Promoting Gender Equity in the Science Classroom

A Practical Guide to Accessing and Implementing Gender-Fair Strategies

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Foreword

The WEEA Equity Resource Center's online course Engaging Middle School Girls in Math and Science is in its fourth offering as this guide is being field-tested, and has received enthusiastic responses from the teachers and others who have taken it. Though the intended audience for this course is middle school math and science teachers, the need for an easily accessible, high quality training course in gender equitable classroom strategies has become clear from the range of people who have registered and taken the course (curriculum developers, teacher trainers, after school program coordinators).

This guide is part of our ongoing efforts to assist and support teachers both in exploring educational equity issues and in translating this learning into realistic, doable strategies and activities that work for them. Our feedback from the course has been extremely positive in terms of the topics covered and the strategies presented. What some of the teachers have pointed out, however, is that the many aspects of classroom teaching and materials that need to be reviewed and possibly modified can seem rather overwhelming to busy educators who have competing demands placed on them, even when they are committed to implementing gender equitable practices.

In this guide, former Boston Public School teacher, and now WEEA staffer, Rebecca Gondek, has undertaken to present the main themes and strategies covered in the course in a format that is easy to review, and to supplement this with additional information and resources designed to provide science teachers with specific, concrete ways to begin the process of building a gender-fair classroom (and hopefully school!). Many of these suggestions are practices or activities that you can do tomorrow. Remember: it is most important that this path be started. Substantive change is a process that happens over time, and it is by beginning that the most important step is taken.

Sundra Flansburg
Director, WEEA Equity Resource Center

Introduction

This guide for the classroom has been designed as a supplementary resource for participants in the WEEA Equity Resource Center's online course Engaging Middle School Girls in Math and Science. Intended to help middle school teachers and others interested in the status of girls and women create more gender-fair content and learning settings, and to encourage girls' interest in and pursuit of math and science, this course encourages teachers to reflect on their classroom practice and examine their pedagogy. Since the goals of the course include raising achievement levels and increasing participation of girls in high level math and science courses and careers, one of the course expectations is that teachers will apply what they have learned to their daily classroom work. This guide was created to help teachers to begin this process and the move toward more equitable education for all students. The resources contained include those appropriate for both science and math classrooms, but with a special focus on science.

Based on the general themes in the online course, the suggestions and resources presented here are drawn from WEEA research projects, the work of other educators and researchers, and the experiences of classroom teachers who have explored how to change the school environment in order to promote the math, science, and technology achievement of girls, especially girls of color and girls with disabilities. The citations provided at the end of each section will lead you to additional resources that explore some of the issues in more detail or offer other specific strategies.

When faced with the multitude of areas one needs to address toward this goal—curriculum, teacher-student interaction patterns, and so on—the creation of a gender-fair classroom may seem a little daunting. It is, however, important to remember that it is not necessary or possible to change everything immediately. This guide is intended to be your tool, to be used over time at your convenience and discretion. It offers a variety of areas in which you can begin to implement changes or reflect on current practices.

Sue Rosser (1993), scientist and the first female dean at Georgia Tech, notes that there tend to be six phases in recognizing gender bias and creating gender equitable science content and teaching:

1. The absence of women in science is not noted in materials.
2. There is some recognition that most scientists are men and thus science may reflect a masculine perspective.
3. There is identification of the barriers that prevent women from pursuing and entering science-related fields.
4. There is a search for women scientists and inclusion of their contributions.
5. Science is done by women (particularly feminists).
6. Science is redefined and reconstructed to include everyone.

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In order to promote female interest and participation in science, we need to advance curriculum and teaching through these phases as quickly as possible.

The guide is organized into two sections. Section 1 begins with strategies and ideas that can be used to create learning settings that encourage girls and all students in science inquiry by focusing on the emotional and physical organization of the classroom. The main points—organized so that they begin with a focus on the teacher's attitude and expectations, move to his/her actions in class, and finally to strategies a teacher can employ in making an impact beyond the classroom—connect to issues raised during the course, and are followed by specific strategies and resources.

Section 2 focuses on curriculum. The strategies focus on modifying existing curricula or adopting new curricula so that the inequities of science education and the neglect of women's contributions to science are addressed. This section is divided into three subsections: evaluation of existing or required materials for biases, "fixing" or dealing with biased materials, and selection of good science curricula that are gender fair.

While the focus of the course and packet is females, it is important to remember boys and girls are also members of different racial, ethnic, and religious groups, as well as people with disabilities and of different sexual orientations. All of these factors also contribute to students' confidence in their academic abilities, and thus, their achievement in math and science. However, here the terms *girls* and *boys* are used for simplicity, it is important to recognize that the term *girls* will include girls who are of different races/ethnicities, social class, and other identities.

Section 1
Learning Settings

What Can Be Done to Change Patterns of Behavior and Reduce Biases?
Teachers provide an essential link between students and their expectations and interest in pursuing careers in science. Teachers care about their students' success and want all students to understand science. Successful teachers strive to reflect their confidence in their students through daily interactions. While there are some general approaches that better serve most students, there are also specific methods for engaging all students in science.

This section is organized in outline form in order to facilitate easy review of different strategies. Designed so that you can try these strategies out one by one, they are organized as follows: The outline begins with points related to teachers' mindset towards and expectations for students, both behaviorally and academically. Next, strategies for modifying teacher actions and interactions with students, and ideas for activity settings and physical layout of the classroom are discussed. Then, exploring career options with students is presented. Finally, this section ends with suggestions for making an impact beyond the classroom walls. Many of these strategies include tips on available resources, and full information on how to access them is included at the end of this section.

➢Teacher is enthusiastic and holds expectations equal for all students.➣

1. **Demonstrate a caring attitude** (Lynch, 2000).
   - A. Make yourself available to students both in class and during free times, and before and after school. Encourage them to come see you for help, or have every student make an appointment with you at the beginning of the year/each term. Caring teachers build connections with their students that lead to greater interest (as demonstrated by higher enrollment and achievement in science classes) because they are perceived to value students and to want to help them. Obviously, this has to do somewhat with a teacher's personality, but more to do with a willingness to demonstrate to students that they should expect personal contact with the teacher each day (Samuels, 1999, pp. 17-18).
   - B. Caring teachers build student-student relationships in class (what Lynch terms "science discourse"), which again leads to more interest and greater achievement. Some tips from Samuels (1999, p. 26) include the following:
     - Encourage the use of study groups.
     - Assign collaborative group projects.
   - C. Teachers can connect the curriculum to students' lives and build an understanding among all students.
     - Invite students to share examples from their own lives, and listen respectfully to their stories.
     - Invite speakers from the students' community and members of that community to participate in class activities. For example, invite a

health care provider from a neighborhood health center to discuss an aspect of biology or nutrition.

D. In addition to the intellectual pedagogy that instructs teachers to connect the curriculum to students' lives and to demonstrate an understanding of their homes and cultural backgrounds, there is also a component of caring and expression of that caring. Lynch considers this affective component of teaching to be best surmised by the term *warm demander,* which she borrows from Vasquez, to describe a warm and caring teacher who values students and works hard to help them succeed (Lynch, 2000, p. 198).

2. **Hold the same *behavioral* expectations for male and female students**. Your practice can have a positive impact on changing behavioral patterns.

A. Students recognize patterns of treatment, and quickly realize what is acceptable for males and what is acceptable for females in terms of behavior, appearance, attitudes and interests, social relations, roles, and occupations. It is important that teachers minimize differences in acceptance of types of behavior based on gender to the greatest extent possible.

