STATUS

A REPORT ON WOMEN IN ASTRONOMY

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The NASA SMD E/PO Community's Commitment to Diversity: Engaging Women and Girls in STEM

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Left to right: Meinke, Jones, Ali.
Photo credit: Karin Hauck

The NASA Science Mission Directorate (SMD) Education and Public Outreach (E/PO) Community engages diverse audiences in science, technology, engineering and mathematics (STEM) through innovative programs that use research-based best practices, field-tested activities, and community-based partnerships. The NASA Science E/PO Forums (Forums) support the NASA SMD E/PO community members in their E/PO efforts. There are four Forums, one for each SMD Division: Astrophysics, Earth Science, Heliophysics, and Planetary Science. The Forums foster collaboration among E/PO teams and support scientists with content expertise and educators with pedagogy expertise. The Forums offer professional development opportunities for community members and resources for community members, scientists, and the public in topics such as engaging diverse audiences. In this article, we highlight four SMD E/PO programs that engage girls and young women in STEM fields relevant to each NASA SMD Division.

Earth Science Program Highlight: *S'COOL*

Imagine you are alone. The sun is shining, the wind whips through your hair, and salty sea mists your face as you row. You check your watch. It's time. You gaze up at the clouds overhead and report your observation to a server thousands of miles away. And then, you row on.

This is the experience of Roz Savage, the first woman ever to row solo across three oceans, as she logged her cloud observations from the Western Pacific and Indian Oceans as part of NASA's *S'COOL* program.

Continued . . .

NASA Engaging Women and Girls in STEM continued

In *S'COOL* (logo shown in Figure 1), students and enthusiasts around the world participate in NASA science research. They make observations of clouds from the ground as a satellite collecting cloud data passes overhead. A few days later, they receive an email with satellite data and imagery that allows them to compare how well their observations matched. For the students, it is an authentic, engaging way to learn about clouds, how and why NASA studies clouds, and the role clouds and the energy cycle play in global climate change. It also assists in the validation of the Clouds and the Earth's Radiant Energy System (CERES) instrument by providing ground truth data.

Figure 1. The *S'COOL* logo

S'COOL was not specifically designed for girls, but its girl-friendly style and content caught the attention of *SciGirls* producers. *SciGirls* is a PBS show for kids ages 8–12 that showcases bright, curious, real girls (not actors!) putting science and engineering to work in their everyday lives. The 2015 Earth Day episode of *SciGirls* featured middle school girls from Virginia Beach participating in *S'COOL*, with support from NASA scientist Dr. Yolanda Roberts.

Since 1997, more than 4,600 schools and more than 236,000 people from 97 countries have registered to participate in *S'COOL*. With a recent submission from Antarctica, *S'COOL* now has observations recorded from all seven continents.

Through *S'COOL*, students are scientists. They analyze data, just like the CERES science team. They are helping NASA better understand how clouds interact with the energy cycle, a process that is not fully understood. *S'COOL* provides a way for the entire world to get involved in NASA science research and to work together to build a better understanding of the sky above us — including the sky above a lone adventurer rowing across the oceans.

Heliophysics Program Highlight: *Solar Week*

Where on the Web can a middle-school girl ask a female solar scientist about solar storms, the trajectory and behavior of charged solar particles, and the origin of the Sun's dynamo — and also find out what the scientist was like as a child, whether the scientist has tattoos or enjoys snowboarding, what she likes and dislikes about her career, and how she balances work and family life? At *Solar Week*!

Established in 2000, this bi-annual celebration (in spring and fall) encourages students in grades 5–9 to explore the wonders of our nearest star. Created by the Multiverse education group at the University of California Berkeley's Space Sciences Laboratory, *Solar Week*'s goals are to educate students about the Sun

From the Editor, Nancy Morrison

In this issue of *Status*, we are pleased to emphasize astronomy education, beginning with a contribution from a team of NASA Education and Public Outreach folks. We hope you will take advantage of the educational resources they describe and perhaps be inspired to develop your own materials for diverse audiences.

In addition, Angie Little has contributed an article based on an invited education workshop talk that she presented at the January 2015 AAS meeting. Her research has led her to develop methods with the potential to improve science teaching and increase retention rates for physical science majors.

The remaining two contributions in this issue are on the theme of "sexism is not dead." Blogger Ramin Skibba (http://raminskibba.net) provides us with a critique of a recent study purporting to show that academia is really a welcoming environment for women, and Gerrit Verschuur reviews a book on the pervasiveness of sexist attitudes in academia during the twentieth century. These attitudes did not suddenly disappear with a change in the centuries digit!

and solar physics and to encourage future careers in science—especially for girls. The *Solar Week* website intentionally does not state that all of the featured solar scientists are women, but, by showcasing women in science, the *Solar Week* team hopes to provide girls with relatable role models and help banish the stereotype that only men do science. The *Solar Week* website is a place where students of both genders interact with female solar scientists.

The *Solar Week* website (lead banner shown in Figure 2) has two parts: a set of curricula, games, and activities for classrooms with a page of science career resources which are available at all times throughout the year; and an interactive bulletin board that goes live twice a year for a week, allowing middle school classrooms to pose questions to a dozen leading solar scientists who volunteer their time and expertise to educate, inspire, and entertain kids. While most questions on the live bulletin board are about the Sun-Earth connection, students are also interested in the (sometimes circuitous) paths that brought the scientists from childhood to their present careers; what inspired and challenged them along the way; and now, what they enjoy most — and least — about their days.

