QUARKNET STEP UP: WOMEN IN PHYSICS
WORKSHOP LEADER NOTES

DESCRIPTION
Women in Physics activity **"**on the underrepresentation of women in physics and the role of implicit and cultural stereotypes."

BEST PRACTICES
Strategies to Model Good Teaching Practices

- Provide context for the workshop; provide the "big picture" up front.
- Lead as a facilitator rather than a lecturer.
- Focus on habits of mind and on the process of science; teach science as science is done.
- Focus on active engagement over slides.
- Use guided inquiry: Participants practice data collection, organization, interpretation as scientific process.
- Provide opportunities for participants to support their claims with evidence (Claims-Evidence-Reasoning).

Workshop Characteristics

- Workshops include a balance of scientific content and process.
- Workshops have an agenda:
  - Prepare agenda in advance with participants' prior experience in mind, if possible.
  - Build in agenda flexibility.
  - Leave time for reflection and discussion.
  - Place workshop agenda online.
- Participants are actively engaged.
- Participants work through activities as if they are students first ("student hat"), then talk about teacher strategies and implementation plans ("teacher hat").
- Activities progress from simple to complex.

Resources for Further Reading:

Criteria for Workshop Review (Young & Associates, 2014)

Principles of Effective Professional Development for Mathematics and Science Education: A Synthesis of Standards (Loucks-Horsley, Susan et al., 1996)

Bibliography

The National Center for Improving Science Education, *Profiling Teacher Development Programs*, Washington, DC, 1993. [Note: Developed for DOE teacher development programs]

National Research Council, *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, Washington, DC: The National Academies Press, 2012.

ENDURING UNDERSTANDINGS
Open discussion can expose and discourage unconscious bias.

LEARNING OBJECTIVES
Teachers will know and be able to:

- Use the *Group Tasks for Women in Physics* to identify areas of unconscious bias that effect career choices using their "student hat."

- Facilitate small group discussions in which students examine the items that illustrate the various ways unconscious bias is present in their lives.
- Facilitate a whole group discussion in which students volunteer instances in which they have experienced unconscious bias.

PRIOR KNOWLEDGE

Your student should be familiar with the concepts covered in *QuarkNet: Changing the Culture* and in the *QuarkNet STEP UP: Careers in Physics* activity.

BACKGROUND MATERIAL

- Information about the STEP UP program

RESOURCES/MATERIALS

- Class whiteboard, projector, computer
- Women in Physics presentation slides
- A document that can be projected/shared
- Paper for writing prompt activities (two per participant)
- (Optional) Devices with Internet access to participate in polls
- Women in Physics Pre-Assignment and Women in Physics Post-Assignment handouts (Print one per participant.)
- Group Tasks for Women in Physics (Print one per participant.)

IMPLEMENTATION

Participants go through the student activity to develop an understanding for the *Women in Physics* activity. Encourage teachers to approach the activity wearing their "student hat." At the end of each task, participants put on their "teacher hat" and reflect on the following questions:

- Do you foresee any challenges in implementing this task with your students?
- How will you overcome these challenges?
- At what point in your school year do you think this task best fits?
- Will you implement the entire activity on the same day? If not, how will you divide the tasks?

Recommended teacher preparation for implementing this activity in the classroom includes: Read *Women in Physics Internationally, Appendix 4*. Teachers who have previously taught this lesson felt more comfortable having more information for themselves beforehand.

Establish a safe and supportive classroom environment before doing the *Women in Physics* activity. Using the activity *QuarkNet: Changing the Culture* will help. Student sharing of personal experiences of conscious and unconscious bias is critical to understanding and shaping their own pathways as well as impacting their peers' conceptions of career pathways. The structure of small group and larger discussion around anonymously submitted answers supports developing a culture of openness in discussing challenging topics.

This activity is divided into three tasks that center around data provided to the students in presentation slides. Note that **Task 3,** the classroom discussion, is the most important piece in encouraging students to pursue a career in physics. It is essential that participants complete **Task 3**.

Task 1: Historical Role of Women in Physics

Participants complete the Women in Physics Pre-Assignment prior to coming to the workshop for the Women in Physics activity. Participants do internet searches to find historical female physicists. At the start of the workshop, divide the participants into groups of two or three. Instruct the participants to share their responses to the questions in the pre-assignment. A representative from

each group will summarize their group responses. Make a running list of group responses to each question on the board, on newsprint or on a slide. You will continue to add to these lists throughout the activity.

Contributions	Obstacles	Challenges today: Easier? Harder? Different?

Task 2: Data on Women in Physics

This activity is included in the *Group Tasks for Women in Physics* student pages. The numbered items below list the questions that students consider. The referred graphs can be found in the *Group Tasks for Women in Physics* handout or in the presentation slides.