- Female students who talk out of turn, are assertive in a more typically "male" fashion, or follow other patterns that are not typically "female" should be treated in the same manner that male students with the same behavior would be treated. *Equal offenses deserve equal punishments whether the perpetrator is male or female.*
    - Students may be expected to raise their hands to ask or answer questions. If this is the case, it should hold for all students. Shouted answers and flailing arms accompanied by attention-grabbing sounds tend to be counter to gender equitable participation (Sanders, 1994, pp. 88-89).
    - If students tend to call out frequently or are noisy in their attempts to grab attention, try giving each student a bright red cup or some other visible marker that can be placed out on their desk when they need help.
    - Speak with students individually if their behavior interrupts the class. It is especially important to not reprimand boys publicly, as their reaction may become more aggressive.
- Compliment or comment on all students equally.
    - Girls are not a homogenous group. Individuals should not be made to feel that their actions represent an entire group based on one characteristic that they share.
    - There is no need to point out the fact that a female has a neat paper (or a messy one), is wearing a dress or skirt for the first time, or any other behavior or display that is contrary to typical popular images of femininity or masculinity.

3. **Hold academic expectations equal for all students**.

A. Encourage females to participate in competitions and contests. If school academic clubs tend to be dominated by males, try having the girls begin an academic club and encourage all students to join (Sanders, 1994, pp. 31-32).

- Participation in MathCounts and Science Olympiad should be stressed for girls and students of color.
- Get girls to join programs outside of school that give them an opportunity to speak with other girls interested in math and science. Middle school girls will be more likely to join a program if it is combined with opportunities to do sports or participate in other activities of interest to them. Find programs (or begin one!) that link up with organizations such as Girls Incorporated (Campbell, 1992).
- Also, there are many summer opportunities available at low or no cost to families. Find a long list of camps that focus on math and science for girls on Education World's website, or through Campbell-Kibler Associates. Spend one-on-one time with girls (and members of their families, if possible) discussing these options and helping them to contact the camps.
- Many universities and colleges have programs that allow students to work with professors in the lab. Find out if they will accept 7th and 8th grade students—you may be surprised to find that they will!

B. Make use of the Internet. The Internet has a wealth of opportunities for girls to enter science competitions, talk to other girls about science, and to learn about the contributions of women to science. Direct girls to Girlstart and Design Your Future: Math, Science, and Technology for Girls, as well as sites that list biographies on women in history (like the WEEA Equity Resource Center: www.edc.org/WomensEquity.

C. *Suggest* advanced work courses for females if they seem interested in the subject matter, even if they may need some additional support to excel in the class. The important factor is that you approach them and discuss the opportunity.

- Issue invitations to *groups* of girls to participate in more advanced work that targets individual strengths or interests.
- Reach out to girls and their families when they need remediation. Set up an all-girl homework help session one day a week.

D. Make modifications that allow all students to succeed at their highest level.

- Modifications allow all students to access the curriculum and achieve the standards within a context that is true to those standards.
- Modifications can include everything from allowing homework to be passed in on a different schedule (for example, allowing more time for reading assignments) to changing *how* science is viewed

in the class, whether it is considered to be a series of unrelated facts or a set of inquiry skills.

E. Mentoring programs can help both older and younger girls.

- When asked to be mentors, older girls feel that they have some knowledge or skills that are useful to others, and the younger girls are encouraged to pursue math and science.
- Mentors from professional organizations and local businesses may be available, or they may be willing to spend some time in the classroom discussing their field.
  - This emphasizes the breadth of careers and the types of people who work in those fields, rather than pressuring girls to *choose* careers. Campbell notes that sessions that focus on choosing careers are very unpopular, but that meeting and talking with people from scientific fields does lead girls to consider those careers for themselves (1992a).
  - The American Association of University Women (AAUW) can help locate members in your area who may be willing and able to visit your class (Sanders, 1994, pp. 50-51).
- This type of program can also encourage girls to learn math and science because it can counter their stereotypes about the types of people who are good at math and science. Meet speakers beforehand (or at least speak to them!) and make sure that they will be different from the "nerd" stereotype—or the program may be counteractive.

F. Stress the usefulness and give examples of the practical applications of subject matter so students can "see" the relevancy of content. Females tend to focus more on the purpose of knowledge, whereas males generally are more willing to explore subject for its own sake (Franklin et al., 1990).

- Make connections between science and other subject areas. There are many great activities that utilize an across-the-curriculum approach to various subjects.
  - Science can connect to language arts using biographies of female scientists (as in the curriculum *The Scientist Within You*, listed in the Appendix at the end of this guide). Science also connects to social studies, from topics as diverse as genetics to food science to evolution to anatomy and physiology.
  - Samuels (1999, pp. 41-52) suggests linking science studies to age-appropriate topics such as nutrition and eating disorders (learn about body image, food choices, menu planning, and eating disorders), human development (including a "baby" adoption program, chick embryology, and an abortion debate), and human sexuality (utilizing multiple demonstration and performance skills).

    - Combine science with other subjects by assigning projects that require going to the library, reading a book, or using math to solve the problem.
    - There are curricula that are already set up to link the topic to catastrophic events that can be read about in newspapers (such as tornadoes, floods, oil spills).
- Take the mystery out of high school/college level courses. Let students know what to expect in high level courses in science by relating what they are learning to the content of those courses. State frameworks can be used to draw parallels between content within a subject area. National and most states' frameworks can be found on the Eisenhower National Clearinghouse web site (http://www.enc.org) or write to your state Department of Education for a free paper copy.
- Present career opportunities in the field. Begin lessons by discussing the types of work that people do that relate to that topic. People who work in genetics study everything from plant breeding to the human genome to cancer and other diseases. For more help in encouraging girls to explore careers, try *Career Choices* (see Selected Resources below for information). The guide helps students determine their vision of success, the realities of career choices, how to do career research, and how to achieve their goals.
- Invite speakers into the class, or take the students to see laboratories and other industries that utilize science.
    - Wastewater treatment plants are sure to get as great a reaction as a zoo or science museum (and are generally free to visit)!
    - Also, if you encounter difficulty finding female speakers, try contacting the Association for Women in Science (AWIS).
- Let girls know about the difference that an education can make in their income earning potential—and let all students know about the continuing disparity between the wages of males and females.

Selected Resources

Association for Women in Science (AWIS), has 66 local chapters in 38 states. The group can be reached at 1200 New York Avenue, Suite 650, Washington, DC 20005; tel.: (202) 326-8940; fax: (202) 326-8960; e-mail: awis@awis.org

Bingham, Mindy, and Sandy Stryker (1996). *Career Choices.* This book and others by the authors can be found in some bookstores, or can be ordered through Academic Innovations, 3463 State Street, Suite 267A, Santa Barbara, CA 93105; tel.: (800) 967-8016; fax: (805) 967-4357. The price should be under $30.

Campbell, Patricia B., and Jennifer N. Storo, "Making It Happen: Pizza Parties, Chemistry Goddesses & Other Strategies that Work for Girls and Others." Campbell-Kibler Associates. Available online at http://www.campbell-

kibler.com/index.htm. The end of the packet contains information on student math and science programs.

Design Your Future: Math, Science, and Technology for Girls is online at http://www.autodesk.com/dyf/dyfmain2.html.

Education World's website http://www.education-world.com/a_curr/curr238.shtml (scroll to the bottom of the page for the list of camps).

