her innovation and dedication continue to empower and enrich her students.

We congratulate Dominique on the prestigious Presidential Award honor, and thank her for her unwavering commitment to science education!

IN HER WORDS

I consider myself a decent teacher most days, but I’m at my best when mentoring my students. Rather than using teacher-directed learning, I integrate as much project-based learning as possible into my classes. The most enjoyable and rewarding part of teaching for me is to facilitate student research projects. I teach students the foundations of science, basic project management, and collaboration and networking skills, and then turn them loose to be creative in their own investigations. I guide students, but allow them to make mistakes. When students can identify their shortcomings and implement their own solutions to the problem, the real learning takes place. I like to feel confident that my students can take charge of their own learning outside of my class – something that goes beyond Google and Wikipedia.

Credit to CSUN

In 2019 I was awarded the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM). Achieving an honor of that level was quite a journey. I credit my time at CSUN, both as an undergrad biology major and during my graduate degree studies in geography, for preparing me to meet the challenges I have faced throughout my career. I created my research class by age appropriately modeling Dr. Larry Allen’s graduate program. As a new teacher, I benefited greatly from Dr. Oppenheimer’s Research Director Fellow Program. Through Dr. Oppenheimer’s grant, I was able to charter the research vessel *Yellowfin* for my own class research projects.

When I discovered Geographic Information Science (GIS), my world was opened to the *science of where*. I soon followed in the footsteps of my CSUN mentors and wrote my own grants to fund the equipment, field trips, and professional development



that make my program so unique. I started with a Toyota TAPESTRY large grant for \$10,000, and then received \$30,000 through UCLA’s Teacher-Initiated Inquiry Projects (TIIP).

As I implemented my proposed programs, our success grew exponentially and made more funding available. As part of its philanthropy initiatives, Lexus donated \$20,000 to my program and UCLA gave me another \$30,000 through TIIP. The Society for Science & the Public (SSP) accepted me as a Fellow, and trained me in project management and how to facilitate student research. SSP funded my research program with \$8,000 each year for four years. Since grant writing was such a great experience and a valuable skill set, I decided to involve my students in the process. Target offers field trip grants of up to \$700. Each

year, my students design and fund their own field trips. One year I collaborated with a student to write a State Farm Youth Advisory Board grant for \$100,000.

With more than \$200,000 in funding over an eight-year period, I was able to create a three-course Career Technical Education GIS Pathway that was accepted as meeting University of California "A-G" requirements. I bought specialized equipment that would have been out of my reach without grant funding, and attended professional development workshops of my choice that were extremely useful.

I also attended industry conferences as a speaker, presenting papers, and as a participant, furthering my knowledge in GIS. I learned to bring biotechnology and bioinformatics into the classroom with the DNA barcoding program from the Coastal Marine Biolabs and the Amgen® Biotech Experience. I participated in three summer internships at Caltech, one in theoretical chemistry, one in protein engineering, and one in atmospheric chemistry. In our research projects, I worked side by side with students, collaborating and learning together instead of teaching and directing activities.

Student Successes

I was able to apply all of these project-based learning programs into my teaching, which offered students opportunities and experiences they would otherwise have to wait until graduate school to obtain. Some of my students were finalists in the International Science and Engineering Fair, and many were student speakers at industry and academic conferences.

Years of student success catapulted me into the district limelight, gaining awards and recognition. When I was nominated as Teacher of the Year, I went to the interview at the Los Angeles County Office of Education carrying three editions of *The New Journal of Student Research Abstracts* featuring my students' work, which totally impressed the judges. The journal, along with a scrapbook of our field work, clinched the award and propelled me to a California State Finalist.

Earlier, I had received the Presidential Innovation Award for Environmental Educators and have a letter signed by President Barack Obama. My students have certificates signed by President Obama. They also have the added benefit of translating their unique experiences to college and internship applications. I get the pleasure of writing interesting recommendation letters that help set my students apart when applying to top-tier universities. I have found that students appreciate the opportunities my program offers. They reciprocated the favor by writing letters to nominate me for the PAEMEM program.

I very much appreciate the opportunities provided by Dr. Oppenheimer, CSUN, and our many project partners that have enriched my program and empowered my students and me in our journey to become better researchers. *The New Journal of Student Research Abstracts* has been a great resource that has benefited both my career and my students' science education.

Read on for more information about Dominique in the following story from *CSUN Today*.

TWICE PRESIDENTIAL-HONORED TEACHER AND CSUN ALUMNA FINDS SUCCESS IN BEING DIFFERENT

From *CSUN Today*

April 29, 2020

By Cary Osborne

A reporter doing a story on Clark Magnet High School teacher and CSUN alumna Dominique Evans-Bye asked one of her students to describe her.

The student's reply: "She's ... different."

"It's true," said Evans-Bye '95 (Environmental Biology), M.S. '12 (Geographic Information Systems). "I do things my own way. I make a mess, my equipment is everywhere. I'm in the way, but this is because I put my students first. I don't have a lot of storage room at school. I'm bouncing between three different rooms, teaching four different subjects, so I have to improvise."

Different has worked for the biology and geography teacher, so much so that in the Fall of 2019 she was selected as a recipient of the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. The honor is one of many in the career of a teacher whose enthusiasm for her work and creative application of knowledge, technology and tools has made her a standout figure in Los Angeles County's educational system.

Evans-Bye didn't initially want to be a teacher. Instead, she said, teaching chose her. And CSUN teachers helped in that choice.

"I give a lot of credit to the opportunities CSUN provided," Evans-Bye said. "I took full advantage of CSUN's programs."

Evans-Bye participated in the California State University International Student Exchange Program at the University of Queensland in Australia and the National Student Exchange Program, where she attended Moss Landings Marine Labs through CSU San Francisco.

Evans-Bye said because she is the curious type she took more classes at CSUN than were required for her to earn her bachelor's degree.

But one class, in particular, she said, was the door-opener to so many things in her life.

"What really changed my life at CSUN was the scuba diving class," she said. "I loved marine biology. I loved the ocean and wanted to scuba dive, but my mom was overprotective and wouldn't allow it. Once I saw the class at CSUN, there was no stopping me. I signed up, made a lot of dive buddies through CSUN, and we dove every chance we got."

The CSUN scuba instructor used past students as TAs for the course. Evans-Bye was recruited to be a TA, but she realized that she needed more training to handle the responsibility. She got all the class TAs together and convinced an associate CSUN scuba instructor to start a rescue/divemaster scuba class for the group. Later, she followed in the footsteps of her mentors and took the LA County Underwater Instructors Certification Course to

become a scuba instructor herself. This led to her also becoming a volunteer public safety diver for the Ventura County Sheriff's Department.



Dominique visits the E/V Nautilus' ROV/Sonar control room, where the first underwater sonar images of the Titanic were identified and seen.

Shortly after earning her bachelor's degree, she began teaching scuba at a sporting goods store and one of her co-workers, who was also the principal in charge of opening the new science and technology magnet high school, encouraged her to make use of her biology degree and teach children. Evans-Bye started by teaching at Roosevelt Middle School in Glendale. She laughs recalling her early days in the profession.

"I was thinking going into it, 'I'm so passionate about biology and about science that these kids have to be interested. With my enthusiasm, they'll love it.' And I was just amazed they could care less what I had to say," she said.

After two years, she moved over to Clark Magnet High School in La Crescenta in 2000 and began to blossom.

What makes Evans-Bye's teaching different, said her new Principal and fellow CSUN alumna Lena Kortoshian, is, she has always been ahead of the time.

In 2013, the state Board of Education adopted Next Generation Science Standards for California public schools, thus giving educators more flexibility to design classroom learning experiences. It also introduced more inquiry-based learning environments where students became more active participants, rather than just textbook learning.

"Dominique has been doing that from day one since she's been a teacher," said Kortoshian '88 (Math – Secondary Teaching), '91 (Credential), M.A. '98 (Educational Administration). "Students learn. They do the inquiry on their own. And then she is a role model for them. They look at Dominique like a mentor."

Evans-Bye developed a three-course GIS program at Clark Magnet, writing curriculum for classes: Geology of Disasters, Honors GIS & Remote Sensing, and Honors Environmental GIS. She introduced project-based learning, allowing her students to choose an environmental issue to investigate and then design a project around. Many of the projects have been entered into and won competitions.

Over the last 13 years, Evans-Bye's teams have earned about \$500,000 in prize money from the Lexus Eco Challenge – a national STEM contest for grades 6-12. Students receive 70 percent of the money, 20 goes to the school and Evans-Bye gets the

remaining 10. She also wrote a grant with a student that earned her school \$100,000.

For her innovative work, passion for her job and ultimately the influence she has had on her students, she has been honored with numerous awards.

Evans-Bye received the California Geographical Society's Distinguished Teaching Award in 2014 and was named Los Angeles County Office of Education Teacher of the Year in 2017. She has also won two extraordinary national honors.

In 2013, she was recognized with the Presidential Innovation Award for Environmental Educators and this past fall she was a recipient of the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring, earning her a trip to The White House.

"She looks for opportunities all the time to make students work hard and harder and prepares them for college and careers, and even life," Kortoshian said. "We're very proud of her."

Recently, her students were given a project based on one of Evans-Bye's real-life experiences.



In her full dive gear, Dominique enters the water from the Ocean Defenders Alliance ship the LegaSea to clear tangled ropes from a sediment sampler.

Last September, the Ventura County Sheriff's Department called on her to help in rescue and recovery efforts after the dive boat Conception burned and sank off the coast of Santa Cruz Island, a tragedy that resulted in 34 deaths. Evans-Bye, who has continued to volunteer for the department since her days at CSUN and has served as its research-and-development officer for nearly a decade, operated a remotely operated vehicle (ROV) aboard a rescue and recovery ship on the day after the tragedy.

Evans-Bye, preparing her students for the potentially critical work that they might have to do in a career, later brought some of the mapping data into the classroom at Clark Magnet. Using a GIS analysis application, the students turned the data into a story map.

The CSUN alumna who didn't want to be a teacher has consistently brought new ideas into the classroom to satisfy her own curiosities, inspire kids and elevate them. She takes a lot of pride in doing things out of the norm. But she takes pride in something greater.

"I do it my own way," she said. "And I'm successful, but more importantly my students are successful."

Thank You to a Distinguished Donor!

BIOLOGY ALUMNA'S GIFT SUPPORTS JOURNAL OF K-12 STUDENT STEM RESEARCH

From *CSUN Today*
 April 28, 2020
 By Perla Colin

Alumna Mina Alikani '83 (Biology), M.Sc. '85 (Biology) has given a \$17,000 donation to help support the publication of CSUN biology professor Steven Oppenheimer's New Journal of Student Research Abstracts, an annual and beloved project in the College of Science and Mathematics.

The publication is celebrating its 25th edition and showcases science, technology, engineering and mathematics (STEM) research discoveries made by local K-12 students, motivating them to continue their involvement in research science.

For over a decade, Los Angeles Unified School District (LAUSD) science teacher Terri Miller assisted her students in publishing their research work in the journal, from 2000–16, earning her recognition as a top contributor.

"The world has been highly involved in trying to rid itself from an insidious, deadly virus," Miller said this month. "We so need our future research scientists and medical professionals. Dr. Oppenheimer has always had the foresight and determination to continue the incorporation of research for students of all ages."

Now retired, Miller continues to help students with their research and even serves as the journal's acquisitions editor, where she advocates for teachers to get involved and recruit their students to participate.

"The United States needs now more than ever for our young people to choose careers in science," Miller said. "Having their science experiments published in the New Journal of Student Research Abstracts and attending a Science Poster Symposium at CSUN encourages students to accomplish this highly important task."

Alikani, a clinical embryologist, laboratory director and consultant in New York, benefited from Oppenheimer's mentorship as a graduate student and while working in his laboratory as a research assistant in developmental biology. It was through her experience in the lab that Alikani forged valuable connections, volunteer opportunities and ultimately a rewarding career in her field of interest – Assisted Reproductive Technology (ART), which includes treatments such as in vitro fertilization (IVF).

"To eventually end up on that path and in the ART field was really quite amazing," Alikani said. "It still is amazing to me when I think back to how I found my way into this field and, of course, being at CSUN and in Dr. Oppenheimer's laboratory in particular, was clearly instrumental."



Oppenheimer's journal and the people who help bring it to life every year, such as faculty and staff in CSUN's Department of Biology and LAUSD teachers, are dedicated to the education of young students and the promotion of STEM fields.

"Mina was one of my great mentees," Oppenheimer said. "I hope that other CSUN mentees will step up to the plate and donate for this journal — a program that rewards all participating students, not just high achievers. This is so important for the security of the United States in helping to inspire new generations of scientists."

Her desire to support the continued success of the journal motivated Alikani to provide funding for a project she considers meaningful and impactful.

"Science teaches us to think critically, to reason and learn through experimentation," Alikani said. "It is important, now more than ever, to have the next generation interested in and committed to science, committed to fact, truth, the scientific process and critical thinking. This is how we ensure our collective future."

COMMENTARY: Steve Oppenheimer

The Value of Recognizing the Efforts of All Science Students

By Steve Oppenheimer



Steve Oppenheimer

Current education research has shown that precollege science experiences substantially increase the number of students choosing a science major in college. However, science fairs usually select a relatively small number of winners from hundreds of participants, leaving most with little to show for their efforts, which can diminish those students' future interest.

About 35 years ago, I established a research training program for K–12 teachers. After training many teachers in our labs, I developed the *Journal of Student Research Abstracts (JSRA)* to showcase and reward participating students with published abstracts in a free online journal. All students, not just the high achievers, should be

encouraged to do precollege science research, as by the time they reach college, they often have decided on careers. The United States needs more research scientists, so we should encourage many more students, not just high achievers, to fall in love with science.

Teachers across Los Angeles and around the world submit abstracts on behalf of their middle and high school students to *JSRA*. Journal editors and teachers rigorously review abstracts, and students have the opportunity to correct any problems. Although this research is conducted by students, scientific rigor is expected. Abstracts document the use of appropriate controls, sufficient replications, and adequate numbers of samples.

Accepted abstracts are published in the journal, and student authors receive a print copy of the journal containing their published research. (*JSRA* is available online at <http://bit.ly/2kkE0Et>.) One teacher said their students dance with joy upon seeing their work in print.

Working with teachers like Greg Zem, Terri Miller, Stacy Tanaka, and

Aphrodite Antoniou, my colleagues and I also created The Center for Cancer and Developmental Biology Pre-College Research Poster Symposium, which also recognizes hundreds of middle and high school student scientists each year. The posters often are based on the reviewed project abstracts submitted to *JSRA*, and a cadre of advanced senior-level university students trained in research science evaluate them. Students conduct their research at their schools and homes, and present their reviewed research in poster form at the symposium, held at California State University, Northridge (CSUN), where they receive medals and certificates recognizing their efforts. This really inspires them to continue in science.

Former students who contributed to the journal and participated in the symposium have reported that their siblings "fight" to become involved. Students have been admitted to a spectrum of higher learning institutions, including the California State University system, University of California system, Drexel University, Oxford, Pepperdine, Stanford, Harvard, Penn State, and the University of Tokyo.

Thousands of good precollege science experiences exist that can motivate students to choose science careers. Just having a great science teacher can spark students' interest. Our journal and poster symposium recognize thousands of kids for their research work. A reward like a published abstract or a medal and certificate may be the first and often only recognition from a university many of these students receive. Following the most recent symposium, CSUN Vice Provost Matt Cahn noted, "This is one of those transformative

opportunities that we hope all students have."

How often do hundreds of students receive university and parental recognition for science research work? The pride that families take in their children's science work provides an extra push for them to choose a science career.

These programs are replicable by teachers, schools, and school districts if they wish to encourage many more students to contemplate future science careers. I also suggest that science educators consider urging their middle and high school students to submit research abstracts to *JSRA*. ●

Author's note

I would like to thank Andrew Weiss, Elizabeth Altman, Mindy Berman, Alvalyn Lundgren, and Helen Chun for their work on JSRA. I have been fortunate to have support from CSUN leadership and staff in launching and running the symposium and the journal. ●

Steve Oppenheimer, professor emeritus, CSUN, has received several awards, including the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring and a CSU System Trustees Outstanding Professor award. He is an American Association for the Advancement of Science Fellow and serves as director of CSUN's Center for Cancer and Developmental Biology. He is editor of Elsevier's international journal Acta Histochemica, affiliated with the International Federation of Societies for Histochemistry and Cytochemistry. He has taught, conducted research, and worked with middle and high school students and teachers at CSUN for 48 years.

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National Science Teaching Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3092
703-243-7100
nstareports@nsta.org

Lynn Petrinjak.....Managing Editor
Debra Shapiro.....Associate Editor
Will Thomas, Jr.....Art Director
Production Staff.....Jack Parker
Catherine Lorrain
David L. Evans.....Executive Director
Jason Sheldrake.....Advertising Director
jsheldrake@nsta.org
703-312-9273

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Are you interested in submitting a Commentary for consideration for *NSTA Reports*? E-mail Lynn Petrinjak at lpetrinjak@nsta.org for more information.

American Journal of Applied Scientific Research**APPLIED SCIENCE RESEARCH FOR ALL PART 1 PRE-COLLEGE LEVEL**

Steven Oppenheimer, Mindy Berman, Helen Chun, Alvalyn Lundgren, Stacy Tanaka, Aphrodite Antoniou, Terri Miller, Greg Zem, Applied Science Research for All Part 1 Pre-College Level, *American Journal of Applied Scientific Research*. Vol. 6, No. 4, 2020, pp. 72-75. doi: 10.11648/j.ajasn.20200604.11

Abstract

The field of applied scientific research is important for the health, welfare and security of all countries in the world. Applied research scientists should be involved in the education of new generations of investigators. Institutions can reward them for such participation. It is well known that science fairs only reward a few winners and hundreds of others are left with no reward and possibly less inspiration to continue in science. In fact, Finland was ranked at the top in the U.N. World Happiness Report primarily because it aims not to leave any student behind, instead of only nurturing high achievers. This paper is intended to interest applied research scientists in the education of new generations of prospective applied researchers by presenting programs that do not leave any interested students behind. As presented in a National Science Teaching Association Commentary, by Steve Oppenheimer read by hundreds of thousands in the education community, and in a National Science Foundation webinar, this paper for the first time brings 2 key programs to applied scientists. One is a journal, whose 25 annual volumes inspire all students. The

other is a symposium that does the same. The concept of science research for all students helped Steve Oppenheimer, win a U.S. Presidential Award for mentoring (PAESMEM), presented at the White House by President Obama. The American Association for the Advancement of Science (AAAS) cited Steve's work with K-12 programs, as well as his glycobiology research, in his election as Fellow AAAS. In the journal and symposium there are only rare rejections. Problem submissions are corrected. The late Nobel laureate Francis Crick, who believed in the motto of science research for all, was an early collaborator in these programs. These programs can be easily replicated, especially with the involvement of applied research scientists, who in partnership with the education community, can interest many more students in applied research science. The involvement of Dr. Crick attests to the importance of bringing research scientists into these training programs. Many universities and organizations will count mentoring involvement in evaluating scientists for tenure and promotion.