Solar Week began as part of the NASA *Yohkoh* mission E/PO program in 2000 and has since been funded by a variety of NASA Heliophysics missions and projects, including the Sun-Earth Connection Forum, MMS, STEREO, and Energy from the Sun.

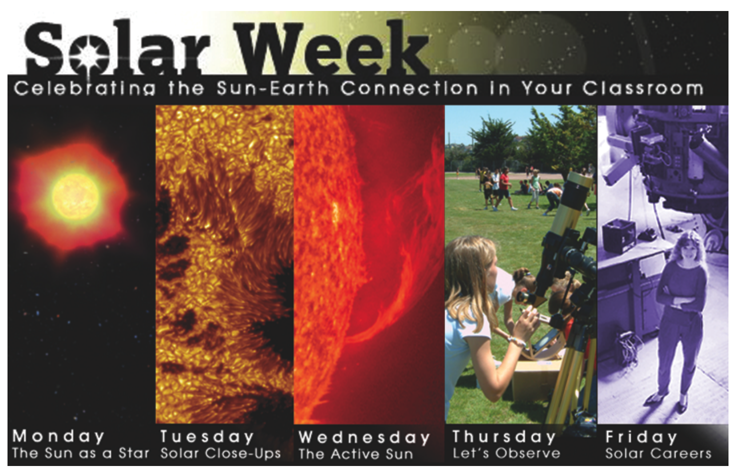

Figure 2: Banner from the *Solar Week* web site (see below for link)

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NASA Engaging Women and Girls in STEM
continued

Figure 3: Girl Scouts participating in *Girls Go to Mars* activities (Courtesy SETI Institute)

Planetary Science Program Spotlight: *Girls Go to Mars*

Girls Go to Mars is a NASA-created Girl Scout program specifically designed for girls — an underrepresented audience in science, especially the physical sciences. The project builds on existing Girl Scout science, math, and technology projects, focusing on the themes of Mars exploration and the science of NASA's Mars Atmosphere and Volatile Evolution Mission (MAVEN) mission. It is designed to increase girls' and adults' interest in and understanding of solar system exploration and to provide opportunities for girls to discover diverse career options in science.

Girls Go to Mars is a short series of collaborative, investigative, hands-on activities for Cadette Girl Scouts that begins with an overview of our inner Solar System, emphasizing the planetary histories of Mars, Earth, and Venus, and concludes with evidence for the greenhouse effect on Earth. The activities were developed by the SETI Institute, in collaboration with Girl Scouts of Northern California. They make use of online NASA resources and integrate MAVEN's discoveries about the atmosphere of Mars. Cadettes simultaneously learn about new technologies and gain new knowledge as they explore career pathways and develop potential service projects linked to the Cadette leadership journey, Breathe: It's Your Planet — Love It!

The overarching goal for *Girls Go to Mars* is: "Think like a scientist; Be a scientist!" Over the course of seven activities, girls learn about the solar system, how planetary characteristics are interrelated, how scientists use models, how atmospheres change, and the effects of magnetic fields. In the end, Cadettes use skills they have learned and apply them to new situations. Cadettes decide what topic(s) they want to explore and how they want to go about it (Girls Changing the World Through STEM/Girl Scout Research Institute).

The *Girls Go to Mars* activity kit will be available online in 2015. When Girl Scouts complete the program activities, they will have fulfilled the requirements for a new Technical Badge (Figure 4).

Figure 4: The *Girls Go to Mars* badge. It was designed by participants in the first program workshop. Girl Scouts earn the badge by completing the program activities, which teach them about MAVEN-related Mars science. (Courtesy LASP)

Continued . . .

NASA Engaging Women and Girls in STEM
continued

Astrophysics-led Program Highlight: *NASA Science4Girls and Their Families*

The *NASA Science4Girls and Their Families* initiative partners NASA SMD science education teams with public libraries to engage girls and their families in NASA mission science during Women's History Month (an annual celebration in March). Participating libraries host events related to NASA's scientific explorations of our home planet Earth, our Sun, our solar system, and the Universe beyond and encourage girls and their families to make scientific discoveries for themselves. Events use field-tested educational activities and resources provided by the NASA SMD science education team. Its logo is shown in Figure 5.

Because *NASA Science4Girls and Their Families* involves collaborations between NASA science teams and local libraries, programming and events are unique for each partnership. The support and resources shared between partners typically includes: library staff training (in person or by teleconference or videoconference), education resources, connections to NASA scientists, research-based tips to make events girl-friendly, and/or support in finding future opportunities and local partnerships for science programming. Each partnership develops events specifically tailored to fit each library's individual resources, space, and audience. In 2013, this resulted in a wide variety of event offerings, from exhibits and lectures to teacher trainings, star parties, and workshops. In 2014, the spectrum of events included hands-on activities with microscopes and telescopes and long-term programming such as book clubs. In order to reach new and geographically underserved audiences, the *NASA Science4Girls and Their Families* initiative offers several remote engagement opportunities for libraries at a distance from select NASA SMD E/PO teams. The intent is to empower women's success — especially in science — from when they are young.

