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Strategies for Educators to Support Females in STEM

**Lynda R. Wiest, Ph.D.
University of Nevada, Reno
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Below are recommended ways for educators to support and encourage females in the STEM (science, technology, engineering, and mathematics) disciplines. The strategies are numbered and lettered for easy reference but do not suggest a prioritized list. While they are especially relevant for supporting females in STEM, many are also important approaches for males. Further, good teaching in general, including positive rapport with students, lays an important foundation for supporting all students in STEM.

1. Make sure females understand that effort and appropriate experiences, rather than natural ability, are mainly responsible for success in the STEM disciplines. Accordingly, praise effort and reasoning to a greater degree than correct answers.
2. Help females develop appropriate dispositions in relation to STEM, such as positive self-perceptions. Similarly, strengthen your own belief that females are as capable as males in STEM and that STEM knowledge, skills, and careers are equally appropriate for and important to both sexes. Be sure this is evident in your group and individual interactions with students. Develop greater competence and confidence in, as well as enthusiasm for, your own STEM knowledge and skills. (Research indicates that perception is more important than reality in terms of the way girls perceive themselves and their instructors' gender-related beliefs and behaviors in STEM.)
3. Hold high expectations for and encourage and support *all* girls in STEM. Interact with girls as much as boys and in qualitatively similar ways. For example, call on girls as often as boys to answer questions and assist in demonstrations, ask them higher-level questions and expect them to demonstrate thinking and reasoning, and ensure they participate actively and meaningfully in small-group work. At the undergraduate and graduate levels, invite female students as often as males to participate in relevant social activities and professional opportunities, such as assisting in research projects and doing joint publications and presentations. Give all students specific, constructive feedback on their work.
4. Use varied, student-centered teaching methods within a "safe" classroom climate. In particular, use mixed-ability, collaborative (rather than competitive) group work, hands-on methods, and meaningful (such as real-world and interdisciplinary) contexts. Use mixed-gender groups, but avoid placing only one girl in a small group, even if that results in having one or more all-male groups. Monitor and rotate these groups regularly. Avoid having girls

and boys compete against each other. Incorporate modern technologies that support math learning, such as graphing calculators and iPads. Note that computer work can involve “social” learning, which might motivate some females to a greater degree. For example, students might be asked, at times, to do joint tasks that rotate who is at the keyboard or to do follow-up, collaborative classroom tasks that apply or build on concepts first explored on the computer. Despite girls’ preference for using manipulative materials, require them to go beyond manipulative use in mathematics. For example, have them analyze problem structures across problem situations. Likewise, help girls develop fluency—efficient retrieval and processing—with STEM facts and procedures. Include practice solving facts and problems mentally. Incorporate investigative tasks and projects that are more holistic in nature, and place responsibility for thinking and learning on the girls themselves. Purposeful games might be included, and girls should sometimes be asked to develop their own problems and projects. Help girls see the practical value of STEM knowledge and skills they learn in school. In general, create a classroom environment that generates interest and curiosity, and which is nonthreatening but holds all students accountable for learning.

5. Emphasize process, not just product. Encourage females to make reasoned conjectures about problems, to explore varied approaches to STEM tasks, and to explain and justify their work. For example, have students try to solve problems in more than one way, explain why they think their answers are reasonable in relation to the problem situation, and—where relevant—tell what potential significance findings of experiments and projects might have. In general, encourage good discussions in relation to STEM tasks. Be sure to include some STEM problems and tasks that are “ill-structured,” in other words, that are somewhat ambiguous and require more creative thought and effort. Have girls do computer work that involves some self-driven, unstructured exploration in addition to that which requires following prescribed procedures. (“Risk-taking” and innovativeness can be important attributes in STEM pursuits.) When girls struggle, give appropriate learning support, but do not “bail them out.” In other words, do not simply tell or show them what to do.
6. Employ measures to ensure equal and fair student participation, such as rotating who answers, how often, and when (e.g., not always being among the first or last to answer questions). Provide sufficient wait-time (at least 3-5 seconds) after posing a question to allow everyone time to think before calling on a student, preferably not allowing any students to raise their hands until you request that they do so *after* allowing thinking time. Provide various ways to respond that extend beyond speaking in front of the class, such as discussing material with a partner or small group or explaining ideas in a journal. Structure tasks so that girls and boys physically use STEM equipment, such as science lab equipment, calculators, computers, and manipulative materials, an equal amount of time and in comparable ways. In general, ensure equal access to quality human, technological, and material resources.
7. Provide ongoing training in two- and three-dimensional visual-spatial skills that involve mental, pictorial, tactile, and kinesthetic tasks. Sample activities include mentally rotating objects to determine what they would look like from another perspective, doing tangram tasks, building and dismantling objects, and physically demonstrating concepts (e.g., representing geometric shapes with one’s body). Stay abreast of current research on other

areas in which females demonstrate weaker performance in relation to males (e.g., geometry, measurement, physics), and give particular support in those areas.