<https://bit.ly/3mYWVSs>

See the full article beginning on the next page.



Photo by Jeswin Thomas / Unsplash /

Applied Science Research for All Part 1 Pre-College Level

Steven Oppenheimer*, Mindy Berman, Helen Chun, Alvalyn Lundgren, Stacy Tanaka, Aphrodite Antoniou, Terri Miller, Greg Zem

Department of Biology and Center for Cancer and Developmental Biology, California State University, Northridge, Northridge, California, United States

Email addresses:

steven.oppenheimer@csun.edu (S. Oppenheimer), mindy@mfcommunications.com (M. Berman), hchun@csudh.edu (H. Chun), alvalyn@alvalyncreative.com (A. Lundgren), stacy.tanaka@lausd.net (S. Tanaka), yiassu@gmail.com (A. Antoniou), billterritina@earthlink.net (T. Miller), gzem@lausd.net (G. Zem)

*Corresponding author

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Abstract: The field of applied scientific research is important for the health, welfare and security of all countries in the world. Applied research scientists should be involved in the education of new generations of investigators. Institutions can reward them for such participation. It is well known that science fairs only reward a few winners and hundreds of others are left with no reward and possibly less inspiration to continue in science. In fact, Finland was ranked at the top in the U.N. World Happiness Report primarily because it aims not to leave any student behind, instead of only nurturing high achievers. This paper is intended to interest applied research scientists in the education of new generations of prospective applied researchers by presenting programs that do not leave any interested students behind. As presented in a National Science Teaching Association Commentary, by Steve Oppenheimer read by hundreds of thousands in the education community, and in a National Science Foundation webinar, this paper for the first time brings 2 key programs to applied scientists. One is a journal, whose 25 annual volumes inspire all students. The other is a symposium that does the same. The concept of science research for all students helped Steve Oppenheimer, win a U.S. Presidential Award for mentoring (PAESMEM), presented at the White House by President Obama. The American Association for the Advancement of Science (AAAS) cited Steve's work with K-12 programs, as well as his glycobiology research, in his election as Fellow AAAS. In the journal and symposium there are only rare rejections. Problem submissions are corrected. The late Nobel laureate Francis Crick, who believed in the motto of science research for all, was an early collaborator in these programs. These programs can be easily replicated, especially with the involvement of applied research scientists, who in partnership with the education community, can interest many more students in applied research science. The involvement of Dr. Crick attests to the importance of bringing research scientists into these training programs. Many universities and organizations will count mentoring involvement in evaluating scientists for tenure and promotion.

Keywords: Pre-college Research, Involvement of Applied Researchers, Journal and Symposium

1. Introduction

In an invited Commentary presented in the October 2019 issue of the Newsletter of the National Science Teaching Association (NSTA), NSTA Reports, Steve Oppenheimer presented "The Value of Recognizing the Efforts of All Science Students." [1]. This Commentary was also presented by Steve in the National Science Foundation invited Webinar

on supporting science research in education on August 11, 2020 [2]. The Commentary was read by hundreds of thousands of mostly pre-college teachers. The gist of the NSTA Commentary, and the focus of this paper, is how to inspire many more pre-college students to enter fields of applied scientific research. The reason for submitting this paper to an applied scientific research journal, rather than an education journal, is because the paper is about how applied

research scientists can influence the future of applied research education at early levels when youngsters are not yet sure of their future careers. By the time they enter college, their career choices are often already decided [3]. This paper presents two award-winning programs [4, 5] to the applied science research community, as previously it was only known by some educators. It is important to present this information to scientists if we are to inspire many more youngsters into choosing applied research careers. This approach has been recently lauded in the literature and is one reason for Steve's receipt of a U.S. Presidential Award for mentoring (PAESMEM) and his election as Fellow of the American Association for the Advancement of Science (AAAS) [6]. Good pre-college science experiences help youngsters choose science majors in college [3].

Finland has been ranked at the top in the U.N. Happiness Report, apparently in large part due to its education system that aims not to leave any student behind, rather than only nurturing high achievers [7].

2. Experimental Procedure

An award-winning [4, 5] pre-college journal is described that recognizes all participating students who have completed their reviewed research work, not just the advanced few. A poster symposium is also described that recognizes all completing participants with medals and certificates. Scientists with expertise in applied research, along with teachers and editors review the student-authored materials. If there are problems with submissions, teachers and students are contacted to make needed corrections. Rejections are very rare. Nothing is rejected unless there was harm to animals or humans that occurs very rarely, and is cited in the journal front material or the work is not repairable. Most abstracts are professionally edited and copies of the journal are distributed to all student authors free of charge. All 25 annual issues [8-33] of the journal are made available online to anyone in the world, free of charge.

3. Results and Discussion

Hundreds of K-12 students each year through their teachers (who do the first review), submit their research abstracts to Steve Oppenheimer (steven.oppenheimer@csun.edu) by email. An examination of the thousands of abstracts in the 25 annual volumes of the journal [8-33] will reveal that many or most are in the area of applied research. Young students love practical research that solves real world problems. Steve looks them over and sends them by email to the expert associate editor Mindy Berman, who gives them rigorous scrutiny and editing, sending them to the other associate editor Dr. Helen Chun who provides a 4th expert review (4 reviews: teacher, Steve, Mindy and Helen). Mindy contacts the teachers of abstracts that need modifications. Each volume of the journal is carefully designed by our award-winning designer Alvalyn Lundgren. The secret to the 25 years of success is this team of editorial

experts and the principle that no child is left behind.

The current 25th Anniversary issue (in press) of the journal, in addition to hundreds of usual abstracts, features work from Dominique Evans-Bye's classes. Dominique is one of a few of hundreds of U.S. Presidential Award winners (PAESMEM) that is a pre-college (high school) teacher... maybe the only one in decades. The Presidential Award is the nation's top award for science student research mentoring. Most winners are college level mentors as is Steve Oppenheimer. Of hundreds of Presidential Award winners, only Dominique was chosen by NSF to present a webinar on research in the classroom [2]. She selected Steve to co-present, indicating that Steve was a major reason for her success, starting in his programs decades ago. In the early days of these programs (1980s- 1990s) the late Nobel laureate Francis Crick worked with Steve on these programs, visiting the campus for about 10 years, working with and inspiring pre-college teachers and their classes. Dr. Crick was a big believer in science research for all. If Nobel laureate Francis Crick believed in these programs, many more applied research scientists might consider involvement. Professional advancement may be enhanced by such involvement. Institutions now-a-days often consider such participation in addition to research productivity.

The annual poster symposium that presents medals and certificates to all student presenters, who have gone through our multi-step process, leaves no student behind. A large cadre of advanced undergraduate students visit each poster and discuss it with the child. California State University, Northridge Vice Provost Matt Cahn said of a recent symposium: "This is one of those transformative opportunities that we hope all students have."

Former students who participated in the journal and symposium report that their siblings "fight" to become involved in the journal and symposium. Rewards like a published abstract and medal and certificate represent university recognition, inspiring many of the youngsters to continue in applied science. While science fairs often only reward a select few advanced students ("winners"), the programs reported here reward all completing participants. That's one reason why the National Science Foundation and White House in reviewing Steve Oppenheimer's application for a U.S. Presidential Award said that his motto of saying that all interested students can do good science research was realized based on well documented data [6].

Applied research scientists can replicate these programs, helping to insure that applied scientific research will continue to flourish for decades to come. While the NSTA Reports Commentary and NSF Webinar were viewed by mostly pre-college teachers, it is the scientific community that will help assure that many more youngsters will consider careers in applied science research. By the time students reach college, their career choices are often already in stone [3]. These programs can be replicated by schools and school districts. But without the involvement of applied research scientists, program quality can not be guaranteed, and university recognition often will not occur. University recognition is so

important an inspiration for pre-college youngsters. Decades ago Dr. Crick played a key collaborative role to help enhance these programs to the success they enjoy today. Both the journal and poster symposium praise the children for their enthusiastic effort. In fact children dance with joy (reported by teacher Terri Miller) when they see their project in print. Terri also concluded, based on decades of observations that these programs enhance students' self image, seeing themselves as real scientists. Praise for effort (34) is a key to how these programs inspire youngsters.

4. Conclusion

In order to motivate many more students to enter careers in applied research science, applied research scientists should be involved in their education. The programs described here provide a model for such involvement. A key concept that helps assure success is that all interested students should be guided to do applied science research where students are recognized for their good efforts.

The value of recognizing the efforts of all interested science students is essential to inspire many more students to seek careers in applied research science. Career choices are often determined way before college and that's a major reason for involving the youngest students in good science opportunities. These programs have been widely recognized by the National Science Foundation, the White House, the National Science Teaching Association, and the American Association for the Advancement of Science. The 10 year collaboration with the late Nobel laureate Francis Crick attests to the importance of these programs in training new generations of applied research scientists.

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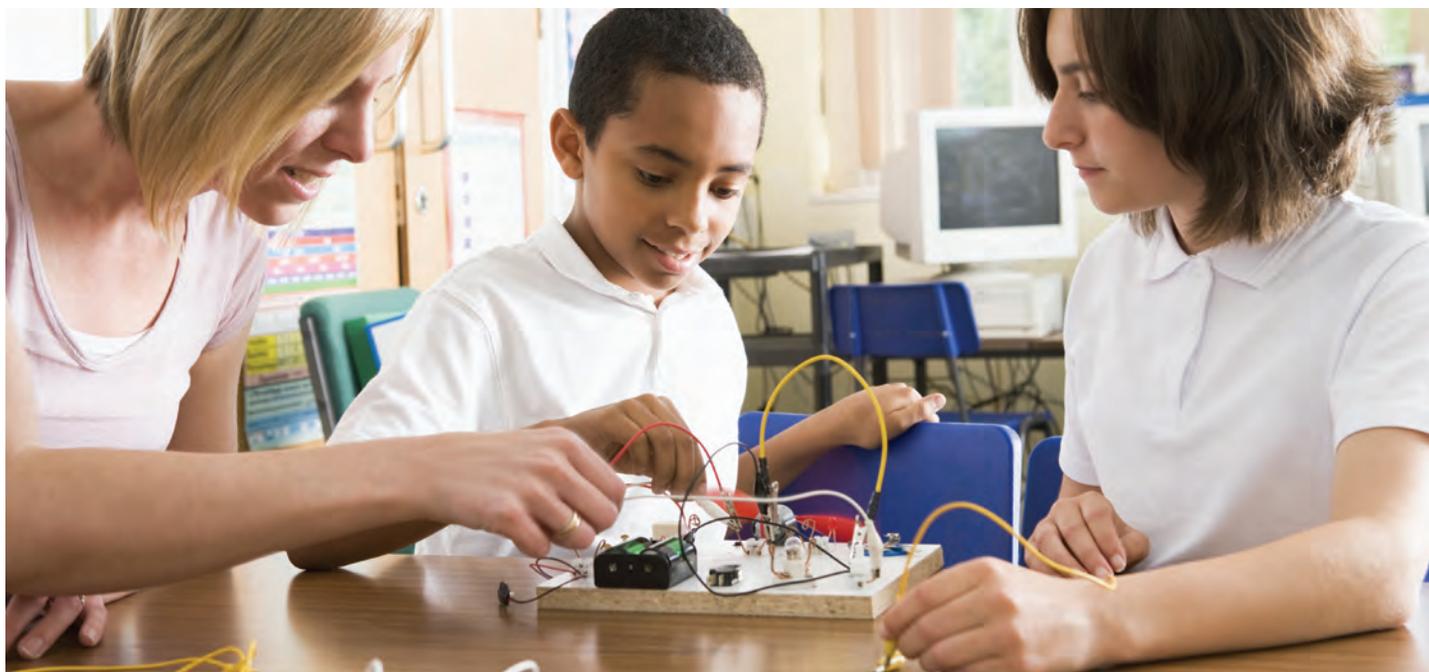
We thank Andrew Weiss and Elizabeth Altman for outstanding work in bringing this journal to the worldwide web.

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American Journal of Applied Scientific Research

APPLIED SCIENCE RESEARCH FOR ALL PART 2 COLLEGE LEVEL

Steven Oppenheimer, Nelli Stepanyan, Aeshah Akram, Osama Alnimri, Gelsey Aranibar, Rachel Assad, Jose Chacon, Coral Chavez, Nolan Dafesh, Roxanne Duong, Fatmanur Ergun, Jessica Escojido, Kevork Keshishian, Pariya Keykhamidesfandabadi, Melisa Morales, Mary Nakkashian, Natta Narkmanee, Angelicamiae Pomares, Ana Ramirez, Nairi Simonyan, Awazeh Taherpourtshizi, Magabrielle Thompson, Vincent Villani, Yi Yang, Applied Science Research for All Part 2 College Level, *American Journal of Applied Scientific Research*. Vol. 7, No. 1, 2021, pp. 1-7. doi: 10.11648/j.ajaser.20210701.11
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Abstract

This paper is for applied research scientists and any scientists who train students to do research. It consists of two parts: (1) an open door hands-on research training program that helped garner a US Presidential Award for Mentoring and election as Fellow, American Association for the Advancement of Science (AAAS); (2) a Covid-19 Pandemic virtual research training program that provides readings and YouTubes for the students followed by an opportunity to develop new research ideas. The co-authors of this paper are the students who pioneered the virtual program. In the hands-on program of 263 students who reported their career outcomes to Steve, 52 achieved doctoral degrees and became professors and researchers, 62 became M.D.s or M.D.-Ph.D.s, 33 became dentists, 17 pharmacists, 97 became scientists in research and/or education and 2 became lawyers.

Many of the students co-authored lab published papers, abstracts and national poster presentations. The program's success resulted from an open door policy that invited all interested students to try their hands at research, regardless of their grade point averages, and organizational components that recruited advanced students to help train new students. Universities and other organizations often look favorably on student mentoring in tenure and promotion decisions. Many students can possibly result in more good publications. Readers can determine, by examining the student co-authored papers in the reference section of this paper, if this expanded student-involved program leads to "good publications," as AAAS and the NSF/White House review committee suggested it did.

Read the full article at <https://bit.ly/3ogMQjg>.

A close-up photograph of several green leaves, showing a detailed network of veins. The leaves are layered, with some in the foreground and others behind, creating a sense of depth. The lighting is bright, highlighting the texture of the leaf surfaces.

ABSTRACTS

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Will the Reproduction Rate of Collembolans Decrease If Spinach Is Added to Their Diet?

Mary Bishop, Destiny Bolt, Lili-Ana Carballo, Jayden Jones, Sydnee Mata, Jared Mielke, Ian Prieto, Manuel Rodriguez, Mark Tramble III, and T. Miller (retired teacher)

Boys & Girls Club of the Colorado River, Bullhead Teen Center
967 Hancock Rd., Ste. 7, Bullhead City, AZ 86442

The purpose of this experiment was to see if adding spinach to the diet of Collembolans increases or decreases their population. Collembolans are small insect-like animals that use a springtail for jumping and have four-part antennae. The hypothesis was that the reproduction rate of Collembolans would increase if spinach was added to their diet. One part powdered charcoal and nine parts plaster of Paris were placed in a 1-quart baggie and mixed completely. It was then poured into a plastic container and water was added. It was stirred and then moved by spoonfuls to six Petri dishes. The Petri dishes were tapped on the table to spread the liquid, remove the bubbles, and make a flat environment for the Collembolans. They were allowed to dry. Water was added to the Petri dishes by dropping it in with eyedroppers. Yeast was placed into the six Petri dishes, and three small pieces of spinach were added to three of them. A total of 38 Collembolans were placed into the Petri dishes with the spinach and yeast (experiment) and a total of 38 Collembolans were placed into the three Petri dishes with just the yeast (control). After five weeks, a total of 142 Collembolans were counted in the Petri dishes with the spinach and yeast. A total of 304 Collembolans were counted in the Petri dishes with only yeast. The hypothesis was incorrect. The number of Collembolans increased when spinach was added to their diet, but not as much as in the control. The reproduction rate was higher without the spinach.

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How Does Temperature Affect a Tennis Ball's Bounce?

Likhitha Battu and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science fair experiment aimed to determine whether different temperatures affect how high a tennis ball bounces. The main reason why a tennis ball bounces is because of the gas pressure inside. The air molecules inside the ball move freely, allowing the ball to contract and expand when it is bounced. When the tennis ball hits the ground, the molecules contract, making the impacted side of the ball flat. When the molecules slide to cover the space, the tennis ball expands, making it bounce off the ground in a spring-like motion. For this experiment, I had one control group and two experimental groups. My control group included tennis balls at room temperature, Group B included frozen tennis balls, and Group C contained tennis balls that were heated by the sun. When I dropped the tennis balls from my control group, I noticed that they reached an average height of 34 inches. Group B's tennis balls only reached an average height of 15 inches, and Group C's tennis

balls reached an average height of 40 inches, the highest of the three groups. This data proved that heated tennis balls bounce the highest because the gas molecules in their heated cores move faster, causing the balls to expand, which ultimately results in higher bounce heights. This experiment can help tennis players like me when they want to get a head start on their opponents.

6915

Can Something So Routine Be the Key to Your Testing Success?

Maya Shtangrud and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science project showed the effect of someone's sleep schedule on their memory. I wanted to know if the amount of time someone sleeps affects their short-term memory and therefore affects their testing. To find this out, I asked 21 teenagers from ages 13 to 15 to fill out a Google form I created. They wrote what time they went to sleep, when they woke up, and how long they slept in total. Then, using a memory test I created with 20 colorful images on it, the participants studied the test for 30 seconds and tried to recall as many of the images as they could within a minute. After collecting my data, I discovered that the people who slept for 8 hours remembered the most images out of the participants. I also discovered that the people who slept for only 4 or 5 hours remembered the fewest number of images from the memory test. In conclusion, the more sleep you get, the better it is not only for your memory, but also for almost all of your bodily and mental functions.

