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Strategies for Parents to Support Daughters in STEM

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Below are recommended ways for parents and other caregivers to support and encourage females in the STEM (science, technology, engineering, and mathematics) disciplines. Research has shown that parent behaviors and attitudes influence children’s STEM performance, participation, and dispositions. (Note: Dispositions include attitudes, beliefs, feelings, etc.) Negative and counterproductive beliefs and actions can limit young women’s potential and options in everyday life and careers. Further, this can reduce the pool of STEM-capable, interested citizens who contribute to the advancement of society, including improved quality of life.

While the strategies that follow are especially relevant for supporting females in STEM, they also represent important approaches for males. They are numbered and lettered for easy reference but do not suggest a prioritized list.

Be sure to maintain these actions over time. In other words, start them at a young age and continue through high school and beyond. It is also important to avoid stereotypes regarding females and males in relation to STEM, such as implying that one gender is more naturally capable at STEM or STEM is more suitable for one gender.

1. **Hold high STEM expectations for your daughter in everyday life and in school** (applies to all key adult figures in girls’ lives). Encourage and expect your daughter to do well in STEM. Support her pursuit of these subjects, including encouragement to take more than minimally required coursework. Show sincere confidence in your daughter’s ability to succeed in STEM. Help her learn to set personal goals related to STEM effort, performance, participation, and dispositions. Know—and help your daughter know—that effort and appropriate experiences, rather than natural ability, are mainly responsible for STEM success. In other words, the STEM disciplines are understandable subjects that can be figured out. Believe that females and males are equally capable of succeeding in the STEM fields, as research continues to show. (Potential differences in performance and participation result from societal influences.) Accordingly, praise effort and reasoning to a greater degree than correct answers. Also stay informed about schoolwork. Ask your daughter to explain what she did in school that day. Specifically inquire about STEM subjects if not otherwise addressed. For example, have her tell at least one thing she learned, an activity she did, something she found confusing, or one thing she would like to learn more about. Stay abreast of what homework your daughter has due and be sure she completes it.
2. **Help your daughter build positive and constructive dispositions (such as attitudes and beliefs) toward STEM.** For example, help her believe it is acceptable and even desirable to like and be good at STEM. Point out successful historical and contemporary females in STEM. Help your daughter see that females who are good at and participate in STEM display a range of personal characteristics just like females in other occupations. They also pursue a variety of interests, such as sports, music, and literature. (In other words, seek to debunk narrow and limiting stereotypes.) Tell your daughter that STEM subject matter is important and useful in school, work, and everyday life and that STEM careers are just as appropriate for and available to females as they are for males. Avoid conveying negative and counterproductive messages toward STEM, which can be done in both overt and subtle ways. For example, if a parent needs help with technological devices and tends to seek help from male instead of female figures, this can send a subtle but clear gender message regarding who is better or expected to be better at STEM (in this case, more technologically inclined).

Because peers can strongly influence young people, it is important to be aware of your daughter’s interactions with her peers. Be sure her peers aren’t acting in ways that counter the efforts described in this document. If they are, address this directly with your daughter and, where appropriate, with her peers.

3. **Maintain good dispositions toward STEM yourself** in the ways noted in the previous strategy: Believe both genders are equally capable, that STEM is important and useful, that STEM knowledge and skills are accessible to everyone with effort and experience, that STEM is appropriate for and available to both genders and all types of people in general. It is important to genuinely believe these things so that subtle messages don’t contradict your words and actions. Model pro-STEM values by showing interest in STEM and discussing and modeling use of STEM concepts and materials (see the ideas that follow).

4. **Provide STEM materials and opportunities.** Sample materials include chemistry sets, calculators, computers, LEGO robotics, and math-oriented games. Place these STEM materials in a neutral location in the home or in females’ as often as males’ (children’s and adults’) home spaces. Sample opportunities include programs and activities offered in after-school, summer, weekend, or online settings, such as computer clubs and math camps. Encourage your daughter to enroll in these types of programs. If you lack needed resources, such as money, materials, or transportation, see if you can get support from your daughter’s school or local organizations or businesses. Many good websites are also available with free, worthwhile learning activities. Accordingly, provide computer access with the latest software, including video games (consult with teachers or reputable websites for suggestions). If possible, provide Internet access at home or through other avenues, such as family and friends, local libraries, or youth centers. (Check, for example, with the local Girl Scouts of America, www.girlscouts.org, or Boys & Girls Clubs of America, www.bgca.org.) Be sure to provide girls and boys with equal access to computers, computer programs, and the Internet, which might mean placing a home computer in a neutral location. This can also encourage family members to do joint activities, which can support females’ tendency to prefer to work collaboratively. When girls participate in joint home activities that are mixed-gender, be sure females handle STEM equipment (e.g., calculators and science equipment) and are otherwise actively involved in STEM to the same degree as males. Note: Girls who
like to read might be provided with engaging STEM-oriented reading material, both fiction and nonfiction.