Eisenhower National Clearinghouse website can be found at http://www.enc.org/professional/standards/

Girls Incorporated, National Resource Center, 441 West Michigan Street, Indianapolis, IN 46202; e-mail: girlsinc@girls-inc.org; web site: http://www.GirlsInc.org/GirlsInc.htm.

Girlstart can be found online at http://www.girlstart.org/index.html.

➢Teacher acts to promote gender equity and higher achievement for all students in the classroom.➣

4. **Build students' confidence in their own abilities**.
   A. Build students' aspirations in science. Students' success is closely tied to their beliefs in their abilities to do science and math.
      - Females do not need any more support than males do simply because they are female. Do not tell girls how to do work (or actually do it for them).
      - Encourage both male and female students to explore materials and learn how they work by using the materials, rather than directing students or performing the task for them.

   B. Use wait time, give girls specific praise, and pay attention to individuals.
      - Many children need time to consider their answers, and some students may need to be called upon if they are giving signals other than raised hands (e.g., making eye contact or facial expressions that indicate understanding/realization).
      - Girls tend to get less attention. Jacqueline Jordan Irvine (1991) points out that *black girls especially* receive much less attention in middle school than any other group of students, black or white, male or female.

   C. Be sure to acknowledge students' strengths both publicly and privately. Students may need to hear from teachers a lot before they begin to change their own attitudes.
      - Do not force the issue by acknowledging effort: praise should be given for accomplishments, such as "Maria, you've really got the hang of setting up an experiment. You should try some independent projects."
         - Note girls' *performance* and also encourage them in their efforts to improve. Positive praise is essential for building self-confidence (Mid-Atlantic, 1993).
         - When girls make disparaging comments about their abilities, respond with a positive one. However, stick with

the rule that the comment should be specific and based on a capability or action, not an effort.
        - Acknowledging a student's ability to do what she or he has set out to do will encourage effort.

D. Recognize and encourage achievement and improvement.
    - Use a reward system (stars or a bulletin board). This need not be a competition, especially if there are ample opportunities for *all* students to be recognized and rewarded.
    - Set good examples of self-appreciation. Let students know about your past experiences in science, and that they can recognize their own achievements.
    - Be positive. Samuels suggests in *Girls Can Succeed in Science!* (1999, p. 23) that everyone can strive to be more tolerant and patient, though we can't expect people to change their personality.

E. Give students many opportunities to practice skills (both repetitiously and using different applications if possible).
    - Practice makes perfect, and it also reinforces skills so students can build on those skills later.
    - To help students understand science, work on just a few themes over the year, which can be approached in several different ways. For example, when teaching about water, begin with an environmental science angle, then explore the biological necessity of water, followed by water chemistry, and end with an independent project on water quality in the area.

F. Modifications—as mentioned above, all work should have some way for students to achieve some degree of success. *Whether it is a purely academic success or simply a success in trying a new skill, all students should be able to accomplish in the classroom.*

G. Science is about experimenting and trying new ideas. There is also a lot of room for mistakes and fixing incorrect hypotheses.
    - As often as possible, allow for students to see that there are other ways of finding an answer, and that the predicted result in not necessarily the only result (or even the correct one in all cases).
    - Allow students (and reward them) to let you know if you've made mistakes and to help you to fix them. Modeling that people make mistakes may help girls feel more comfortable in science (and math), which is often perceived as a subject that leaves no room for making any (i.e., answers are either right or wrong).
    - Allow students to question the material and you. If they have questions or concerns about science that are related to your material, ask students to share them privately or with the class (if appropriate). Students often find great material that can be useful to everyone.

H. Use girls as peer tutors. They will build confidence in their abilities and reinforce their learning.

5. **Recognize and eliminate biases in classroom practices**.

A. Give all students an equal chance to understand material, ponder questions and new information, and formulate their own ideas and questions.

- Equal prodding and scaffolding should be provided for students on the same ability level or with the same prior knowledge/ experience.
- Do not solve problems *for* girls; all students should be told how to go about solving a problem.
- Give equal talk time (try counting minutes of male and female talk time—use a video camera to make the count less noticeable). Or mark the number of times students are called upon—boys versus girls (Mid-Atlantic, 1993).
- In using the scientific method (for experimenting, problem-solving), increase the numbers of observations and spend more time in the observational stage of data-gathering—this will help ameliorate the gender gap in use of scientific materials and equipment (Rosser, 1993).
- Campbell (1996a) suggests that students should be given the opportunity to read about a topic and do some problems about it before learning the material in class. Give students a pre-assessment or introductory assignment the night before beginning a new topic.

B. Use *gender-neutral language* as much as possible.

- Don't refer to the class or a group as "guys," especially if there are females in it--they're not! Try "Hey everyone, can I have your attention?" or "Are we all paying attention now?" rather than "Hey guys!" or "Guys, let's pay attention!" Besides being less demeaning towards the "gals," these references also allow students to take responsibility for self-monitoring their behavior and attention (Sanders, 1994, pp. 89-90).
- As well as avoiding the traps of using male pronouns to refer to engineers, mathematicians, politicians, and other prominent figures and female pronouns to refer to nurses, flight attendants, and other nurturers, also help the school to avoid referring to a student as "he" in its literature. If the gender of a person does not matter, a female pronoun or s/he can be used just as easily, and it conveys a strong message.

C. Be aware of how you listen to boys and girls: what are your facial expressions, how do you hold your body, do you interrupt girls more than you do boys? Acknowledge that your body language speaks volumes about how much you value the person's thoughts and ideas.

D. Give boys and girls equally complex responses to their questions or answers, whether they are positive or negative.

- "Uh-huh" or a nod are not helpful cues that you accept and understand an answer (Samuels, 1999, p. 24).

- Do not try to "soften" your responses for females—they are able to take the same criticism as boys, since criticism should be given in a caring way. Criticism helps students learn to evaluate their work and thinking processes.
- High order questions help all students to more clearly define their understanding, and are essential for all students to tackle. Use a list of types of questions that fall into each order when creating a lesson plan. During the lesson, mark off whether question was answered by a boy, a girl, or, if both, who answered first.

6. **Eliminate all biases in task assignments and access to materials.** Ensure that girls are not always being assigned tasks that are traditionally "female," such as cleaning up, while boys are asked to fix or move things. Also, it is important that girls and boys are given equal time to use computers and other equipment. This is because girls tend to spend less time in free exploration—make sure that they do so in your class (Sanders, 1994, pp. 73-75).
   A. Set schedules that alternate access for boys and girls (boys get first access on Mondays and Wednesdays and girls get first access on Tuesdays and Thursdays).
   B. It is essential that you monitor group work and class activities. Make counts and keep records (even simple notes next to your lesson plan to help remember who used what and for how long—this will eliminate many arguments.
   C. Set up a sign-up list or coupon system for students to use computers and other equipment. This will ensure that no one uses more than his or her fair share, and allows you to keep a lasting record of who is using materials—and who isn't.
   D. Use a female lab assistant if one is needed (or alternate between using a boy and a girl—this can be used as part of a reward system) (Sanders, 1994, p. 23).
   E. Divide technical tasks and chores such as cleaning and doing paperwork evenly between boys and girls.
   F. All students should be given the opportunity to set up and use all technical equipment in the school, and girls should also try out new materials.
   G. Require that lab reports be typed/word processed—*and make sure there is sufficient access for all students during school time*. Make extra time available for those who don't have computer access at home.

7. **Note in the class that science is not genderless.** Males have had a dominating influence over science, and thus the male perspective has influenced many of the theories that we teach in schools.
   A. In order to teach about observation or primates, you may want to have students find out about the work of Jane Goodall or Dian Fossey, two women who revolutionized primatology, and changed the way that primates were viewed from the former male perspective. For more information, try some of the web sites listed below in Selected Resources.