Figure 5: The *NASA Science4Girls and Their Families* logo

NASA Science4Girls and Their Families is a multi-faceted effort, reflecting the role of the NASA SMD E/PO Forums in increasing the efficiency and effectiveness of the SMD E/PO program, the partnerships between NASA science education programs and libraries, and the educational events held in conjunction with Women's History Month. This year, 2015, is the fourth year of the collaborative effort of the SMD E/PO community to engage girls in STEM during Women's History Month. Between 2012 and 2014, *NASA Science4Girls and Their Families* reached over 50 libraries in 32 states and Puerto Rico. Multi-year participation has allowed for sustained partnerships between science educators and libraries, improved remote-engagement efforts, and enhanced professional development programs.

The NASA SMD E/PO Commitment to Diversity

The SMD E/PO community is dedicated to sharing the excitement of NASA science and exploration with the nation and the world, including audiences underserved and underrepresented in STEM fields. In support of this vision, the SMD E/PO Forums have compiled a set of resources (e.g., activities, partnership opportunities, best practices on working with different audiences) on the SMD E/PO community workspace intended to help scientists and educators more effectively work with some of the most common underserved audiences, including girls. The workspace pages also highlight the work done within the SMD E/PO community engaging underserved and underrepresented audiences, as a way to highlight effective examples of working with these audiences, to connect interested people to the program facilitators, and to build a community of practice interested in serving these audiences.

NASA Engaging Women and Girls in STEM continued

Find out more about SMD E/PO Programs

S'COOL is implemented by Director Dr. Lin Chambers, Sarah Crecelius, and Tina Rogerson at NASA's Langley Research Center. To learn more about *S'COOL* and to get involved, visit: http://science-edu.larc.nasa.gov/SCOOL/. To learn more about *SciGirls* and to find the episode featuring *S'COOL*, visit: http://www.pbs.org/parents/scigirls/episodes/.

The *Solar Week* website is http://www.solarweek.org. If you are a solar scientist who enjoys talking to eager audiences of students about what you know, how you go about your day, and what inspires you, please contact *Solar Week* at solarweek@solarweek.org or email Karin Hauck (University of California, Berkeley) at Karin@ssl.berkeley.edu.

The *Girls Go to Mars* website is http://lasp.colorado.edu/home/maven/education-outreach/afterschoolsummer-programs/girls-go-to-mars/. For more information about *Girls Go to Mars*, to receive information about training workshops or webinars, or if you would like to add your name to our troop leader professional development distribution list, please email epomail@lasp.colorado.edu with "Girls Go to Mars inquiry" in the subject line.

Information for librarians interested in participating in *NASA Science4Girls and Their Families* is available at http://smdepo.org/topic/5705. Please contact Bonnie Meinke at Meinke@stsci.edu for any further details.

For resources on engaging girls, women, or any other underserved/underrepresented group, visit the SMD E/PO diversity resource page at http://smdepo.org/post/7770.

To learn more about NASA's SMD E/PO Forums and SMD E/PO community programs, visit: http://smdepo.org.

Proudness: What Is It? Why Is It Important? And How Do We Design for It in College Physics and Astronomy Education?

Angela Little (Michigan State University)

This article expands on my invited talk given at the 225th AAS Meeting, January, 2015, in Seattle, WA. [1]

Photo credit: Matt Beardsley

Transitions are tough on students, especially big transitions like the one between high school and college. Among the many reasons why this transition in particular can be tough, a big one is that students from a wide variety of high school preparations are often thrown together into large introductory STEM courses. In these courses, it's easy to mistake background for innate ability, and students often compare themselves to their classmates through grades and through their relative speed on homework and exams. These comparisons can heavily influence students' decision to major in, for example, computer science [2] and most likely have similar effects on majoring in STEM in general. This tendency to mistake background for ability is likely amplified in courses and majors in physics, math, and computer science, where students face additional U.S. cultural narratives around the need for inherent "genius" ability: either you're a math person or you're not [3]. Researchers have also shown that such genius narratives particularly affect African Americans and women from all racial backgrounds due to U.S. stereotypes about these groups[1] [3], [4], [5], [6].

Instructors can play a critical role in either pushing back on these genius narratives or amplifying them further. When instructors don't point out to students that they might be coming from different backgrounds than their peers, don't teach the holistic set of skills important to succeeding in science and college more generally, and don't support students in learning how to give effective self- and peer-feedback to improve their work, no wonder students frame their struggle as something inherent to failures in their own brains.

I'm one of the co-founders of The Compass Project [7], an APS-award winning program at the University of California, Berkeley that supports undergraduate physical science majors, particularly from marginalized backgrounds. Compass builds an encouraging community, engages students in physics projects, and has a special focus on being reflective about the learning process. In my curriculum and program design work for Compass, I often felt that I was fighting against students' experiences in introductory calculus-based physics. Among the experiences with negative impact on students is that courses were often graded on a curve,[2] which served to amplify students' comparisons with one another on every exam. Previously, as a TA for introductory physics, I even had one student in a section refuse to work with anyone else because he had done well on the first exam and "didn't want to bring up the curve."

What would it look like for students to have additional information, beyond comparison with other introductory physics students, in deciding whether to major in physics and astronomy? How might it influence students' decisions on a major if they were also engaged in a challenging project of interest to them in which they could acknowledge their strengths and weaknesses, be supported to grow and improve, and feel really good about the outcome?