5. **Promote good learning practices while doing STEM activities.** The approaches described here are methods recommended for approaching all types of tasks, whether homework or supplementary activities.

**Thinking-Oriented, Investigative Tasks**

Have your daughter do *real* thinking rather than memorizing procedures. Give different types of tasks, such as authentic, context-free, and hypothetical (see examples below). Investigative tasks should allow your child to wrestle with material in an exploratory way, taking from minutes to weeks or even longer to arrive at a well-reasoned response. Resolving questions might involve experimenting with physical or computer models, researching information on the Internet or in libraries, and/or asking the opinions of experts in relevant fields. In essence, your daughter should be responsible for doing important thinking and explanation when working individually and collaboratively.

Choose questions and tasks that appear to be sufficiently engaging, which can differ among girls. Examples:

A. How can we determine how much paint is needed to paint our living room? *(authentic)*

B. Develop a report that shows which of several cell phone plans seems best for the family. *(authentic)*

C. Why do you think popcorn kernels pop when heated? What other things might respond similarly in the real world? *(authentic; similar situation might be something like car windows cracking on a very hot day when the windows were fully closed for some time)*

D. Can you find the sum of three consecutive numbers using a different method than adding them? Can you find any other “number rules” that work consistently for problems like this? *(context-free; an answer to first question is to multiply the middle number by three)*

E. How can you design a computer spreadsheet to add all whole numbers from one number to another for any two numbers whose range is an even-numbered set (such as 1 to 100)? *(context-free; a procedure is to add the two given extremes and multiply the sum by the number at the midpoint of the series; for 1 and 100, that is (1+100)50; for a story related to this topic, consult information on Carl Friedrich Gauss)*

F. Can you determine a rule that can be used to find the angle sum measures for any polygon (a closed figure with all straight sides that do not cross over each other, such as a square or pentagon)? *(context-free; a standard procedure is to take the number of sides minus 2 and multiply it by 180)*

G. What do you think would happen if another star suddenly started burning as brightly as the sun and we now had two suns? *(hypothetical)*

H. If you were an engineer designing a dog house in an earthquake zone, how might you try to design it to withstand an earthquake? *(hypothetical)*

I. If a new drug came out that cured cancer for 99% of people but killed the other 1%, do you think it should be released to the public? *(hypothetical; involves science ethics)*
**Explanation and Discussion**

Take sufficient time for discussion after your daughter has explored questions and tasks. Your daughter should tell what she thinks something means or why it happens, what strategy might be used to approach a task and why, whether her solution method seems to be working (and why) while she is implementing it, and whether she thinks her conclusions for a task are reasonable and why. For example, have your daughter tell *why* or *why not* for decisions such as letter I above. She should be expected to explain and defend her thinking and conclusions and respond to questions posed about them. She should try to tell why she thinks something works. For example, if you take one number off the largest of three consecutive numbers and add it to the smallest, you have three identical numbers. This is why you can multiply the middle of three consecutive numbers by three to find their total. For the most part, your daughter should explain ideas, orally and/or in writing, rather than hearing someone else explain them to her. However, it is appropriate for parents who are knowledgeable about particular STEM content to explain and show it to daughters to some degree while engaging them in thinking about the material.