B. Use resources such as *The Scientist Within You* or the "4000 Years of Women in Science" web site to find out about women who have worked and made many of the important discoveries in various science fields. Often, their names are not mentioned in books, and most people do not know that their work was essential to those discoveries. (Check out Section 2 of this document for more detailed information about women in science.) Be sure to mention the first *and* last names of scientists, so students do not automatically assume that the person is a man.

Selected Resources

For information on Dian Fossey, Jane Goodall, and their work, try some of the following sites: http://www.dianfossey.org/, http://www.janegoodall.org, and http://www.pbs.org/wnet/nature/goodall/html/body_resc.html.

"4000 Years of Women in Science" web site has the following URL: http://www.astr.ua.edu/4000ws/

➢Teacher modifies activity settings and physical layout of class in order to promote gender equity.➢

8. **Avoid the "equity trap": use a variety of teaching methods (lecture, free exploration, experimentation, projects, and computer research, for example) as well as a variety of approaches/connections to a subject.**

A. While it is fine to have math and science topics that relate to the human body (since girls are often interested in their bodies), it is also a good idea to include some areas that might not be a current interest to the girls. Encourage them to explore science in their world and develop new interests.

- Evidence from other countries (such as Australia and Britain) suggests that males and females have responded to science that relates to traditionally female tasks (such as the connection between chemistry and "women's work"), while that is not the case when it is connected to traditionally male activities (Harding, 1996).
- The Girls Scouts of America has an excellent web site that offers girls some links to get them excited about science and technology. Web sites linked to the page are all about science, and a section focuses on women in science. This is a great way to get girls to "tinker" more on the computer, which will help them in the future. (Remember: it is this hobby that promotes computer literacy amongst boys—their willingness to use the computer for nonassigned projects.)
- Another nice web site for girls is maintained by Girls Incorporated. The most interesting section found here focuses on archeology. Direct girls to this web site for independent learning activities.

B. Do incorporate and validate the experiences of students in order to ease the discomfort of a new situation or idea (Rosser, 1993).

Selected Resources
Girls Scouts of America site can be found at: http://www.gsusa.org/girls/LINKS/scilnks.htm#Awesome#Science#Links
Girls Incorporated web site is located at: http://www.GirlsInc.org/GirlsHome.htm.

9. **Cooperative learning can be useful.** However, simply creating cooperative learning groups does not ensure that students will participate equally and have the same opportunities to be active contributors. Both students and teachers often need to learn how to make cooperative groups work and run equitably. Given the typically more aggressive nature of boys (coupled with males' perceptions of the value of their views), male students may take over the group and allow little input from females.
   A. Single-sex groups may be tempting, but this solution doesn't fix the problem that girls have with working in coed groups. At times, you may use this strategy in order to help girls gain confidence or to see what it is about this group dynamic that encourages girls—but it will benefit all students more if they learn to work together (Sanders, 1994, pp. 13-14; Krajcik et al., 1999, p. 136).
   B. Do not assign groups by ability, even if given a homogenous high- or low-ability group. Mix ability levels as much as possible, then work to design the assignment that is a challenge that all students can participate in accomplishing.
   C. Assign a female to be the group leader/director. Often, good curricula have divided the cooperative group members into roles. Be sure to alternate between having girls and boys act as the managers and leaders.
      - Make roles clear from the beginning, and monitor groups to ensure that students are acting in their assigned roles.
      - Keep track of who is being assigned which role, and ensure that roles are rotated for different activities.
   D. Pay close attention to *whose* topic ideas are being used within the group. If there is time, have the girls choose one topic, the boys another, and have all students work on both topics. Alternately, keep the groups the same for two or more topic areas, and have them alternate between using the boys' and girls' ideas.
   E. Be vigilant about the inappropriateness of put-downs. When girls' are brushed aside or their ideas are belittled, they will be unlikely to make further suggestions.
      - Have students work together to come up with a class policy against put-downs and to regulate class behavior.
      - Discuss sexual harassment with your class—each school district's policy should be strictly enforced in your class and in the school, so make sure that you have read it.

10. **The physical environment is important for students to collaborate and become engaged in science.**

   A. Show male and female representatives of various races, ethnicities, and cultures actively engaged in *doing* science. Try contacting some national organizations for posters, including the National Women's History Project and Organization for Equal Education of the Sexes, Inc.

   B. The physical environment invites and supports interests in science.

      - Create a "Science in Your Life" board where students can bring in scientific information that is of interest/concern to them.
      - Create activity centers around the room that promote extracurricular science inquiry (try looking through a science catalog—there are often inexpensive kits or items that demonstrate some scientific phenomena such as the properties of mixtures or how magnetism works).
      - A flexible classroom setup in which students are able to move to collaborate, access resources, and be coached by the teacher helps ensure that students in the rear of the room are not overlooked and uninvolved.

Selected Resources

National Women's History Project, www.nwhp.org.

Organization for Equal Education of the Sexes, Inc., does not have a website. The mailing address can be found at http://www.parentsoup.com/ or call the group at (207) 374-2489.

➢Teacher strives to expand career awareness for students.➣

11. **Set up partnerships with scientists or people who work in science-related businesses to create lessons that exemplify how science is used in the workplace**.

   A. Develop programs that allow girls and boys to job shadow people who use science in their work.

   B. Find out if a local university or college is amenable to creating a program for teachers and faculty to exchange ideas and work together to create science labs or activities.

12. **Keep informed about the types of jobs that require science backgrounds and experience as many of them as you can in person**.

   A. Try job shadowing with someone who uses science or scientific principles in their own work.

   B. Use some of your professional development time to explore science-related careers.

13. **Have students research jobs that relate to the field or specific topic that they are currently studying**.

   A. Students can find both jobs that use the content knowledge and that use the scientific skills learned by studying science. Samuels (1999, p. 41) points out that there are many people who hold nonscientific jobs but have done advanced studies in science that enable them to do their jobs better.

B. Require that students try to represent the racial/ethnic/gender/disability spectrum in their research.

➢Teacher works to make an impact beyond the classroom.➣

14. **Talk to families—especially families of girls**.

A. Direct families to resources such as Linda Samuels' *Girls Can Succeed in Science,* Patricia Campbell's *Math, Science, and Your Daughter,* and the Equity in Education publication *Gender Equity for Educators, Parents, and Community*.

B. At the beginning of the year, send a letter home to families explaining which topics will be covered, and find some resources for them to help their children. Some good places to direct parents are groups such as Girls Incorporated and Girlstart, whose web sites are listed below in Selected Resources, or send them some book titles that can be found at the local library (good titles can be found online).

C. Encourage parents to encourage children's interest in science, but not to badger them if they are not interested.

D. Encourage parents to spend some time bringing children to science museums, parks for nature walks, or cooking. All of these activities will socialize children to understand the importance and prevalence of science in their lives. Help parents find appropriate places to visit using the web sites listed below in Selected Resources.

E. Ask parents to do Internet searches for the family, or to find exciting science projects/experiments that can be done at home together. If they have Internet access, advise them to look at some of the selected sites just for kids and their families listed below in Selected Resources.

F. If families do not have Internet/computer access, refer them to a local library (many have computers for public use) or set up a Computer Night once a week at the school. Stress participation for girls and their families.