[1] The study by Leslie et al. [3] about genius narratives provided data only on African Americans and on women from all racial and ethnic backgrounds. It is likely that other groups would be similarly affected, as additional stereotype threat research has found effects on other marginalized groups.

[2] For more about the history of grading practices in the U.S., see the article, "Teaching More by Grading Less (or Differently)" [8].

Proudness continued

Proudness: What is It?

It turns out that the way people use the word *proud* isn't incredibly precise. For about two years, I've been leading workshops for STEM educators who want to design curriculum that is most likely to result in their students feeling proud. As part of these workshops, I introduce the word *proudness* to imply that this is an idea we need to define for ourselves. Together, participants and I try to understand what *proudness* is by sharing examples of what we're personally proud of and naming similarities and differences across examples. After hearing over 100 examples from my workshop participants, it's clear to me that there is an incredible variety of experiences along with a number of common core features. Before getting into the core features, I'll first ground us with two examples: one from outside of STEM and the second in STEM research. While neither of these examples comes directly from my workshops (one is from YouTube and the other from the STEM education literature), they nevertheless highlight important aspects of proudness and share many commonalities with examples given by my workshop participants. As you read through these examples, consider whether you've had any experiences that have had a similar feel.

Example 1: Completing a Skateboarding Move

YouTube user The Berrics posted a video (Figure 1 [9]) of "Nine-year-old Sabre Norris from New South Wales, Australia, [who] just landed her first 540 . . . " Norris describes the work that led up to this moment:

"I've been skating for about 3 years. My favorite trick is a 540. I watched Lyn-Z Adams Hawkins do it on the internet, and I just had to do it. That was my 75th attempt of the day. Every time I tried one and didn't land it I put a rock on the table. It ended up being my 75th rock. I was frothing.[3]"

What fascinates me about this example is that Norris kept track of her experience by placing a rock on a table every time she fell.

Example 2: Working in a Biology Research Lab

This feeling of working hard for a long time before a breakthrough isn't unique to skateboarding. An undergraduate biology major shared a story about working on DNA in a research lab [10]:

"I like working in the lab because . . . you have no idea what you're doing . . . And so you do a lot of stuff . . . and then you find out that it works, and you're just kind of like ***"Wow, I did that, and it worked!"***

At the core of these experiences is a time where the work is frustrating, challenging, unclear, and/or repetitive. Eventually, there is a "Wow!" moment that could involve a breakthrough or a good feeling of accomplishment that leaves you "frothing" or excited as in Figure 2:

Figure 1: From left to right: two of Norris's failed attempts and her celebration at succeeding.

[3] "Frothing" is an Australian slang term for being excited

Proudness continued

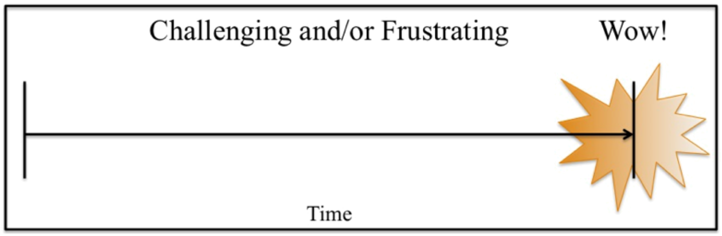

Figure 2: The proudness diagram

This simple diagram invites questions like: what might allow us to amplify the Wow! moment at the end? What kind of factors might dampen the Wow! moment? What is the time scale?

The diagram and the two examples that I highlighted give a sense of the basic structure of *proudness*. By the end of the workshops that I lead, participants arrive at a set of principles for an *Ideal Proudness Project* to guide instructional design. In coming up with these principles, the goal isn't to make a list that holds true across every single proudness example. Instead, the goal is to make a list of key elements that, taken together, would most likely result in students feeling proud. Participants in a number of workshops have all come up with remarkably similar principles. Below, I've chosen six themes that arise most often.

Ownership Work that one feels personally responsible for and invested in

Improvement Work that is iteratively improved over long time scales

Feedback Constructive feedback by peers/mentors/mentees

Challenge Work that is outside one's comfort zone

Communicability Work that is shared publicly and positively engaged with

Tangibility Work that culminates in something concrete, e.g., a talk, a poster, an art work, or a computer program

These ideas are not new. Rather, they connect to a number of areas of research in the STEM education literature. What I find so compelling about proudness is that it acts as an umbrella, bringing together many ideas that we know to be important.

Proudness: Why is it Important?

There are many potential connections to make between the six proudness strands and the STEM education literature. For instance, the **Tangibility** and **Communicability** strands are related to Papert and colleagues' theory of constructionism, which asserts that learning happens especially well "in a context where the learner is consciously engaged in constructing a public entity" [11]. The **Communicability** strand connects to Carlone and Johnson's work on science identity and the importance of competence, performance, and recognition [10]. The **Improvement** strand connects to Dweck and colleagues' work on growth mindset and the importance of believing that one can improve [12],[13]. Many more connections can be made. For the sake of brevity, I'll go into detail only on the latter topic: growth mindset.

