Auto-ethnographic Reflections : Lessons from Leading a STEM Initiative for Girls in School While We Ourselves Were in School

Kayli Heather Battel, Tufts University

Kayli Battel is currently a sophomore at Tufts University, majoring in Human Factors Engineering and minoring in Education and Art. One of SiS's three original founders, she organized, led, marketed, and fundraised the program from 2018-2020, and continues to mentor SiS to this day. As a leader then President of Saguaro's FRC Robotics team, Kayli led numerous STEM outreach events at local middle and elementary schools, and beyond. The success of the SiS program earned Saguaro's Robotics Team 4146 their first FRC Chairman's Award, in 2020. Kayli is one of Junior Achievement's 2020 Arizona 18 Under 18 award recipients; was chosen as the Scottsdale Charros Female Student of the Year; graduated with distinction from Saguaro's Math and Science Academy; and was a 2020 Saguaro Valedictorian. Kayli is passionate about STEM and STEAM education for all children, and devotes much time to exploring the interplay between the Art and STEM fields.

Kritin Mandala, Saguaro High School

Kritin Mandala is currently a junior at Saguaro High School in Scottsdale, AZ. His interest in engineering education began when he attended the first Sisters in STEM (SiS) event as a student in 2018. Since then he has become a team leader in Saguaro's FRC robotics club and Sisters in STEM initiative. Kritin is a co-founder of Saguaro's CyberSiS program which is an offshoot of SiS that aims to teach students in grades K-6 about cybersecurity. He is also leading a team of high school students in writing, illustrating, and publishing an innovative children's book series focused on STEM and cooperative principles.

Dr. Sreyoshi Bhaduri, Society of Women Engineers

Dr. Sreyoshi Bhaduri is an Engineering Educator and Research Scientist. She currently serves as a Senator at the Society of Women Engineers - a global not-for-profit organization with over 40,000 global members and the world's largest advocate for women in engineering and technology. Dr. Bhaduri has an interdisciplinary expertise with a Ph.D. in Engineering Education and Masters degrees in Statistics and Mechanical Engineering, from Virginia Tech. Her research interests include: future of work, women in technology, assessing the impact and effectiveness of inclusion and diversity initiatives as well as employing innovative, ethical and inclusive mixed-methods research approaches to uncovering insights about the 21st century workforce.

Natalie Anna Foster, Sisters in STEM - Saguaro High School

Natalie Foster is a current high school senior at Saguaro in Scottsdale, Arizona. She is the president of the school's FRC robotics club and has been a member of the team since her freshman year. During her time on the team she has served as an outreach representative as well as a lead engineer. Through her involvement with Sabercat robotics she was introduced to the Sisters in STEM. Natalie has been the director of Sisters in STEM since the fall of 2020, overseeing the initiative's online transition during the pandemic. She is also a founder of a spin off program called CyberSIS, which was launched in the Spring of 2020.

Dr. Lilianny Virguez, University of Florida

Lilianny Virguez is an Instructional Assistant Professor at the Engineering Education Department at University of Florida. She holds a Masters' degree in Management Systems Engineering and a Ph.D. in Engineering Education from Virginia Tech. She has work experience in telecommunications engineering and teaches undergraduate engineering courses such as engineering design and elements of electrical engineering. Her research interests include the intersection of core non-cognitive skills and engineering students' success.

Ms. Lissa Erickson, Battel Engineering

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CFO Battel Engineering President/Board Member Parent Board Scottsdale Math & Science Academy AZ Past Treasurer Board of Directors All Saints' Episcopal Day School AZ Past Program Manager Honeywell Aerospace AZ Past Supervisor Price Waterhouse CA

Dr. Krishna Pakala, Boise State University

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Autoethnographic Reflections : Lessons from Leading a STEM Initiative for Girls in School While We Ourselves Were in School

Abstract

In this paper, we use an auto-ethnographic approach to describe first-hand the reflections and learnings from leading an organization to help school children, especially girls, familiarize themselves with STEM and Cyber Security. The primary authors and ethnographers are founders of STEM initiatives for young learners. The primary author is a recent high school graduate who has taken up an engineering field, and two other contributing authors are high-schoolers currently leading these initiatives. With help from the three engineering educators on our authorship team, we use our individual self-narratives to develop a set of recommendations for other young engineering educators across the globe looking to start their own initiatives.