Continue with the small groups from **Task 1**. Assign each group an item to study. Each group decides on answers to the prompts and shares their results with the class. The activities are keyed to specific slides. Give the students group time to discuss the prompts and develop group answers. When you call time, have each group describe their topic and explain to the class their group responses.

The topics from the Group Tasks are listed along with possible claims that students may make in each area:

1. Data on international women in physics
   Participants will be surprised that Iran has the highest percentage of female physics degrees granted. They will also be surprised that the U.S. is among the lowest percentage of female physics degrees granted. Claims may include that women are not as intelligent as men, cultural attitudes prevent women from pursuing science degrees, women naturally prefer "helping careers."
2. Gendered Professions
   Possible participant claims may include: doctors, nurses and teachers are more likely to be women. Surgeons and specialists are more likely to be men. Scientists, engineers and mathematicians are more likely to be men. Claims include cultural expectations for men and women push women into "helping careers" and men into "more inventive" fields.
3. Data on undergraduate women in STEM fields in the U.S.
   Possible student claims may include: choosing biology and/or chemistry majors will increase their chances of getting into medical school. Choosing math, physics and engineering less often is likely because they perceive the material is much harder. Questions may arise about the cause of the negative slope in all of the graphs after about 2005.
4. Examples of gender inequalities (Academic Achievement)
   Possible participant claims may include: there are unconscious biases that cause women to be viewed as not as smart as men. These include the notion that women get lower grades, women are not as smart as men, women are underprepared for these "hard" courses.
5. Defining Unconscious Bias
   Possible student claims may include: people who study physics are smarter than other people, or women cannot write as well as men. The differences in women participation in STEM fields is entirely due to sexism.

6. Intersection of Race/Ethnicity and Gender
   Possible participant claims may include: there is a strong bias towards white students and Asian students; Black, Hispanic and Native American students are not encouraged to pursue physics. There is a bias that Black, Hispanic and Native American students are not smart enough to study physics. Over time, there is an increase in Hispanic students receiving physics degrees, but there is very little change in the number of Black students receiving physics degrees. This suggests that there is a greater bias against Black students than Hispanic student.

TASK 3: REFLECTION AND STRATEGIES

The data examination and sharing in Task 2 has prepared the participants for this critical portion– relating to this data through personal experiences. Task 3 is divided into a few different sections with a variety of implementation strategies possible. Of critical importance are having the participants share personal reflections (with an anonymous option) and a whole group discussion using evidence to discuss bias. The research shows that the most important technique for changing attitudes related to the role of women in physics is the discussion of real bias experienced (Lock, R. M., Hazari, Z. Phys. Rev. Phys. Educ. Res. 12, 020101 – Published 5 July 2016).

Personal Reflection Writing Prompt

Participants respond to a prompt in writing, wearing their "student hat" and share with a neighbor. Prompts for discussion:

a) Describe experiences you or a friend has had related to science and gender issues.

Examples:

- Who did you feel comfortable working with in class?
- Did you feel more comfortable in any particular class?
- Have you felt your abilities were questioned?
- Have you seen or experienced gender biases in your own life, either purposeful or unintentional?

b) Do you think societal beliefs related to gender had any influence on the career you want edto pursue? or careers you did not consider?

c) What can be done to support diversity in physics? What could you do?

Whole Group Discussion: Essential step!

Participants now share another response anonymously, on a second piece of paper, for themselves. You can collect the papers and read them out to prompt discussion or pass them back out for workshop participants to read for each other. Having teachers share their own experiences in workshops, and hearing each other's, gives them critical confidence and examples to bring back to their classrooms. During the teacher workshop, encourage the teachers to share real personal experiences.

Proposing Strategies

In their classroom, the teachers will collaboratively build suggestions and strategies with their students on how to build a more equitable classroom. This can be done in the workshop wearing "student hats" or the group can brainstorm ways that they as teachers can address bias and build equitable classrooms. The Guidelines for Conduct During Discussion poster or the Everyday Actions Guide is a great tool for this portion of the workshop.

Post-Assignment

Have participants complete the post-assignment as homework.

Task 4: Teacher Reflection
End with time for teachers to reflect and develop an implementation plan for their classrooms. Suggested questions include:

- Do you foresee any challenges in implementing this task with your students?
- How will you overcome these challenges?
- At what point in your school year do you think this task best fits?
- Will you implement the entire activity on the same day? If not, how will you divide the tasks?

ASSESSMENT
This activity lends itself to formative assessment in which the teachers are encouraged to gather after implementing the student activity in their classroom. Return to the questions in the implementation section. Follow up with the following questions:

- What went well during implementation?
- What would you do differently if you do it again with a different group of students?
- Have the students expressed interest in majoring in physics?
- Have the students been more involved and excited about studying physics?
- Do more students share their thoughts and answers with the class?