The concept of growth mindset comes out of nearly 40 years of psychology research by Carol Dweck and her colleagues. On her Mindset website [14], Dweck defines both a fixed and a growth mindset:

"People with a fixed mindset believe that their traits are just givens. They have a certain amount of brains and talent and nothing can change that. If they have a lot, they're all set, but if they don't . . . So people in this mindset worry about their traits and how adequate they are. They have something to prove to themselves and others."

and

"People with a growth mindset, on the other hand, see their qualities as things that can be developed through their dedication and effort. Sure they're happy if they're brainy or talented, but that's just the starting point. They understand that no one has ever accomplished great things . . . without years of passionate practice and learning."

One can have different mindsets in different contexts. For instance, someone might have a fixed mindset about art, but a growth mindset about biology or even just certain sub-areas of biology. It's a simple yet powerful idea: your beliefs about your ability to learn and grow impact the learning process. The idea of growth mindset has been shown to be critical for both students and instructors in STEM learning in particular. Research has shown that, for students,

Proudness continued

having a growth mindset influences decisions to major in computer science [2]. Whether college math learning environments send a fixed or growth mindset message to students has been shown to have a negative or a positive impact on female math majors' sense of belonging [15]. Faculty members' fixed mindsets can also lead to their giving harmful "comfort feedback" that deemphasizes the possibility that students can improve [16].

Ideal Proudness Projects, with their goal of providing students with a concrete experience of their own improvement, have the potential to support the development of a growth mindset in college physics. Traditionally, interventions aimed at supporting the development of a growth mindset have focused on the neuroscience of the brain, and how the brain can form new connections. Such interventions, some given online in as little as as 30 minutes, have had major impacts on struggling middle school math students and remarkable correlations with college persistence when given to seniors in high school [17]. If 30 minutes of hearing that one can theoretically grow and improve has such an impact, imagine what the direct experience of one's own growth and improvement could do. At Michigan State University, a colleague and I are currently studying whether and how in-depth projects paired with an introductory calculus-based physics course can support students' development of a growth mindset in physics.

Proudness: How Do We Design For It?

In an ideal world, I would want all students to take on a *Proudness Project* every year of their university experience. It is important to create room in the structure of the university for students to take on projects of interest, whether through offering course credit,[4] paying students to engage in research, bringing open-ended problems into introductory physics courses,[5] or supporting students' volunteering or outreach efforts. While there is clearly work still to be done in creating this room, many mentors and advisors are currently advising students on educational, disciplinary, or interdisciplinary projects. How might a mentor or research adviser apply ideas from proudness to advising students?

In this discussion, I'll first focus on the *proudness* diagram (Figure 2) and ask: (1) How do we support students through the time period where the work is "frustrating, challenging, unclear, and/or repetitive?" and (2) How do we amplify the Wow! moment in a way that helps students see their growth and improvement, toward building a growth mindset? I'll conclude by highlighting three proudness principles and suggest some concrete questions that mentor/mentee pairs can discuss for better alignment of their projects with the principles.

The Proudness Diagram Part 1: How do we support students through the time period where the work is "frustrating, challenging, unclear, and/or repetitive?"

If students are working on an in-depth research project that might require long periods of frustration before seeing results, helping them to find some way of tracking the time that they put in is important. In the first *proudness* example, Sabre Norris tracked her attempts with rocks on a table. When I was working on my dissertation research, a colleague of mine recommended tracking the time I spent in 45-minute increments with gold stars in a day planner, as in Figure 3. Perhaps gold stars seem reminiscent of grade school, but the data provided two critical pieces of insight for me: (1) I could see how many hours were required before I would make a research breakthrough. I could then develop resiliency for hitting a research wall, built on the knowledge that I would eventually be able to push through it. (2) I could also make note of time periods with fewer stars and realize that they were causally tied to events important for me to develop self-awareness around. For instance, it turns out that stress associated with cross-country travel and conferences often led to an interval showing fewer stars after I returned. The perhaps unsurprising result of this measure gave me a tool for more effectively planning around travel if I had a deadline coming up.

Once I finished my Ph. D., it also felt good to be able to leaf through the day planner and see all of the gold

[4] This is the approach we've taken in The Compass Project. [18]

[5] See, for example, Dan Reinholz's [19] work on bringing one open-ended problem into traditional introductory college math and physics college courses and supporting students in giving peer feedback.

Proudness continued

stars that I'd used to get there. CSWA member Jessica Kirkpatrick recently blogged [20] about how her startup company has everyone track and share things that they're proud of every week. Whether you use gold stars or a spreadsheet, tracking can provide insightful data as well as emotional support during times of struggle.

Figure 3: The star system worked for me. (By Flickr user Pewari CC-BY-NC-SA 2.0)

The Proudness Diagram Part 2: How do we amplify the Wow! moment in a way that helps students see their growth and improvement, toward building a growth mindset?

There are a number of ways in which we might amplify the Wow! moment. In this discussion, I'll focus on the role of reflection in helping students see their improvement. This often requires planning and new tools.

Using Rubrics to Reflect on Improvement

A big question that students need to address when working on projects is: what skills do I care most about improving? A number of rubrics measuring general STEM skills have been developed to support students in identifying what skills to work on and in tracking their improvement. For instance, in the past, Compass freshman students used a Guided Reflection Rubric [21] to pick a holistic science skill to evaluate themselves on (examples being organization and persistence). They would journal on this skill weekly and then would brainstorm some initial ideas on how they could improve the skill. They then received concrete feedback on how to move forward week by week from a graduate student instructor. The rubrics by themselves don't necessarily amplify the Wow! moment; Compass instructors paired them with explicit reflection activities at the end of the semester to do so. At this time, students also had to write up a one-page reflection on their growth and create a diagram, drawing, or some other kind of representation. During periods of frustration, a visual of one's growth can become an important reminder that such growth is possible.

