APS physics

CSWP & COM
Gazette

Vol. 30, No. 2

Fall 2011

Newsletter of the Committee on the Status of Women in Physics & the Committee on Minorities of the American Physical Society

INSIDE

Community and Learning Environment Matters for a Successful Undergraduate Program

Yesim Darici, Associate Professor of Physics, Interim Director of Women Studies, FIU, COM member

Yesim Darici

In the United States many physics departments are concerned about how to increase the number of undergraduate students in their program and how to support and attract historically underrepresented groups to their programs. I am writing this article to share with you what has worked for us at Florida International University (FIU), and to suggest a few tips that may help you foster similar success in your departments.

FIU is a minority-serving, urban public research institution in Miami, Florida serving 44,010 students, of which 64% are Hispanic, 13% are Black, and 56% are women. It is one of the 25 largest universities in the country and is the largest source of Hispanic STEM Bachelors and Masters degrees.

The FIU Physics Department has transformed its undergraduate program over the last 10 years leading to a 1,500% increase in the number of intended and declared majors (comparing current 3-year averages to the early 1990's), *Figure 1*. Vital to our success has been the use of Learning

continued on page 3

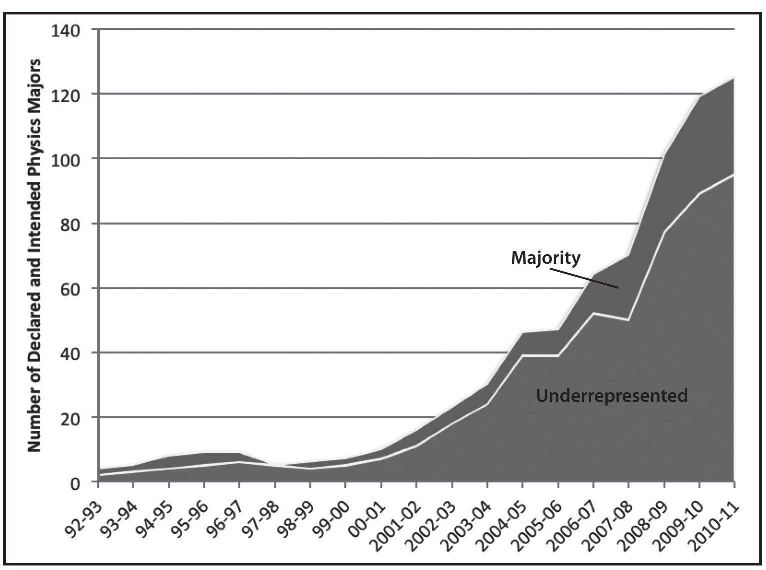


Figure 1: Number of intended and declared physics majors 1992-2010, disaggregated by historical representation in physics (grouped as Majority and Underrepresented). In Fall 2010, there were 126 majors including 84 Hispanic students. Underrepresented include students from Hispanic, African-American, and Native American backgrounds.

Comments from the FIU Learning Community!

"The Department of Physics at Florida International University serves as a saving grace amidst a crowd of endless and nameless majors and departments. It hosts and promotes a humanistic learning environment — that is, it allows for the learning of people from people, and emphasizes the need for a student to be in balance with her everyday and school life. For me the Physics Department, specifically the community built around VH (building where learning center is located), is a source of comfort where I can come and release both the confusion and joy of physics and relate to others who, despite having different experiences, share in the odd life that is understanding Physics."

—Macarena Sagredo

Physics Programs Under Stress

By William J. Evans, Lawrence Livermore National Laboratory, Chair of COM

The economic downturn forcing reductions in federal, state and local budgets is having devastating effects on the vitality of physics departments and degree programs and in particular those at minority serving institutions (MSI's). Physics bachelor's degree programs at a number of MSI's are facing the possibility of consolidation, suspension or even termination. Institutions with physics programs facing these challenges include Tennessee State University, Southern University at Baton Rouge, and Virginia State University. This list will continue to grow as Boards of Regents and Trustees dealing with budget contractions review their academic institutions with an eye toward cuts and cost savings. Despite the budgetary challenges, physics program reductions at MSI's can deliver a devastating blow to the enhanced participation of under-represented groups in the physics enterprise.

MSI's account for a significant fraction of the annual physics degrees awarded to under-represented groups. In the case of African American physics students, more than 40% of the African American degree recipients in 2008 had attended a Historically Black Colleges and Universities (HBCU's). This is in spite of the fact that in 2008 physics programs at HBCU's constituted only 4.5% of the departments in the US (P.J. Mulvey & S Nicholson, AIP Physics Undergraduate Degrees, May 2011). The majority of college and university physics programs still lag in educating a population representative of the US's diverse ethnic population. Thus, the prominent role of MSI's in educating under-represented groups must be acknowledged and supported.

There are many motivations for the physics program reductions at MSI's. A recurring issue is low-production of degrees. The feature article in this issue of the Gazette highlights the dramatic growth of the student population being educated in physics at the Florida International University Physics Department. This example of phenomenal success holds important lessons and motivational approaches to stimulate and grow physics programs at not just MSI's, but also across the physics community. ■

Publication Information
The COM/CSWP GAZETTE, a newsletter of the American Physical Society Committee on Minorities (COM) and Committee on the Status of Women in Physics (CSWP), is mailed free of charge to all those listed on the Roster of Women and Minorities in Physics, all U.S. physics department chairs, and others upon request. Because editorial responsibility rotates among COM and CSWP members, please address all correspondence to: COM/CSWP Gazette, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, or email to: ratnikova@aps.org. Opinions expressed are those of the authors and do not necessarily reflect the views of the APS or of the COM and CSWP.

Guest Editorial, *continued from page 1*

Communities (LC), which have contributed to the retention and success of our students. Learning Communities (groups of students actively engaged in learning together and from each other to achieve their goal of learning physics and earning a degree) are part of the larger reform efforts that include reformed classes, new programs, advising, mentoring and social events. We started this journey when we realized our students needed to have better support. We read the SPIN UP report (it surveyed several successful departments and noted what they did), we also read some articles on improving courses and tried to build on what was established as a successful path by others. That is how we planted a seed. The idea of LC's came partly from the SPIN UP report and they were not explicit LC's at the beginning, but evolved into them.

How To Integrate Science Students Into Learning Communities

As scientists, we are embedded in multiple research and learning communities. We gain from participation in these communities in order to achieve our common goal. If we make the same kind of learning communities for our students, it has the added benefit of attracting and retaining them in the discipline. In the FIU Physics Department, our reform all started with two NSF grants, one small CCLI (Course, Curriculum and Laboratory Improvement, 2000) and CHEPREO (Center for High Energy Physics Research and Education Outreach, 2003). Improved outreach efforts, innovative curricula and programs, classroom reform, a Learning Assistant (LA) Program, a Physics Learning Center with rooms dedicated to these efforts, and a Physics Education Research Group (PERG) were established with these and later grant projects. As a result of this multipronged approach, today our students are integrated into a comprehensive research and learning community.

Classroom Reform: Teaching Component

I am not a member of the PERG group, but with my 24 years of teaching experience at FIU I know what works and what does not work. One has to create an environment where students are actively engaged and motivated to learn. Further, if students are given the responsibility for their learning and this expectation is clearly established, students will rise to the challenge.