6916

How Does Music Affect Physical and Mental Performance?

Raj Patel and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

For my science project, I wanted to see how music affects performance both physically and mentally. To find the answer to this question, I decided to use data from 13 individuals. I asked them to do two separate tests – one for physical performance and one for mental performance. In the physical test, I asked them to do two basic exercises: squats and push-ups. The first time they did the test, they were supposed to do it without music, and the next time with music. There was no time restriction for how many they could do; they just had to do them until they couldn't do any more. Rest time in between the sets with and without music was also unrestricted. The mental performance test required the participants to do three sub-tests: one about spotting the difference, one about basic arithmetic, and one using the memory game. (In this game, players need to match the same card types without the cards being face up. They flip the cards over two at a time, and try to remember which card is at which position and match them.) For both the

spot the difference and arithmetic tests, the participants were supposed to record the time. However, for the memory game, they had to record the number of guesses they took to complete the game. For all of the tests, they needed to do them twice, once with music and once without. My hypothesis was that in the physical category, the numbers would be greater for the tests with music, but in the mental category, the results for the no music tests would be better. The results showed somewhat similar findings. On average, with music, the participants completed 10 more push-ups and eight more squats than without music. Also, with music, on average the participants spotted the difference 3 minutes quicker and completed the arithmetic test 20 seconds quicker. On the other hand, without music, the memory game was easier: an average of two fewer guesses were needed. In conclusion, my study using a series of tests conducted with 13 people proved that music allowed them to perform better both mentally and physically.

6917 Do Different Paper Airplane Structures Affect Flight Distance?

Danielle Lee and G. Zem (teacher)
Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science project focused on finding which paper airplane structure results in the greatest flight distance. I wanted to see if changing the structure of a paper airplane would drastically affect its flight distance negatively or help it fly farther. For my project, I created six different paper airplane models. I took each model to a starting line and threw it with my arm starting at a 90° angle until it was fully extended. I repeated this another four times, ending up with five trials total for each airplane model. After each trial, I measured the distance the airplane model flew from the starting point to where it landed. I then added up all of the numbers from the five trials for each model and divided them by five to get the average distances. Out of the six paper airplane models, Model 4 had the greatest average distance, at 278.2 inches, while Model 6 had the shortest average distance, at 139.6 inches. The total distance between the models with the longest and shortest average flight lengths was 138.6 inches. In conclusion, different paper airplane structures do have a great impact on how far an airplane travels. The type of structure you fold can greatly affect how your airplane performs in the air.

6918 Discoloration Experimentation

Jatin Gundara and G. Zem (teacher)
Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science project showed how different drinks can affect the color of teeth. I wanted to find out which of these drinks stain teeth the most so that I could tell my friends and family to not consume them too often. I used hard-boiled eggs to represent

teeth in my experiment, and I had one control group and one experimental group. In the control group, the eggs were submerged in one of five liquids (water, black tea, black coffee, Coke®, and red wine) for one day. They were then taken out and given a rating of 1–5 based on how dark they were, with 5 being the darkest. The experimental group had a fairly similar procedure. The eggs in this group were also submerged in one of the five liquids for one day before being taken out. However, after being taken out of the liquids, the eggs in the experimental group got a light brushing. I then rated the brushed areas of the eggs on a scale of 1–5. Both of these groups were stained alongside each other two separate times for accuracy. The end results showed that the brushed areas on the eggs in the experimental group scored much lower than the eggs that weren't brushed. The constant highest-scoring drink in both groups was red wine, coming in at a 5 without brushing and a 4 with it. After that, Coke, black coffee, and black tea all had mixed results around the 3–4 range. Water expectedly placed the lowest, coming in at a 1 in both tests. All of this showed that when consuming the drinks tested (or any dark or colored drink), brushing your teeth afterward may help combat permanent discoloration or staining of teeth. In conclusion, it is clear that this experiment could be helpful to those who consume a lot of colored or dark drinks.

6919 The Effect of Different Materials on Sound Waves

Samanyu Warhade and G. Zem (teacher)
Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

In this experiment, I learned about sound and how it passes through different materials, and developed an understanding of its properties. I also learned about the Adobe® Audition® audio software and how to analyze audio using this software. I explored and learned a lot about different types of microphones, and then selected a suitable microphone for the project, which was a cardioid mic. I set up the experiment so that the microphone and the speaker kept in the tested materials were equally distanced from each other every time. However, there were setup limitations. I used different materials such as wood, Styrofoam, cardboard, glass, plastic, and steel, but some of them were airtight and some may have had air leakages, therefore creating problems for very accurate results. Also, different thicknesses and shapes may have affected the accuracy of the results. My hypothesis was that Styrofoam would absorb the most sound, but surprisingly, it allowed the most amount of sound to pass through. I came to the conclusion that Styrofoam was able to absorb some of the sound, but that didn't mean it did not allow the sound to transfer through the material. For the metal, it did allow some sound to go through it, but most of the sound wasn't absorbed. It repelled off the walls of the metal (a metal pot) instead of traveling through. So the sound waves eventually lost kinetic energy. This project can be used as a future reference for more professional and useful experiments. For example, testing acoustical foams and different shapes of materials to see the amount of absorption and reflection can be

used for future architectural purposes. I experienced several setup limitations and environmental problems in doing this experiment. The appropriate environment for this experiment to get the most accurate results would be an anechoic chamber, as no materials would affect the direction of the sound. However, overall, although my environment wasn't perfect, I got a lot of interesting information and results.

6920

Fecal Transplant and Bacteria

Brittany Mora Ibarra, Lexi Serna, and M. Lewis (teacher)

Mulholland Middle School

17120 Vanowen St., Lake Balboa, CA 91406

A fecal transplant is a cure for people with unbalanced microbiome levels. Having uneven microbiome levels is dangerous because your gut has a high chance of growing infectious bacteria such as *C. difficile*. Our bodies can be filled with both good and bad bacteria, but our research focused on bad bacteria. *C. difficile* are bacteria that can cause symptoms ranging from diarrhea, vomiting, and fevers to life-threatening inflammation of the colon. *C. difficile* bacteria also result in hard-to-treat gut infections that can kill you. Because of the deadly infections, *C. difficile* cause thousands of people to die each year, and are sometimes referred to as “killer bacteria.” (Source: “Microbiome,” *Amplify Science*, the Regents of the University of California, 2018, <https://bit.ly/2Uvqb8h>.)

C. difficile are common in nature. These microorganisms are found in the soil, where they eat almost anything as food, but they also can survive in the human gut. *C. difficile* can grow or spread rapidly into a powerful poison that causes irritation on the gut lining, potentially resulting in the cells dying. Sometimes *C. difficile* bacteria move into the bloodstream, spreading the infection, which in some cases leads to death. *C. difficile* most commonly affect older adults in hospitals or in long-term care facilities, and typically develop after use of antibiotic medications. However, not all bacteria are bad bacteria. In fact, without most bacteria in your gut, you wouldn't be able to do a lot of things. For example, if you didn't have the bacteria *B. animalis*, you wouldn't be able to digest milk. *B. animalis* can be found in the guts of mammals, and they keep bad bacteria from intruding because they need to live in places with very little oxygen. If not, they will die, so they live in the deep parts of your gut and protect it from any bad bacteria, such as *C. difficile*. *B. fragilis* are an obligatory anaerobic, gram-negative, rod-shaped bacteria, which are also a good bacteria that can protect people from bad bacteria such as *C. difficile*. Without these bacteria, people would suffer from health problems. However, they also can cause infections. “*Bacteroides* species are significant clinical pathogens and are found in most anaerobic infections, with an associated mortality of more than 19%.” (Source: “*Bacteroides*: the Good, the Bad, and the Nitty-Gritty,” Hannah M. Wexler, *Clinical Microbiology Reviews*, American Society of Microbiology, October 2007, <https://bit.ly/3J5E3tl>.) “These bacteria normally help humans in several ways. First, they strengthen

the body's defenses by helping the immune system produce enough immune cells to kill harmful invading bacteria. Another important way *B. fragilis* bacteria help humans is through their habit of sticking to the gut wall.” *B. fragilis* are a strong bacteria because they can use nearly anything as food. “Because they take up living space, *B. fragilis* bacteria prevent harmful microorganisms from moving in” to the human body. (Source: “Bacteria: *B. fragilis*,” the Regents of the University of California, 2018, <https://bit.ly/3ivRTcE>.) **Why should people have a fecal transplant?** When you have uneven microbiome levels, you are vulnerable to bad bacteria such as *C. difficile*. A fecal transplant can restore your microbiome levels to give good bacteria such as *B. fragilis* and *B. animalis* the opportunity to grow. Antibiotics cannot distinguish between good and bad bacteria and kill both, leaving the gut microbiome vulnerable to growing bad bacteria. This is when the bad bacteria like *C. difficile* can attack your gut, leaving you defenseless and making it harder for you to get rid of the bacteria. In these cases fecal transplants are beneficial. They can help you get rid of only bad bacteria without killing the good bacteria. This is accomplished by filling your gut microbiome with healthy bacteria, cutting the food source for bad bacteria.

6921

The Effect of Ocean Currents on Air Temperature

Jonathan Bernal and M. Lewis (teacher)

Mulholland Middle School

17120 Vanowen St., Lake Balboa, CA 91406

Ocean currents are paths of flowing water that travel in a pattern. They can occur for many reasons, such as wind, temperature, and the Earth's rotation. Ocean currents can carry water from different latitudes and bring warmer- or colder-than-expected water temperatures. They have energy transferred to them, based on the location of the current, then carry it to somewhere else, transferring the energy to the air because heat absorbed and stored by the ocean releases the energy into the atmosphere. The ocean water currents are moved when strong winds push the surface of the water. The deeper the currents are, the less they are affected by winds; instead they rely on the ocean temperature, density, and salinity of the nearby water to move. The warmer the water is, the less dense it becomes, and as a result it moves to the surface and colder water sinks to the bottom. This causes ocean currents to travel around the world in the Thermohaline Conveyor. This current exchanges the warm water of the equator with the cold water of the poles. Therefore, areas affected by ocean currents have a temperature that varies at certain latitudes, as the currents transfer energy to the air or the air transfers energy to the water (meaning the energy from the sun moves between the ocean and the atmosphere). Ocean currents, such as the Gulf Stream, take warmer water from near the equator and transfer it to another location, then take the colder-temperature water and carry it somewhere else. The Gulf Stream takes the warmer water up across the East Coast of the United States, where it turns to the east because the Earth's rotation changes the direction of

the winds, thus pushing the water toward Europe. This warmer water creates warmer ocean temperatures than in any other area of that same latitude. This shows that ocean currents are pathways of water that move in patterns and take water with different temperatures around the world. These currents can be moved by strong winds on the surface, but then rely on density and temperature differences to move deeper down. Therefore, by bringing different water temperatures to other areas, ocean currents significantly affect those areas and the people who live there. For example, in Europe, if the Gulf Stream did not take warm water from the equator there, parts of Europe would be cold and desolate. This shows just how important ocean currents are to people, as the currents balance water temperatures from around the world.

6922 The Effects of El Niño

Ilianna Chavarria and M. Lewis (teacher)
Mulholland Middle School
17120 Vanowen St., Lake Balboa, CA 91406

El Niño can have varying effects on air temperature, ocean currents, and climate in different locations. The temperatures depend on where the sun (the energy source) is reflecting. Areas closer to the equator are warmer because the sun reflects most of its energy to the equator. For example, Alaska and New Zealand are different distances from the equator. Alaska is at latitude 60° north and New Zealand is at latitude 40° south, so Alaska is located farther from the equator than New Zealand, which makes Alaska's air temperature cooler than New Zealand's because it receives less energy from the sun. Based on research, I learned that different locations could experience the same or different effects during El Niño years. For example, in the South American country of Columbia, El Niño could cause droughts. Such droughts affect the farmers, but more so the overall population. Mosquitoes carry the disease malaria, and they often breed during El Niño years. The more these mosquitoes breed, the greater the risk of spreading malaria to people. In Pakistan, during El Niño years, the climate generally changes and becomes hotter, with a weaker monsoon season. This causes a lot of health problems as well, and means people can't grow crops since there is much less water. El Niño events generally occur every two to seven years. Depending on what climate an area has during normal years, the climate could become the opposite or increase or decrease in intensity during El Niño years. For instance, during normal years, New Zealand's air temperature is cool, but during El Niño years, it is cooler than usual, meaning that the air gets less energy transferred from the water during these times. Buenos Aires in Argentina gets ocean currents moving away from the equator, and since the equator is the warmest spot and receives the most direct sunlight, the ocean current contains more sunlight energy to make warmer water. Farther south it is cooler, meaning that the ocean currents carry less energy from the sun. Energy is always trans-

ferred from warmer to colder regions. When there are warmer ocean currents the air temperature increases. The same applies to colder ocean currents and decreasing air temperatures.

6923 Surface Area Versus Evaporation

Adam Lukomski and G. Zem (teacher)
Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

For my science project I decided to explore how the surface area and temperature of water affect its evaporation. I already had a basic idea of the evaporation process, but I intended to analyze it scientifically. For this experiment I used six containers with different surface areas filled with water. They were located in places with different temperatures. The level of water was monitored in each container during 410 hours. The results showed that the surface area of water had no effect on the rate of evaporation. I also observed that the rate of evaporation at 4°C was about 2.5 times slower compared to the rate of evaporation at 21°C.

6924 Which Color Light Is the Most Effective For Growing Plants?

Kerra Bae and G. Zem (teacher)
Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science project was about finding out which color of light is the most effective for growing plants. The colors of light that I used for this project were green, blue, white, red, and no light. So, I had five plants and four colored lights in total. After planting the seeds and wrapping four light bulbs in clear, colored cellophane paper, I set everything up. I turned off the lights during the day, and I turned them on during the night. The plant that had no light did not have a light bulb. I did this for 20 days and I gave the exact same amount of water to each plant. After the seeds started to sprout, I could already see a difference in the heights of the plants. The blue plant was always the tallest every day. The red plant was usually the shortest. After 20 days, the blue plant had grown 10 centimeters, the tallest of the group. The plant with no light and the plant with red light had grown the least. They both grew 7.9 centimeters. Through the project, I learned that blue was the most effective color of light for growing the plants I used. I also learned that if I want plants to grow more quickly I can use blue light because it is more effective than no light. Also, I should try not to use red light if I want plants to grow quickly, because it does not benefit them very much.

6925

Effects of Liquids on Gummy Bears

Ariana Vazquez and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science experiment showed how different liquids affect the growth of gummy bears. I wanted to see if and how gummy bears grow if they are soaked in different liquids. I chose to use four different containers, each with different liquids. In the first container, I put $\frac{1}{2}$ cup of water with a green gummy bear. In the second container, I put $\frac{1}{2}$ cup of water and 2 tablespoons of salt with a red gummy bear. In the third container, I put $\frac{1}{4}$ cup of water and $\frac{1}{4}$ cup of vinegar with an orange gummy bear. In the fourth container, I put $\frac{1}{2}$ cup of water and 1 tablespoon of baking soda with a yellow gummy bear. Before I put the gummy bears in their designated containers, I measured each one. After that, I put each gummy bear into its container. After 5 minutes, 1 hour, 6 hours, and 24 hours, I recorded the gummy bears' new measurements and new features. After 5 minutes, I saw no change in any of them. After 1 hour, the green gummy bear had grown a little bit, but the others barely had any changes. After 6 hours, the green gummy bear reached its peak height of 4 cm. The red gummy bear had grown a tad, but the others had begun to dissolve. After 24 hours, the orange gummy bear had completely dissolved; also, the green gummy bear had partially dissolved and its measurement was then 2 cm. At the beginning of the experiment, I predicted that the gummy bears would continue to grow and I had no idea they would eventually dissolve. In conclusion, gummy bears are affected by liquids in more ways than average humans may think.

6926

Which Type of Battery Lasts the Longest?

Sparsh Virwaney and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

For my science project, I decided to find out which type of battery lasts the longest among alkaline, carbon-zinc, lithium, nickel-cadmium, nickel-metal hydride, lithium rechargeable, and lead-acid. I did not experiment with any real batteries; I researched online and used the information I found, including: Batteries have three different measures of life — run time, shelf life, and cycle life. Run time is how long a battery lasts in a single use. This is difficult to find out because different devices use different amounts of energy. Shelf life is the amount of time a battery holds a charge while it is unused. Cycle life is the number of charges and discharges a rechargeable battery can complete before it no longer holds a charge. The run time for alkaline batteries depends on the device that is using it, and the shelf life is around 5–10 years. Carbon-zinc batteries have less capacity than other non-rechargeable batteries, and have a shelf life of around 3–5 years. Lithium batteries should last around 10–12 years. Their shelf life could be around 10 years, but it

depends on the manufacturing process and a few other factors. Nickel-cadmium batteries are more temperature-tolerant and have a longer cycle life than newer batteries, but are toxic to the environment. Their shelf life is around 1.5–3 years, and their cycle life is 1,000+ charging cycles. They also have less energy density than other batteries. For lithium rechargeable batteries, there are many types and all of them perform differently. They can last anywhere from 2–4 years with a cycle life of 600–1,000 charging cycles. The shelf life for lead-acid is 6 months, and cycle life varies but is very low. From all of this I found that lithium non-rechargeable batteries last longer than most batteries on average, as they have a shelf life of 10–12 years. They may not be rechargeable, but will still last longer.

6927

Are Fingerprint Patterns Inherited?