G. Also ask that parents encourage daughters to help out in *all* aspects of home maintenance (cooking, cleaning, repairs) and find out about the science of these activities together. For example, mowing the lawn or tinkering with machines can lead to discussion in how engines work or how machines are designed. A great book for girls and their families to read is *Girls and Young Women Inventing,* which describes the inventions of some girls and young women, and allows them to tell their story and the impact that inventing has had on them.

H. Encourage parents to speak positively about science, and to *not* tell their children that they were bad at or hated science.

Selected Resources

The Association of Science-Technology Centers (ASTC) has a great web site with a list of science centers around the nation and internationally at http://www.tryscience.org/fieldTripFASC.html, with tips for preparing kids, available at http://www.astc.org/members/tips.htm (see the Appendix for more details).

List of Science museums around the country: http://www.familytravelguides.com/articles/museums/science1.html.

Listed by state, you can find some science museums that have been evaluated and recommended by engineers and their children, along with an interesting analysis of the family interactions and career exploration that resulted from these family trips (you might use those statistics when talking to families): http://www.spectrum.ieee.org/publicaccess/0995muse.html.

U.S. Department of Energy's web site lists some of the U.S. Science Centers. The site can be found at http://www.doe.gov/educate/eduus.htm.

Girls Incorporated is located at http://www.GirlsInc.org/), and Girlstart's web page is at http://www.girlstart.org/index.html.

For families and students, suggest some of these Internet sites: www.lib.iastate.edu/spcl/wise.k12.html, http://www.academic.org/, http://www.education-world.com/science/, http://www.parentsoup.com/edcentral, and http://www.figurethis.org/index40.htm (math).

Girls and Young Women Inventing (1995) is written by Dr. Frances Karnes and Dr. Suzanne Bean and is available from Free Spirit Publishing.

15. **Change your school and school system by making women into leaders and demonstrating your commitment to a gender bias-free environment** (Samuels, 1999).

A. Class and student councils can have co-presidents—one male, one female.

B. School speakers should represent the school population—be sure to include females, people of color, and people with disabilities as participants in school events and organizations.

C. Posted around the school should be the following:

- Information about national prizes and contests for girls.
- Camps and activities for girls—especially math and science camps and programs. The Selected Resources section below has some places to begin looking.
- Profiles of successful women and women who achieved "firsts" (stress women who did something before men did, not just "first women"). Contact the National Women's History Project or Organization for Equal Education of the Sexes, Inc.
- Advertise other women's issues, especially health-related ones.

D. Attend parent council meetings and ask that gender issues be discussed with parents and administrators.

Selected Resources

Find organizations in your area that run programs and camps for girls by looking at http://www.education-world.com/a_curr/curr238.shtml. Also, AAUW has a list of math, science, and technology programs in most states at http://www.aauw.org/2000/modelsbd.html.

Contact National Women's History Project at www.nwhp.org or7738 Bell Road, Windsor, CA 95492.

Contact Organization for Equal Education of the Sexes, Inc., at http://www.parentsoup.com/. Phone the group at (207) 374-2489.

Section 2

Curriculum

> *Most curricula, according to Rosser (1986, 1993), are only in the first stage toward being bias-free (as described at the beginning of this document).*

State and national testing drives the school climate and agenda these days. Consequently, states have drafted curricular standards and frameworks, which school districts then use to adopt curricula. In some schools there is freedom to choose among curricula to best match the course content to the students in a classroom. For many other teachers, the curriculum (often a textbook, even in middle school) is chosen by the school, and must be adhered to strictly. However, most teachers are able to supplement mandatory curricula, and this can significantly enhance the efficacy of teaching content material.

Whether a teacher has the option to choose her or his curriculum, or needs to follow a prescribed curriculum and supplement as necessary, there are important considerations in eliminating (or dealing with) bias from the curriculum. Whether adopting a curriculum suited to a specific class or preferred teaching style, begin by evaluating or reviewing the curriculum for biases. Listed below are some ideas for evaluating materials. If the materials are extremely biased (such as older textbooks), and must still be used, conduct exercises in the class that will allow students to find those biases for themselves. There are also a variety of supplementary activities that can be used to ameliorate the biases that some curricula may foster. Some great projects that can be used in this capacity are mentioned in this section. Otherwise, if an alternative curriculum can be used, adopt it instead. The end of the section offers suggestions for choosing good curricula, and some examples of good curricula that are being used in middle schools. The strengths of each suggested curriculum are described, as well as possible steps that can be taken to use these curricula to tackle gender bias and stereotypes in the classroom.

➢Evaluate and Review Materials≺

1. **Note what *is* and *is not* included that demonstrates biases on the basis of gender, class, race, and culture.**
   A. This includes both discriminatory language and images/stereotypes of women, people of color, and people with disabilities. Ask whether students can see themselves within the curriculum.
   B. Does the curriculum make a concerted effort to dissuage stereotypical images of scientists? If not, try some of the course activities asking students to draw or write about their own images of scientists, and then follow some of the suggestions given in this guide for reinforcing the reality of who scientists are.

2. **Look at the text for biases in imagery.**
   A. Are the number of images of men and women equal? In number? In types of activity/experimentation that they are engaged in? Are females

shown in the forefront, actually performing science, or are they background figures (Cotera, 1982, pp. 9, 18)?

B. Are members of diverse groups represented (both males and females)? Are they in the background or the forefront? How are they depicted working (in contrast to white counterparts and with others) (Cotera, 1982, pp. 1, 9, 18)?

3. Does the curriculum address the issue of contributions made by women to the field and how does it do so?

A. Is there any reference? Is the reference made in passing or is it substantive?

B. Is the female scientist represented as extraordinary (compared to other women)? Does it acknowledge the difficulties that women encountered in having their work recognized?

C. Is there any connection between the reference to a woman's work and the curriculum? Does the curriculum make the woman and her work seem to be "token," added only to be politically correct, or is there a real value added by knowing about the woman and her work?

- There is a long step from tokenism to a real integration of women's work and scientific values/perspective in science teaching, but it is better to begin with some token portraits of women than not to begin at all.
- After integrating portraits of women and their work into relevant lessons, begin making reference to the lack of attention to noted women in science and build class lessons based on student responses.

4. **The curriculum addresses problems with which more girls may be more familiar—such as the human body, nursing, or cooking.** Though this may seem stereotypical, most teachers recognize that female students generally enter the classroom with different experiences than boys. The key is to expose students to areas that both males and females can learn more about and succeed in studying.

A. However, problems dealing with traditionally masculine areas should not be left out either—*balance* is key. Both boys and girls should be introduced to new experiences in school. This is why they are in school (Rosser, 1993).

B. The material should contain both feminine and masculine perspectives. Make sure that at least some of the experiments have social rather than simply militaristic or capitalistic applications (Rosser, 1993).

C. There are areas that boys and girls will both be interested in—ask the class what those might be. Student input can help make the teacher's job easier because students will be more invested in the work (Samuels, 1999, p. 43).

D. All students (especially middle school students) are interested in their bodies—both learning about them and using them to do new things. Try to relate lessons and topics to humans as often as possible.

E. Girls and boys both also are often interested in animals, though often it is the case that middle school boys generally want to dissect them, while middle school girls prefer to observe or learn about them without dissection. Try to allow all students to have access without forcing the issue of dissection on unwilling students. This is one of the major benefits of the Internet—virtual dissections.

➢Fixing or dealing with biased curricula or lessons➢

Discussion of bias

1. **Discuss sexism in science if you are using older, more gender-biased textbooks and materials.**
   A. Have students spend a class period looking at the text and determining how gender-fair it is.
   B. Students can evaluate text based on illustrations or text content (for example, is the book using *man* to substitute for *humans*?) (Sanders, 1994, p. 47).