Keywords – entrepreneurs, children in STEM, primary education, allyship

This paper is structured into 4 main parts – we begin by introducing the Sisters in STEM initiative, followed by background on why the initiative came into being and what it has achieved so far, we then transition to results from our auto-ethnographic enquiry to discern learnings and reflections on our journey as leaders and part of Sisters in STEM. Finally, we will end the paper with a set of recommendations for future leaders and young STEMinists looking to make a difference.

So let's get started and learn more about the initiative we founded, ran, and learned from – Sisters in STEM.

The Sisters in STEM (SIS) program was launched in fall of 2018 as a response to the unexpected cancellation of an annual Girl Power event hosted by a local community college. Three young women leaders in FRC Robotics approached Saguaro High School's leadership with a plan: Create a separate event, encompassing all STEM disciplines, to provide an outreach venue for young girls in the Scottsdale and surrounding regions. With 3 weeks to plan, the founders developed a suite of age-appropriate activities, marketing materials, graphics and a robot mascot, recruited 40 volunteers and 10 industry/partner school sponsors for this inaugural year. All costs of the event were fully absorbed by the Saguaro Math & Science Academy parent Booster Board's 501 (c) (3) general funds. ● Anticipating participation similar to that of the annual Girl Power event of 40 students, the launch year event fielded 130 young children and 100 adult participants. ● From the connections made at the event, three long running 'spinoff' outreach initiatives were launched: a student-led math tutoring program at a local Title 1 school; a student mentored young girls' programming group; and full development and launch of the Sisters in STEM website for connectivity with young girls interested in STEM related education.

The Core concept behind SiS : interactive teaching methods. Students in SiS experience STEM, vs. passive learning or 'information download'. Our Fundamental mission is to empower young girls. STEM can be theirs at any age! For more information please see [1]

Sisters In STEM Girls Inspiring Girls

The Sisters In STEM Program: Origins

- The **Sisters in STEM (SIS) program** launched in fall of 2018
- **Response to the unexpected cancellation of an local Girl Power event**
- **Three young women leaders** in FRC Robotics proposal: Create a separate event, **encompassing all STEM disciplines**,
- **3 weeks** to plan
- Founders/mentors developed:
  - A suite of **age-appropriate activities**,
  - **Marketing materials**, **graphics** and a **robot mascot**,
  - Recruited **40 volunteers** and **10 industry/partner school sponsors** for this inaugural year.
  - **All costs absorbed** by parent 501 (3)(c) nonprofit.

- **Results:**
  - Launch year: **130 young children** and **100 adult** participants.
  - Year 2: **200 children/150** adult participants
  - Year 3: (**Covid online**) **155 students** and **107** adult participants
  - From Year 1, **three long running 'spinoffs'** - outreach initiatives - were launched
- **Each year, new major initiatives are launched** and maintained via community conversations on STEM interests





The SiS Business Model: Personnel Needs

Finance Light, Talent Heavy

SMSA Parent Boosters & their 501(3) © provide required community support for events/initiatives.

Students provide the volunteer 'engine' for all SIS initiatives, often managing programs and tasks far above the typical level seen in other high school programs.

There are 300+ students in the SMSA → No shortage of available talent for the SiS programs.

Students provide: leadership, 'idea pool,' grant writing, illustration and narrative content, development of business partnerships, educational material development, fundraising, and lesson planning and instruction.

Sisters in STEM program considered a 'best practices' model for SUSD student-empowered community outreach and engagement within SUSD and enjoys the full support of SUSD leadership in their efforts.