Arhana Desai and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

My science project focused on the inheritance of fingerprint patterns and their similarities in families. While there are three major fingerprint pattern categories — loop, whorl, and arch — there are a few variations in each category, and the details in each person's fingerprint pattern make it so that no one's fingerprint is the exact same as anyone else's. I compared the three main fingerprint pattern categories between parents and their children and between siblings to determine inheritance based on pattern matches in family members. The information gained through this project can help people further understand how genetics works and influences traits in families. My hypothesis was that fingerprint patterns are inherited from parents, but that everyone has a unique fingerprint. I started out by having each person from eight different families first draw a small rectangle on a piece of white paper and shade it with a pencil until it was completely dark, with no gaps. Then they each pressed their right index finger into the shaded area and kept it there for 20 seconds. Next they removed their index finger, put a piece of clear tape on it, and held it in place for another 20 seconds. They peeled off the tape from the finger and made sure the fingerprint was clearly visible on the piece of tape. Lastly, they put their piece of tape on a sheet of clean white paper and labeled it with their name. After I got all of the fingerprints and analyzed the data, I found that fingerprint patterns are inherited. While I found that the percentage of matching parent-to-child fingerprint pairs was 79%, more of the children had matching fingerprint patterns with their mother than their father. The mother-child fingerprint patterns matched in 64% of those reviewed, while the father-child fingerprint patterns matched in 14%. The sibling matching pairs were 71%. So, based on these findings, there is a greater chance of having the same fingerprint pattern as your sibling or mother. The percentage of individuals who had a different fingerprint pattern than the rest of their family was 30%, where 15% of those individuals were fathers, which made sense because their parents weren't

included in the data. Yet there was at least one child in every family who had the same fingerprint pattern as one or both of their parents, so according to this project, most likely you'll have the same fingerprint pattern as at least one of your family members.

6928

Free Drinking Water? Solar Desalination Made Easy

Olivia Yoshizaki and G. Zem (teacher)

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave., Chatsworth, CA 91311

For my science project I attempted to answer the question, "Does container color affect the efficiency and efficacy of a solar desalination apparatus?" To do this, I created three identical solar desalination contraptions, each with a different-colored container: black, white, and silver (from aluminum foil). Each one had two containers that were attached together by a pipe with a funnel on one end. The larger container was filled with saltwater and had Saran™ Wrap on top of it, and was weighted in the middle to create a condensation drip into the funnel. The other container collected the fresh water condensation from the first container. I left them all outside for the same amount of time (one day for the first trial, and two days for the second). I then measured both the volume and salinity of the collected water in each desalination apparatus in order to obtain my data and results. In conclusion, I found out that all of the desalination units I created were effective. Each container collected freshwater that, once tested with a refractometer, had zero saline in it (zero parts per thousand (ppt) and specific gravity of 1.000). This efficacy was as expected, as evaporating water leaves the salt behind because it is too dense and heavy, just like when ocean water evaporates in the water cycle. However, the black container was the most efficient out of all of them. It collected the largest amount of freshwater during the time that all of the containers sat out for in the experiment. The black one ended up collecting the most water because black absorbs the most sunlight and heat, causing there to be more condensation.

6929

Perioperative Opioid Consumption in Anterior Cruciate Ligament Reconstruction Patients: A Systematic Review and Meta-Analysis of Regional and Local Anesthesia Trials

Cassidy Burdette and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

The anterior cruciate ligament (ACL) is the tissue located in the knee that connects the femur to the tibia and aids in stabilization. ACL reconstruction is one of the most common sports medicine procedures performed due to the high frequency of ACL tears. Despite being performed arthroscopically, ACL reconstruction is still a painful procedure, requiring

multimodal pain control. Regional and local anesthesia are two common methods of pain control for ACL reconstruction that reduce the need for opioids postoperatively. Opioids are safe and effective if taken as prescribed. It is important to manage and quantify the distribution and use of opioids to minimize their misuse. In this study, we performed a systematic review and meta-analysis of level 1 randomized controlled trials of regional and local anesthesia methods to quantify perioperative opioid consumption in patients undergoing ACL reconstruction. We also wanted to compare opioid use between types of regional and local anesthesia. Peer-reviewed published articles were retrieved from various online databases following specified criteria. After review, 46 studies met the inclusion criteria and were included in the study. The data pulled were evaluated regarding patient demographics, perioperative opioid consumption converted to total milligram equivalents (TMEs), and other primary outcomes, such as pain scores, quadriceps strength, and complications. This study is ongoing and results are not yet completed. The results of this study can help surgeons know the average amount of opioids administered to ACL reconstruction patients in the perioperative period in order to help determine which type of regional or local anesthesia provides the best pain control.

6930

Effective Mission Design For Lidar-Equipped Lunar Orbiting Satellite

Emily Kosloski and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

The moon has recently become an object of greater scientific interest both for itself and as a gateway to other scientific endeavors. In this study, information was gathered about the use of lidar instruments on satellites orbiting celestial bodies, with the end goal of designing a theoretical lunar satellite mission. Lidar is an acronym for Light Detection and Ranging, and refers to the process of sending a laser beam at a surface and measuring the time elapsed before the reflected light returns to the instrument. In the past 30 years, NASA has launched laser altimeters on satellites orbiting the Earth, the moon, Mercury, and Mars to measure the topography of all four surfaces, clouds and aerosols in the atmosphere, and polar ice sheets on Earth. In addition to one-beam lidar that gathers data about geodetic topography, surface roughness, slope, and reflectance, multispectral reflectance lidar employs multiple simultaneous laser beams of varying wavelengths to analyze the chemical makeup of the surface. In order to design a theoretical mission, instrument parameters and measurements from past lidar missions were scrutinized and compiled into a potential combination based on the goal of more accurately mapping the topography and analyzing the chemical makeup of the lunar south pole. Considerations were given to wavelength, orbit altitude, mass, field of view, and electrical power, because these factors greatly influence the rest of the satellite design.

The results of this project would simply be the first step in the long process of designing a satellite to gather information and further knowledge of the natural world.

6931

The Role of Racial and Ethnic Disparities in SARS-CoV-2 Infections

Hannah Shaffrey and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

As the world continues to grapple with the COVID-19 pandemic, new information is coming to light regarding the disparities that are present in certain groups. In this study, a special emphasis was placed on vitamin D levels in SARS-CoV-2 cases in BAME (Black, Asian, and minority ethnic) groups. Data pulled from the Centers for Disease Control and Prevention (CDC) indicated that members of the BAME groups have a higher number of cases than other racial groups, but have a lower death rate. It may be that the BAME groups are more likely to have a vitamin D deficiency due to the greater amount of melanin in their skin, and less production of vitamin D in response to sunlight, which makes them more vulnerable to the virus. Data examined from the CDC show that while whites have a higher number of deaths in the United States, there are collectively more cases among the BAME groups. In order to determine if there is a cause-and-effect relationship between vitamin D levels and the number of SARS-CoV-2 cases, more data need to be examined.

6932

The Effect of Technology on Amount of Quality Sleep

Josephine Hunter and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

Technology has vastly changed the world today, specifically for teenagers, who are in a stage of growth and change. In this study, various impacts of electronic time upon adolescents were examined to determine if there is a relationship between electronic time and quality sleep. A survey was created and sent to the students at Mount de Sales Academy, an all-female private high school located in Maryland with approximately 500 students. Out of the student body, 252 students who varied in age from 14–18 in grades 9–12 responded to the survey. The average amount of nightly sleep among those surveyed was 6 hours and 40 minutes. In addition, 96% of those surveyed who received insufficient sleep were on technology within an hour of going to bed. Survey data results suggest that use of technology right before going to sleep has a potential direct impact on the quality of sleep a student receives. However, given that current teenagers are using technology more than they have ever before, this area of research should continue to be studied in order to find a clear cause-and-effect relationship.

6933

Cystic Fibrosis and the Future of Gene Therapy

Cate Manos and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

Cystic fibrosis is a life-threatening genetic disorder caused by mutations in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. The mutated CFTR gene is unable to produce a properly functioning CFTR protein, thus causing the unbalance of chloride ions in various membranes of the body — notably the lungs and pancreas. As a result, a thick layer of mucus forms and lines epithelial cells in these body organs, making breathing and digestion difficult, as well as causing serious infections. In this study, several forms of treatments were examined from published literature. After examination, studies incorporating gene therapy approaches were identified as favorable because gene therapy attempts to add a normal copy of the CFTR gene to patients' diseased tissues (in some cases replacing the mutated CFTR gene) so that these patients can produce properly functioning CFTR proteins. Several methods of gene therapy are currently being tested and observed to determine the most effective, safe, and durable form for CF patients. For further examination, one British study that conducted a clinical trial to evaluate the effects of inhaled CFTR DNA aerosol on lung function in CF patients was highlighted. The results showed stabilization in lung function of CF patients who received active treatment in the form of a CFTR gene-liposome complex taken via inhaled aerosol, versus the lung function decline of a placebo group. Results, although modest, provide hope to patients and will drive a great deal of additional clinical research in the future. Further work is needed to completely understand how gene therapy approaches affect patients diagnosed with cystic fibrosis.

6934

Analyzing Indigenous Population Movement in Response to Landscape Change in the Chesapeake Bay Region

Julia Ribblett and S.G. Ribblett (teacher)

Mount de Sales Academy
700 Academy Rd., Catonsville, MD 21228

Before Europeans colonized the continents of what are now North and South America, the landscape of the Western Hemisphere was inhabited by various tribes of Native, or Indigenous, American peoples. The possibility that landscape change may have played a role in Indigenous population movement was examined, specifically between the time periods from 1500 CE (Common Era) to the present day. Three characteristics of landscape within the region were considered: geology/soil type(s), forest cover, and sea level. Data on these landscape characteristics were compiled from various peer-reviewed published journal articles. Patterns of settlement locations across time periods were previously identified through archaeological sites and mapped through the sub-

scription-based service ArcGIS Online. Data analysis showed evidence of shallow, nutrient-rich soil in sites dating from 1500 CE; declining forest cover percentage as well as Indigenous population numbers; and a rise in sea level over time that threatens present-day reservations. While a direct cause-and-effect relationship could not be determined from the compiled data, patterns of movement were revealed, and landscape was determined to be more complex than originally thought. Future work to fully examine the reasons for movement of Indigenous peoples in this region must take European influence into further consideration.

6935

Assessing the Abundance of Microplastics and the Effect on Fish Reproduction in Chesapeake Bay

Isabella Pope and S.G. Ribblett (teacher)

Mount de Sales Academy

700 Academy Rd., Catonsville, MD 21228

Microplastics are tiny pieces of plastic less than 5 mm in size, and are known to have a negative effect on living organisms. In this study, peer-reviewed published articles were examined to establish if microplastics affect fish. Specifically, studies were examined that had recorded information on fish reproduction or microplastics. These studies were independent of each other, but were used to ask the overall question of whether in Bay tributaries the presence of microplastics could be the reason for fish larvae mortality. In studies where the number of eggs a fish produced after being fed microplastics was counted, the overall egg production decreased, and the mortality percentage of larvae increased. These findings suggest there might be a link between the presence of microplastics and overall fish reproductive health. Further studies should be conducted to determine if this is a significant cause-and-effect relationship.

6936

Difference in the Presentation of ADHD Symptoms in Females and Males and the Effect on Diagnosis

Patricia C. Ringstad and S.G. Ribblett (teacher)

Mount de Sales Academy

700 Academy Rd., Catonsville, MD 21228

The difference between females and males with ADHD is something that can be difficult to study since there are significantly more diagnoses for males with ADHD than females. This study focused on how symptom severity differences affect the ADHD diagnoses of males and females. In addition, it was considered how a later diagnosis could influence the psychological health of a patient. The study was conducted with data collected from peer-reviewed published journal articles that included age of diagnosis, specific diagnosis, and symptoms of the patients. The data were then analyzed to find the average age of diagnosis for males and females, respectively, as well as the percentage of patients with each ADHD type (hyperactive, inattentive, or combination). Finally, the symptoms were

analyzed to see which more commonly occurred in females compared to males and vice versa. In the examined studies, there were 1,055 adolescent male patients versus 466 adolescent female patients. It was found that males are more likely to be diagnosed with hyperactive type than inattentive type, and females are more likely to be diagnosed with inattentive type than hyperactive type. This study found females presenting symptoms in a less physical and noticeable way, rather than in a disruptive manner, leading to a lack of diagnoses and treatment for females. The males in the study more severely presented hyperactivity and impulsivity, while the females more severely presented inattention, anxiety, and depression, and had poorer coping skills. The data also revealed that males were diagnosed at an earlier age than females. Though the data were taken from groups of patients around the same age, the averages showed that females were diagnosed later at 8.4 years, while the male average was 8.3 years. It is important to note that the number of males in the study greatly affected this average, as the group was much larger than that of the females. The females with a later diagnosis also were found to have poorer coping skills and more psychological comorbidities, suggesting that their psychological health declined as they were undiagnosed and untreated. In conclusion, this study brought to light that this difference between males and females persists, and it should be investigated further. While an earlier diagnosis would not necessarily eliminate the tendency for females to have poorer coping skills and more comorbidities, it certainly could help address these issues sooner.

6937

How Does the Amount of Baking Soda Affect Fizzing Time in a Bath Bomb?

Joanna Sadek and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet

17960 Chase St., Northridge, CA 91325

Bath bombs are used to moisturize your skin and make it smooth. They also help you calm down during bath time. Bath bombs get fizzy when the ingredients in shower gel react with baking soda to create carbon dioxide gas. The purpose of this experiment was to determine how the amount of baking soda affects fizzing time. My hypothesis was that increasing the amount of baking soda would increase the fizzing time of my bath bombs. To test my hypothesis, I tested four different amounts of baking soda: 1 cup, 2 cups, 3 cups, and 4 cups. First I mixed 2 tablespoons of shower gel, one drop of food coloring, and 1 cup of baking soda to create my bath bomb. Then I put the bath bomb in a cup of water and measured the fizzing time. According to my results, the bath bomb with 1 cup of baking soda had a fizzing time of 10 minutes. The bath bomb with 2 cups of baking soda had a fizzing time of 2 minutes. The bath bomb with 3 cups of baking soda had a fizzing time of 8 minutes. And lastly, the bath bomb with 4 cups of baking soda had a fizzing time of 3 minutes. Increasing the amount of baking soda over 1 cup decreased the fizzing time, and the results did

not support my hypothesis. If I had to improve something in my experiment, I would run multiple trials so that I could collect more accurate data.

6938

How Much Salt Does It Take to Make an Egg Float?

Samuel Ortiz and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91325

When salt dissolves in water, it makes the water more dense, allowing things to float on the surface. Have you ever wondered how much salt you need to add to water for an egg to float? The purpose of my experiment was to determine how much salt it takes to make an egg float on top of water. My hypothesis was that if I added 4 tablespoons of salt, then it would make the water really dense and cause my egg to float the highest. To test my hypothesis, I used five different amounts of salt: no salt, 1 tablespoon, 2 tablespoons, 3 tablespoons, and 4 tablespoons. First I got 1 cup of water and added different amounts of salt to the water. I added a fresh egg to the water each time and measured how high the egg floated. According to my results, using 3 tablespoons of salt made my egg float the highest. It floated about a quarter of an inch high. The results did not support my hypothesis. One way I would improve my experiment would be by having more trials and calculating the average heights of the floating egg.

6939

The Effect of Different Substances on Ice

Helen Pineda and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91325

In cold places, people spread salt on icy roads to help the ice melt more quickly. Have you ever questioned how road salt melts the ice so quickly and thoroughly? The biggest reason for pouring salt on icy roads is that it lowers the freezing point of water. My project question was, "What substance makes ice melt the quickest?" My hypothesis was that if I put 1 teaspoon of each substance on different ice cubes, the ice cube with the baking soda would melt the quickest due to the minerals that make up baking soda. To test my hypothesis, I used salt, baking soda, sugar, and vinegar. First I added 1 teaspoon of each substance to different ice cubes. Then I measured the time that it took to melt each entire ice cube. According to the results, sugar melted the ice cube the quickest, with a melting time of 25 minutes. The results did not support my hypothesis. If I were to make changes to this experiment, I would like to test how changing the temperature of the room would affect the melting time of the ice cubes. I would also like to test how the amount of the substances I put on each ice cube would affect the melting time.

6940

The Effect of Different Materials on My Wi-Fi Signal

Caitlin Reyes and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91325

Almost everyone uses the Internet daily. It can be used for work, school, or even enjoyment, but has your Internet connection ever stopped working all of a sudden? If it has, then there's a possibility that there might be items interfering with it or around it. The purpose of this experiment was to test what materials block my Wi-Fi signal. My hypothesis was that wet items would block my Wi-Fi signal more, because I observed that on rainy days my Internet connection gets a lot slower. To test my hypothesis, I placed different materials around my Wi-Fi router to see which one interfered with my Wi-Fi the most. First I gathered my materials: cardboard, wet cardboard, tinfoil, glass, and books. Then I placed these items around the Wi-Fi router and recorded how long it took to load a page. After I collected my data, I found out that wet cardboard interfered with my Wi-Fi signal the most. With the wet cardboard, it took an average of 6 seconds to load a page. Surprisingly, the results did support my hypothesis. In the future, I'd like to test how distance affects my Wi-Fi signal.

6941

How Does the Type of Container Affect My Elephant Toothpaste Reaction?

Ruby Batres and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91325

Elephant toothpaste is a fun foamy substance to make. It is made from the reaction of hydrogen peroxide, soap, yeast, and water. The reason it is called elephant toothpaste is that the big, foamy reaction looks like toothpaste squirting out of a tube, and looks like it could be big enough for an elephant to use as toothpaste. In this project, I wanted to test different conditions to observe which would produce the biggest foam reaction. My hypothesis was that if half of a plastic water bottle was used for elephant toothpaste, then there would be a larger reaction than with the other containers tested in the experiment. To test my hypothesis, I used four different types of containers: an aloe vera plastic bottle, a Gatorade® bottle, half of a plastic water bottle, and a full plastic water bottle. I measured the height of the foam produced by each container's reaction. According to my results, the full plastic water bottle produced a height of 8 inches of foam, the Gatorade bottle produced a height of 6 inches of foam, the half of a plastic water bottle produced a height of 5 inches of foam, and the aloe vera plastic bottle produced a height of 5 inches of foam. I hypothesized that the shortest container would produce the biggest reaction, but the results did not support my hypothesis. If I were to make improvements to my project, I would perform more trials with more containers of different sizes. Also, instead of measuring the height of the foam, I would like to measure how long it takes to start and complete the reaction.

6942

How Can I Cool Down a Soda Can Quickly?