Compass' rubric development has been the subject of a blog [22] and has more recently evolved into a larger community of both university and high school educators called the Prism network, who now use an online modified version of it [23] and are researching its use [24]. The Rutgers Physics and Astronomy Education Group has developed a rubric [25] on more specific science skills such as collecting and analyzing experimental data, communicating scientific ideas, and more. There's even a rubric for creating student rubrics [26].

Comparing Drafts for an Explicit View of Improvement

In assisting students to see their growth, it can be important to make sure that they save early drafts of their work and be explicitly asked to compare them with later drafts (Figure 4). By means of self-assessment, students can push back on the traditional introductory physics experience of comparing to others. I'm not arguing that we should never compare ourselves to others; we often identify skills that we would like to improve through admiring those skills in others. Our peers can push us to do better. The goal here is that students, rather than judging themselves harshly on their preparation, identify and pay attention to some skills they care about improving and then work on tracking those skills.

To see one example of draft comparison, take a look at a short video called "Austin's Butterfly [27]." In it, younger kids are trying to create a precise drawing of a butterfly, but it gives a clear discussion of the important role of making multiple drafts and receiving specific and detailed feedback from peers. One could encourage mentees to watch the video and decide which drafts would make sense to keep in their own contexts.

Proudness continued

Figure 4: It can be hard to see progress if we don't keep early drafts of work and look at them side by side.

Mentor/Mentee Discussion Questions

As a mentor, you could ask your mentees to respond to the questions below. Then, you could discuss with them some of the reflection activities highlighted in this section to help in refining what makes the most sense for their contexts. It can also be helpful for mentors to answer these same questions and share their own process with their mentees. Through hearing about mentors' struggles, students can realize that even mentors are still growing and working on a lot of things.

1. Do there exist any explicit reflection activities at the end of your project to assess the ways that you have grown, improved, and/or accomplished your goals? Please describe.
2. What is one skill that you hope to develop over the course of your project? How will you tell whether you have developed this skill?
3. Assuming that you have a tangible creation at the end of your project (e.g., a blog, poster, art project, lesson plan, etc.), what is one way in which you would like the final draft to be better than your initial draft? How will you be able to tell that it is better?

Additional Mentor/Mentee Discussion Questions Related to Proudness Principles

Below, I've provided some additional mentor/mentee discussion questions. The mentor can have the mentees fill out these questions and then discuss their responses and help them brainstorm additional things that they may not have been aware of. The questions are built around three proudness principles: **Feedback** for the first question and both **Tangibility** and **Communicability** for the second.

Feedback As part of this project, what kind of mentor/peer/mentee/family/friend/other feedback and support will you have? What type of feedback will you receive from each source? Do you think this is a sufficient support network? If not, how will you build in additional support?

Tangibility and Communicability At the end of your project, will you have created something concrete that you can share with others (e.g., poster, presentation, art piece, blog post, computer simulation, writing, performance, etc.)? If not, what might a concrete thing look like that would be a culmination of your project work?

I encourage you to treat these questions as a starting point and adapt them in whatever ways make sense based on your own context.

Conclusion

In this article, I've introduced the idea of *proudness* and how it serves as an effective umbrella in drawing together many ideas that we know to be important for student success in STEM. I discussed the idea of growth mindset in additional detail. Finally, I ended with some practical approaches to supporting and amplifying *proudness*.

Special thank you to the folks who have deeply thought with me about these ideas. In particular, Dimitri Dounas-Frazer with whom I developed the original proudness workshop, Gina Quan and Joel Corbo for batting these ideas around with me, Colleen Lewis for originally introducing me to the importance of Growth Mindset, and all of the Compass folks for the many wonderful conversations that led to these ideas over the years. Thank you also to the wonderful Proudness Workshop participants over the past two years for their valuable insight. Lastly, a big thanks for everyone who provided feedback on drafts of this blog post: Dimitri Dounas-Frazer, Jessica Kirkpatrick, Meagan Morscher, and Mel Sabella.

Continued . . .

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Struggling Against Gender Bias in STEM Fields

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Suppose that two astrophysicists with similar education, experience, and accomplishments — let's call them Dr. X and Dr. Y — apply for a tenure-track faculty position. If Dr. X is female and Dr. Y is male, and if the selection committee members have conscious or unconscious gender bias, then, unfortunately, one might expect it to be more likely that Dr. Y would be offered the position.

But a controversial and influential new paper argues the opposite. In the title of their April 2015 article in the *Proceedings of the National Academy of Sciences (PNAS)*, Wendy M. Williams and Stephen J. Ceci, both psychologists and full professors at Cornell University, claim, "National hiring experiments reveal 2:1 faculty preference for women on STEM tenure track." [1]

The authors base their conclusions on five randomized, controlled experiments at 371 U.S. colleges and universities in biology, engineering, economics, and psychology. In these experiments, tenure-track faculty members evaluated the biographical summaries or the curricula vitae of fictitious faculty candidates —including one "foil" candidate — mostly with impressive qualifications but with different genders and different life situations, such as being a single parent or having taken parental leave.