SMSA faculty committed to providing ongoing oversight and interface with Saguaro and SUSD administration. Faculty provides the guidance, students support.

The SiS Business Model: Business and Educational Partners

Finance Light, Talent Heavy

The SIS program is supported by strong partnerships within the Scottsdale community and on a national level. Current partnerships include:

Northrop Grumman: Sponsors who provide Cybersecurity information and training.

Battel Engineering: Funding, science materials, and a professional speakers series.

Scottsdale Community College/ASU SWE/Luminosity Labs: Provides support/materials/volunteers for all SiS Showcase nights.

Society of Women Engineers: NY SWE mentors and the SiS team developed an academic autoethnographic paper that was presented at the IEEE FIE Conference 2021: *"We Make the Village" - Inspiring STEM Among Young Girls and the Power of Creative Engineering Education in Action.*

Partnerships in progress: ASU Center for Gender Equity in Science and Technology (CGEST)

The SiS Business Model: Succession Planning and Sustainability

Finance Light, Talent Heavy

Saguaro High and Math & Science Academy include SiS as integral part of program offerings.

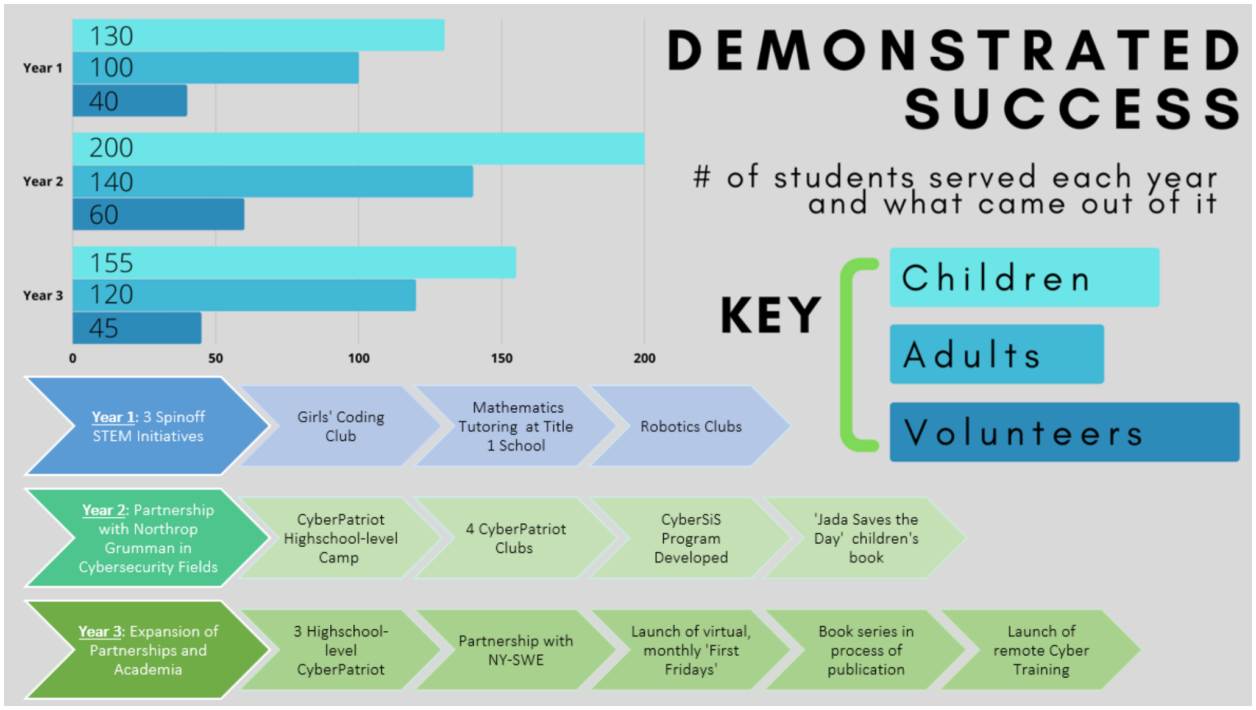
Modeled after FRC Robotics, SiS student leadership is determined at the beginning of each school year based on the interest and talent within the 300+ student SMSA pool.