Hector Mendez and L. Byun (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91325

What is the best way to cool a can of soda? This project examined what methods can cool a can of soda the quickest. You're probably thinking, well I can put it in the refrigerator, but it will take a while to get cold. You are also probably thinking about putting it in the freezer so it gets even colder. But are there any other methods to cool down a can of soda? Soda is a liquid made up of molecules that has thermal energy inside of it. So when you put a can of soda in a cold environment, like the refrigerator, the heat transfers from the liquid through the can into the surroundings within the refrigerator, causing the temperature of the soda to drop. My hypothesis was that if I wrapped a wet paper towel around the soda can and put it in the freezer, the soda would get cold the quickest because the wet paper towel would keep the outside of the can cold enough to transfer thermal energy out of the can the quickest. To test my hypothesis, I used four different methods: putting a can of soda directly in a freezer, putting a can of soda in a tub of ice cubes, putting a can of soda in a tub of cold tap water, and wrapping a wet paper towel around a can of soda and putting it in the freezer. According to my results, the first method got the soda can down to 36°F in 30 minutes, the second method got it down to 22°F in 30 minutes, the third method got it down to 60°F in 30 minutes, and the fourth method got it down to 39°F in 30 minutes. My results did not support my hypothesis, because wrapping the can of soda in a wet paper towel did not cool down the can the quickest. Putting a can of soda in a tub of ice cubes was the best method of cooling it down.

6943

Effect of pH on Marigold Growth

Claudia Balikcian and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The overall purpose of this study was to identify which solution of varying pH is the most beneficial to the overall success of marigold flowers. With solutions at different pH, you can identify which pH levels are harmful to marigolds. For this experiment you need eight marigold plants – four for each trial. Each trial should be conducted at the same time to get accurate results. To make the solutions for the plants you need three bowls, while for the fourth plant in each trial, you only need any available source of water. For the solutions, you need water, lime, and lemons. The acidic solutions need less water to make compared to the solutions of higher pH, and need more lemon/lime juice. Once you believe you have the proper measurements, you need to take pH strips and test the solutions. If the outcomes aren't what is needed, you can always add more water or more lemon and lime juice. Once you have the correct pH solution values, you need to put the solutions into their designated spray bottles. You should label them and

tape each pH strip onto the appropriate bottle. Then you need to place the marigold flowers in two rows of four, with each row being a trial. Each trial should be treated the same, as each flower should be watered with one of the four solutions. This should continue until you can see clear results. Major findings of this experiment were that the more acidic a solution is, the less beneficial it is to marigolds. My findings supported my hypothesis, as they indicated that the marigolds watered with solutions at pH of 3 and 4 showed dryness and brittleness, while the marigolds watered with a solution of pH 7 thrived.

6944

The Effects of Wildfire and Drought on Plant Growth

Victoria Donis and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The overall purpose of this study was to see the results that a drought and a wildfire triggered by the drought have on the environment — specifically the plants in that environment. I investigated whether the effects of a drought on my plants were positive or negative. I took three of the same type of plant and planted them in different containers. I used one as the control, which was watered regularly with a good amount of water. The second was a “plain drought” plant, which was given a good amount of water, but only once every four days. The third plant was watered once every four days as well, and was also covered in charcoal/ash to account for the wildfire that occurred due to the drought. For my conclusion, I saw that the drought condition had negative effects on my plants, and the wildfire also had mainly negative impacts, making my plants grow more slowly and even die at the end. The control plant lived, but the plant with the drought test died, and the plant with the drought test and added wildfire test ended up on the brink of death.

6945

Effect of Fire on Soil Nutrients

Alyssa Encina, Brielle Fredeluces, and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The overall purpose of this experiment was to study the effects of fire on soil. We specifically studied if the soil received any added nutrients that would benefit *Sedum adolphii* (Golden Sedum). Various research issues we investigated were the topic of fire ecology; the usual environments for the type of plant we tested (*Sedum adolphii*, which is a succulent); factors of adaptation that both animals and plants go through when their environments are affected by fires; and both advantages and disadvantages of wildfires that burn environments. To set up for our study, we burned soil in an aluminum tray by placing dried leaves on top and igniting it. We then put the soil into a cup, and put regular soil into another cup. The cups had holes and rocks at the bottom for drainage. Both research partners planted the *Sedum adolphii* and watered them. The most

significant result we found from this study was that the *Sedum adolphii* grown in burnt soil thrived more than the succulents planted in regular soil. We measured better survival based on growth, color, and number of new leaves. Heights on average every three or four days ranged from about 0.2 to 0.4 cm. After comparing our results to multiple sources and studies, we concluded that the dried leaves we used to help ignite the fire to burn the soil must have released extra nutrients. These extra nutrients could have included nitrogen and phosphorus, both of which benefit plants' growth.

6946

Climate Change and Its Impact on Butterfly Hatching

Isabella Garcia, Jennifer Munoz, Genesis Quezada, and S. Wilson (teacher)
John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

According to the National Oceanic and Atmospheric Administration (NOAA), the global annual temperature has increased about 0.14°F per decade since 1880. If global temperatures continue rising, it will pose a series of effects on life on Earth, as it could disrupt habitats, and cause sea levels to rise and droughts to occur more often. Temperature affects the painted lady butterfly's life cycle because it depends on seasonal changes and their temperatures. This study aimed to further determine the effects of global warming on the painted lady butterfly's life cycle, but more specifically to measure how long they can live in warmer temperatures. We conducted the experiment with three groups of 15 painted lady butterfly eggs. There was a control group that was in room temperature at about 68°–70°F, and two treatment groups — a low heat at about 88°F and a high heat at about 96°F, for which we used reptile heating pads. Painted lady butterflies' normal living temperatures are around 60°F and no higher than 108°F. We observed the groups for about four weeks. The control group lived up to 22 days and started hatching by Day 4. The low-heat group lived for 13 days and also hatched by Day 4, whereas the ones in the high heat did not hatch at all. The control group and low-heat group both had six eggs hatch into caterpillars throughout the entire experiment. The study showed that major increases in temperature affected butterflies' life span and life cycle, meaning global warming could decrease their life expectancy and possibly their population size.

6947

Impact of COVID-19 Quarantine on Weight Gain and Loss

Olivia Grech and S. Wilson (teacher)
John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

In my longitudinal study, my goal was to determine the effects of the COVID-19 quarantine on weight gain and weight loss trends in the U.S. For many years, weight gain trends have been significantly on the rise in the U.S. With this being a

major health issue for the country, I felt that knowing if the quarantine was contributing to these trends would allow us to prevent an even further increase in the obesity epidemic. In my study, I used both data and results from a professionally conducted study on this issue and my own research with 32 test subjects. I used the results from the professional study to make predictions and to further explain my topic. In my experiment, I collected the subjects' weight classes, along with their rates of eating out, eating junk foods, eating healthy, exercising, anxiety levels, and the amount of weight gained or lost since the pandemic began. My trial period was from the beginning of the quarantine in March 2020 to May 10, 2021, a total of 14 months. Both the professional study data and my own data showed that a significant number of test subjects gained weight during the quarantine. The professional study reported that 33.4% of the already-obese subjects gained weight, as opposed to weight gain by 27.5% of the total subject population. While my study did not find that the obese and overweight participants were much more likely to gain weight, the results showed that a large majority of the subjects did in fact gain weight. These results are significant because they indicate that a large proportion of people are gaining weight during the quarantine, which ultimately means the quarantine is causing a large number of people's physical health to diminish due to a significant change in lifestyle habits. Thus the quarantine is ultimately resulting in poorer health for many individuals because they are forming new, unhealthy habits by remaining at home so often. Knowing this, it is important to try to lift the quarantine as soon as possible, because otherwise many people's physical health will continue to diminish the longer the quarantine goes on.

6948

Testing the Antibacterial Properties of Honey and Its Effectiveness in Naturally Treating Acne

Samantha Lopez and S. Wilson (teacher)
John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The purpose of this study was to compare the efficacy of raw Manuka honey, filtered clover honey, and over-the-counter 10% benzoyl peroxide cream in preventing growth of bacteria collected from the faces of teens with acne to determine if honey can be considered a legitimate acne treatment. The basic design of the study was to place paper squares coated with nothing (as a negative control), raw Manuka honey, filtered clover honey, or 10% benzoyl peroxide cream in the center of Petri dishes prepared with nutrient agar and colonized with bacteria. I then recorded the approximate percentage of bacterial coverage and number of days until complete coverage of each square in the test groups to determine the effectiveness of each substance in stopping bacterial spread relative to the others over a week. I found that the paper coated in 10% benzoyl peroxide cream lasted longer than any of the other papers, as the one covered in the cream went the whole seven-day period without becoming completely covered in bacteria. The papers coated in Manuka

and clover honey became completely covered by bacteria within an average of five to seven days. By the seventh day of the experiment, only an average of 20% of the paper coated in benzoyl peroxide cream was covered by bacteria, while by that point 100% of the papers coated in either type of honey were completely covered by bacteria. Because the paper coated in benzoyl peroxide cream lasted longer with less bacteria coverage than the papers coated in nothing, Manuka honey, and clover honey, I can assume that the cream is a more effective acne treatment than honey.

6949

The Effect of Music on Blood Pressure in Stressful Situations

Haley Jacoby, Amanda Parks, and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

This experiment tested how different genres of music affect one's stress and ability to complete a task. A math test was distributed to 12 test subjects of different ages and genders to take while listening to classical music, R&B, rap, and then rock. The blood pressure of each participant was recorded before and after each trial (taking the math test with the different music genres). Testing occurred once a week for four weeks, and the test questions on the exam were shuffled so the testees didn't become too familiar with them. Recording and analyzing the blood pressure of each testee helped identify when they were stressed and when they were relaxed and focused. The null hypothesis stated that different genres of music do not affect one's stress level and ability to complete a task, but we believed that when the music was loud and fast paced, the participants' stress levels and blood pressure would increase, and when the music was slower and calmer, their blood pressure levels would remain in a normal range. Our research showed that when the math test was taken with classical and R&B music, the results were similar. The participants' systolic and diastolic blood pressures decreased in a normal range. This decrease was related to lower stress levels due to the calming music, which allowed the testees to focus more. On the other hand, when the math test was taken with rock and rap music, the participants' systolic and diastolic blood pressures rose. This increase was related to the stress levels that also increased due to the hectic music, which disrupted the participants' focus. This evidence is important because it shows the biological effects of music on one's brain, as the brain produces hormones and chemicals that signal the body to increase its blood pressure when in a stressful situation.

6950

A Comparison of Native and Invasive Species Root Development

Garret Roth and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

Invasive species with high reproductive rates have created competition among native plants that are well adapted to survive through the dry summer climate due to having a large root structure. By comparing the root development of a non-native plant, such as wall barley (*Hordeum murinum*), to a native strain, such as deer grass (*Muhlenbergia rigens*), we can test how plant development negatively affects growth rate in non-native plants compared to native ones. In two separate trials, I compared the root development, blade length, and soil moisture of the non-native wall barley in conditions where water was present, where water was scarce, and in the normal California climate. In a third trial I tested the same things, but used the deer grass in similar settings. This experiment showed how seed development in the wall barley did not allow for continual growth and had killed the majority of the population in approximately 90–100 days. Even in the trial where I continually used collected rainwater for the wall barley, the increased soil moisture had no impact on survival rates after the seed was produced; however, a shorter root length was observed. Despite soil moisture, blade length, or root length, at around the same period, wall barley of all maturity had developed a seed and died shortly thereafter. In the native deer grass, the root structure was significantly longer and had blades that were sustainable for the environment, allowing it to survive longer. The deer grass also was able to maintain a higher soil moisture level for a longer period of time compared to the wall barley. By supplementing the native plants in sites that are predominantly populated by a non-native species after their death, we can prolong the "green" periods of many Southern California areas.

6951

Testing the CDC Handwashing Guidelines and Their Impact on Bacterial Growth

Alexandra Andrade and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

For this project, I studied the guidelines provided by the Centers for Disease Control and Prevention (CDC) for washing your hands efficiently. In the experiment, I tested to see if 20 seconds is a good recommendation. This was done by conducting three different trials with three different subjects, comparing non-washed hands with hands washed for 10 seconds and hands washed for 20 seconds. The intent was to see if there was a difference in bacterial growth in the three trials. For each trial the subjects did the same thing, washing and swabbing, with only slight modifications for each. Trial

1 was the control, and the only thing that happened was the swabbing of hands before any washing was done. In Trials 2 and 3, the subjects washed their hands with water and soap, and the modification between the two was the time — in Trial 2 they washed their hands for 10 seconds, and in Trial 3 for 20 seconds. My experiment's data showed that the 20-second trial had the fewest number of bacterial colonies, which supports the CDC guidelines that 20 seconds is a good amount of time for washing hands.

6952

Effect of Fabric Texture on Bacterial Colony Growth

Jieun Han and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

This experiment was conducted to answer the question, "Which of the following materials is the most likely to catch more bacteria onto its surface: cotton, linen, silk, or knitted?" Finding the answer to this may solve a lot of problems like the spread of viral diseases. For example, clothing materials that are less affected by bacteria could be worn by people to lower the likelihood of getting COVID-19. In this experiment, we used four different fabrics to swipe hands daily for three days and see how much bacteria got transferred from the hands. My hypothesis before this experiment was that the knitted textile would pick up the most bacteria on its surface because of its grip and rough textures; it takes the most effort in washing and drying; and it is the best place for bacteria to thrive on according to the research that has been done. The results did not support my hypothesis. From just looking at the white clumps on the surface, cotton had the least amount of bacteria, and linen had the most visible white patches. A reason why the cotton had the least amount of bacteria could be because cotton has a lower hedonic value, meaning it has less odor. This may suggest that cotton is the best fabric to let air through instead of keeping it moist, and may be why dry fabrics do not have a lot of bacterial growth. The reason why the linen had the most bacteria could be that linen is also textured like knit, and it consists of fiber looking outer interior. This experiment was done with constant variables that were controlled. With controlled variables like the temperature, amount of agar in the Petri dishes, the number of swipes per day, and the quality of the fabrics before the swiping, I was able to ensure that the experiment was performed in an accurate manner. Variables like the different fabrics were used to see the differences and to compare. It is known that cotton has a lower hedonic value compared to other fabric materials. Hedonic values define how much odor a fabric creates. The cause of the odor of fabrics may be related to the moisture or texture of the fabrics that allows for better attachment for bacteria. This relates to the investigation that was done to find out how likely it is for each tested fabric to have bacteria adhere to it, because that explains the odor and the unsanitary fabrics. From the research that has been done, I would assume that cotton is the least likely place for bacteria to adhere to, and knitted fabrics are the most likely place.

6953

Effect of Azelaic Acid on Post-Acne Hyperpigmentation

Daniela Ibarra and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

My longitudinal study goal was to observe and record the effects of 10% azelaic acid on post-acne hyperpigmentation, as well as any other notable effects that presented themselves. I had three participants apply azelaic acid consistently for approximately six weeks on all areas affected with hyperpigmentation. To keep my study accurate and controlled, the participants had to follow the exact same skincare regimen they used prior to the testing. To record my data, I required the participants to take one photo a day of their faces for 42 days to observe any progression in their post-acne hyperpigmentation. The use of 10% azelaic acid in my experiment was based on the science behind its properties, such as the prevention of melanin synthesis, which is a process that produces melanin and could result in excess melanin on the skin, thus causing hyperpigmentation. Its antibacterial and anti-inflammatory properties also prevent and treat active acne, therefore reducing post-acne hyperpigmentation, which is what was intended to be seen within my data. Although there was slight improvement in one of my participants, I did not find any major trends within my data. I interpreted this lack of major trends as potential error within my experiment. My initial hypothesis was that the 10% azelaic acid would have an effect on post-acne hyperpigmentation by improving the appearance of my subjects' faces, but this hypothesis was neither supported nor not supported by my data, as it was inconclusive.

6954

Surgical Mask Effectiveness Over Time

Gabriela Miranda and S. Wilson (teacher)

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

A surgical mask can be described as a "loose-fitting, disposable device that creates a physical barrier between the mouth and nose of the wearer and potential contaminants in the immediate environment." (Source: U.S. Food and Drug Administration, <https://bit.ly/2WCozt1>.) It works by filtering out particles from going into the nostrils of the person wearing it. This experiment included a total of three trials. Each trial consisted of wearing a mask for 1–3 hours, coughing on a Petri dish, and letting the bacteria grow from two to four weeks. The control of the experiment was a cough with no mask. Trial 1 seemed to have an error when it came to the location of the study. Trial 2 had some problems, but the data were clear that the mask was 100% effective in hours 0 and 1 but not 100% effective after 2 hours. Trial 3 had very similar results. Hour 1 showed that the mask was 100% effective, while hours 2 and 3 showed bacterial colonies all over the Petri dish. A surgical mask is only effective for about an hour when the person wearing it is in a safe, unsanitary environment.

6955**Leopard Gecko Surface Type Selection and Behavior***Amanda Reyes and S. Wilson (teacher)*John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The guiding question leading this investigation was: Do leopard geckos' behavioral choices to roam and climb remain constant when they are given various areas to do so during their active nocturnal hours? Investigating their surface type preference was another aspect that was examined. This study relied on daily observations of leopard gecko movement within an enclosure: which surfaces were roamed on and what the gecko interacted with in the enclosure were recorded. The data collected specifically focused on how many times the leopard gecko interacted with a surface type. Major findings included an indifference in preference for smooth or textured surfaces. The gecko did not interact with the glass and plastic surfaces at all, but did interact with all of the other surface categories. The textured surfaces had the most interactions, but when compared to the smooth surfaces, the data weren't significant enough to conclude a strong preference. A stimulus or taxis regarding the surface types exclusively wasn't concluded. Other aspects within the enclosure seemed to contribute more to a stimulus as opposed to only the surface type. Based on this project, the leopard gecko seems to be indifferent toward the type of surface it roams on. An important aspect of the surface that determines whether the leopard gecko will interact with it is if its claws permit it to. If the surface fits the limitations of the leopard gecko's claws in particular, the gecko will interact with it.

6956**Effect of Dog Lifestyle on Bacteria Present on Paws***Rita Ruiz and S. Wilson (teacher)*John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

The purpose of this study was to find out if a dog's lifestyle affects the amount of bacteria found on its paws. For the study, lifestyle meant whether a dog is kept indoors, outdoors, or both. To determine which resulted in the least amount of bacteria on the paws, I ran three trials with my three dogs in each lifestyle. The control condition was keeping a dog indoors for 6 hours and outdoors for 6 hours. The two experimental conditions were keeping a dog outdoors for 12 hours or indoors for 12 hours. I did this with three trials, with each dog rotating to have a turn in each lifestyle. After 12 hours I swabbed each of their paws to collect bacteria to grow on Petri dishes for 72 hours. I counted bacterial colonies throughout the 72 hours to determine which lifestyle produced the fewest number of colonies. My hypothesis was that the indoor lifestyle would result in the least amount of bacteria found on the dogs' paws. My data consisted of a table showing the average number of bacterial colonies for my three dogs in each lifestyle. I also included pictures and a bar graph of the three dogs' averages put

together and divided for each lifestyle. The bar graph showed a major difference between the indoor condition and the outdoor and half indoor-half outdoor conditions. The average number of bacterial colonies for the dogs when they stayed indoors was 112.83, the outdoor average was 74.5, and the half indoor-half outdoor average was 72.42. This indicated that my hypothesis was wrong. Based on my project results, the lifestyle that allows dogs to have less bacteria on their paws is an indoor and outdoor lifestyle. This evidence was deemed credible because of a chi square analysis test that resulted in rejection of the null hypothesis, that a dog's lifestyle does not affect the amount of bacteria on its paws.