Their analysis reveals an unexpected result: faculty reviewers strongly preferred female candidates to male ones by a highly significant 2:1 advantage. Williams and Ceci conclude, "Efforts to combat formerly wide-spread sexism in hiring appear to have succeeded. After decades of overt and covert discrimination against women in academic hiring, our results indicate a surprisingly welcoming atmosphere today for female job candidates in STEM disciplines, by faculty of both genders."

The article received considerable media attention from a variety of outlets. In particular, *Nature*, *The Washington Post*, *The Economist*, and *Inside Higher Ed* reviewed the article without much skepticism. Presumably, the authors' claim that sexism no longer exists and gender bias is a thing of the past is a message that many people want to hear. On October 31, 2014, Williams and Ceci published an op-ed in *The New York Times* entitled, "Academic Science Isn't Sexist," in which they presented a shorter version of the same argument. [2]

On the other hand, Lisa Grossman in *New Scientist* [3] and Matthew Francis in *Slate* [4] analyzed the study in more detail and expressed more criticism. Both authors outlined the flaws in the analysis by Williams and Ceci. The experimental evaluations in their study involved only reviews of candidates' biographies, without all the other activities that normally enter into faculty hiring and that may be affected by gender bias: personal interviews, presentation of talks, social events with potential colleagues, and determination of a short list by a selection committee. These simplified experiments do not accurately represent a real hiring process.

Many other studies and and a wealth of anecdotal evidence contradict the conclusions of Williams and Ceci. For example, Viviane Callier, Ph. D., contractor at the National Cancer Institute, told us [5] that recent surveys [6], [7] found evidence of pervasive sexism in letters of recommendation — a domain in which the assumption of a level playing field does not apply and which is out of the woman applicant's control.

Struggling with Gender Bias continued

Moreover, faculty hiring is dominated by graduates of a few prestigious institutions and labs that are disproportionately headed by men, who are more likely to hire other men. "To imply, like Williams and Ceci, that 'we are done,' or that 'the problem is solved,' does a great disservice to the scientific community," Callier said.

In any case, analysts agree that the underrepresentation of women in STEM fields is an ongoing problem. According to a National Science Foundation study in 2008, 31% of full-time science and engineering faculty are women. This fraction varies among different fields, however. In an American Institute of Physics survey [8], the representation of women among physics faculty members reached 14% in 2010, and for astronomy-only departments, it was 19%. Similarly, a 2013 CSWA survey of gender demographics [10] found that 23% of faculty at universities and national research centers are women. These fractions demonstrate improvement in recent decades, but clearly much more work needs to be done.

Furthermore, although women outnumber men among college and university graduates, men continue to dominate the physical sciences, math, and engineering. At higher levels of academic careers, the gender demographics worsen, in what is often described as a "leaky pipeline." Women constitute only one third of astronomy graduate students and less than 30% of astronomy postdoctoral researchers. In addition to the underrepresentation of women, gender inequality persists in other areas as well: according to a report by the Institute for Women's Policy Research [9], although women now pursue graduate degrees at the same levels as men, women with such degrees earn no more than 70% of their male colleagues, a larger divide than the overall pay gap.

Unconscious bias against women in science and math is not unique to men. In a 2012 PNAS study [11], Corinne A. Moss-Racusin and her Yale University colleagues found that female faculty are just as biased as men against female scientists. When people assess students, hire postdocs, award fellowships, and hire and promote faculty, biases propagate through the pipeline. Contrary to the conclusions of Williams and Ceci, the problem is on both the supply side and the demand side.

What can be done to address such biases? Meg Urry argued in the January 2014 issue of *Status* [12] that people who are aware of bias tend be more careful about how they make hiring decisions. Increasing the fraction of women in hiring pools and in search committees tends to reduce unconscious bias as well.

Some institutions have National Science Foundation-funded ADVANCE Programs to increase the representation and advancement of women in STEM careers. The University of Michigan's program [13], for example, includes efforts to develop equitable faculty recruitment practices, increase retention of valued faculty, improve the departmental climate and develop encouraging leadership skills of faculty, staff and students. Their program could be emulated at other institutions.

Finally, other important issues relate to gender bias and underrepresentation of women, including improving maternal and paternal leave policies, increasing access to child care, developing dual-career policies, promoting work-life balance, and reducing gender inequality of housework. Furthermore, other forms of underrepresentation are also important, and workers in STEM fields continue to strive to improve diversity in race, class, and sexual orientation, as well as gender.

Continued . . .

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Archaeology, Sexism, and Scandal (Alan Kaiser), a Review

Gerrit Verschuur (Arecibo Observatory)

Is there anything really new under the Sun? In 1922, a report was issued by a committee of the American Association of University Professors "examining the gender inequities in faculty employment and pay and seeking remedies." This I learned upon reading a fascinating book [1] by Alan Kaiser, Professor of Archaeology at the University of Evansville. It concerns a young woman, Mary Ross Ellingson, whose deep love for the subject led to an initially successful graduate-level project. But then she faded into obscurity, even as her work was apparently plagiarized by her thesis advisor.