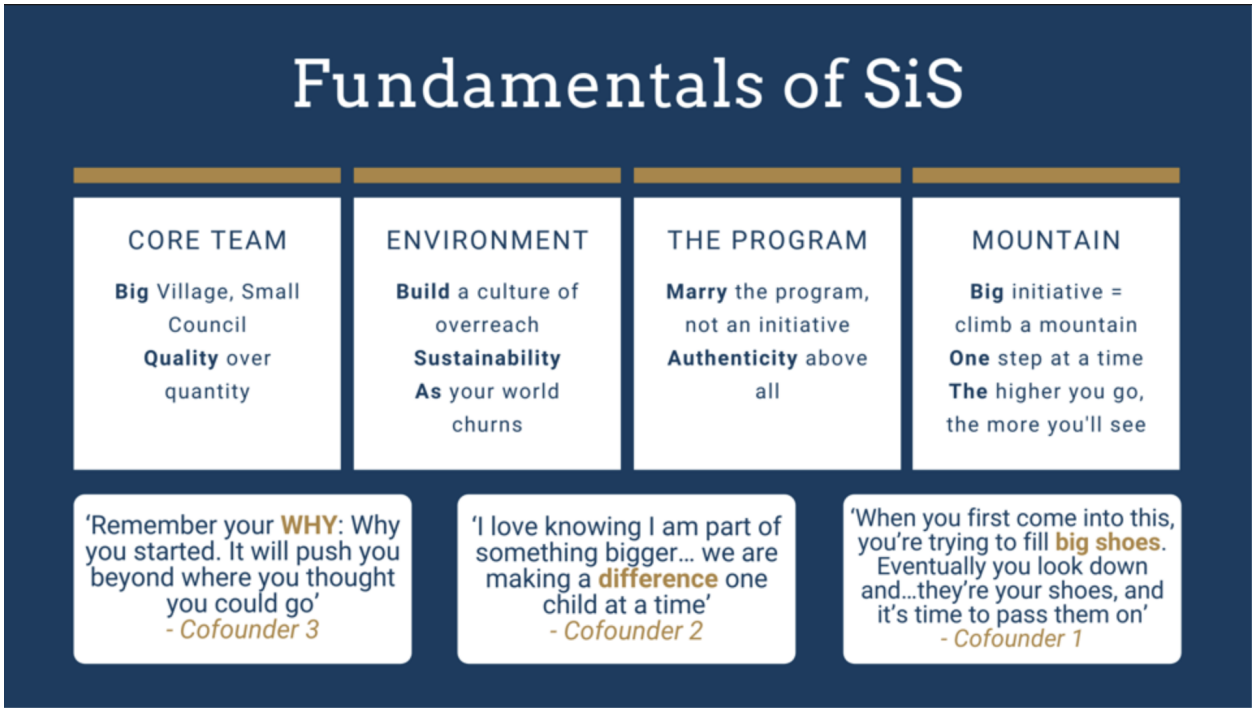
The parent nonprofit assigns 1 Board member annually as the community advocate for SiS.

SMSA and school faculty/administration are fully committed to supporting the SIS program for the long term.

Future leaders are recruited annually as apprentices to the current leadership team, to ensure the sustainability of the program. The selection is based on skillsets, passion, and long term commitment to the program.

One teacher/mentor and 1-2 industry mentors dedicate their full support to the program annually.