6957**Fertilizer Impact on Seed Growth***Mia Vasquez and S. Wilson (teacher)*John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave., Granada Hills, CA 91344

Pollution caused by fertilizer runoff has become an increasing problem. Fertilizers enter water, causing a reduction in dissolved oxygen and water quality. Fertilizer runoff also can increase algae and weed growth. This study was conducted in the hope of finding a more eco-friendly option to enhance plant growth instead of harmful chemicals found in some chemical fertilizers. It was also conducted to see how much harm fertilizers cause and how necessary fertilizers really are. Three types of chemical fertilizers (nitrogen, phosphate, and potassium) were added to the soil of two poppy seeds, and there was a negative control with no fertilizer. These bowls were observed for 12 days. An analysis of the results showed that poppy seeds grew in an environment with no fertilizer added. One of the poppy seeds grew a maximum of 2.5 centimeters in this control bowl. None of the poppy seeds with added fertilizer grew, and crystallization in the soil with the fertilizers was observed. These results showed that large quantities of chemical fertilizer are not needed to enhance the growth of plants, which would be a more eco-friendly option to reduce ocean pollution. However, further research should be conducted on other plants, possibly ones that grow by the ocean, to see if the same results would occur.

6958

Which Type of Mask Is Most Effective at Reducing the Spread of Respiratory Droplets?

Tiana Mareko, Katherine Delgado Castro, Victoria Guevara, Julie S. Lopez, Nailah Rayhan, George Samuel, Xavier Serrano, Stephanie Trinh, Emma Vu, Carlos Bobadilla, Teresa Berber Avila, Savannah Faith Corea, Osvaldo Garcia-Sanchez, Vanessa Lopez Galvez, Randy Morales Orozco, Khang Duy Nuyen, Trinity Orellana-Ramirez, Hiyla Singh, Martin Solorzano, Diego Velazquez, Patris Babakhanian, Pedro Bracamonte, Celin Discua, Dwayne Jonathan Famenia, Andrea Mendoza, Oliva Rosales, Jaslene Fernandez, and E. Galanukan (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91356

Which type of mask is most effective at reducing the spread of respiratory droplets? We chose to test different types of masks' effectiveness against the COVID-19 virus because it is a common question that people have had during the pandemic. From our research, we discovered that N95 respirators (without valves) are the most effective against COVID-19; however, these masks are primarily used by health care professionals. So instead of using these, the Centers for Disease Control and Prevention (CDC) recommends wearing breathable fabric face coverings with two or more layers. These should fit comfortably around the sides of your face, leaving no gaps, and cover your mouth and nose entirely. The masks also should have a nose wire so air cannot leak from the top. Since most cloth masks do not fit all of these categories, surgical masks typically provide better protection. We believed our experiment would show that surgical masks are more effective than cloth masks at reducing the spread of respiratory droplets. The materials used in our experiment were surgical masks, cloth masks, N95 masks (optional), flame/candle, and water. To test the masks, we conducted two experiments: a water droplet test and a candle test. Our variables were the following: 1) independent variable: the different types of masks used in the experiment; 2) dependent variables: whether the masks absorbed the droplets of water, and whether the candle flame was blown out when a mask was worn; and 3) constants: the distance of the candle from the mask wearer, and the number of water droplets dropped onto the masks. The experimental procedures for the water droplet test were as follows: 1. Drop a water droplet onto the outside of the surgical mask. 2. Check absorption of water by the mask by either visually confirming absorption on the other side or touching the other side to see if it is wet. 3. Record observations. 4. Repeat with the other mask(s). The experimental procedures for the candle blowing test were as follows: 1. Put on the surgical mask and light a candle. 2. Blow on the candle from 4 inches away. 3. Record observations of the candle flame. 4. Repeat with the other mask(s). After conducting the experiment, we found that the average number of times the cloth mask absorbed water and enabled the wearer to blow out the candle flame was much higher than for the surgical mask. According to the data for the water droplet test, the cloth mask absorbed the liquid six out of eight times, while the surgical mask absorbed the liquid only two out of eight times. This meant that the surgical mask was more water-resistant,

which would make it very effective against the virus. This also meant that our hypothesis was correct based on the data we collected. Cloth masks are more likely to absorb liquid, which means they will likely absorb respiratory droplets instead of repelling them. As for the candle test, with the cloth mask on, the wearer blew out the flame six out of eight times, but with the surgical mask it was blown out once out of the eight trials. The results we received were as we expected. (Visit <https://sites.google.com/lausd.net/sciencefairwebsite1/home> for a presentation of this experiment.)

6959

Which Is More Effective: Hand Sanitizer or Soap?

Amari Ray, Ariyanna Taylor, Ashly Lopez Tobias, Yvonne Cuellar, Abigail Corea, Esteban Onofre Morales, Diego Ortega, Zachary Ignacio, Abel Martin, Kairi Catalan, Madeline Perez, Jaiden Ligorria, Irlanda Garcia Rubio, Vincent Thompson, Sergio Medrano, Isaac Ramirez, Mitzi Vargas Salgado, Om Sijunta, Delylah Chavez, Fraen Quidera Torres, Arvin Maleki Miabadi, Michelle Duran Hernandez, Josue Mendoza, Brianna Fregoso, Nathan Hernandez, Joel Macias Gutierrez, Valerie Figueroa, Jaden Moening, Leticia Herrera, and E. Galanukan (teacher)

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St., Northridge, CA 91356

Which is more effective: hand sanitizer or soap? Our hypothesis was that soap is more effective than hand sanitizer, and we learned this from our background research. Soap is better able to break down the membranes of different bacteria and viruses. When using hand sanitizer, the most effective type contains 60% or more alcohol. Soap removes many different types of viruses and germs, while hand sanitizer can only remove some of the viruses and germs. Hand sanitizer kills most germs, but not all. We also learned that hand sanitizer can cause more irritation to the skin when used often, in comparison to soap, which can cause less irritation when used often. Hand sanitizer works well with germs directly, but not when it comes to hands that are dirty or greasy. Soap is preferred for dirt or grease. For our experiment we used Glo Germ™, lotion, black light (UV light), hand soap, and hand sanitizer (more than 60% alcohol). Our experimental procedure was as follows: 1. Make a mixture of the lotion and Glo Germ powder. You need enough lotion to entirely cover both hands twice. 2. Cover both of your hands with half of the Glo Germ/lotion mixture. 3. Use the black light to look at your hands, estimate the percentage of your hands that is covered in "germs," and record this on the Google Form. 4. Wash your hands with soap and water for 30 seconds. 5. Use the black light to look at your hands, estimate the percentage of your hands that is covered in "germs," and record this on the Google Form. 6. Cover your hands with the other half of the Glo Germ/lotion mixture, rub your hands with hand sanitizer, and rinse them off in the sink. 7. Use the black light to look at your hands and estimate the percentage of your hands that is covered in "germs." After conducting our experiment, we found that about 75% of our hands were covered in Glo Germ before being sanitized or washed. After we washed with hand soap, the amount of Glo Germ left on the hands reduced to about 35%. About 37% of Glo Germ was left

on the hands when using water and hand sanitizer. From these results, our conclusion was that soap is slightly more effective than hand sanitizer. Using soap or hand sanitizer did show a significant reduction in Glo Germ left on the hands. We can further conclude that although washing your hands with soap and water is more effective, if that is not available, using hand sanitizer is still a good alternative. (For a presentation of this experiment, visit <https://bit.ly/3K3E3KG>.)

6960

Can a Magnet Be Used to Detect Iron in Cereal?

Julianna Avelar, Annabelle Bilbray, Peyton Bilbray, Naomii Donovan, Raegan Kruger, Isabella Pupua, Emma Schaefer, Shayden Monroe (staff), and T. Miller (teacher, retired)

Boys & Girls Club of the Colorado River, Laughlin Unit
1975 Arie Dr., Laughlin, NV 89029

The purpose of this project was to determine if a magnet can be used to detect iron in cereal. The hypothesis was that a magnet can be used to detect iron in cereal. One cup of cereal and one cup of water were placed in a plastic bag, and the bag was gently squeezed to break up the cereal. Then magnets were used to attract the iron by making a circular motion next to the bag. All of the cereals — frost bite-sized wheat, Rice Krispies®, Cheerios™, and Signature SELECT™ Corn Flakes — were found to have particles of iron. Our hypothesis was correct.

6961

Is a Seed Floating Test a Good Indication of Seed Viability?

Annabelle Bilbray, Payton Bilbray, Emily Coplan, Naomii Donovan, Landen Gutierrez, Jameson Hernandez, Angelica Pacheco Leora, Dustin Minnicks, Eli Zaccardo, Emma Zaccardo, Shayden Monroe (staff), Sarah Pryor (staff), and T. Miller (teacher, retired)

Boys & Girls Club of the Colorado River, Laughlin Unit
1975 Arie Dr., Laughlin, NV 89029

The purpose of the experiment was to see if a floating water test is a good way to determine if a seed will germinate. The hypothesis was that the test would be a good one for nasturtium seed viability. We believed the seeds that sank would be denser, and so more of them would germinate. Nasturtium seeds were dropped into a container with water and soaked for 15 minutes. After this time, the seeds were separated into those that floated and those that sank. Two large plastic containers with holes in the bottom were filled with potting soil. Fifty seeds that floated were planted in one container and 50 seeds that sank were planted in the other container. The seeds were watered every day. At the end of two weeks, 33 seeds (66%) that floated germinated, and 28 seeds (56%) that sank germinated. The hypothesis was incorrect because more seeds that floated germinated.

6962

Leachate-Filtering Efficacy of Varied Liners

Marta Pambukhchyan and O. Tuason (teacher)

Crescenta Valley High School
2900 Community Ave., La Crescenta, CA 91214

To prevent the leaching of contaminated water (leachate) into the surrounding environment, current landfills utilize a system of liners that often contain bentonite powder, a material intended to filter acidic leachate and release clean water. This research aimed to test different powders' neutralizing abilities to find a better alternative to the currently used bentonite. It was hypothesized that if the basic powders kaolin (KL), diatomaceous earth (DE), and activated charcoal (AC) were used to filter acidic leachates, then the most basic powder would shift the pH closer to neutral than bentonite. This was tested through gravitational filtration by placing each clay into holed cups and running them through with lemon juice (pH of 4.8) or vinegar (pH of 4.5). The filtered samples were collected and the average pH changes for each powder were recorded. As shown from the means, DE and AC displayed higher pH increases than bentonite, while KL clay failed to filter any leachate. The data were analyzed by conducting one-tailed (directional) t-tests. The final comparisons of DE (avg. pH=6.57, SD=0.11, n=5, p=0.023) and AC (avg. pH=6.54, SD=0.15, n=5, p=0.068) with bentonite (avg. pH=6.45, SD=0.3, n=5) revealed that DE had the highest pH increase. The t-test results gave sufficient evidence (p=0.023) to conclude that DE powder is a better filtering alternative to bentonite. Future research will investigate other factors that contribute to the finest landfill powder. (Editor's Note: For the work summarized in this abstract, Marta was selected as a finalist in the Earth and Environmental Sciences category at the Virtual Regeneration International Science and Engineering Fair 2021. See more project details at <https://bit.ly/3h1A1RB>. Congratulations Marta and great work!)

6963

Effect of Fibroblast-Like Synoviocytes on Rheumatoid Arthritis

Thalia Miller and O. Tuason (teacher)

Crescenta Valley High School
2900 Community Ave., La Crescenta, CA 91214

In order to identify the importance of fibroblast-like synoviocytes (FLS) on rheumatoid arthritis (RA), an experiment should be conducted in which the relationship of FLS to RA is specifically observed. If observed correctly, there would most likely be information found that suggests an increase in FLS near RA sites will further cause the RA to flare up. The FLS may also act as an indicator to highlight the RA flare within the body. By completing this project and its experiments, new knowledge of RA would be found, and possible new treatments could be made to counteract the effects of FLS. Since the

COVID pandemic has caused people to stay at home, now is an opportune time to utilize computer modeling systems for research. For this area of research, I will utilize ClusPro, an online modeling system, to simulate my experiments. These simulations will require me to use specific proteins, so I will represent RA with the HLA-DQ2 molecule. The FLS will be represented by the Cadherin-11 molecule. Modeling these interactions will allow me to further the research into RA treatments and to utilize current technology for an important application in the medical field. After completing the simulations, I have found that FLS and RA do have an affinity for each other. However, certain chains of RA have a higher bonding affinity for FLS than the overall molecule, which explains why RA inflammation is inconsistent within patients, causing flare-ups intermittently.

6964

Identification and Characterization of Minerals That Inhibit or Promote Seed Germination

Michelle Chung and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

There has been a recent increase in the frequency and magnitude of California wildfires, which decrease soil quality and in turn slow down or even completely stop the process of seed germination. Despite negative impacts on soil quality, the resulting wood ash has been known to improve plant growth. Therefore, since calcium and potassium are major components of wood ash, it was hypothesized that if calcium and potassium supplemental treatments are applied to soil containing dormant seeds, the treatments will promote seed germination. This project focused on identifying components of wildfire-produced wood ash that had either inhibitory or enhancing effects on seed germination, as well as the effect that different concentrations of such components had on the germination rate. The experiment consisted of a negative control group and six experimental seed groups that received varied concentrations of a calcium or potassium mineral supplement treatment. The treatments received different amounts of the supplements and water, which were then applied to soil containing mung beans. The germination states of the mung beans were recorded over five days, with results demonstrating that the groups that received the highest concentration (Ca-0.15M and K-1.0M) treatment (Group 3) had the greatest germination success rates, with 100% seed germination. Although Group 3 had the highest germination rate, no significant differences in overall growth rate were observed, confirming that seed germination was promoted by applying the treatments created using the main minerals found in wood ash.

6965

Determining the Life Span of *Raphanus sativus*, *Brassica rapa* (Ruvo Group), and *Lepidium sativum* Plants in Drought Conditions When Treated With a Nutrition-Rich Compost

Eliza Pambukhchyan and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

This experiment tested a method of increasing the life span of three plant species with compost in a water-depleted environment. The greenhouse effect causes the absorption of heat in the atmosphere, which increases the surface temperature. This induces water depletion over land and the annual death of thousands of crops. It was hypothesized that if *Raphanus sativus* (radish), *Brassica rapa* (Ruvo group) (broccoli rabe), and *Lepidium sativum* (cress) were treated with a nutrition-rich compost, then their life span would increase due to their greater absorption of vital nutrients such as carbon, phosphorus, hydrogen, potassium, and nitrogen through cell transport pathway communications. The compost consisted of kiwi, mango, and cucumber peelings. The three plant species were grown in two rows of four pots with compost concentrations of 0% (control), 25%, 50%, and 75%. One row had 5.0 mL of water added daily, while the second row didn't receive water. Volume, number of seeds, temperature, and pH were controlled. The height was checked with a ruler. The average height differed by +0.20-0.50 cm when concentrations of compost increased. The data also showed a longer life span for crops that received an increased compost concentration, with three additional days for *Raphanus sativus*, two additional days for *Lepidium sativum*, and one more day for *Brassica rapa* (Ruvo group). There wasn't enough support for the hypothesis that compost potentially could replace water. The results indicated that only *Raphanus sativus* could flourish in drought conditions. Therefore, only that specific plant could be grown in water-depleted environments the longest.

6966

The NFL Positions With the Most Cases of Neurodegenerative Diseases

Angelica Agahsi and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

Chronic traumatic encephalopathy (CTE) buildup of the protein tau in the brain is caused by several years of constant football tackling that results in the brain rattling inside the skull. With the accumulation of tau, it spreads through the brain and hardens the tissue, which leads to memory loss, confusion, personality change, aggression, depression, and/or suicidal thoughts. CTE and other neurodegenerative diseases, such as dementia, amyotrophic lateral sclerosis (ALS), and Parkinson's disease (less common), are the main risks when one chooses to play American football. CTE can only be diagnosed in a patient postmortem. The focus of this project was which category of

football players, speed or non-speed, has the most cases of neurodegenerative diseases, and which position overall has the most cases. Due to COVID-19, only literary research could be used. Of non-speed players (22), the most prominent neurodegenerative disease was CTE (86%). Of speed players (90), the most prominent disease also was CTE (81%). Besides CTE, ALS (6%) and dementia (6%) were found in non-speed players, but not Parkinson's disease. In speed players, ALS (23%), dementia (21%), and Parkinson's disease (1%) were found. I can conclude that speed players have a greater concentration of neurodegenerative diseases than non-speed players. Yet linemen, also known as non-speed players, play the position that has the most neurodegenerative diseases, because they had the most reported cases out of any position.

6967

Identifying a Therapeutic Gene Target in Metastatic Melanoma Using R and Molecular Modeling

Seon-Jae Yoon and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

Melanoma is a highly aggressive skin cancer with increasing incidents worldwide. It is often diagnosed after it has left its original skin location and has spread, or metastasized, to other places in the body. Metastatic melanoma, or melanoma that has spread to lymph nodes and other organs, has a poor survival rate, and new therapies are needed to improve current treatments. Genetic studies have yielded few new targeted therapies because normal skin cells are potentially mixed into the melanoma samples. I proposed to address this problem by performing an analysis of publicly available gene datasets from metastatic and non-metastatic melanoma samples, obtained from The Cancer Genome Atlas (TCGA-SKGM), using R programming. I excluded genes that are expressed in the normal skin cells obtained from the Gene Expression Omnibus (GEO) and normal tissue databases. From my analysis, I identified a new gene, SLITRK4, which is only expressed in metastasized melanoma, not expressed in normal skin cells, and expressed in few normal tissues. I found that SLITRK4 is associated with a three-year survival rate of 0% in metastatic melanoma patients. To potentially target SLITRK4 therapeutically, I used the 3D chemical structure of the ligand NAG obtained from the computational platform canSAR and determined the binding affinity of NAG to SLITRK4 using PyRX, a software for virtual screening for drug discovery. In summary, by using R programming and molecular modeling, I identified a novel therapeutic gene target, SLITRK4, which potentially can be developed further for targeted therapy in metastatic melanoma. (PyRx citation: "Small-molecule library screening by docking with PyRx" (<https://bit.ly/3IsOIOV>), Dallakyan, S. and Olson, A.J. *Methods Mol Biol.* 2015; 1263:243-50, 1263:243-50, doi: 10.1007/978-1-4939-2269-7_19.)