One of the unexpected outcomes in our efforts is how eager students are to learn, evidenced both inside and outside the classroom. Modeling instruction engenders this framework of engaged, student-driven learning through inquiry activities that rely on student conjecture, sense-making, argumentation, and consensus. In "Modeling classes" lead by Dr. Laird Kramer, students engage in the process of building, validating and deploying models, and then articulate the models amongst themselves. In addition to gaining a deeper understanding of the scientific concepts they are learning, students engaging in modeling activities together provides an opportunity for peer-to-peer learning in the classroom and strengthens the collaborative environment. For example, after developing models in groups, students report out their ideas via portable whiteboards and work towards consensus based on evidence, *Figure 2*. Moreover, this collaborating environment extends beyond the classroom as students are often found engaged in scientific discourse as they study together. This illustrates how placing the responsibility for learning on students, and developing these skills early on, can change how students approach their learning. They explicitly drive their learning.

Modeling also replicates the central activity of practicing scientists, thus providing students with an authentic scientific experience throughout their introductory course. Again, this innovative method of learning contributes enormously to the Learning Community. It is accomplished through curricula that engage students in learning, builds on collaborative group work, and replicates the experiences of scientists.

Figure 2: Students in modeling class.

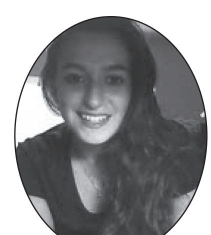
While our classroom reform is a deep approach that moves completely away from lecture, the range of reform efforts includes supplemental instruction outside of class, laboratory-only re-

"Upon entering FIU I was considering changing my major from chemistry to physics but I was unsure if physics would be doable or helpful for me. My advisor, Caroline Simpson, was very helpful in explaining to me how long the physics program would take and what courses it entailed. Dr. Simpson helped me decide which physics track would be best suited for me. I decided to keep my chemistry major and double major with a BS degree in Chemistry and a BA in Biophysics. I initially thought there was only one undergraduate program but she showed me that the Physics Department at FIU has a Bachelor Science program for physics, and also a Bachelor of Arts. Furthermore, you can choose a number of concentrations. In my first semester at FIU as a transfer student, I enrolled in a junior level physics course in thermodynamics. I found out that they had a place where the undergraduate students would meet and study and soon I knew every student in my class. Having people to do homework with really helped and when one of us couldn't solve a problem a few, or all, students would work together on it until we figured it out. There was a sense of community and it was motivational and supportive to the working physics student.

Throughout my studies at FIU I always had someone I could count on in the physics department. In every one of my classes, there were people who would help me when I needed it. Also, helping others made solving problems so much more rewarding than when keeping it to myself.

I have finished all my undergraduate physics courses and only have one more semester of chemistry to graduate. It is a lot of work but it IS possible, it IS fun, and it IS rewarding to do physics. If you are considering physics major, I hope you consider doing your undergraduate career at Florida International University. You won't regret it".

—Mercy Jimenez



"Being a physics undergraduate would probably be very different if I didn't attend FIU. I am part of a dynamic physics community made up of undergrads, grads, and faculty that thrives thanks to the efforts of the faculty and the structures they have established. For example, physics undergrads have ample space and resources at their disposal in order to gather for academic and social ventures. There is a conference room, lounge area, and classroom that make it easy for us to meet up, talk, eat, and study together. Besides its pragmatic uses, this space nurtures friendships and networks among those that use the facilities. Studying physics is not easy, but we have all quickly developed a deep sense of camaraderie and support for one another. It also creates an informal space for us to approach faculty members (office hours or in between classes can be intimidating). There are subgroups within our big group as well: some of us can connect not only through our passion for physics, but for teaching (by being part of the LA program). But anything else I think boils down to VH (the physical space of the learning center), the beehive and heart of our activities."

—Maria Paula Angarita

"I am starting my fourth year of graduate school pursuing research in experimental plasma physics. Originally an undergraduate biology major at FIU, I switched to physics after enjoying my physics classes, meeting such friendly and welcoming professors and staff, and meeting a small but strong undergraduate community."

—Ramona L V Perez

form, active engagement within lectures, or a combination of these methods. We advocate incorporating collaborative group work, explicit learning communities, and scientific argumentation into your implementation.

Learning Assistants (LAs)

Any student who passes Physics with Calculus 1 can apply to be a learning assistant. LAs are the back-bone of our learning community. It is a very powerful teaching tool because as the LAs help each other learn, they convey their passion about physics while they develop a deeper understanding of physics. They are rewarded for their efforts both financially and by experiencing the joy of seeing their peers' 'aha' moments. Many students see the dedication the physics faculty put into teaching and supporting students, and are thus attracted into the department and its learning community. This certainly contributes to our increase in both majors and minors in physics. So our LA program and related reform efforts are very powerful recruitment tools.

Departmental Space to Study, Socialize and Build Community

Physical space for students is a crucial part of integrating physics students into learning communities. The FIU Physics learning center consists of a conference room, lounge with kitchen, and modeling classroom, which is available to students while the modeling class is not in session. Give students access to labs and classrooms when they are not in session. Our experience is that not micromanaging the students, giving them ownership, and trusting them works.

There are many signs that we have a very strong learning community, such as a very strong SPS, which was chosen twice as the FIU Club of the Year, and was nationally recognized by the American Institute of Physics (AIP). Our students know each other, help each other, do homework together, and organize game nights, graduation and thanksgiving dinners to which faculty members are invited.

In our case, FIU's diverse student population propelled us towards methods that would be inclusive of all students, thus we focused on collaborative learning modalities. Prior investigations found that underrepresented groups can be isolated from the majority students and not receive supportive mentoring from faculty; hence, our community participation framework. As academics, we thrive as a result of being integrated into our community. It is only natural that students would thrive being an explicit member of a physics community. Research literature confirms this approach for students; see for example references by Rogoff, Lave, or Wenger.

As Ed Bertschinger's Blog Entry says, 11.29.10, http://diversity.mit.edu/blog/ "When students become excited about their own learning and empowered to help others, they are the best recruiters and teachers of new students. (News flash: students can learn more from their peers than from faculty!) Students must be given departmental space for study and for socializing and resources to support their initiatives. The outcome is magical."

Competition and Group Management

Competition, both explicit and implicit, can poison a classroom environment, undermining a collaborative working environment. Studies have shown this can be especially detrimental to underrepresented students, who can feel isolated in a competitive environment. Further, students often expect competition in the classroom, and may not know how to respond to collaboration in the classroom. Thus we must take clear actions to promote collaborative learning and downplay competition. Replace the curve with a fixed grade scale on the syllabus and encourage students to cooperate. Cooperation improves learning for both helper and helpee, which improves grades for all.

Group management is another critical tool in a collaborative classroom, thus you must set policy that encourages good group dynamics. Designating groups is often more effective than self selection, as students learn from a variety of students and don't simply rely on their friends. Designations can take into account student ability and demographics to reduce domination and/or isolation of students. Using group contracts and/or assigning specific roles to each group member are also an effective means of explicitly encouraging good group cooperation. Perhaps most important is selecting the appropriate activity. We often assign activities that are above the capacity of a single student, thus enforcing the need to work collaboratively.