Our paper looks at the problem of low gender representation from the lens of attracting young girls into STEM fields [2], [3]. We acknowledge the benefits of STEM initiatives targeted towards attracting girls in school to consider pursuing Engineering degrees and careers [4], [5], [6],[7]. Further, we consider initiatives aiming to address this disparity as significant and

irreplaceable. We build on this narrative to posit the significance of such initiatives introducing young school-girls to STEM, on the student leaders ideating and championing such initiatives. Specifically, in this section we present results from our autoethnographic analysis of the impact of a STEM-focused initiative on the founders and current young leaders of the SiS program. Reflections are presented in an autoethnographic format, thus allowing the authors to narrate their stories and capture thoughts, but also goes a step further by providing a metacognitive exercise allowing the authors to reflect on learnings [8],[9],[10]. This endeavor promotes convergence as well as increased inclusion within engineering education, by bringing in more voices and helping develop budding leaders into lifelong contributors to the engineering education community.


You have a lot more influence than you think, so make the most out of it!!!
My advice for adults part of stem initiatives is to Let the students be the driving force - they have much more influence, ideas, and innovation than you think. Let them run the show, but support them using resources and by providing them the help that they may need.


At first, I had a main perception of STEM being a mostly male-led field, because all the men in my family had gone into engineering fields while the women had done things outside of STEM for the most part. However, with the encouragement of my family, I experienced Sisters in STEM and it changed my entire view. I realized that STEM is for everyone regardless of gender and really needs more women.

WHAT THEY HAVE

Endless creativity
Close connectivity and relevance with younger children
Similar experience base
Culture of volunteerism

THE STUDENT STAKEHOLDERS

WHAT THEY GET

Win-win for everyone
Enlightened self-interest
Early understanding of leadership and making a difference
Setting up for future greatness

Best Practices - The SiS Recipe

DIRECTION AND DRIVE

Build your foundation to last
Passion over technology
Teens can and will be power players

EMBRACE EVOLUTION

Love your hurdles
Be flexible in all things
The internet is an engine for change! (And it's free)

CREATE FOR THE COMMUNITY

'Rock, paper, scissors' - hard science, home supplies: **Hands-on**, every time
Create for the community, act for the individual

COMMUNICATE

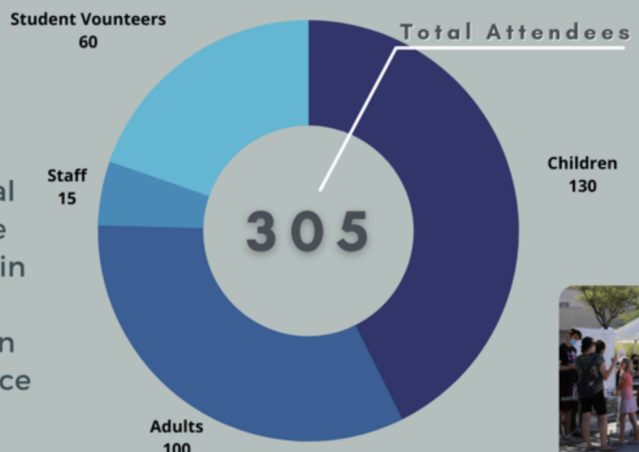
Can we talk?
"**Make** the Village": Anyone 6 - 60 years of age
Mind your audience

DEMONSTRATED SUCCESS

COMING BACK FROM COVID - A NEW BEGINNING

MOVING FORWARD

After a year of virtual SiS events, we came back even stronger in our 4th annual SiS Event held in-person for the first time since the pandemic