What makes the telling of Kaiser's story so fascinating is that it was triggered by a treasure trove of information he stumbled upon one day while clearing a shelf in a room adjoining his office. There he found a photo album accompanied by a stack of letters and clippings, all resting on a couple of boxes of ancient Greek artifacts. All of these materials had been left by Ellingson, a former graduate student at Johns Hopkins who had studied classical archaeology and had done site work at a place called Olynthus in Greece in 1931. She subsequently worked at Evansville College, which later evolved into the University of Evansville. That is where Kaiser began to page through her photo album and read the letters she had left behind.

His book represents, for me, a remarkable example of detective work, a form of modern archaeology. The definition of that discipline [2] is the "study of human activity in the past, primarily through the recovery and analysis of the material culture and environmental data that has been left behind by past human populations ..." In this case the "past human population" involves a young woman, her colleagues, their families, her teachers, and the workers she managed at Olynthus.

One may wonder what possible interest this book could hold for astronomers reading *Status*. It turns out that Mary Ross Ellingson had to negotiate many of the potholes still faced by young women trying to establish a research career. Ellingson was entering a field that was almost entirely male-dominated. To give a flavor of the attitudes that confronted her, a recommendation written by her thesis advisor in 1939 included the following: "... she showed remarkable executive ability, and was able to superintend the Greek workers in a very efficient way, a thing that is very unusual in a woman."

Kaiser's book is filled with insights and statistics on the meanderings of gender inequality during the twentieth century. When Ellingson began her graduate work, the role of women at archaeological digs was routine documentation of artifacts found at the site. Ellingson was not supposed to participate in the actual digging, but she managed to infiltrate that hallowed male domain and much to everyone's amazement was quite capable of handling the responsibility.

Such prejudices about a woman's role in a research project no doubt remind you of the lot of the 'computers' at the Harvard College Observatory in the early 20th century, who not only did the routine work but made major discoveries, as for example Henrietta Leavitt and Cepheid variables. Or perhaps they remind you of the fact that, in mid-century, women couldn't get time on certain large telescopes. For example, Margaret Burbidge had to have her husband apply for time for her. Or perhaps they remind you of the prejudices that still persist today but which seem to be losing their power thanks to the work of organizations such as the CSWA of the AAS.

Archaeology, Sexism, and Scandal, a Review continued

Kaiser's research into Mary Ross Ellingson's unusual life is stunning in its depth. Guided by the detailed letters she wrote about her experiences, he dug deeply into the archives. On that basis, he describes the state of gender inequities back in the 1930's and outlines how the fortunes of women striving for academic recognition oscillated during the twentieth century, and how that affected one woman who made important discoveries at Olynthus, which she wrote up in her dissertation. But then she faded into relative obscurity and settled down to marriage and raising a family while teaching at Evansville College, which position allowed her no further chance at doing research. As Kaiser writes, "The 'alternative career style' Ellingson pursued left her on the margins of the field and academia for much of her career." There is no record that she was ever unhappy in her choice. But what history does reveal is that her thesis adviser, who published dozens of books on the Olynthus digs, used material taken directly from her thesis without giving her due credit. Kaiser argues that she should have been granted authorship of at least one of those books, which was based almost entirely on her thesis, words and all. He sums it up as follows: "This was by far the most egregious case of plagiarism in classical archaeology, perhaps even in all of archaeology and even the sciences, anyone had yet been able to document."

Another fascinating part of Kaiser's story is his struggle to publish a report on his discovery about what happened to Ellingson in an academic journal. He rewrote an article about the plagiarism case many times only to have his work rejected by eleven journal editors and more than two dozen anonymous referees, many of whom preferred that the story simply be forgotten. Now you can read the story for yourself. In so doing, take heart the next time a referee rejects your latest masterpiece. Kaiser's experience proves that it could be worse for you, but hopefully you won't have to resort to publishing an entire book to get the results of your research appreciated.

His story is illustrated by many images from the album he found on that shelf. My favorite scene shows Mary Ross Ellingson borrowing a book from a mobile lending library carried on the back of a donkey in the impoverished part of Greece near the archaeological dig at Olynthus.

As one of the blurbs on the back cover of this delightful book notes, it "… is an engaging read [and] in a field where women still struggle for recognition, Kaiser's work is vital." I would add that this is an engaging work no matter what your field of research may be. The book has details of gender inequalities of the time and anecdotes concerning attitudes that may seem familiar even today. Describing some of the stereotypes that were prevalent in the mid-1970s, Kaiser reports that the chair of a chemistry department summarized those as follows: "Women get good grades but have no imagination. They do well in humanities but not in science. They are good at routine work but have no ideas. They may have jobs but they should not have careers." He also quotes a sociologist writing in 1941 about the different career paths chosen by women, another manifestation of harmful stereotypes: "Women were most satisfied when their jobs possessed prestige and provided contacts with pleasant people." That was "in contrast with men who worked for advancement, opportunity and [the] future — suggesting a permanent and sustained vocational drive."

Unfortunately, Mary Ross Ellingson's story does not end triumphantly, but neither is there any indication that she regretted the career choice she made. Kaiser cannot find evidence that she was even aware of the magnitude of the plagiarism that had occurred, so she seems to have lived happily ever after.

In this review, I can only scratch the surface of Kaiser's marvelous dig into the past. Astronomers will surely enjoy reading it, especially those who may have to deal with stereotypes that still lurk to derail the unwary on the path to a full and rewarding career.

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