Advising and Mentoring

Advising and mentoring can be used as a very effective recruitment tool. We have seen that un-advised students make poor college career decisions, decisions that can add years to a degree. We now place advising holds on intended or declared majors to require that students come and talk to the physics advisors before they register. This gives us advisors (Drs. Simpson, Darici and Markowitz) a chance to meet all of our intended and declared majors and an opportunity to encourage them to join our community. In parallel with this effort, to bring new and prospective majors into the department to meet faculty and each other, the Department of Physics has modified the physics curriculum by requiring students with an interest in physics or astronomy to take a one-credit Introductory Seminar course. This course has been taught every semester by CHEPREO lead faculty member Laird Kramer, and astronomer Caroline Simpson, and focuses on introducing students to areas of research in physics and astronomy. It also provides information about working in the field (both in industry and academia), how to succeed in their undergraduate courses, and basic information on graduate programs and career opportunities. Most importantly, it connects students to the department, which is critical at our large institution. Approximately 15-25 students take this course each semester. It's a 'what you need to know, but no one ever tells you' kind of course. As one can imagine, this course is also a recruitment and retention tool. This course teaches the students everything they need to know about the learning community they are entering.

In summary, we have a successful undergraduate program due to the reforms we planted but perhaps most unexpected is the power of our students to lead the education reform. By giving them ownership of their learning, they have risen to new heights. This is part of our boundless rewards; our students' success drives us to further develop our program. If your department is ready for change, just identify a few committed faculty members and start the transformation by finding out what works elsewhere and focus on your needs. Depending on your goals, adopt a model that has been implemented successfully in other physics departments. As a starter, set an achievable goal such as reforming a lecture class, or a few labs to introduce active engagement. Provide physical space for your students to study together. Hire a few LAs ($10/hour) to help in the labs and the lectures, or ask them to volunteer. These are the small steps you can take before moving on to larger reforms, and the seeds you can plant to harvest a learning community.

I would like to thank Dr. Laird Kramer for providing sections of this article, Dr. Eric Brewe for figure 1, and Ms. Arlene Knowles, from APS for proofreading it and making invaluable suggestions.

References

J. Lave, E. Wenger, Situated Learning: Legitimate Peripheral Participation, New York: Cambridge University Press, 1991.

B. Rogoff, E. Matusov, C. White, Models of teaching and learning: Participation in a community of learners, in The Handbook of Education and Human Development: New Models of Learning, Teaching, and Schooling, edited by D.R. Olson and N. Torrance Cambridge, MA: Blackwell Publishers, 1996, pp 388- 414. ■

"Early in my time as an undergraduate I learned the importance of studying and learning in groups. I rarely felt that I learned anything without at least 1 or 2 other people around. After entering FIU, I found the same thing to be true of graduate school. Here, however, it was easy to form a group of people to study together. From my very first year in Math Methods I found myself learning and socializing with a core group of people. Often, after working on a problem late into the night, one of us would come in the next morning saying, "I had this idea while showering/running/eating this morning," and we'd be off again. We'd take breaks for food, and walks across campus to the best water fountains, but ultimately studying with these people is what got me through. Without them, I'm sure I would never would have survived Jackson E&M or passed my qualifying exams. I owe my success as a graduate student in physics to the learning community we created."

—Vashti Sawtelle,
5th year graduate student

"This past spring, Dr. Darici and Dr. Simpson filled our afternoon with sweet aromas and pastries as they hosted our 3rd Annual FIU Physics Department Lady's Tea Party. Once a year female undergraduate physics majors, physics minors, Society of Physics Students members, graduate students, and post-docs receive an invitation to tea. Our graduate students make up around half of the party. Is this because we like spinach puffs and pink lemonade more than most, want to set an example for the undergraduates, enjoy the community spirit of bonding with our female colleagues, or perhaps a combination of these? Unable to speak for at least three quarters of our female graduate population, I can only offer my own experience.

Amidst cupcakes and assorted cookie delights, we say something interesting about ourselves and ask each other questions that have been on our mind. Topics have included the career path to become a professor, different career paths to become a scientist, the two-body problem in academia, and what has expanded our undergraduate physics population. Additionally we have talked about how we can make time to have children while pursuing a career, adopting, balancing being married and having a family life while being a graduate student, and tips for getting through the first few years of graduate school. Because we have so many women at different points in their physics careers, we can hear many perspectives.

Learning about each other, our goals, experiences (both positive and negative), and different support systems we rely upon encourages me and makes me feel part of a larger group working towards something, as opposed to one graduate student in a cubicle. As many of my mentors and closest colleagues in graduate school are male, they might not be able to relate to how I feel when I walk into a large science lecture at a national lab and feel out of place when I only see a few women. The fact that there are so many others who share concerns and experiences similar to mine always comes back to me when I sit at the table and start to pour a small cup of tea."

—Ramona L V Perez

PHOTO: MARIANA GABRIELYAN

"I am starting my fourth year of graduate school pursuing my doctorate in physics. Coming from Bryn Mawr (an all women's undergraduate college), I was very impressed with the amount of female student presence in the FIU physics department and the attitude of equality towards women in physics. I also very much enjoy the support of my adviser, Caroline Simpson, whom I worked for during the SARA REU program. I enjoyed doing research with her so much that I decided to apply to the graduate program here at FIU, where I now currently continue my research in extragalactic astronomy."

—Trisha Ashley

Gender Differences in Introductory Physics: The Impact of a Self-Affirmation Intervention[1]

By Lauren E. Kost-Smith, Steven J. Pollock and Noah D. Finkelstein of the Department of Physics, University of Colorado at Boulder, Geoffrey L. Cohen, School of Education and Department of Psychology, Stanford University and Tiffany A. Ito and Akira Miyake, Department of Psychology and Neuroscience, University of Colorado at Boulder

Stereotype threat is "the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype."

Self-affirmation is a process through which a person affirms his or her overall sense of self-worth and integrity.

Despite about equal representations of males and females in biology, chemistry, and mathematics at the undergraduate level, females continue to make up only 21% of bachelor's degrees awarded in physics.[2] For several years, we have been working to understand this gender difference in participation at the University of Colorado (CU). Our work has examined gender differences in the first-semester, calculus-based mechanics course (Physics 1) at CU.[3] Collecting data from twelve offerings of Physics 1, we find consistent pre- and post-course gender gaps (differences in male and female performance) on a conceptual survey of mechanics.[4] On average, the pre-course gender gap is about 10% and the post-course gender gap is about 12% (effect sizes of 0.4 to 0.5). These gender gaps exist despite the use of interactive engagement methods (e.g. Peer Instruction[5] and *Tutorials in Introductory Physics*[6]), and even in courses where all students learn significant amounts, with average normalized learning gains[7] between 30% and 60%.

We have also found, when modeling students' post-test scores using linear regression techniques, that background differences of males and females (differences in pre-course physics and math performance and incoming attitudes and beliefs) can account for about 70% of the post-course gender gap.[3] That is, controlling for student background factors so that we only compare students with the same pre-course preparation reduces the post-test gender gap by up to 70%. This suggests that the gender gap we observe at the end of Physics 1 is largely due to the under-preparation of females compared to males.

We are interested in understanding the mechanism by which the gender gap persists and what other factors impact the gender gap. Based on our prior work on self-efficacy, showing that females are more worried and nervous about taking exams,[8] we hypothesized that stereotype threat (described below) may be inhibiting females' performance in the course. Researchers have demonstrated that stereotype threat can be alleviated through self-affirmation.[9,10] In this paper, we summarize the results of a recent study[1] to test the impact of a self-affirmation exercise on the gender gap in Physics 1. We found that the gender gap for students who affirmed their personal values was reduced by about half compared to students who did not affirm their own values. Further, when accounting for pre-course physics performance and students' endorsement of the stereotype, the gender gap among students who affirmed their values was not significantly different from zero.