**Struggle and Support**

Be sure tasks are pursued in a nonthreatening environment where your daughter feels intellectually, psychologically, and emotionally safe to take risks. Allow and encourage sufficient time to struggle with material since this is where real learning occurs. This includes homework. Give support, provide a quiet workspace with needed materials, and monitor homework completion. However, be careful not to be overly involved, which can give the impression that you perceive that your daughter needs help or is not sufficiently independent and could thus cause her to have lower self-confidence about her competence in the subject matter. Encourage experimentation, some degree of calculated risk-taking, and creative efforts. This includes exploring computers with no agenda, in other words, simply “tinkering” with them to see how they work. You and your daughter should not shy away from mistakes and wrong answers but rather see them as rich opportunities to learn. Expect some disequilibrium and confusion to be part of the process. Help your daughter learn how to accept that and find ways to move past it. Especially, if she gets stuck or frustrated, resist the temptation to “bail her out” by telling her how to think or proceed. Instead, give support and appropriate hints, or pose questions that do not give away too much but which might help her think about things differently. General questions you can pose for most tasks involve asking your daughter to explain what problem she is trying to solve, what she has tried so far, why she thinks those methods didn’t work (if relevant), and what she might try next and why. If she is still stuck or can’t remember specific information, try “scaffolding” her thinking. For example, if your daughter can’t remember the answer to $8+5$, you might say, “Can you first get from 8 to 10 by breaking off part of the 5? (yes, 2) What is left over from the 5? (3) So, what do you get if you add on that remaining part? (13) Do you think that is the answer to $8+5$? Why or why not?” (You might have your daughter use dried beans or other objects to explore this.) Or if your daughter can’t remember the formula for finding the area of a rectangle, you might first ask her to explain what area is. Next you might have her draw a rectangle on grid paper and ask how to find the number of square units inside. If your daughter counts them all, ask if she can think of a faster way to find the answer. Be sure to avoid finalizing tasks by presenting the “right” way to do or think about something.
Varied Approaches
Ask your daughter to complete tasks in more than one way, if possible. For example, when she solves a math word problem and explains why she thinks it is correct, ask if she can find a different way to solve it (which might confirm or call into question her original answer in addition to expanding her repertoire of strategies). Have her brainstorm more than one scientific reason why things might work as they do, such as why a shorter person can typically change directions faster than a taller person when running, why a shower curtain might blow inward when the shower is running, or why cracks are put into in sidewalks. Ask your daughter to do some work mentally, as in figuring math in her head or imagining various science-related scenarios.

Calculator Use
Permit your daughter to use a calculator to do carefully chosen explorations or to assist with tedious computations. In the former case, an example for a younger child who has not yet studied negative numbers is to ask if it is possible to “take away”/subtract a larger number from a smaller number. Let her give her prediction (always with an explanation) and then have her test it with some examples on a calculator, recording the results. When she sees the answer to problems such as 4-5, 3-6, and 2-8, let her try to determine the “rule” for finding answers to these types of problems now that she sees they do yield valid answers. You might even see if she can give a real-world example of when this can happen. Another example is determining whether multiplication always “makes bigger” and division smaller. Exploration on a calculator should show that the answer to both of these is no. For problems involving large computations, the guideline is that calculators are appropriate, real-world tools to use when they do not replace the very thing a student is trying to learn. For example, it does not make sense to use a calculator to find the answer to double-digit subtraction problems if the focus of the lesson is to learn how to subtract two-digit numbers. An appropriate use of a calculator is to perform difficult or lengthy computations while solving word problems. In this case, the focus is learning how to solve word problems, where the most important and challenging part is determining what solution method to use.

Learning Preferences
Females tend to like using hands-on models (sketching drawings may also be helpful). However, variety is important and girls should use abstract and mental methods as well. Females also tend to like working collaboratively on tasks (including on the computer) and to do tasks that have a purpose, such as creating a spreadsheet that calculates pay for a dog-walking or babysitting business, using the Internet to research information for a specific project, or preparing a class assignment with presentation or graphing software. Again, some context-free and hypothetical activities should be included with more authentic tasks to provide a more varied experience. Please note that the learning preferences presented here do not imply biological differences in processing information. Rather, they are research-identified tendencies—across females as a group—that likely have sociocultural origins. Further, as indicated, girls must be expected to practice various approaches and, with proper support, they are fully capable of achieving the same STEM outcomes as males regardless of their chosen “means to an end.”
Developmental Appropriateness
Be sure tasks given are developmentally appropriate, meaning neither too easy nor too hard. For example, a younger child might be asked to think about ways to add two numbers less than ten that are two numbers apart, such as 6 and 8 or 3 and 5, for which she might determine that she can use doubles to find the answer. (Examples: take 2 off of one number, add the doubles, and then add the 2 back on; double the numbers and subtract 2; double the number between the two.) As a science example, a younger child might be asked to consider why ice is bigger than the amount of water it came from or why pancakes are round.