6968

The Effect of Liquid Smoke on the Composition of Grape Beverages

Neil Breckow and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

The fires in Napa Valley are causing damage to the wine industry that has taken root there. I performed an experiment to see chemical changes due to adding liquid smoke (a food additive) to homemade grape juice. I used pH paper and paper chromatography to test the different chemical properties, and a spectrophotometer to check the differences in concentration of liquid smoke. The increase in concentration of liquid smoke gave me a clear and somewhat precise linear trend of the rising transmittance (light passing through). So if a solution has less than 10%, it will not be as noticeable to the consumer. I understand that the concentration is around 1% or less in order to go unnoticed, but since I don't have sensitive enough equipment to test such low concentrations, I am using this experiment to form a broader conclusion versus an exact value. Hopefully in the future I will have access to more advanced technology or taste-testers to determine more accurate conclusions. The different chemical properties showed that when smoke is added to grape juice, there is no change in pH, and the smoke molecules bind to water more effectively. So the consumer will not notice any difference in acidity, yet the smoke will most likely combine in the wine to form a homogeneous solution, making it harder to remove if the smoke is already in the beverage.

6969

Determining the Most Effective COMT Inhibitor for Parkinson's Disease Treatment Using Molecular Docking

Mantra Roointan and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

This project's objective was to determine which catechol-O-methyltransferase (COMT) inhibitor, opicapone or entacapone, exhibits a higher binding affinity with the active site of the COMT enzyme and would act as a more effective add-on drug for carbidopa-levodopa therapy in the treatment of Parkinson's disease. It was expected that opicapone would exhibit a higher binding affinity with the COMT enzyme when tested through molecular docking. This project evaluation was done with computational methods using molecular docking and visualization software. Methods used for this project included utilizing the MGLTools software for preparation of the COMT protein, ligand editing, and generation of docking grid boxes. Then the AutoDock Vina software was used to run docking trials between the ligands (including levodopa, the substrate, as a positive control) and the COMT protein. The binding affinity was evaluated through the docking output and

software calculations. Visualization software including UCSF Chimera and MGLTools was used to observe the interactions and binding poses between the ligands and the COMT protein. Additionally, the binding residues of the protein's binding site were identified. The inhibitors bound to serine, while levodopa, the natural ligand, bound to glutamine. As expected, opicapone exhibited the highest binding affinity (kcal/mol) of -8.6, while entacapone and levodopa had binding affinities of -6.9 and -6.4, respectively. The results supported opicapone as the current most effective add-on COMT inhibitor for Parkinson's disease treatment. The experimentation methods and results open possibilities for further drug research and discovery.

6970

A Prevention Method for Inflammation-Induced Organ Damage Through Targeted Vitamin Delivery

Debayon Roy, Mahesh Arunachalam, and O. Tuason (teacher)

Crescenta Valley High School

2900 Community Ave., La Crescenta, CA 91214

Countless numbers of people experience organ damage due to common illnesses such as the flu and COVID-19. Medications already exist to help reduce the effects; however, there could be a way to develop a prevention method for such problems. This project primarily targeted COVID, and the causes behind what exactly is involved in the body when organs suffer. We found

that if inflammation increases, there in turn will be a higher chance of organ damage, meaning there is a need to limit the amount of inflammation that occurs. Various research papers located using a data tool called NCBI (National Center for Biotechnology Information) PubMed® led to data showing that cytokines (proteins involved in the immune system) play a key role in a condition called hypercytokinemia (Cytokine Storm), which is what causes inflammation and organ damage. Data analysis indicated that people suffering from severe COVID and influenza had at least four times the amount of cytokines compared to a healthy person. The next step was to find out whether or not vitamin D deficiency is related to elevated levels of cytokine production, but very little data exists in this category. We requested information from doctors. Various methods of testing conducted by medical labs were able to correlate a lack of vitamin D to high levels of cytokine production, resulting in inflammation. Our evidence was able to prove the beneficial effects of vitamin D; however, not enough tested data has been collected to approve this for medical usage. Based on this, we wanted to create a targeted method of vitamin D supplementation, as opposed to the usual tablets taken through oral ingestion. Using the knowledge that vitamin D restricts cytokine production by binding to T cells (cells in the immune system), we tried to find a way to bind vitamin D to a molecule that is able to detect T cells quickly.

A close-up photograph of several overlapping green leaves. The leaves are vibrant green and show a detailed network of veins. The central vein of each leaf is prominent, branching out into smaller veins. The lighting is bright, highlighting the texture and color of the foliage.

RESEARCH REPORT

R3 Surveying High-Risk Fire Areas: Mapping Homelessness Via Infrared Sensors

Daniel Bet Sarghez, Matthew Keshishian, Gabriela Marcucci, Vahe Haleblian, and D. Evans-Bye (teacher)

Anderson W. Clark Magnet High School
4747 New York Ave., La Crescenta, CA 91214

I. Mission Abstract

Our CubeSat (small cube satellite) mission was to document homeless encampments within a high-wildfire-risk area and to determine if they are occupied or not by using infrared remote sensing. First, we evaluated a FLIR infrared sensor on a Parrot ANAFI unmanned aerial vehicle (UAV) to show proof of concept. Our evaluation proved that IR could identify homeless camps. Next, we built a CubeSat from the XinaBox XK90 and Arduino IoT Bundle Kits. However, our CubeSat went through numerous revisions to fix problems, including removal of the XinaBox. The flight-ready version of our CubeSat used an Adafruit MLX90640 infrared sensor in it to determine where people have set up residence within the high-vegetation region of Hansen Dam Recreation Area. Since this area is Federal Aviation Administration (FAA) Unmanned Aircraft Systems (UAS)-controlled airspace, we used a tethered weather balloon to fly our CubeSat. We imported our data into ArcGIS Online for analysis to determine where camps have been established. Frequent fires are common in this area due to heavy dry brush and a large homeless population that often starts fires for cooking and warmth. The risk is intensified during the fall, when Santa Ana winds are common. The purpose of this mission was to evaluate the use of an infrared sensor to identify homeless camps in high-fire-risk areas in order to save lives and nearby property. Our research question was: Can an aerial IR sensor be used to document homeless encampments in wildfire-prone areas? Our hypothesis — an IR sensor in our CubeSat would be able to identify homeless encampments — was accepted.

Keywords: CubeSat, infrared sensor, homeless, fire risk, Arduino

II. Introduction

The U.S. Department of Education developed the Career and Technical Education (CTE) Mission: CubeSat as a national challenge “to build technical skills for careers in space and beyond” (CTE Mission: CubeSat). As part of our Honors GIS and Remote Sensing class, we submitted a proposal to build a CubeSat with an infrared sensor to identify homeless encampments within high-fire-risk areas.

Homelessness has been a persistent problem in the Los Angeles area, with L.A. County seeing a 13% increase in homelessness from 2019 to 2020 (L.A. Homeless Services Authority). COVID-19 exacerbated this issue, as costs for common goods rose and many jobs were lost (L.A. Controller).

Another incessant problem the region faces is wildfires. California is plagued by frequent droughts, causing extremely dry vegetation in many areas. Arid areas, combined with a growing homeless population and strong Santa Ana winds, make L.A. County a hotspot for wildfires (CAL FIRE).

The confluence of these issues occurs when homeless people settle in high-fire-risk areas in L.A., such as the Hansen Dam Recreation Area. This creates a twofold problem: frequent fires caused by people residing in homeless encampments, and risk to those in the area who may be unaware a fire has started. This is due to the homeless either lighting fires to stay warm or cook food, or discarding materials such as lit cigarettes, which endangers themselves and others.

Our proposal was chosen as one of five national finalists, and we were provided a \$5,000 budget to fulfill our mission. Our research question was: Can an aerial infrared sensor be used to document homeless encampments in wildfire-prone areas? Our hypothesis was that an infrared sensor in our CubeSat could identify homeless encampments in the Hansen Dam area.

Our group initially intended to fly a drone over our survey area, but after conducting a site suitability analysis we found that our survey area overlapped with FAA UAS-controlled airspace, which is a no-fly zone for drones. This is because there are three airports in close proximity to our study area. To overcome this, our group changed our launch method to a weather balloon that remained tethered to avoid air traffic.

The purpose of this mission was to evaluate the use of an infrared sensor to identify homeless camps in high-fire-risk areas in order to save lives and nearby property. Our research question was: Can an aerial IR sensor be used to document homeless encampments in wildfire-prone areas? Our hypothesis was: If we used an IR sensor in our CubeSat, then we would be able to identify homeless encampments.

III. Materials and Methods

Before starting our project, we evaluated an infrared FLIR sensor by flying a Parrot ANAFI UAV over the Willoughby Preserve in Ventura in an effort to obtain a proof of concept of our mission. After obtaining a proof of concept, we chose to study the Hansen Dam area because it fit best within our parameters (*Figure 1*). This area is an open space, has a lot of dry brush, is within a high-fire-risk zone, and is known to harbor camps of homeless people. To determine areas that could be imaged with a drone, we used a site suitability analysis that was created in ArcGIS Online (*Figures 2 and 3*). To begin with, we wanted our study area to be within a 15-mile radius of Clark Magnet High School to keep commuting distances short. This was achieved by adding a 15-mile buffer radius around the school. Since our data had to be collected from the air, we needed to take into consideration and map any FAA UAS-controlled airspaces in our 15-mile buffer zone. Next, we

mapped open spaces (green areas) in which a drone or payload-carrying device could fly, and ruled out the open spaces that reside in controlled airspaces for drones, but kept them on our list for a weather balloon. After determining the open spaces in which we could fly, we ascertained which areas are considered to be moderate to high-risk fire areas (orange hexagons), and defined any intersecting open spaces within wildfire-risk areas (*Figure 2*). Running these geoprocesses identified the open spaces that met all of our criteria, shown in purple (*Figure 3*).

With the \$5,000 budget, and the study area in mind, our team began to design and build our flight-ready CubeSat. The following components were used: an aluminum frame that contained the hardware of our CubeSat; an external power bank that supplied our Arduino with power; an 8238 meteorological balloon with an inflated diameter of 9 feet to carry our payload; and an Arduino MLX90640 Lite, which ran our GPS, thermal imaging, and data storage. This Arduino was accompanied by an Arduino MLX90640 thermal camera that captured all of the thermal imaging data used for our results, and by a device running Strava, an app that recorded the elevation of the flight. These two devices were the major components of our subsystems.

Our original subsystems sketch can be seen in *Figure 4*, but it underwent a near-complete overhaul before our flight to match the guidelines of the competition. The structure remained relatively similar, but the XinaBox had to be removed for reasons that are expanded upon in the computing section. The solar panel and power bank ended up being a singular item, and our team logo was excluded from the final flight, as mounting it reduced the structural integrity of the payload.

For power, our team used the onboard battery with the Arduino IoT Carrier Board. However, in case this proved insufficient, we included a redundant system, which was a 30,000 mAh power bank that had a solar panel on the top. The battery was replaced and the power bank fully charged before the flight to ensure that power would not be a concern. Tests with the power bank and battery yielded a minimum of 10 hours of use before depletion, which was far beyond what was necessary for the flight.

To launch our CubeSat, we used a weather balloon filled with just enough helium to carry the payload. The amount of helium needed was calculated by using the lifting capacity of helium, 30.34 g/ft³, and multiplying that by the weight of our CubeSat, which was 0.88 kilograms. As a result, we needed a minimum of 30 cubic feet of helium to lift it. The CubeSat frame with the components mounted inside was subjected to a heavy shake test before launch to ensure that wind would not dislodge any critical components. Once the frame was mounted to the balloon with zip ties, we attached the balloon to a 120-foot-long nylon line on a cave diving reel and filled it with helium. Since our study area was near three airports, we could not risk losing the balloon, so we put redundant safety protocols in place. We tied our nylon line to the balloon, then folded and secured it with duct tape. Two students held the line during the opera-

tion, one held the reel, and one held the line itself a few feet up from the reel. Our weather balloon remained tethered during the entire flight. Our teacher advisor kept a pellet gun on hand to immediately deflate the balloon in case of emergency.

Our project had three main computing components: thermal imaging, GPS, and communication. While we originally planned to use XinaBox for the latter two, a problem with the XinaBox software prevented us from flashing the firmware onto our chips and using them. We thus had to improvise and use the Arduino as an all-in-one solution. Our thermal camera, the MLX90640 (*Figure 5*), took a 24x32 image with a 55° field of view, with each individual pixel reporting a thermal reading. The Arduino MKR IoT Carrier also included an ambient temperature sensor. To find where thermal readings were present, we programmed the Arduino MKR WIFI 1010 Board to compare these two readings. If any pixel of the MLX90640's image was more than 15% hotter than the ambient temperature, a thermal reading was reported and the GPS coordinates at the time of the picture being taken were reported. We used BLE (Bluetooth® Low Energy) to communicate with our ground team. We also had to calculate the height we needed to fly our CubeSat using field of view (FOV), which can be seen in *Figure 6*.

To secure our components to our payload, we used a combination of zip ties and VELCRO® tape. VELCRO tape was used to secure our largest component, which was the solar power bank, as the zip ties were unable to support its bulky size. However, we opted for zip ties to secure our Arduino (*Figure 8*), GPS module (*Figure 9*), and thermal camera. By crisscrossing the zip ties, we were able to secure these smaller parts and prevent them from breaking off. The removal of the XinaBox kit resulted in a challenge when it came to balancing the weight of the CubeSat payload; however, doing so was necessary to ensure our thermal camera at the bottom of the payload would get a clean shot of the area below it. We secured the GPS module and Arduino Carrier Board on opposite sides of the CubeSat, and the rest of the components were either secured on the top or bottom as identified in our original subsystem sketch (*Figure 10*). We tested the balance of the payload by holding the balloon attached to it close to the ground, and we found that it was able to stay perpendicular to the ground.

For communication and data storage, we used a twofold approach in case of equipment failure. Our primary method of communication was BLE, which is a low-energy variation of Bluetooth capable of communication up to 300 feet away with line of sight. However, due to the unreliability of such wireless communication methods, we also included an SD card on an Arduino LAN Board that would store any data recorded before it attempted to communicate with our ground station. Our data was stored in the form of a CSV file to allow the creation of a story map on ArcGIS. The data points were recorded in four columns: latitude, longitude, elevation, and thermal reading. All four of these points were collected by the sensors mentioned above.

For our ground component, we had to find an alternative to the XinaBox ground station to receive data from our satellite. As noted, we opted for BLE as our communication method. To receive this data, we used an application called nRF Connect that is available on Android and iOS devices. This allowed us to connect to the MKR WIFI 1010 Board (*Figure 8*) remotely and provided an output console log that reported the four elements described in the communication and data storage section.

After obtaining the results from our flights, we utilized ArcGIS Online to analyze our results. We began by adding the GPX file from the Strava app that had the location coordinates and elevation data. We buffered the flight path to 60 feet on either side of the CubeSat and used that as an FOV boundary. Then we created a tessellation analysis of 5x5 bins and set it to the boundary of 60 feet. The visibility range of the map was set to show IR data when zoomed in to the “Buildings” level. The 5x5 bins that were marked red indicated thermal readings that were 15% or higher than the total ambient temperature of the area, and represented possible homeless encampments. The total ambient temperature of the area was determined by our Arduino’s infrared sensor. The elevation data was used to create a 3D ArcScene that displayed the elevation change during the CubeSat’s flight and aided in determining the view distance of the thermal camera.

IV. Results

Our team was able to conduct one flight with a Parrot UAV equipped with a FLIR infrared sensor over a dry riverbed in Ventura. The readings of the FLIR sensor (<https://bit.ly/3BfRjxy>) are shown in bright yellow (*Figure 7*). Our initial exploration proved that an IR sensor was capable of identifying homeless camps in heavy brush. Two subsequent flights with our CubeSat using the Arduino IR sensor were conducted in the Hansen Dam area to identify the locations of homeless encampments. We created an overview (<https://bit.ly/2Y1tvJY>) of the second flight over Hansen Dam where trackpoints are shown in yellow (*Figure 14*). Using an MLX90640 thermal camera, we were able to find the coordinates of homeless encampments in a high-fire-risk area. Pixel readings that were 15% higher than ambient temperatures were recorded and designated as positive for the presence of homeless camps (*Figure 15*). Symbology of the data was classified with ambient readings as light green, and thermal readings over 15% ambient as light red. We identified five camps within a 13,300-square-foot area. We ground-truthed our data with visual confirmation (*Figure 11*). We created a Strava Walk activity map to display the locations and elevations of the CubeSat flights (*Figure 12*). A Map of Flight Path and Elevation (<https://bit.ly/3nE5XU5>) of the CubeSat during the second flight is shown in *Figure 13*, with the darker the color, the higher the elevation. We used an ArcGIS story map (<https://bit.ly/3EzzDc5>) to communicate our results with the City of Los Angeles Fire Department.

V. Discussion/Conclusion

Our CubeSat design process involved a series of failures that culminated in a success; without these roadblocks, we would not have had such a successful flight (*Figure 16*).

Problems first began to rear their head as soon as we attempted to upload firmware to our XinaBox Flight Stations, as neither of our students responsible was able to get the program running. After postponing working on our subsystems for two weeks in hopes of a software update, we ended up opting to move all of the functionality our XinaBox was responsible for to our Arduino. This also signified our first success, as we were able to put together a configuration for our Arduino that included all of the necessary components for a flight station: wireless connectivity and communication, sensors, thermal cameras, power, and onboard storage.

However, as we dipped our feet in the waters of success, a wave of new challenges rose to meet us. We had many problems with developing code on the Arduino. Our first and most persistent issue was our Arduino failing to connect to a COM port on Windows devices. Thankfully, our student software developer was able to borrow a laptop running macOS to be able to upload his code.