Stereotype threat and self-affirmation

Stereotype threat is "the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype".[11] This fear of confirming the stereotype can negatively impact members of a stereotyped group and result in worse performance.[12] Several researchers have found that stereotype threat can be alleviated through self-affirmation.[9,10] Self-affirmation is a process through which a person affirms his or her overall sense of self-worth and integrity.[13] Work on self-affirmation assumes that people are motivated to maintain a positive sense of overall integrity, identity, and worth. When our integrity or identity is threatened, we seek ways to resolve the threat. Because it is often difficult to resolve the specific identity threat (that "girls can't do science"), individuals can affirm a more general sense of worth and integrity ("I'm a good person") or a specific, but unrelated, aspect of their identity ("I'm good at music"), which will help to protect from the threat. In a laboratory experiment with college students, Martens, *et al.*[10] found that females who were given the opportunity to write about a characteristic of themselves that they valued performed better on a subsequent difficult math test than females who wrote about a characteristic that they did not value. Similar results were found by Cohen, *et al.*[9] comparing the school achievement of middle-school African-Americans who did and did not affirm their personal values.

Study Design

We conducted a randomized experiment in order to test the impact of self-affirmation on the performance of males and females in Physics 1, the first semester of our three-semester introductory physics sequence for science majors and engineers. It is a calculus-based course that covers Newton's laws, work, energy, momentum, and waves. In this semester, there were about 600 students in the course. Peer Instruction[5] and ConcepTests[5] were employed during lecture and students worked through *Tutorials in Introductory Physics*[6] during recitation. In terms of the curriculum, the course was nearly identical to previous semesters of Physics 1. The lead instructor of the course was experienced in interactive engagement methods and had recently taught this same course.

In the first week of the course, during recitation, students were randomly assigned to complete either a self-affirmation exercise where they wrote about values that were important to them, or a control exercise, where they wrote about values that were important to other people. This writing exercise took about 15 minutes, and then students completed the Force and Motion Concept Evaluation (FMCE)[4] for the remainder of the 50-minute recitation. In the fourth week of the semester, the week before the first midterm exam, students again completed the same self-affirmation or control writing exercise as part of an online homework assignment. Students took three midterm exams and a final exam over the course of the semester. They completed the FMCE again during the last recitation. Exam and FMCE scores were collected as well as homework and participation scores. In addition to the writing exercises, students were asked to fill out an online, optional survey (worth token extra credit) in the second week of the course. The survey asked students several questions about their perception of the stereotype that men were better at physics than women. This survey was meant to measure students' awareness and endorsement of the stereotype that men are better at physics than women.

We were interested in the impact of the self-affirmation intervention on student performance on the FMCE. We hypothesized that females who completed the self-affirmation exercise would perform better on the post-FMCE than females who completed the control exercise. Also, because we expected that there would be no significant impact of the self-affirmation exercise on male performance, we expected that the gender gap among students who completed the self-affirmation exercise would be smaller than the gender gap among students who completed the control exercise.

Results

Students were only included in the analysis if they satisfied the following conditions: 1) they completed both writing exercises, 2) they took both the pre- and post-FMCE and the final exam, 3) they completed the stereotype threat survey, and 4) we had data from their SAT- or ACT-Math test. This left us with a total of 308 students (52% of the class).[14] The self-affirmation group had 137 males and 55 females, while the control group had 75 males and 41 females. By design, there are more students in the self-affirmation than the control condition (60% versus 40%). This was done to ensure that more students would receive the potentially beneficial self-affirmation exercise. There were no significant differences on any prior factors[15] between the self-affirmation and control groups, by gender.

We used a multiple regression analysis to test the effect of the self-affirmation exercise on students' post-FMCE scores. This standard statistical approach allowed us to create a model of FMCE post-scores that accounts for other factors in addition to gender and experimental condition. In these models, we were specifically interested in the interaction between gender and condition. The significance of this interaction indicates that the gender gap in the self-affirmation condition is not equal to the gender gap in the control condition. The final model includes *gender, condition*, the *gender*x*condition interaction*, as well as a measure of student background (FMCE pre-test score), and a measure of students' endorsement of the stereotype that men are better than women at physics.

There is some evidence in prior work on stereotype threat that students' personal endorsement of the stereotype can moderate the effects of stereotype threat (i.e. students who personally believe a stereotype are more subject to its threat).[16] We decided to test this as part of our study. Students' pre-course responses to the statement, *According to my own personal beliefs, I expect men to generally do better in physics than women*, were used as a measure of students' endorsement of the gender stereotype. Students agreed or disagreed with the statement on a 5-point Likert scale (strongly disagree, somewhat disagree, neutral, somewhat agree, or strongly agree). The three-way interaction, *gender x condition x stereotype endorsement*, was included in the model to test whether the effect of the self-affirmation depended on students' level of stereotype endorsement.

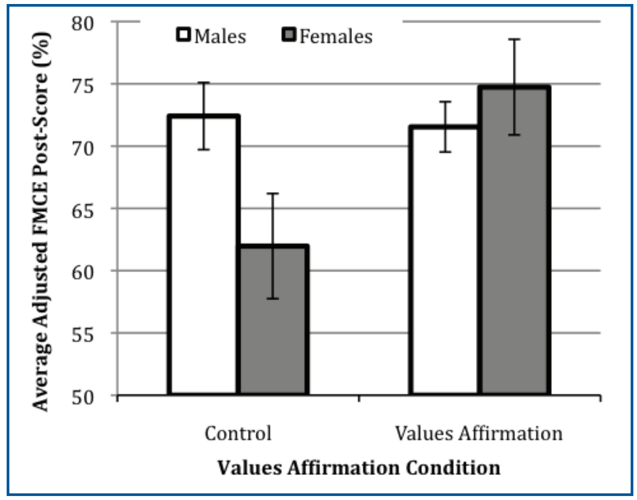


Figure 1. Student performance on the FMCE post-test as a function of gender and condition. FMCE post-test scores are adjusted based on FMCE pre-test and stereotype endorsement scores. Error bars represent the standard error on the mean. The gender gap in the control condition is statistically significant (p<0.01), but the gender gap in the affirmation condition is not statistically significant (p=0.33).

The final statistical model included eleven variables: *gender, condition, gender x condition, FMCE pre-test score, stereotype (ST) endorsement, gender x ST endorsement, condition x ST endorsement, gender x condition x stereotype endorsement, gender x FMCE pre-test, condition x FMCE pre-test,* and *stereotype endorsement x FMCE pre-test*. The latter three interactions are included only to ensure that our final estimates are unbiased and are not important for interpreting the results.[17] These variables included in the final model account for a significant fraction (37%) of the variance in FMCE post-scores (F statistic p value < 0.01).

Figure 1 presents the male and female average FMCE post-test scores by condition. These post-test scores have been adjusted for students' FMCE pre-test score as well as stereotype endorsement, meaning that the values presented are calculated at the average FMCE pre-test and stereotype endorsement scores for the entire sample. From Figure 1, we see that the gender gap in the control group is 10% ± 5% ($p=0.01$), while the gender gap in the self-affirmation group is -3% ± 4% ($p=0.3$). The gender gap has been eliminated in the self-affirmation condition, after controlling for pre-course differences between males and females. Recall that we expected that females in the self-affirmation condition would have higher FMCE scores than females in the control condition, and males' scores would not be different in the two conditions. We find that this is the case. Females in the self-affirmation condition have FMCE post-scores 13% ± 6% ($p<0.01$) higher than females in the control condition, and males in the self-affirmation condition have FMCE post-scores 1% ± 3% (p=0.8) lower than males in the control condition. Not only is the gender gap eliminated among students who completed the self-affirmation writing exercises, but the elimination of the gender gap was entirely due to females' increased performance in the affirmation versus the control condition.