6. **Interact and participate with your daughter in relation to STEM material** (*both* female and male adult figures). Make STEM an enjoyable, challenging experience beginning at an early age. For example, investigate interesting, complex math problems together, both contrived and authentic, and conduct science explorations using chemistry sets or experiments described in print or online sources. Jointly research information in print and online resources to increase STEM knowledge and skills and to build awareness of female role models and their accomplishments. Do hands-on and computer/online STEM-oriented puzzles and games, such as Connect Four, Tangoes, Chinese checkers, Set, Yahtzee, and the Tower of Hanoi. Include age-appropriate video games. Build, dismantle, repair, and develop things together. For example, assemble or construct furniture, build a doghouse, repair household items, take apart a bed frame to be placed into storage, or install software on a computer. Attend STEM presentations and talks, and watch STEM programs on television. Go to planetariums and STEM-oriented museums and centers. Arrange trips to various STEM workplaces, such as science labs, high-tech industries, engineering companies, or actuarial firms, to take a tour, observe workers in action, or talk with STEM professionals. Explore and/or connect with professional organizations, such as Association for Women in Science (awis.org) or Society of Women Engineers (swe.org). Include your daughter’s friends in some of these activities, not only for their sake but also to build a needed peer support network. Engage girls in discussion of these activities, and allow them to ask questions. See the resources listed at the end of this document for STEM activities to pursue jointly.

7. **Help your daughter see how STEM is used in everyday life.** For example, point out and discuss math found in cooking, shopping, and family finances. Examine restaurant checks to be sure they are correct and to determine what tip to leave. Have your daughter participate in budgeting and monitoring family expenses for a period of time (e.g., a month). Interpret graphs found in newspapers, and explore new technological devices. In general, discuss and explore STEM information found in the news and elsewhere, and help your daughter see how STEM can be used to help make the world a better place for living things (tends to motivate girls).

8. **Provide ethnically/racially diverse female historical and contemporary role models, networking/mentoring opportunities, and STEM career information.** Arrange ways for your daughter to observe and/or interact with female role models in STEM degree programs and careers to learn about these individuals and their work. Historical and contemporary role models may also be accessed online at many sites, such as Biographies of Women Mathematicians (http://www.agnesscott.edu/lriddle/women/women.htm) and Biographies of Women in Science (http://www.eiu.edu/wism/about_biographies.php). Note that some same-
age or older peers might also serve as good role models, and some mentoring opportunities can be found online (see for example, MentorNet, http://mentornet.net/). Further, carefully chosen stories, posters, and films can portray appropriate female role models in STEM. (Also see earlier comments about ways that you can be a good role model.) Be sure to use gender-neutral language when mentioning STEM professionals, for example, “Mathematicians… they…,” or better yet, “When a scientist…she or he….” Note that it is also important for males to see and learn about female role models.

Talk with your daughter about career information and what careers she might enjoy. Ask what she envisions doing in the future. Seek information from school personnel, people in STEM careers, and reputable online sources regarding STEM careers and career preparation, and help your daughter choose appropriate coursework and other paths that lead to these or other careers of interest. Parental encouragement and support are important when it comes to girls choosing and preparing for STEM careers.

9. **Build an active, ongoing relationship with your daughter’s teacher, school counselor, and administrators, and consider participating in a parent-teacher organization.** Communicate with your daughter’s teacher periodically about her STEM performance, homework completion, classroom engagement, and dispositions. If need be, create an action plan with the teacher to ensure your daughter is performing satisfactorily. Seek information from her teacher about formal and informal STEM resources and opportunities, such as good programs, contests, events, and online and print self-learning options, for furthering knowledge and skills, learning about female role models, and coping with math anxiety, if relevant. Ask school counselors for print and online information on STEM careers and the preparation required to enter those careers. Become informed about what your school is doing to encourage girls in STEM. Advocate for a school program that devotes substantial attention to quality STEM. This includes sufficient instructional time, adequate equipment/materials, opportunities to hear/interact with female guest speakers and/or mentors, and regular, high-quality professional development for teachers, administrators, and school counselors. Expect high-quality instruction, including homework, that focuses on significant, meaningful material rather than memorized procedures and drill. (A focus on completing pages of computation problems, for example, would not align with today’s understanding of best practices for math teaching and learning.) Optimal instructional settings for females tend to involve hands-on, investigative tasks done collaboratively and in which females assume a significant role (e.g., they are not relegated to recording the group’s work). Allowing time for written and/or oral explanation and questions in a nonthreatening environment is also important. Seek to have your daughter placed in sufficiently challenging coursework. For example, if your daughter shows promise and interest in STEM, request that she be placed in advanced or additional courses, such as algebra and honors science and mathematics courses as soon as they are available, optional computer courses, and further STEM courses once the minimum requirements have been met. To further strengthen your relationship with the school, consider joining a parent-teacher association/organization (see, for example, National PTA, pta.org).
Selected Resources

- Figure This! Math Challenges for Families: http://www.figurethis.org
- Great Science for Girls: Families Taking Action: