Getting Girls to Thrive in STEM

Assistant Director of Advancement Dana Sundblad sat down with Raja Guha Thakurta, Professor of Astronomy and Astrophysics at the University of California, Santa Cruz, and Josée Band, Dean of Teaching and Learning at Castilleja, to discuss what it takes for girls to succeed in science, technology, engineering, and math.

Dana Sundblad (DS): What are the key things girls need to have/know to thrive in STEM related disciplines?

Raja Thakurta (RT): I think for many, if not most girls, the most important thing is a female mentor or role model. They also need to have a passion for learning complex concepts and techniques and they need to fearless in their approach to problem solving and learning. They need to be flexible and adaptable in order to cope with an ever-changing landscape and be able to balance a breadth of vision with an almost obsessive eye for detail.

Josee Band (JB): I would add that they also need resilience, grit, and a tolerance for making mistakes. The nature of scientific inquiry and open-ended problem solving requires patience.

RT: From a skills perspective they need to have strong critical thinking and creative problem solving abilities and well developed oral and written communication skills. Computer programming skills are also essential.

DS: What is being done in the classroom to make sure Castilleja students develop these skills and traits?

JB: In the Middle School we are providing opportunities for girls to learn coding as part of the curriculum. Younger students gain familiarity with Scratch in grades 6 and 7 and then move to a more sophisticated programming language, Python, in grade 8. A wide range of interdisciplinary projects, including one that combines the scientific and historical foundations of archeology, help the girls learn how to integrate information and tackle complex problems. There is even an elective that teaches girls how to create an iPhone app.

In the Upper School, students tackle real-world design challenges in engineering class, use computer modeling techniques to study the spread of infectious diseases in biology, or take electives including:

- Engineering I: The Design and Science of Everyday Things
- Engineering Environmental Systems, and Astronomy

Students also have the opportunity to participate in FIRST Robotics, the Technovation Challenge and Siemens and Intel competitions.

DS: How does the change to Advanced Topics, from Advanced Placement, support this effort?

JB: Each course includes open-ended labs that introduce advanced lab techniques and require increasingly sophisticated data analysis. Students are required not only to do a calculation or answer a question but also to explain and justify their answers on both homework and tests. Students spend much more time working with computer models and in the case of Physics actually write computer programs. In each course, students are asked to read and write using scientific language and critical analysis of material.

DS: What about the Bourn Lab?

JB: Having a dedicated space where students can practice solving open-ended problems collaboratively using the engineering design process and the philosophy of design thinking has been really transformative. We are finding that hands-on project work encourages the development of hard skills, like how to use a drill or microcontroller, and soft skills including communication, collaboration, and resilience. It also reinforces concepts taught in the classroom and builds their confidence.

RT: The confidence-building piece is so important.

JB: It is. At the beginning, they have little tolerance for frustration and look to teachers for answers. As they become more familiar with the environment, tools, and processes their tolerance for failure increases, and they are more willing to make errors, try again, take risks, and rely on themselves.

DS: Last spring, Castilleja offered for the first time a Research Methods course (RM4) that was designed as an "on-ramp" to summer internships and independent STEM work. The course covered four subject areas including environmental science, astrophysics/physics, chemistry, and biology and also offered the girls opportunities to work with mentors during each module. What was the inspiration for the course and what has been the response?

RT: The inspiration for RM4 came from two sources. First, I had mentored a handful of students during the spring term of 2010 on short independent study projects and a couple of them went on to successful summer internship stints. It was clear that having some lab experience and a mentor was helpful in getting them to move to the next level. Second, other schools run very effective research classes and that was something we wanted to do at Castilleja specifically for girls.

JB: We were surprised by the enthusiastic response—especially given the early evening time slot and Saturday sessions. A total of 33 students participated and many took two or more of the modules. It really exceeded our expectations.

RT: The instructors and mentors were creative and supportive.

JB: And the girls really had a great time doing something new, gained a better understanding of the research process, and had the opportunity to practice all the steps.

DS: More students seem to be entering research oriented competitions. Beyond "winning" why is this experience important?