We also tested the three-way interaction of *gender x condition x stereotype endorsement*, and found that the interaction was significant (p=0.02). The significance of this three-way interaction indicates that the *gender x condition* interaction varies depending on how much students believe the stereotype. This is most easily seen in Figure 2. There is no relationship between belief in the stereotype and FMCE post-score for males in either the affirmation or control group (simple slopes[18] not significantly different from zero). However, for females, believing in the gender stereotype negatively impacts their FMCE post-score (simple slope is significant), unless they completed the self-affirmation exercises (slope not significant). This demonstrates not only that those who moderately endorse the stereotype and are part of the stereotyped group are harmed the most by stereotype threat, but also that the self-affirmation exercises were particularly beneficial for those students under the highest threat.

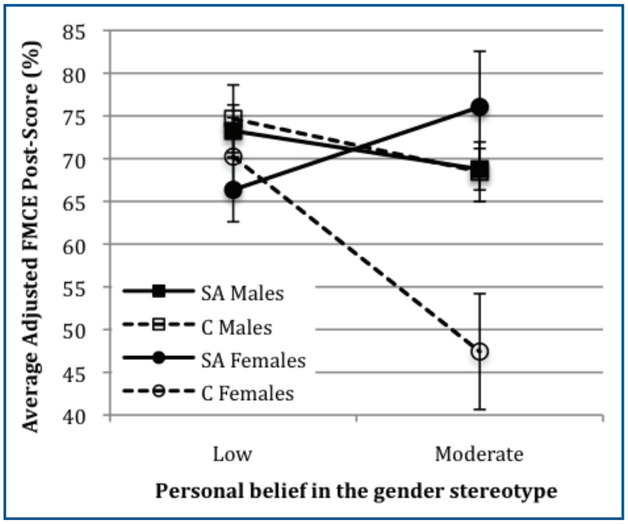


Figure 2. Student performance on the FMCE post-test as a function of gender, condition, and the level of stereotype endorsement. The FMCE post-test score is adjusted based on the FMCE pre-test score. The error bars represent the standard error on the mean. Moderate and low gender stereotype endorsement represent ±0.75 SD of the grand mean of stereotype endorsement. The relationship between mean exam score and stereotype endorsement is only significant for females in the control group. Among females who moderately endorsed the gender stereotype, females in the control group had significantly lower mean exam scores than females in the affirmation group. SA indicates self-affirmation and C indicates control.

Discussion

We have found that two simple, 15-minute writing exercises completed at the beginning of the semester positively correlated with increased performance of females (while not significantly hurting male performance) on the FMCE post-survey and were thus associated with a reduced gender gap. Further, in our linear model, the effect of the self-affirmation was moderated by students' belief in the stereotype that men will do better in physics than women. The self-affirmation was more beneficial for females who moderately endorsed the stereotype, i.e. those females who were most threatened. We argue that the self-affirmation exercises can be effective in an authentic physics classroom environment for college-age students. These results were also confirmed in exam and course grades.[1]

Our findings here are consistent with our prior work3; a large fraction of the post-course gender gap can be accounted for by pre-course gender differences. Additionally, the reduction of the gender gap among affirmed students supports our hypothesis that the remainder of the gender gap is due, at least in part, to stereotype threat.

There are at least two implications to take away from this study: 1) We, as educators and researchers, need to be more aware of and attentive to psychological factors that can impact student performance in our courses, and 2) We need to do more to help those students who are under-prepared to succeed in introductory physics courses, a group that is predominantly female.

Acknowledgments

This work is supported by iSTEM (#0833364) and DRL (#0910373). We thank the PER at Colorado group and the faculty that were involved. We also thank Lindsey Newnes and Natalie Golaszewski for their assistance with data collection.

References

1 This article is based on the following papers: A. Miyake, L. E. Kost-Smith, N. D. Finkelstein, S. J. Pollock, G. L. Cohen & T. A. Ito, Reducing the gender achievement gap in college science: A classroom study of values affirmation, *Science* **330** 1234 (2010), and L. Kost-Smith, S. J. Pollock, N. D. Finkelstein, G. L. Cohen, T. A. Ito, and A. Miyaka, "Gender Differences in Physics 1: The Impact of a Self-Affirmation Intervention", Proceedings of the 2010 Physics Education Research Conferences, edited by C. Singh, M. Sabella and S. Rebello, (AIP Conference Proceedings, New York, 2010) p. 197

2 National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2011*, NSF 11-309 (Arlington, VA, 2011). Available from http://www.nsf.gov/statistics/women/.

3 L. E. Kost, S. J. Pollock & N. D. Finkelstein, Characterizing the gender gap in introductory physics, *Physical Review Special Topics - Physics Education Research* **5**, 010101 (2009).

4 R. K. Thornton & D. R. Sokoloff, Assessing student learning of Newton's laws: The force and motion conceptual evaluation, *American Journal of Physics* **66**, 338 (1998).

5 E. Mazur, *Peer Instruction: A Users Manual* (Prentice-Hall, Upper Saddle River, NJ, 1997).

6 L. C. McDermott & P. S. Schaffer, *Tutorials in Introductory Physics* (Prentice-Hall, Upper Saddle River, NJ, 2002).

7 R. R. Hake, Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses, *American Journal of Physics* **66**, 64 (1998).

8 L. E. Kost, S. J. Pollock & N. D. Finkelstein, "Unpacking Gender Differences in Students' Perceived Experiences in Introductory Physics" in *Proceedings of the 2009 Physics Education Research Conference*, edited by M. Sabella, C. Henderson & C. Singh (AIP Conference Proceedings, New York, 2009) p. 177.

9 G. L. Cohen, J. Garcia, N. Apfel & A. Master, Reducing the racial achievement gap: A social- psychological intervention, *Science* **313**, 1307 (2006).

10 A. Martens, M. Johns, J. Greenberg & J. Schimel, Combating stereotype threat: The effect of self-affirmation on women's intellectual performance, *Journal of Experimental Social Psychology* **42**, 236 (2006).

11 C. M. Steele, A threat in the air: How stereotypes shape intellectual identity and performance, *American Psychologist* **52**, 613 (1997).

12 S. J. Spencer, C. M. Steele & D. M. Quinn, Stereotype threat and women's math performance, *Journal of Experimental Social Psychology* **34**, 4 (1999).

13 C. M. Steele, "The psychology of self-affirmation: Sustaining the integrity of the self," in *Advances in Experimental Social Psychology*, edited by L. Berkowitz (Academic Press, New York, 1988) p. 261.

14 As is usually the case, students who participated in the study had higher course grades than those who did not.

15 Prior factors included SAT-Verbal, SAT-Math, SAT total score, ACT-Reading, ACT-English, ACT-Math, ACT-Scientific Reasoning, ACT total score, years of high school physics and calculus, and high school GPA.

16 T. Schmader, M. Johns & M. Barquissau, The costs of accepting gender differences: The role of stereotype endorsement in women's experience in the math domain, *Sex Roles: A Journal of Research* **50**, 835 (2004).

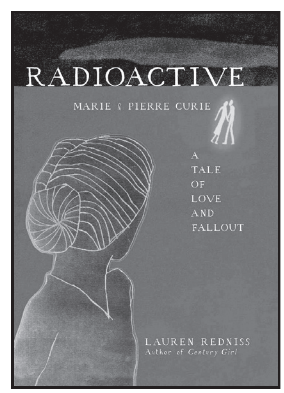
17 V. Y. Yzerbyt, D. Muller & C. M. Judd, Adjusting researchers' approach to adjustment: On the use of covariates when testing interactions, *Journal of Experimental Social Psychology* **40**, 424 (2004).