WHY WE'RE SUCCESSFUL

THIS IS THE VILLAGE

Students, parents, faculty, administrators, volunteers
Culture of giving

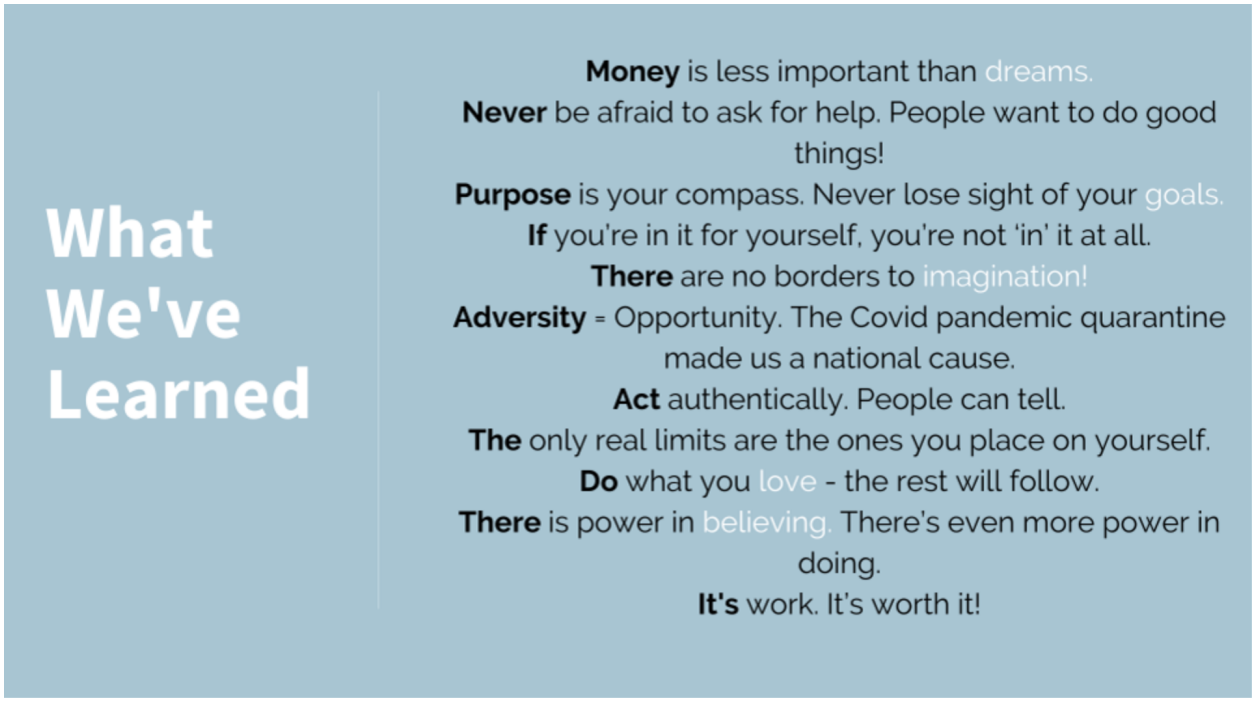
WORKING TOGETHER

Partnership between high school and lower schools
Partnerships within the industry and other academic institutions

"GIVING ALL HIGH SCHOOL STUDENTS A CHANCE TO SHINE & REFINE LEADERSHIP SKILLS"

Based on our experience, high school students are far more capable of managing the development of powerful Engineering/STEM messaging and materials than is generally accepted. By getting out of their way, we have empowered them to design their own programs and ideas without relying on the 'adults in the room', - and the SiS program is much stronger for that. We do not presume that we know better than our students, how to teach love of engineering and STEM. The young educators reflected on some of the important attributes contributing to the success of their initiatives: Endless creativity, close connectivity and relevance with young children, a similar experience base, a culture of volunteerism, mutually beneficial for both student leaders and young participants, new skills gained by high school students, early understanding of leadership & making a difference → all setting up for future greatness

An important theme that emerged from analyzing the reflections was that - This is the "village" - Students, parents, faculty, administrators, high schoolers all create the volunteer pool. There is a "culture of giving" that is critical to success and impacts the partnerships within industry & other academic institutions. Further, partnerships between high school & lower school are important contributors to the success of such initiatives. A key goal is to continue "to give all high schoolers a chance to shine & refine leadership skills."



Questions?