Once our code was successfully uploaded to our Arduino board, all that remained was to ensure our hardware was able to function properly. This is where we faced the majority of the roadblocks in our project. Our team attempted to use four different thermal cameras before finding one that gave us readings accurate enough at a long distance, with some being poorly calibrated and others lacking the resolution to take accurate thermal measurements. However, our fifth attempt, with the MLX90640 camera, proved to be successful. Another component that gave us grief was the GPS module. Because we were surveying a heavily wooded area in L.A. County, we had problems getting our original GPS to connect before launching through the trees. We decided to swap out our MKR GPS Shield for a Grove GPS module, which is specifically designed to pick up a weak signal in areas with high-rise buildings that would obstruct it. Although our project was not its intended use case, it ended up working and we got a GPS signal despite the dense vegetation. However, any time a hardware component was changed, it required the software to be changed. This ended up becoming a major time sink, but we managed to get a working final prototype in time for flight week.

Upon our flight, we were faced with both a failure and a success. After allowing our balloon to gain some altitude, we found that our BLE connection was extremely unstable. We were very rarely able to receive any data at our ground station. However, this also proved the success of our onboard storage system. Despite the failure to record data during the flight, after the flight we were able to recover all flight data from our SD card as a CSV file. This proved the success of our redundant data recording system.

Another interesting event during our second flight was the outbreak of a wildfire. Our ArcScene map (*Figure 13*), showing elevation, had a sudden drop in elevation near the homeless camps. The reason was that a fire broke out, and helicopters flew in overhead to reach the scene quickly. The balloon needed to be lowered to avoid interfering with them, despite it restricting our data range.

Our biggest achievement over the course of this project was our adaptability. Our team ran into problems at about every step of the development process, but we were able to overcome them by being flexible and dividing work among team members. While our student software developer worked on rewriting code for a new component, our design team worked on a way to integrate it into our CubeSat frame. By the end of the project, our CubeSat only contained the original Arduino base-board from the first prototype, and it ended up working better than we had expected from our original subsystems sketch.

Another major success of our project was the implementation of redundant systems. As discussed previously, by using two methods to record data we were able to ensure that we had all of our measurements by the end of the flight. Even though our wireless communication between the flight and ground stations failed, our onboard storage system was a success. Another example of a successful redundant system was the power. While the onboard battery was sufficient according to the specifications provided by Arduino, after our flight we found that it had been depleted and the board had fallen back to our power bank for energy. Without having this backup battery system, our Arduino would have died halfway through the flight and failed to record or communicate any data.

One thing we would do differently given the chance to do this project again would be not waiting for a XinaBox software update. If we had begun moving our functionality to the Arduino instantly instead of waiting for two weeks, we would have had much more flexibility in our scheduling before flight week. In a best-case scenario, we might have been able to create two prototypes, one with Arduino for subsystems and one with XinaBox. However, this proved not to be a major roadblock, as our Arduino prototype was functional.

Another mistake our team made was testing components one at a time. A more prudent approach would have been to buy a batch of components for each function: multiple thermal cameras, computing boards, GPS modules, and wireless communication modules. This would have eliminated the time we had to wait between trying and returning parts, as this involved a minimum two-day wait from Amazon. This alteration to our procedure would have given us more time to polish our prototype before our first flight.

The biggest success and differentiating factor in our project was the integration of our data into a story map (<https://bit.ly/2XRpGHb>). This representation of our data is much more interactive than a table with coordinates, and it combines our knowledge from activities throughout the year in class with what we learned from completing the project.

The biggest lesson we learned from this experience is the importance of having redundancy in your systems, along with having a backup plan. In both cases where redundancy was implemented in our final CubeSat prototype, it ended up being necessary and saving our flight. We also would not have been able to overcome many of the challenges discussed earlier in this report if we had not prepared alternative approaches for certain components. Conducting this project without these precautions would have resulted in a comprehensive failure.

Our project ended up being a success due to the iterative approach we used, and this method is not something we would change if we were to participate in this competition again. It gave us the chance to refine our subsystems and payload design while also learning more about troubleshooting hardware and software.

We were able to contact Captain Steve Marotta from the City of Los Angeles Fire Department and share our CTE Mission: CubeSat story map with him. He provided us with his thoughts and suggestions regarding the project. Marotta agreed that homeless camps are especially dangerous in the creation and spread of wildfires in the L.A. area. He also agreed that mapping the Hansen Dam Recreation Area was a good idea due to the high amount of vegetation and homeless people who reside there. He added that “this type of intelligence will help us to focus rescue and evacuation of homeless people during vegetation fires. The other benefit is that it will help us to locate patients during EMS incidents.” Marotta suggested that we share our data with the Police Department to help them locate suspects more efficiently.

Our research question was: Can an aerial infrared sensor be used to document homeless encampments in wildfire-prone areas? After analyzing our data we came to the conclusion that it is possible to document homeless camps using an IR sensor. Our hypothesis — an infrared sensor in our CubeSat would be able to identify homeless encampments — was accepted.

VI. Acknowledgements

First, we would like to thank the U.S. Department of Education for giving us the opportunity to create this project. We also would like to recognize the help from Luminary Labs, which managed the CTE Mission: CubeSat. Thank you to Captain Steve Marotta from the City of Los Angeles Fire Department for taking the time to communicate with us and provide his thoughts on the CubeSat project. Thank you to Kyle and Larry Fuller, who helped with thermal imaging of the Willoughby Preserve in Ventura with their Parrot ANAFI drone and shared their data with us. Special acknowledgements to the parents

who helped. Special thanks to Lauris Bye for help with the helium, teacher David Black for equipment, and Dino's Party Supply for not charging us for extra time with the helium cylinder. Thank you to everyone who stood by us while we worked on this tough, yet rewarding project.

VII. Literature Cited (MLA)

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The Los Angeles Homeless Services Authority. "2020 Greater Los Angeles Homeless Count Results," 3 Sept. 2020, <https://bit.ly/3J2ZHhP>



Figure 1: Map of our study area that displays the fire risk present there

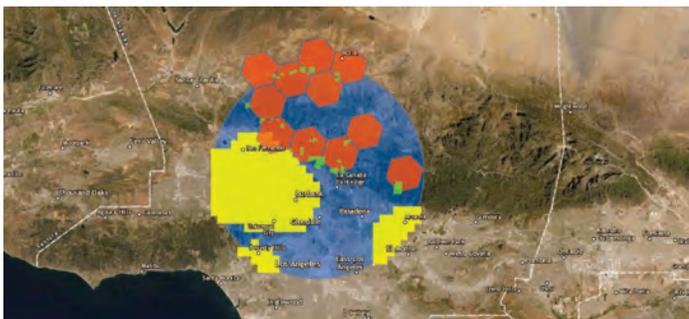


Figure 2: This is the site suitability analysis we ran to determine sites that met our criteria and could be surveyed with a UAV.

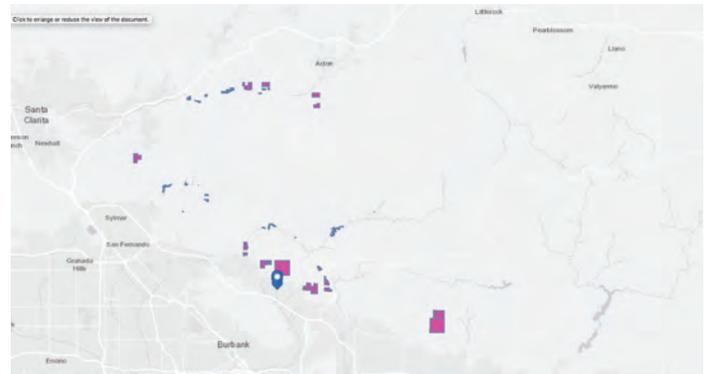


Figure 3: The purple squares are the locations that were possible study areas, as they met our parameters.

CubeSat Subsystems Sketch Template

Download and print this template for your team's collaboration. Use it to brainstorm the different components of the proposed CubeSat prototype with short descriptions (1-2 sentences). You may upload a doc, pdf, or ppt of the completed template in response to the "Subsystems sketch" field of the mission proposal.

Communication and data storage
 Use WAN (LoRa?) to transfer data from flight to ground station, data stored as CSV on SSD.
 320-GB SD Card on flight station to store data if connection dropped.

Computing and payload
 Use Arduino Mkr Wis: 101 board for logging sensors and Xc-70 XBee flight station to transmit GPS data to ground. Solder thermal camera to Arduino board, mount to CUBESAT frame w/ zip ties

Power
 10000 mAh Power bank is necessary to maintain backup power if Xbee/Arduino batteries run out, solar panel can also be added for backup

Structure	Top	Bottom	Left	Right	Front	Back
Inside					Xbee/Arduino Flight station	Arduino Power Board
Outside	Power Bank + solar panel	Thermal Camera			Team Logo(?)	GPS Module

*Try to keep weight balanced for stability

Launch
 Hot air balloon w/ retractable spool (payload needs to be recovered for subsequent flights)

CTEMISSIONCUBESAT.COM

Figure 4: Our subsystems sketch

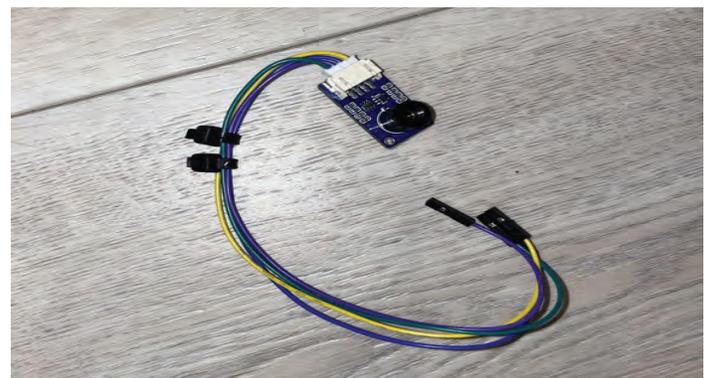


Figure 5: MLX90640 camera

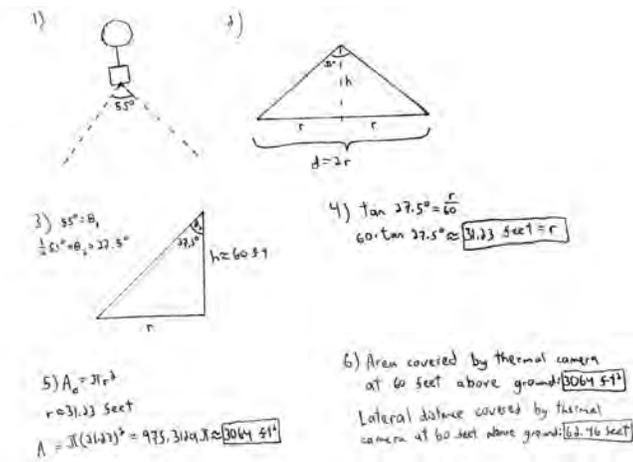


Figure 6: Field of view (FOV) calculations

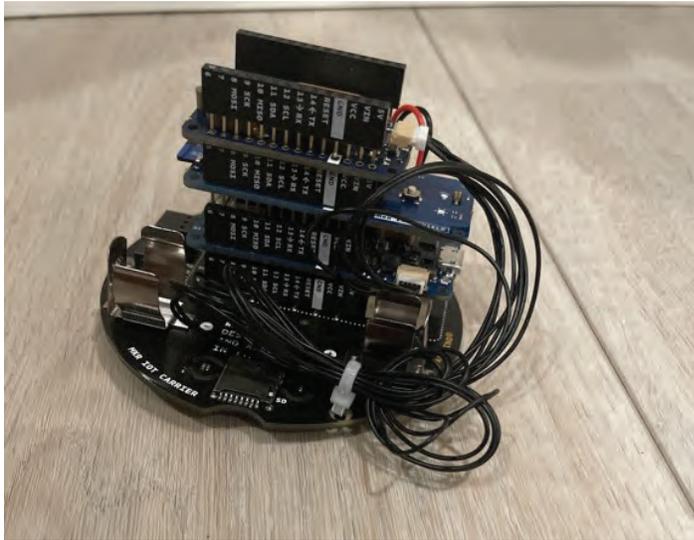


Figure 8: Arduino MKR Board, including an ambient temperature sensor and an MKR WiFi 1010 Board

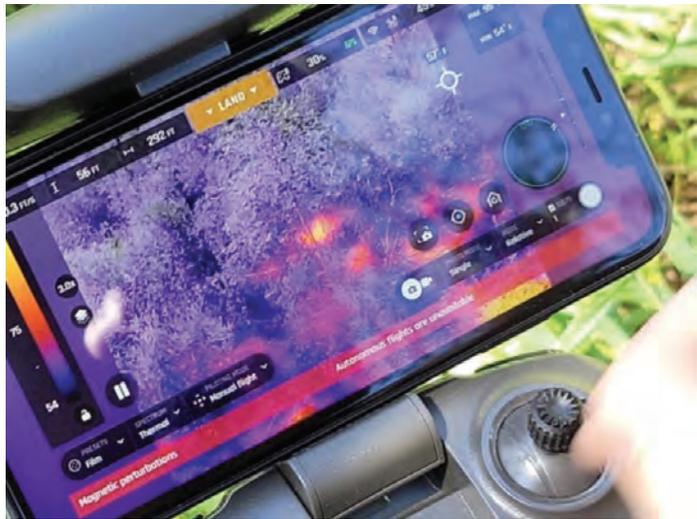


Figure 7: Thermal readings (<https://bit.ly/3umcrvN>) from a FLIR sensor are shown in bright yellow. Image taken in Ventura with a Parrot ANAFI Thermal UAV as proof of concept.

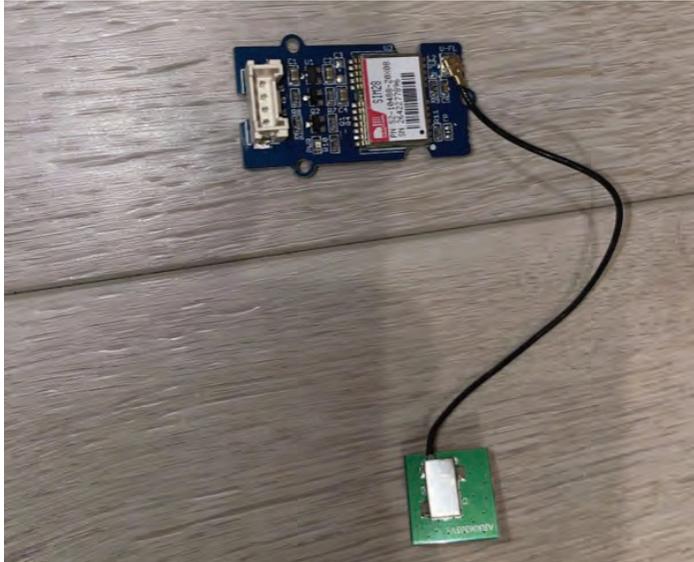


Figure 9: Grove GPS module



Figure 10: Final CubeSat model and mounting system



Figure 11: Photo showing a homeless encampment in natural color to prove the accuracy of the IR sensor

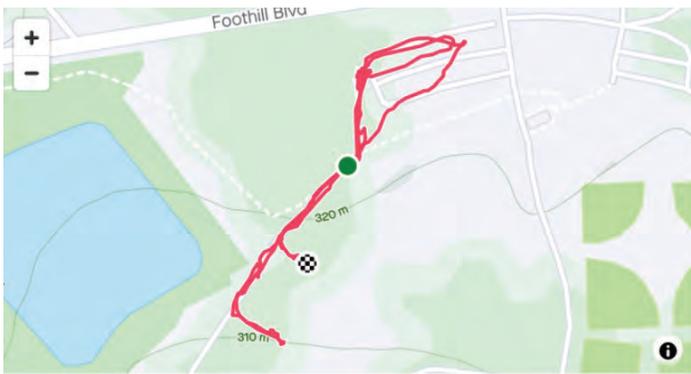


Figure 12: Location and elevation (<https://bit.ly/3GsgBF1>) of CubeSat Flight 1 from Strava app



Figure 13: Map of Flight Path and Elevation of the CubeSat (<https://bit.ly/3nAXqkS>) during Flight 2, with the darker the color, the higher the elevation. The elevation changed due to a wildfire and the need to lower the balloon to keep it away from Fire Department helicopters.



Figure 14: Overview (<https://bit.ly/3bkRp6h>) of second flight over Hansen Dam



Figure 15: Second flight over Hansen Dam zoomed to the tessellations on FOV IR sensor (<https://bit.ly/3vYgpJN>) positive readings



Figure 16: Our final flight

TEACHER / MENTOR INDEX

Laura Byun

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St.
Northridge, CA 91325
laura.byun@lausd.net

Dominique Evans-Bye

Anderson W. Clark Magnet High School
4747 New York Ave.
La Crescenta, CA 91214
devans-bye@gusd.net

Erina Galanukan

Northridge Middle School Medical and Health Careers Magnet
17960 Chase St.
Northridge, CA 91325
erina.galanukan@lausd.net

Marci Lewis

Mulholland Middle School
17120 Vanowen St.
Lake Balboa, CA 91406
mjl6537@lausd.net

Terri Miller (retired)

Boys & Girls Club of the Colorado River,
Bullhead Teen Center
967 Hancock Rd., Ste. 7
Bullhead City, AZ 86442
billterritina@earthlink.net

Terri Miller (retired)

Boys & Girls Club of the Colorado River, Laughlin Unit
1975 Arie Dr.
Laughlin, NV 89029
billterritina@earthlink.net

Shayden Monroe (staff)

Boys & Girls Club of the Colorado River, Laughlin Unit
1975 Arie Dr.
Laughlin, NV 89029

Sarah Pryor (staff)

Boys & Girls Club of the Colorado River, Laughlin Unit
1975 Arie Dr.
Laughlin, NV 89029

Suzanna G. Ribblett

Mount de Sales Academy
700 Academy Rd.
Catonsville, MD 21228
SRibblett@mountdesales.org

Orenda Tuason

Crescenta Valley High School
2900 Community Ave.
La Crescenta, CA 91214
otuason@gusd.net

Sara Wilson

John F. Kennedy High School Gifted/Highly Gifted/High Ability Medical Magnet
11254 Gothic Ave.
Granada Hills, CA 91344
sjw3755@lausd.net

Greg Zem

Ernest Lawrence Gifted/Highly Gifted Magnet
10100 Variel Ave.
Chatsworth, CA 91311

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