18 L. S. Aiken & S. G. West, *Multiple Regression: Testing and Interpreting Interactions* (Sage, Thousand Oaks, CA, 1991). ■

BOOK REVIEW

Radioactive: Marie & Pierre Curie: A Tale of Love and Fallout

by Lauren Redniss, Reviewed by Stephanie Majewski, Brookhaven National Laboratory



When you pick up this book, at first glance it seems perhaps more appropriate for a teenager rather than a mature physicist... it is colorful and textured, has the word "love" in the title, and the back cover promises "DUELS!". In fact, I was a bit self-conscious to have the book sitting on my desk in a shared office — it definitely stands out against the normal array of serious physics texts. However, once I opened the front cover, I found myself pulled into the story and enjoying a beautiful work of art.

The story of Marie and Pierre Curie's work and relationship is meticulously researched and captivating. Marie Curie is the protagonist, and we follow her interesting life, career, and legacy. Her story is still inspiring to female physicists: deciding not to return to her homeland of Poland for love and love of scientific research, becoming the first woman to earn a PhD in France, winning a Nobel Prize, becoming the first woman professor at the Sorbonne, winning a second Nobel Prize... and even helping x-ray the wounded in World War I. There are also the ever-appalling anecdotes involving first experiences with radioactive material; for example, Pierre Curie strapping a tube of radium to his arm for 10 hours and reveling in the resulting lesion that appeared. And there is, in fact, a duel involving Paul Langevin and a journalist. The excitement of discovery, the pain of loss, the struggle to balance (and separate) work and home life; all of these themes are present and connect the reader to Marie Curie in a tangible way, even 100 years later.

Interleaved throughout are stories pulled from later in history that give a full sense of the impact and significance of the Curies' discoveries: from a cancer patient being treated with radiation therapy, to the lawsuit against the U.S. Radium Corporation in the 1920s, to Hiroshima, Chernobyl, and Three Mile Island. The transitions are well-executed, and Ms. Redniss is able to provide context without interrupting the flow of the overarching story.

The true star of this book is the art. The pages are filled with rich colors, drawings, photographs, maps, and even secret documents through and around which the story's text flows: the drill assemblies used to conduct underground nuclear tests in Nevada, which look like ancient works of art; mutant flowers collected from Three Mile Island; a photograph of Marie Curie at the Sorbonne. A brief explanation of the cyanotype printing method is provided as an endnote, and through this explanation one gets a sense of the depth of the author/artist's passion for the subject. And this aspect means that the book itself is a conversation piece (and would make an excellent gift), great for engaging non-physicists but technical enough to satisfy the scientist. I thoroughly enjoyed it, and it will occupy a prominent position on my coffee table.

And, the cover glows in the dark. ■

Remembering Women Physicists

By Mike Lucibella, APS Science Staff Writer

The physics community recently lost two women physicists—Dr. Gertrude Neumark Rothschild and Dr. Rosalyn S. Yalow—and a notable physicist-in-training, Michele Dufault. These women were outstanding advocates and role models for women in science.

Dr. Gertrude Neumark Rothschild

Contributions of 20th Century Women to Physics. *cwp.library.ucla.edu*

Michele Dufault
Photo by Facebook

Dr. Rosalyn S. Yalow
Courtesy of AIP Emilio Segrè Visual Archives, Physics Today Collection

Gertrude Neumark Rothschild

On November 9, 2010, one of its strongest advocates for the fair treatment of women scientists passed away. Gertrude Neumark Rothschild is most widely known for taking to court some of the biggest electronics giants over patent infringements, and winning. Her colleagues remember her as a brilliant and dedicated researcher who cared deeply about the well-being of her colleagues.

Gertrude Neumark was born in Nuremburg Germany on April 29, 1927. She and her family fled in 1935, ultimately settling in the United States. She earned her undergraduate degree in chemistry from Barnard College in 1948, then her chemistry masters at Radcliff the following year, and her PhD from Columbia in 1951.

After finishing her degree, she went to work in private industry, first at Sylvania Research Laboratories then at Phillips Laboratories where she started working with semiconductors. In 1982 she returned to Columbia University, first as an adjunct professor, then as a full professor in 1985. There she did much of her work developing semiconductors and laid much of the groundwork for the development of laser diodes and LEDs.

She became a leader in her field of wide bandgap semiconductors, and was most noted for her development of diodes that emitted the upper range of the visible spectrum, as well as ultraviolet light. LEDs and laser diodes based on her work were more energy efficient, lasted longer and were more reliable than previous generations of LEDs and have found their way into countless commercial electronic devices, including Blu-ray disc players, flat screen TVs and cell phones.

Rothschild rose to public prominence near the end of her life when she brought to court several major electronics companies for patent infringements. She held several patents on wide band gap semiconductors that she developed at Columbia. However these and other companies had been producing LEDs using techniques she developed, without honoring her patents or paying her licensing fees.

"She had patents that addressed a way of resolving or improving wide bad gap semiconductors. Then she found out one or two important companies were using her ideas and not paying attention to the fact that she had the patents," said Maria Tamargo, a researcher at City College of New York who collaborated with Rothschild on numerous projects.

She started in 2005, filing suits against several smaller lighting companies including Epistar, Osram, Phillips Lumileds Lighting Company and Toyoda Gosei for violating two of her patents. Many in her field didn't expect her to prevail, but eventually nearly all of the companies settled out of court.

Encouraged by her success, and able to afford the legal fees for a bigger push, in 2008 she filed complaints with the United States International Trade Commission against 34 additional electronics companies, including giants like Hitachi, Nokia and Sony. Once the commission agreed to take up the case, she added several more companies to her list. In total, more than 40 companies settled and she reportedly received over $27 million in compensation.

"They were intellectual thieves and she didn't like that," said Ismail Noyan, a professor at Columbia University who worked with Rothschild on several papers. "She didn't take injustice sitting down, and she felt this was an injustice."

Her colleagues said that though she was fighting on several fronts, against the companies, the legal establishment even with her own lawyers on occasion, she never let the stress on her show. Taking on the electronics companies for her was never about the money, but about respect and recognition of her work.

"Her motivation was for people to recognize what's been done," said Igor Kuskovsky, her former PhD student and later colleague. "It was important for her that people had to recognize her research."

She also fought for the respect of women physicists at all levels. At Columbia she was an outspoken advocate, calling attention to the disparity of women receiving tenure at the university.

Her colleagues remember her persistence and her perseverance. They spoke of her fondly as a caring mentor, a dedicated researcher and a rigorous experimentalist who expected the best out of her collaborators.

"She was nice, she would never yell at you, but if you had to do things better, she would push you," Kuskovsky said.

Tamargo remembers watching as Rothschild mentored her PhD student Kuskovsky. After receiving his degree he continued to work with her as a research scientist.

"Watching her take care of him, or doing the best she could to assist him in his career development, was very inspirational," Tamargo said. "She clearly saw the promise and made sure it went forward."

"We worked together right up until she passed away," Kuskovsky said. He added that anytime he was stuck on some aspect of his research she would guide him just enough for him to be able to figure out a solution for himself. She would always tell him "You have to do your project, it's your PhD."

Tamargo met Rothschild in 1993 when she first came to City College from Bellcore. Tamargo specialized in growing crystals for semiconductors, and Rothschild wanted to collaborate.

"I would make things, and she would try to figure out if it was going in the right direction or not," Tamargo said. "I really feel a lot of fondness and affection for Gertrude. She was the best colleague to have at that stage of my career."