If you'd like to learn more, check out the following links:

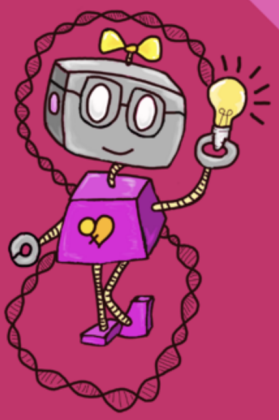
The SiS Program: SistersinSTEM.net

SiS Email: SistersinSTEM.net

CyberSiS program video:

https://youtu.be/6PMLkWnW5k8

Contacts:



Girls Inspiring Girls

Special Thanks To:

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- *Event Leader*

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Eli Arnold
- *Founder/Technical Director*

Zoe Daily
- *Activity Coordinator*

Kayli Battel
- *Founder*

Mrs. Lindberg
- *Teacher Sponsor*

The Scottsdale Math & Science Academy
Scottsdale MSA Booster Club
Sisters in STEM Volunteers

Northrop Grumman – Frank Lillo - Northrop Grumman Northrop Grumman Employee Matching Program

Farley Family Charitable Foundation

Saguaro High School

Sabercat Robotics 4146 Sabercat Robotics

ASU Luminosity Lab

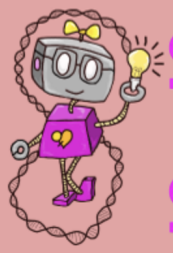
Scottsdale Math & Science Academy – Saguaro High School Booster Club

Scottsdale Community College

Scottsdale Unified School District

"SIS IS FILLING AN ENORMOUS GAP IN THE EDUCATION OF ELEMENTARY STUDENTS. AS A CYBERSECURITY PROFESSIONAL AND PROUD FATHER OF A 3RD GRADE STEM GIRL, I AM INSPIRED BY WHAT THEY HAVE ACCOMPLISHED"

- Frank Lillo, Northrop Grumman Cybersecurity Manager



Sisters In STEM

NSF

"AS AN ENGINEERING EDUCATOR, I SEE IMMENSE VALUE IN THE SIS AND CYBERSIS INITIATIVES. THEY ARE HELPING EMPOWER THE NEXT GENERATION OF 'STEMINISTS' TO BE INCLUSIVE- AND ETHICAL. IT HAS BEEN A REAL TREAT TO MEET THIS TEAM. I AM INSPIRED BY THEIR PASSION AND LOOK FORWARD TO OUR CONTINUED COLLABORATIONS!"

- Dr. Sreyoshi Bhaduri, NY Society of Women's Engineers

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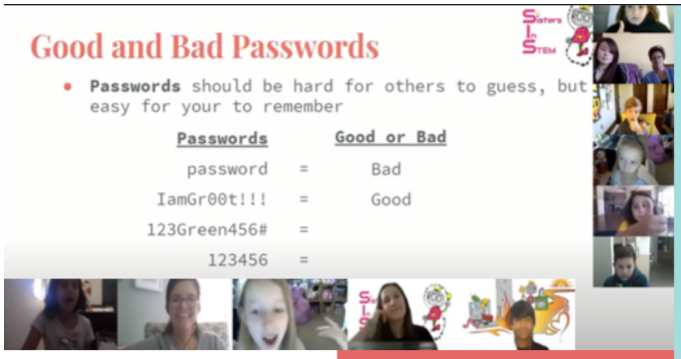
Appendix – Read more about our exciting projects



CyberSiS

COVID DEMANDED A NEW APPROACH...CYBERSIS WAS ONE

With the help of Northrop Grumman, and the guidance of the CyberPatriot program, our team developed several *engaging*, online presentation that we could share with elementary students during the pandemic.

It was *incredibly* successful, with many students asking for more and requests from schools to integrate our program into their curriculum.

The 'Jada Saves the Day' book series aims to introduce children to the world of STEM at an early age and encourage a socially and ethnically diverse STEM environment