2. **If presenting outside data to the class, do so for both male and female subjects, whether it pertains to people or animals.** If nothing else, Samuels (1999) points out, this conveys awareness to students about differences between genders.
   A. Campbell also mentions that it should be noted in the science classroom that the female body is actually the "default" type for humans—it is the presence of testosterone that creates the male form. Thus, it would be a service to students to point out/provide a learning experience on the impact of clinical trials done on males being used to treat female patients.
   B. If studying world diseases, it is often important to note gender differences in contraction and mortality rates—this indicates to students a serious inequity, which can be used as the basis for a debate on morality and science.

Supplementary activities

3. **Concentrate on using an activity-based, student-centered science program.**
   A. Try to use as much hands-on, minds-on science as possible. Don't just end each lesson or unit with a demonstrative experiment.
      - Have girls participate in activities that reflect the type of work that is done in a math or science field.
      - Incorporate engineering activities. Girls that participated in engineering activities were six times more likely to consider engineering in one program cited by Pat Campbell (in *Encouraging Girls in Math and Science*, 1992a & 1992b).

   B. Make connections to student interests throughout the lesson and draw them into more complex science processes through those connections.

C. Try reading some of the suggested books on inquiry-based science teaching listed in the Appendix.

D. Highly recommended curricula for the middle school are listed at the end of the guide as well, in the Appendix. Many WEEA products are quite low-cost supplementary materials.

4. **When creating lessons, tie them to equity ideas**. The *Playtime Is Science* curriculum for elementary school students (see details in the Appendix) correlates each lesson to one of their ideas. Those ideas can readily be applied to middle school lessons as well.

A. Help children to recognize that family members use science, math, and technology in performing many home activities, including cooking, making repairs, storing food, and applying first aid.

B. Often children in special education are stereotyped as unable to stay still and pay attention. Science activities that give students the opportunity to manipulate materials, solve problems, and think creatively will engage all students and mitigate restlessness.

C. Girls typically have fewer play experiences that involve gross-motor and spatial-relation skills. Since these skills are essential for success in science, it is important to provide activities that allow girls access to improving these skills.

D. Students gain countless science skills from gross-motor construction activities – so add as many as possible to lessons (have students construct levers and pulleys, building composting bins, or designing and making containers that will cushion an egg's journey from a high level to the ground).

- These skills can be acquired through the use of recyclables—the things we throw away—in class activities and homework assignments.
- The materials' contributions made by students also reflect the diversity of the children's home cultures, which can encourage them to share more of their own experiences in science and nature.

E. Girls need kinesthetic tossing activities and experiences that will develop their spatial-relation skills, which are essential for science success. Boys generally have more opportunities to develop those skills in their free time.

F. Teamwork encourages cooperation rather than competition. Promoting teamwork is an equity strategy that reflects the preferred and most productive learning mode of many children.

G. Noncompetitive activities allow all students to begin on a level playing field. Everyone has the same opportunity to create a tool, and to have a successful experience. Children can express their knowledge and ideas in many ways.

H. Dealing with materials that are perceived as "yucky" can be detrimental to some students' learning. Offer intriguing substances that are fun to work with in order to break down that barrier. If you are dealing with dissection or body parts, there are some good web pages that can be useful in this respect. See the Selected Resources section below.

I. For as many activities as possible, gather pictures of people from a variety of cultures using the same or other materials for similar purposes.

- For example: in other countries, what products might people use as straining devices? Answer: in South Africa, grass baskets or wooden spoons with holes burnt into the bottom are used; in Australia, those in the Outback use eucalyptus re-growth trees (the spindly, small trees that grow back after an area is clear-cut.
- Ask the students to contribute examples from their own experiences.

J. All children, not just those with a predisposition, need opportunities to "tinker" with machines in order to become comfortable with the technological world in which they live.

Selected Resources

The human body can be explored interactively on the web at:

http://www.innerbody.com.htm/body.html

5. **When creating word problems to supplement text or test items, be sure to depict women in technical careers as the center of the problem.** For example, "Gloria is an engineer. She needs to figure out how much weight can be supported by the bridge she is designing." This creates a realistic situation for students to follow the word problem, and can help reduce stereotypes.

6. **Add women scientists and their contributions to your area of study** (Rosser, 1993). The contributions of women have often been brushed aside or classified as nonscience because their methods may have been different from those of men. It may encourage females to learn more about these women and their different methods of doing science—as many females are made to feel as though they don't "see" the "right" things in science when they are in school.

Note: In this section, because many of the resources are listed repeatedly, all contact information is listed at the end in Selected Resources in alphabetical order.

A. General Science

- 4000 Years of Women in Science gives an introduction to women in science, biographies, photographs, and references.
- *The Scientist Within You* links 2,000 years of women in science to various lessons in topics ranging in scope from "Who Are Scientists?" to Natural Science to Geology to Atomic Physics, and each unit can be used independently or the entire curriculum can be used in its entirety.
- The Association for Women in Science and Engineering has a webpage that includes personal development, activities, a chatroom, and access to the journal, as well as related links.

- Women in Science is a website developed at Humboldt University and includes sections on Professional Associations, Outline Key Concerns, Actions Being Taken, and Ways to Get Involved.
- The San Diego Supercomputer Center has a Web page on 16 significant women in science. The Supercomputer Center site also highlights some of the programs that are offered, such as the Science Interest Group (done in collaboration with the Girl Scouts of America) and K-12 Science and Mathematics Resources that are excellent. The resources are broken down into grade levels and subject area (Biology, Physics, Chemistry, Space and Earth Science, and Geology).
- National Women's History Project site—besides having a catalog of great materials (especially posters of women in science)—has lots of links to learn about the history of women in math and science, aviation, and African-American women.
- Math, Science, and Technology contributors can also be found through the ERIC Clearinghouse.
- The Girls Scouts of America has an excellent web site that offers girls some links to get them excited about science, and technology. Web sites linked to the page are all about science, and a section focuses on women in science.

B. Biology—animals

- Rosalind Franklin's crucial work in DNA provided the foundation for Watson and Crick's later work on the double helix structure. There is a wealth of information about her (bibliographies and discussions about her contributions). Have students conduct a treasure hunt on the Internet, or create some other noncomputer-based activity that would allow them to research her life's work. Since she died very young of cancer, there is a possible connection between DNA and cancer that you could make here.
- 4000 Years of Women in Science has biographies of biologists, marine biologists, behavioral scientists, and zoologists.
- Prentice-Hall has a website that compliments its textbooks, but can also be used to find "bizarre facts" about topic areas, current issues and relevant topics (to the topics covered by the text, but which may coincide with topics in any curriculum), and links to other topics in biology.
- For marine biology, if studying oceans or animals, try the website devoted to Woods Hole's early women (Woods Hole is a marine research station on Cape Cod, Mass.).

C. Biology—plants

- From *The Scientist Within You*, Unit Number 22 focuses on Dr. Elma Gonzalez, a Mexican-born biologist. Students germinate and observe lima beans as they learn about Dr. Gonzalez' research and life.

- 4000 Years of Women in Science has biographies of horticulturalists and botanists.

D. Physics

- The Contributions of 20th Century Women to Physics website has an archive of women physicists in this century, as well as a discussion about the absence of women in physics in the seventeenth, eighteen, and nineteenth centuries.
- 4000 Years of Women in Science has biographies of physicists.