Michele Dufault

On April 12, 2011, Michele Dufault died as a result of a tragic lab accident. The 22-year-old was a very active member of the Yale Physics department and university community. Her activities included: the Conference for Undergraduate Women in Physics, the Society of Physics Students as co-president, the Girls Science Investigations as a volunteer, the Yale Physics Olympics as a volunteer, the DROP Team, the 4th International Conference for Women in Physics, and a Summer Student Fellow at Woods Hole Oceanographic Institute.

Yale Physics department chair, C. Meg Urry, called Dufault "an outstanding astronomy and physics student" who "was passionate about science and about encouraging others, especially young women, to pursue science careers." An asteroid has been named in her honor: Asteroid (15338) Dufault = 1994 AZ4.

Rosalyn Yalow

Medical Physicist Rosalyn S. Yalow was the second woman to earn a Nobel Prize in Medicine. She passed away May 30, 2011. Yalow graduated magna cum laude from New York's Hunter College as the college's first physics major. She received her doctorate in nuclear physics in 1945, a field that she called "the most exciting field in the world" in her official Nobel autobiography.

In the 1950s she co-discovered the radioimmunoassay, a technique that made possible major advances in diabetes research and hormonal problems. In awarding Yalow the Nobel Prize in Medicine, the Karolinska Institute in Sweden said her technique "brought a revolution in biological and medical research." ■

Upper-level graduate students are now welcome to apply for the NSF-funded Professional Skills Development Workshops.

APS announces 2011 Blewett Fellows

By Mike Lucibella, APS Science Staff Writer

Natalia Drichko

Silvia Luescher Folk

APS recently announced this year's recipients of the M. Hildred Blewett Fellowship. Chosen by a subcommittee of the Committee on the Status of Women in Physics, the two are Silvia Luescher Folk at the University of British Columbia and Natalia Drichko at The Johns Hopkins University. The fellowship is dedicated to helping women who are returning to research careers that had been interrupted for family or other reasons. The fellowship is a one-year grant, which can be renewed, of up to $45,000 for use towards a wide range of necessities, including equipment procurement, stipend, travel, tuition, and dependent care. This is the seventh year the fellowship has been awarded.

Natalia Drichko

This is the second year that Natalia Drichko was selected as a Blewett fellow. At Johns Hopkins University in Baltimore, Maryland she is studying spin fluctuations in unconventional superconductors especially characterizing the magnetic order of organic conductors suing Raman scattering, as a visiting research assistant professor.

When she was interviewed last year she was just beginning the process of assembling a lab and acquiring the equipment needed to conduct her research, including most importantly building a Raman spectrometer. In the intervening twelve months she has gotten the lab completely assembled and has already begun taking preliminary data.

"In the last year I basically put the lab together so it's in a working condition," Drichko said."As the result of that first year I have a working lab."

Using the fellowship, Drichko also traveled to the APS March Meeting and gave an invited talk at Argonne National Lab.

Drichko originally hails from Russia where she earned her MSc from St. Petersburg State University in 1996 and her PhD in 2002 from the Ioffe Phsico-Technical Institute, also in St. Petersburg. As a postgraduate she received an Alexander von Hombolt Foundation Fellowship for her research into organic conductors and superconductors and was travelling back and forth between Russia and Germany.

At a conference in Europe she met her future husband Peter Armitage, an associate professor at Johns Hopkins University. The two started travelling together, fell in love and decided to get married and move to the United States.

For Drichko it was a tough decision to leave her research and move across the Atlantic. It meant giving up the clear career path before her in Europe, and moving to a country she had only been to twice before in her life.

Shortly after moving she found out she was pregnant and gave birth to her daughter. Even while caring for her new family member, she still found time to correspond with her old associates in Germany to help wrap up projects she had started with them. However she wanted to return to hands-on research.

Once her daughter got a little older she started working with researchers at Johns Hopkins on unconventional superconductivity, always with an eye on starting her own lab. The people at the university were helpful, but starting from scratch was daunting.

''It's very challenging if you just come to some place and say I want to do this and that", Drichko said. "From a research point of view, there was a perfect place for me to come to at Hopkins."

With the funding from the Blewett Fellowship she was able to get her lab started. She also received some funding from the condensed matter group at the Johns Hopkins Institute for Quantum Matter.

Now she's established at the Institute for the next three years. This upcoming year she plans on using the Blewett fellowship to continue her research, and hopefully hire a grad student. She also plans on applying for NSF grants as well.

Silvia Luescher Folk

Silvia Luescher Folk was born and grew up in Switzerland. She received her degree and PhD in physics at the Swiss Federal Institute of Technology in Zurich where she specialized in condensed matter and transporting nanostructures.

After completing her PhD she looked around for place to do her post doc, and ended up at Stanford under Dr. David Goldhaber Gordon. Before traveling to California, she stopped over for six weeks at the lab of Joshua Folk at Harvard. She had known him from her PhD; his was a name that kept popping up in her research. She hadn't met him until working at his lab for that month and a half. They first started dating shortly after that, and got married in 2004.

Once she arrived in Stanford, she helped Gordon build up his lab and research nanostructures. One of the big experiments she was working on involved charge tensing in quantum point contacts. Unfortunately the specific problem she was working on proved thornier than expected and her visa to the United States expired after three years so she returned to Switzerland

"I was forced to stop a little bit early than was convenient for immigration reasons," Folk said.

After Josh finished his project at Harvard in 2005, they moved to Delft in the Netherlands for six months so that she could finish her post doc at the Delft University of Technology. After she finished, two big life changing events happened; Silvia discovered she was pregnant and Josh received a position at the University of British Columbia. So, the couple moved to British Columbia, and she gave birth to their son Nicholas, in 2005. Having just moved, they didn't have many family or friends in the area, so Silvia took some time off from her research to look after little Nicholas. At the same time Josh was busy setting up his lab at the University of British Columbia. Three years later she gave birth to their daughter Ilana.

While she was at home and the kids were away at day care, she found time to do some part time work, working out numerical simulations. She missed research and academia and kept in close touch with the university through her husband.

"You really start to miss it," Folk said about working on new research. "I missed being good at it, I missed knowing about it."

In 2010, after the kids were a little older and more independent she was able to work with both the materials measurement research group and the low temperature group.

"I guess I kept bugging the department, and they were able to create a position that is not really a research position… but it's more like a liaison between two groups," Folk said.

Returning to research after the five year break has not been without its challenges. Time management always takes effort to balance work and home life. In addition breaking back into research is its own challenge when you're not already holding a research position. Folk said that the Blewett fellowship should help her establish herself as an independent researcher so she can move into working on her own projects.

"I'm really grateful for this fellowship," Folk said, "It's a wonderful opportunity for people like me." ■

2012 Conferences for Undergraduate Women in Physics

Conferences for Undergraduate Women in Physics (CUWIP) are three-day regional conferences for undergraduate physics majors. The 2012 conferences will be held January 13-15, 2012 at the following locations:

- The University of Washington in Seattle, Washington
- Stanford University in Stanford, California
- Texas A&M in College Station, Texas
- The University of Tennessee at Knoxville in Knoxville, Tennessee
- Yale University in New Haven, Connecticut
- Case Western Reserve in Cleveland, Ohio

Links to conference websites are available at: www.aps.org/programs/women/workshops/cuwip.cfm. Students are encouraged to apply to the nearest conference. In most cases, students will be provided full support for travel, room, and board. The application deadline is November 15, 2011.