RT: I think the process of entering a competition like Siemens or Intel really teaches the girls a lot—sometimes even more than they learned while doing the research that is the basis for the paper. Not only does the student have to complete a

Succeeding in STEM

Professor Thakurta asked his PhD students, many of whom were SIP mentors, what they thought were the most important things girls need to have/know to succeed in STEM fields. Read what a few of them had to say:

"You need focus, patience, and perseverance in working through difficult problems for extended periods of time. I also think a balance between broader vision and attention to detail is at least as important as either item on its own."
- Claire Dorman

"While having a role model/mentor for all science students is very important, it is my opinion that having a female mentor or role model is especially important for aspiring female scientists, as it can be difficult to picture yourself fitting into and succeeding in a male-dominated field without a strong example."
- Emily Cunningham

"One of the best traits you have can have as a scientist is a healthy dose of stubbornness. This is especially important for girls, who might have an erroneous, subconscious sense of inferiority. Things never work the first time, and the successful researcher has to learn from failure and keep going until it's right. You also need to be passionate. If the deep desire to learn about science isn't there, then the intrinsic motivation required for original research just isn't going to happen."
- Evan Kirby

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substantive research project but she also has to be able to communicate effectively. This is the most important thing in my mind. Writing a paper for competition teaches students how to tell one's story in an engaging and logical way and how to explain complex/technical concepts and processes in non-technical terms while maintaining scientific rigor.

JB: We have seen the number of girls submitting research papers to competitions soar in the last year or so. I think there is a direct link to the SIP and other internships—not only do they do real work, but the bonds they forge with their mentors who continue to support their work beyond the scope of the internship is really invaluable.

DS: It seems as if the internship component is really important—not only for developing skills but also for the mentoring relationships that develop. Is that true?

JB: Absolutely. I'd add that it is also a great way for them to meet other high school students with similar interests and to foster a learning community beyond Castilleja.

RT: I agree. The internships provide one-on-one mentoring and exposure to impressive young adults who are excited about their work. It is important for girls to learn to navigate the social culture of a research environment, build relationships, and appreciate the value of teamwork and collaboration in science.

JB: Internships give students the opportunity to interact with professionals in the field, pursue their research beyond scope of an internship, and write a professional-grade paper with the support of a mentor. It can even lead to invitations to attend professional conferences or other events. As the result of her internship, one student was accepted to present a poster at a prestigious global Applied and Environmental Microbiology Conference. She had the chance to feel part of a scientific community and developed the courage to interact with professors and post-docs despite her age. While explaining her poster someone remarked, "That's great! Which university are you from?" Her response, "I'm actually in high school."

Before coming to Castilleja in 2010, Josée Band was Middle Years Program Coordinator at the Copenhagen International School where she was responsible for curriculum development. Previously, she held a similar role at the Washington International School for 10 years. She is also a veteran teacher with more than twenty years of classroom experience. She received her Licence ès Lettres and Certificate de Maitrise from Université de Dijon.

Raja Guha Thakurta is a professor and astronomer at UCO/Lick Observatory, Astronomy and Astrophysics Department at the University of California, Santa Cruz. His research is focused on the formation and evolution of galaxies. He is also the director of the UCSC Science Internship Program (SIP) which he founded in 2009 with the recognition that immersion in a university research experience could be a transformational experience for bright, well-prepared high school students and that such experiences accelerated student development toward becoming serious scholars and researchers. He received a BSc from St Xavier's College and PhD from Princeton University.

stem awards

Students take Siemens Competition by Storm

Casti students excelled in the 2013 Siemens Competition in Math, Science & Technology, the nation's premier research competition for high school students. A record twelve students entered this year and three were named semifinalists and two regional finalists. This year's competition drew 2,440 entrants nationwide.

Regional finalists **Ayesha Bajwa '14** (astrophysics) and **Smriti Pramanick '14** (astrophysics) were among the 15 students from California and one hundred nationally who will advance the next round of the competition.

Kiana Borjian '16 (astrophysics), **Sarah Dunn '15** (ecology & evolutionary biology), and **Tara Thakurta '16** (ecology & evolutionary biology) were among the 51 semifinalists in California and 331 semifinalists nationally.

All five students participated in the Science Internship Program (SIP) at the University of Santa Cruz this summer.