8. Use gender-fair teaching materials. For example, use a fairly even balance of whole-class tasks that include stereotypical female contexts (e.g., shopping, cooking, art/literature), stereotypically male topics (e.g., sports, politics, economics), and “neutral” topics (e.g., animals, food, music). Be sure these materials—for example, print material, photos and illustrations, and films—are diverse not only in terms of gender but also in terms of race/ethnicity and other dimensions of human diversity. This approach helps challenge potential stereotypes about who can do STEM.
9. Provide diverse historical and contemporary female role models (and their work) in STEM through stories, posters, films, guest speakers, class assignments, and so on. Arrange—or help girls find—opportunities to network with both adult and peer role models and mentors. (See, for example, mentornet.net.)
10. Use a variety of formal and informal assessment techniques so that girls may demonstrate learning through conventional tests and assignments, as well as performance on projects, presentations, role plays and skits, video and website productions, community service, and other means that may at times involve a choice among designated options. Value both process and product in grading. Devote some attention to test-taking techniques for standard test types due to their pervasive and high-stakes use.
11. Use online, face-to-face, and other outreach methods to actively recruit girls into voluntary courses and STEM activities. Offer out-of-school-time (e.g., after-school, weekend, summer, or online) programs for girls and/or in-school programs, such as an all-girls computer club, that encourage girls to participate in emotionally and psychologically “safe” STEM programs with peers. (There is some evidence that targeting girls specifically and including supplementary single-sex options can be valuable in an area like STEM where females are underrepresented.)
12. Provide information and resources on STEM careers and career preparation. Make it clear that STEM careers are both appropriate for and available to females, and encourage girls to consider these careers. Use gender-inclusive language when discussing occupational roles, such as “When a mathematician...he or she...” Help girls see how STEM—and thus their participation in STEM—can help make the world a better place for living things.
13. Teach girls how to help themselves in STEM. Perhaps offer a workshop to teach strategies and provide resources for girls to strengthen their own STEM performance and participation. Stay abreast of good websites, local programs and events, contests, and other learning opportunities to promote.

Encourage girls to

- A. take an active part in school STEM activities, such as handling equipment and tools in important ways and serving as group spokesperson as often as other students;

- B. share their thinking and work in class;
- C. try different approaches to tasks;
- D. seek to understand how and why things work the way they do;
- E. identify personal strengths and weaknesses and seek to improve weaker areas of knowledge and skill;
- F. join voluntary in- and out-of-school programs and make use of supplementary print and electronic resources (e.g., high-quality websites), especially in such areas as geometry, measurement, spatial skills, earth science, physics, and chemistry;
- G. seek help from qualified others when needed (after a sincere individual effort) and work collaboratively with peers (e.g., form study groups);
- H. find female role models and mentors, as well as like-minded and supportive peers, to communicate with in person or in safe online settings, or consult websites and books that profile such individuals (males can also fill these roles; however, it is important to ensure that females are included);
- I. notice STEM in the surrounding world and seek to know more about it;
- J. educate themselves about STEM careers and career preparation;
- K. maintain a positive self-image in relation to STEM—for example, realize that they have much potential in STEM and can improve ability with effort, value STEM contributions to daily life and the world at large, and recognize themselves as legitimate mathematicians, scientists, technologists, and engineers capable of preparing for and entering these careers; and
- L. personally address inequities that take place toward themselves or others in school or elsewhere, for example, hearing sexist or stereotypical comments, being held to lower expectations, or having fewer opportunities to participate in meaningful STEM; speak about this directly with the responsible person(s) or seek help from an appropriate authority.

Similarly, teach students to assess their own actions during school work. Help them learn what is fair and respectful behavior and have them monitor their actions in structured ways, such as reviewing a checklist of equitable behaviors after completing a small-group activity and determining how well they think they did.

14. Educate parents through such avenues as newsletters, parents' nights/workshops, and online information regarding the importance of STEM performance and participation for females. Be sure they, like students, understand that females' and males' STEM *abilities*, regardless of *performance*, are comparable and are highly subject to effort and experience. Suggest that they provide daughters with STEM materials (e.g., chemistry sets, calculators, computers, math games) and opportunities (e.g., after-school or summer programs) to the degree possible and that they model pro-STEM values by showing interest in STEM and discussing and modeling use of STEM concepts and materials. Inform them that STEM materials should be located in a neutral place in the home or in females' as often as males' home spaces. Provide girls and their parents with information on various types of STEM resource materials, such as careers and career preparation, opportunities for STEM participation (e.g., available programs, contests, and events), and self-learning options (e.g., good print and online materials) related to increasing knowledge and skills, learning about female role models, coping with math anxiety, and accessing career information.

15. Advocate for gender equity in the STEM disciplines at the school and community levels, as well as that of the wider society. This means sharing information and strategies with colleagues, parents, and students themselves, as well as seeking formal structural changes or policies and programs that will help forward this important educational agenda. For example, it is important to seek administrative support that is committed to providing quality STEM teachers with proper training in both STEM and gender issues, access to modern instructional technologies, gender-fair curricula, and assessment data that is disaggregated by sex. You might also start a professional learning community within or across schools that is devoted to gender issues in STEM (or gender issues in general, which would include males in relation to reading and writing). Being an advocate also means voicing your concerns when you witness inequitable or potentially harmful comments and actions.
16. Continue to grow professionally by learning more about gender issues in the STEM disciplines and how to address these issues effectively. Two ways to do this are through engaging in structured professional development opportunities and professional reading. You might also audiotape or videotape your teaching for self-analysis or have a qualified individual evaluate your teaching for gender-fairness.

Selected Resources

- Baker, D. (2014). Teaching for gender difference [in science].
<http://www.narst.org/publications/research/gender.cfm>
- Kehl, W. (2013). Closing the STEM gender gap in K-12 education: How teachers can help.
<http://getttingsmart.com/2013/03/closing-the-stem-gender-gap-in-k-12-education-how-teachers-can-help/>
- Post, G. (2013). What stops girls from learning math?
<http://giftedchallenges.blogspot.com/2013/06/what-stops-girls-from-studying-math.html>