The goal of CUWIP is to help undergraduate women continue in physics by providing them with the opportunity to experience a professional conference, information about graduate school and professions in physics, and access to other women in physics of all ages with whom they can share experiences, advice, and ideas. The program includes research talks by faculty, panel discussions about graduate school and careers in physics, presentations and discussions about women in physics, laboratory tours, student research talks, a student poster session, and several meals during which presenters and students interact with each other. ■

CUWIP works to help undergraduate women continue in physics by providing them with the opportunity to experience a professional conference.

APS Announces the 2011/2012 Minority Scholars

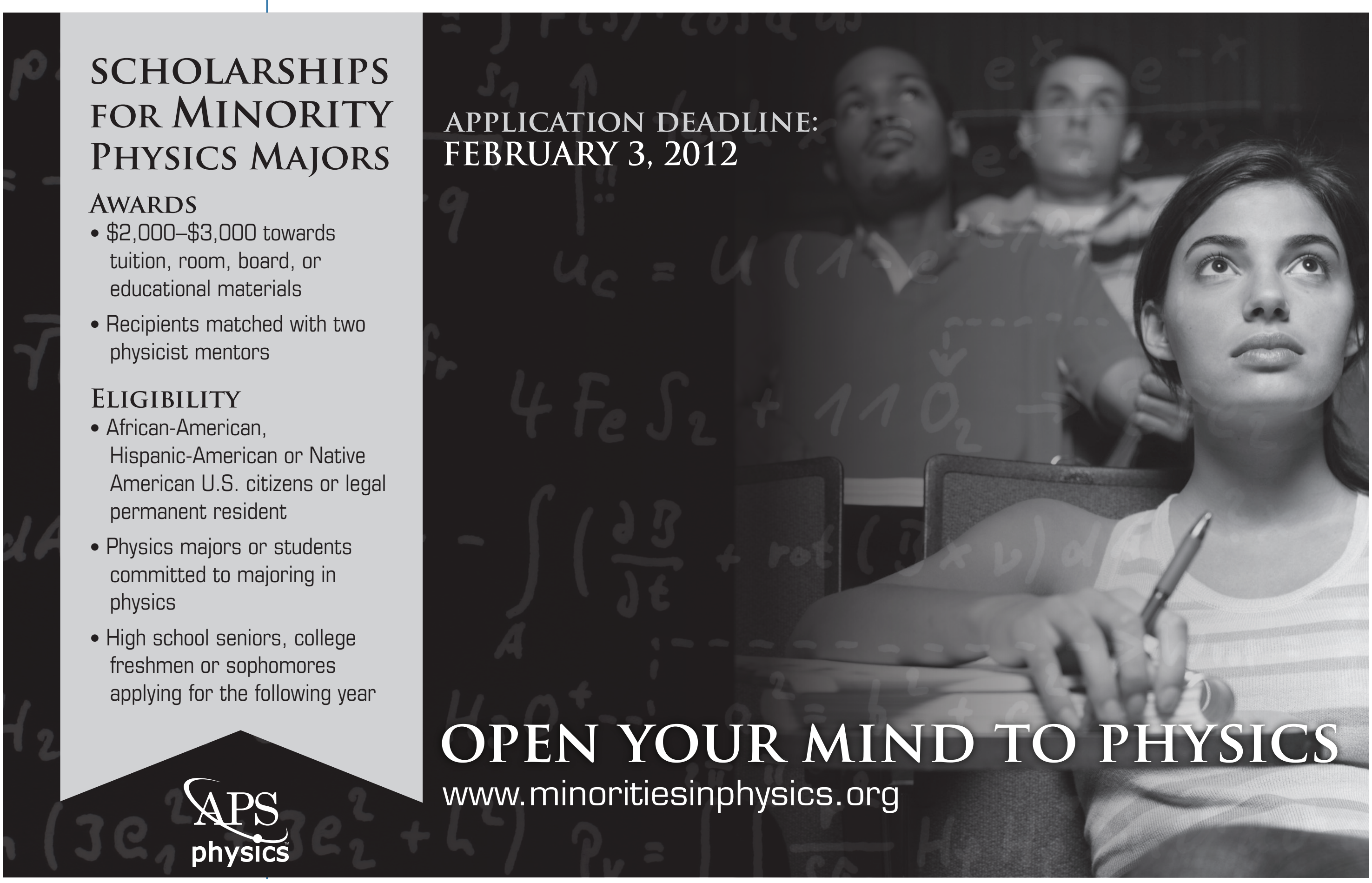
The APS Committee on Minorities is happy to announce that 42 Minority Scholarships were awarded this year – 17 renewals and 25 new recipients. The goal of this minority scholarship is to increase the number of under-represented minorities obtaining degrees in physics. It provides funding and mentoring to minority physics students to enhance their education and help them prepare for success in various careers.

New Recipients

Michael Brannan
Daniel Bulhosa-Solorzano
Daniel Contreras
Carlos Del-Castillo-Negrete
Haris Durrani
Natalia Guerrero
Takiyah Harrell
Xavier Hubbard
Christopher Hunter
Keonia Jenkins
Stephan Johnson
Marcus Levine
Stephanie Lona
Mark Miller
Mario Morales
Akin Morrison
Ashli Nieves
Ryan O'Donnell
Lucas Orona
Matthias Raives
Steven Reyes
Victor Rodriguez
Sabrina Rosa
Aaron Sharpe
Alejandro Zuniga Sacks

Renewals

Ronald Alexander
Andrew Emerick
Simon Segert
Alan Wagner
Rolando La Placa
Kamal Ndousse
Margo Batie
Victoria Villar
Kristina Pardo
Daniel Martinez
Roberto Rodriguez
Carrine Johnson
Olivia Smarr
Sarah Leu
Gustavo Resendiz
Iris Gray
Brent Cook



American Physical Society Travel Grant Programs

Travel Grants are available for Physics Departments at U.S. institutions to host Women, Minority, and Career Development Speakers!

The Women and Minorities Speakers Programs are intended to expand the opportunity for physics departments to invite women and minority colloquium/seminar speakers who can serve as role models for undergraduates, graduate students and faculty. The program also recognizes the scientific accomplishments and contributions of these physicists.

The Career Development Speakers Program provides assistance to physics departments that are trying to increase the career development activities and career awareness of students seeking undergraduate and graduate physics degrees.

For more information and to complete an online application, please visit:

Women Speakers Program Travel Grants:
http://www.aps.org/programs/women/speakers/travel-grants.cfm

Minority Speakers Program Travel Grants:
http://www.aps.org/programs/minorities/speakers/travel-grants.cfm

Career Development Speakers Program Travel Grants:
http://www.aps.org/careers/educator/travelgrant/index.cfm

WOMEN & MINORITY SPEAKERS LIST

Need a speaker? Consider consulting the American Physical Society's Speakers List, an online list of physicists who are willing to give colloquium or seminar talks to various audiences. This list serves as a wonderful resource for colleges, universities, and general audiences. It has been especially useful for Colloquium chairs and for those taking advantage of the Travel Grant Program for Women and Minority Speakers. To make the easy to use, we have made the online version searchable by state, field of physics, or speakers' last names.

If you'd like to search the list to find a woman speaker, go to: **www.aps.org/programs/women/speakers/**

If you'd like to search the list to find a minority speaker, go to: **www.aps.org/programs/minorities/speakers**

American Physical Society
One Physics Ellipse
College Park, MD 20740-3844

Non-Profit Org.
U.S. Postage
PAID
College Park, MD
Permit No. 1233