E. Chemistry

- BioChemNet provides links for chemistry-related pages, with some overlap in biology. Somewhat useful, but also a lot of quizzes that you can skip past.

F. Earth and Space Sciences

- *Women of NASA*. This is an interactive project that includes a forum for discussion, and provides lesson plans and teaching strategies. Students can read about female astronauts and learn what it takes to be a space shuttle commander. There are creative lesson plans, as well as a chance for students to ask some of these women questions online. Don't worry, the science is in here too! Basic aeronautical science and social science on women's roles in the workplace allow for students to make connections between NASA's work and their own futures. The curriculum is correlated to national standards in English/language arts, social science, mathematics, as well as science in personal and social perspectives, motions and forces, science and technology, and science processes. Site also includes books for both teachers and students.
- *Rescue at Sea—Marine Conservation*. This science lesson plan allows students to examine their own stereotypes about scientists as they learn about preservation of species.
- *4000 Years of Women in Science.* Has biographies of aviators and architects, as well as natural historians and natural philosophers.
- The *University of California at Berkeley* site has links and women's history in astronomy.
- The United States Navy has a *history of naval women* website that is quite interesting.
- In the environmental arena, there is a *Rachel Carson* website that is geared toward high school level and beyond, but promises the development of a Rachel Carson Homestead page that will target middle-schoolers. The site does have a list of books about Ms. Carson, which includes children's titles.

Selected Resources

4000 Years of Women in Science has a website: http://www.astr.ua.edu/4000ws/.

Association for Women in Science and Engineering web page is located at http://www.awise.org.

BioChemNet's links for chemistry-related pages. Try http://schmidel.com/bionet/teaching.html.

Rachel Carson Homestead page that will target middle-schoolers is in development. Try it at www.rachelcarson.org.

Contributions of 20th Century Women to Physics website is at http://www.physics.ucla.edu/~cwp/.

ERIC Clearinghouse's list of contributors in math, science, and technology can be found at http://www.ericse.org/whm2000.html.

Rosalind Franklin's life and work is well documented on the web. To start, look at these sites: http://www.sdsc.edu/ScienceWomen/franklin or http://www.pbs.org/wgbh/aso/databank/entries/bofran.html (which connects to a DNA Workshop for use in the classroom, though that requires ShockWave to operate).

The Girls Scouts of America's website with link to other pages focused on science is located at http://www.gsusa.org/girls/LINKS/scilinks.htm#AwesomeScienceLinks

National Women's History Project page is at www.nwhp.org.

Prentice Hall's website that compliments its texts can be found at www.prenhall.com/audesirk

Rescue At Sea—Marine Conservation is found at http://www.nytimes.com/learning/teachers/lessons/980922tuesday.html.

The San Diego Supercomputer Center site, listing 16 women in science and programs offered for girls, is http://www.sdsc.edu/Publications/ScienceWomen/.

The Scientist Within You, by Rebecca Lowe Warren and Mary H. Thompson. See the Appendix for a more complete citation.

The United States Navy website on the history of naval women is located at maia.usno.navy.mil/women_history/history.html

The University of California at Berkeley—women in astronomy is found at http://astron.berkeley.edu/~gmarcy/women/history.html

The Women in Science website is located at http://www.humboldt.edu/~jlm12/fem-science.html

Women of NASA is found at http://quest.arc.nasa.gov/women/teachingtips.html or http://quest.arc.nasa.gov/space/frontiers/activities/desk/over.html

The Woods Hole's early women (Woods Hole is a marine research station on Cape Cod, Mass.) page can be found at www.mbl.edu/html/WOMEN/women.html.

Use of Other Materials

7. Take care in selecting materials for demonstrations and activities.

A. Use female mannequins and posters for demonstration (Sanders, 1994, p. 23).

B. Try to access enough probes and sensors that students can use to measures living things (temperature, salinity, force, etc.). Girls and boys will love to work with these gadgets, and the CBL and CBR sensors can be connected to calculators to record data (Sanders, 1994, p. 23).

C. Decrease the numbers of exercises and experiments that require students to work with dead animals or other materials that might be offensive to them (Rosser, 1993).

D. Have students read science-related novels and short stories, since many boys and girls tend to have a lot of interest in literature (Sanders, 1994, p. 23).

8. **Add books on females in science to the school library or your classroom collection** (Sanders, 1994, p. 47). Some examples include the following:

A. *Girls and Young Women Inventing* by Frances A. Karnes and Suzanne M. Bean.

B. Series of *Cool Careers for Girls…*, by Ceel Pasternak and Linda Thornburg.

➢Selecting Excellent Science Curriculum and Lesson Plans➢

Middle school is the time period when the curriculum moves from the concrete to the abstract. This is also when the achievement gap begins to gulf between boys and girls. This is based on the fact that boys generally have more concrete experiences in observing phenomena than girls have. Thus, Samuels (1999, p.12) explains that we need to compensate by providing curricula that begin in the concrete and move towards the abstract concepts that students should understand. The following are examples of curricula that are exemplary in challenging traditional gender stereotypes, either through direct and explicit lessons or in the scope and perspective of the activities. Most can be used to supplement other curricula, or can be used as they were written. Also, most of these can be used as models in adjusting or reorganizing present curricula if you have a little flexibility. Detailed contact information for obtaining these materials is provided in the Appendix.

Science EQUALS Success

By Catherine R. Conwell, The Charlotte EQUALS Program

- Based on the EQUALS program for math at University of California Berkeley, this is a discovery approach to learning science. These activities were designed to meet the specific needs of females and people of color.
- Contains hands-on activities that center on four processes: problem solving, cooperative learning, spatial skills and career awareness. All four of these are areas that have been discussed and targeted as key in interesting, motivating, and preparing girls for careers and academic success in science.
- Activities are designed to supplement an existing program, and most can be completed in a single, 50-minute period.
- Activities include such titles as “Animals Today and Long Ago,” “Directions form the Sun,” and “pH Paint.” They are all listed in a process chart to

demonstrate which processes are used in each, and titles are quite explicit in highlighting the content.

Add-Ventures for Girls: Building Math Confidence for Junior High
By Dr. Margaret Franklin, University of Nevada

- Though this book is written to build math confidence, many activities and suggestions are easily adapted to the science classroom.
- In five parts, this book addresses issues of attitudes and math, relevance of math, the learning environment, issues of computer access, improving spatial visualization skills, improving test-taking skills, and promotion of mathematics. Most, if not all, of the strategies could easily and clearly be adapted to the science classroom.
- Unfortunately for the science teacher, the activities are geared to the math classroom, but some carry over to science. This is especially true for activities in the “Building Math Confidence” section, where students can practice calculating volume, measuring, estimating and “guesstimating.” Also, there is lots of work in percents and ratios that could be applied to science experiments and using statistics, which could be used as the basis for discussions, such as those mentioned earlier for highlighting differences in gender in drug testing.
- All around, a great resource book, and has many activities that can be used in interdisciplinary work between math and science.

Spatial Encounters
By the Behavioral Research Division of the Institute for Applied Research Services at University of New Mexico, Albuquerque, under the direction of Peggy J. Blackwell

- Book addresses the difficulty that females have in perceiving the relationships in and among three-dimensional objects. These activities are meant to ameliorate the lack of experience that girls often have in learning the total concept of space due to limited opportunities to practice such skills. A series of activities on spatial relationships focuses on building skills in both visualization and orientation. Visualization refers to the ability to manipulate and rotate two- and three-dimensional objects mentally, while orientation refers to the perception of elements in patterns, comparison of patterns, and determination of one’s body position in space.
- To build visualization, students are put through a series of memory games. In addition, occupations that require such skills are highlighted, as well as other applications of the skill (in order to answer those questions about the value of doing a lesson).

- Spatial orientation is built through a series of activities (and many others are recommended for students to try on their own or in class, such as “play electronic games in which you have to understand patterns and how they are arranged” or “read and interpret topographical maps”). Students engage in Memory of Shapes, Figure Completion, and Rotations.
- The guide also has a Careers section, as well as Suggested Readings and Games.
- Activities are great because they can be used independently or as a unit, there is a progression of exercises from easier to more difficult in order to accommodate learners at both ends of the spectrum, and the exercises are appropriate for all age levels.

Girls Can Succeed in Science
By Linda S. Samuels

Sample Activity—Nutrition: Draw Your Body Image

- This is one of the great lessons in Samuels’ book, since it does correlate to many of the ideal qualities of a gender-fair curriculum. It is obviously relevant to the topic of food and nutrition (a staple topic of middle school science and health), and it pertains to real life, as well as being a topic that girls—and boys—in middle school are interested in learning. The best aspect of this lesson is that it is one that does not simply have a vague or token reference to women or a female perspective. Rather, it truly integrates the female perspective and interests at this age (middle school). This lesson does not involve any “hard” science, but it can be linked to a curriculum that does.
- Samuels does a great job of linking her lessons and activities to her principals of teaching. In this laboratory experiment, Samuels supports the use of this lesson because it is interdisciplinary, relates to real life, is an age-appropriate activity, and incorporates alternative laboratory assessment, four of the key criteria listed in her philosophy of science education.
- Samuels gives a good introduction discussing the relationship between distorted body images and eating disorders, then shares the purpose of the lesson (to learn about body image and how it affects nutrition and eating habits, and to raise awareness about disorders).
- The only materials listed are art supplies, and the methods are short.
- The methods for students are to draw a picture of yourself to share with the teacher, write three things you are proud of about yourself, and, finally, draw an ideal man and woman, with a key for the latter drawings that labels the characteristics that each sex should have. The teacher then chooses drawings from the class to interpret with them regarding American’s ideas about body image.
- Samuels also lists two books for the teacher to use in obtaining information and advice on teaching about eating disorders.
- Samuels has other lessons on nutrition in the book, including nutrition and digestion, “Cafeteria Lab” (which explores nutrition, practicing the scientific

method, and learning about the topic of unhealthy eating and disorders), and a "Food Fair" lab (which allows students to learn more about nutritional values, balanced meals, and the foods of other cultures).

- The book also lists lessons in animal observation, writing in science (about classification, ecology, genetics), and labs in genetics, reproduction, biotechnology, and other middle school topics. Most follow the philosophy of this lab in addressing gender issues in the perspective of the lab, the topic area and activities, and by involving students in the issue.

Dance Science

By Linda S. Samuels and Rebecca Flanagan

- This course, developed by the Tufts University Fellows Program, was designed to bring together science and dance through an activity-based and collaborative course while studying genetics, evolution, and human anatomy and physiology.
- Topics are meant to help students understand themselves as human machines and as people.
- The course covers both biology and health-related issues including nutrition, weight control, fitness, and psychology.
- While the course was intended to be used at an all-girl school, its basic premise follows many of the underlying principles of gender-fair curricula, and should be studied for adaptation and applications in coeducational settings.
- Again, as in her lessons in *Girls Can Succeed in Science,* Samuels deals with gender inequity not through trivial references to women, but by creating materials that will interest girls, are relevant to issues that trouble girls, and by using activities and learning settings that are interesting to girls. Her entire perspective on science is welcoming to girls and boys, and would help students from many backgrounds. For example, Irving (1991) notes that black children especially achieve better when in a learning environment that capitalizes on their cultural learning style—including, for example, activities involving physical movement and that stimulate sensations. However, all students can benefit from these types of instruction.

Women of NASA

- This is a series of interdisciplinary activities that can be used by printing sheets from the Internet. There are activity sheets, readings, student guides, and student worksheets, which are used along with the material found on the web.
- Covers aeronautical science (with a hands-on exploration of the orbiter's control surfaces).

- Some mathematical applications of aeronautical science are offered for students, as well as a section on the social science approach to women's work (with a chart on the changing role of women in the workplace that can be used as a starting point for discussions or writing assignments), and a section on the first flight guided by a female commander.
- The last section also makes a connection between the women and students' lives.
- Students are asked to imagine what their own trip to space would be like. They are able to chat online with the first female commander of a space flight, and with other women involved in NASA, including Spanish-English bilingual women.
- In addition, the site has many suggestions for students and teacher readings, as well as a list of websites that feature women in flight and space shuttles in general. There is also a curriculum link to "Women's Issues and Career Research Unit" that can be used for supplementary activities.
- Overall, this curriculum is obviously focused on a topic that may interest both boys and girls. There is a strong female component that challenges the image of a male astronaut, and opportunities for females to challenge traditional female roles and images. Unfortunately, there is a stronger emphasis on social science and interdisciplinary work than on scientific investigation, but that can be supplemented with other curricula on physics or earth sciences.

Unmixed Messages

By Association for the Promotion and Advancement of Science Education.

Following is a description of the program taken from the foreword on the project website: "A world where countless women influence and practice science, where those who don't are not intimidated or turned off by it, where all people retain a healthy curiosity about it, will have its genesis in today's elementary classrooms. Such a place and time promises not so much the transformation of girls and women and the reorientation of boys and men, but the metamorphosis of science. No longer the exclusive preserve of the masculine, science can expand into new dimensions through the infusion of different voices. Vestigial stereotypes, such as the mad scientist, man's domination over "Nature," the girl too pretty to do math, and all the other cobwebs of science can be neatly brushed away. But this change won't come easily. And it might never transpire without you.

"*Unmixed Messages* is designed as a benchmark for teachers' self-monitoring, as a trigger for personal interpretations of equity and as a practical instrument for applying ideas in the classroom. Scribble in it. Refer to it. Challenge it. Revisit it. Above all test it.

"A de-scrambler of the vast and sometimes contradictory array of teaching options advocated by practitioners, governments, feminists and other visionaries, researchers and torchbearers for the status quo, Unmixed Messages presents you with a stepping-stone approach to equity theory and practice." (http://www.apase.bc.ca/unmixed/unhome.html)

- This program is meant to provide teachers with easy to use (in terms of time and effort) activities to interest both boys and girls.

- Interdisciplinary, though science is the key focus.
- There are three sets of activities, each with suggestions for extending the activities into more interdisciplinary work.
- The first section explores chemistry using materials such as toothpaste, ice cream, and paper. The second section explores the science of music—sounds, force, instrument design and construction, and sound engineering. The third section gives students the opportunity to practice science skills including deduction and invention.
- It is geared to elementary age students (though the applications to middle school topics are clear) with topics that both boys and girls find interesting.
- The activities allow students to use multiple learning styles and utilizes group work.
- As with Linda Samuels's lessons, this curriculum is extremely relevant to students' lives, connects to things that they know and understand, is interdisciplinary, and allows for career exploration in a meaningful way. The lessons are definitely intriguing and involve enough movement and "messing around" to stimulate all students.
- The only downside to these lessons is that they are not an entire curriculum, and do not necessarily provide links to career resources for the teacher. However, the website has all of the materials available for printing out, and there are many fun activities to supplement a curriculum, or to design a curriculum around.

Uncommon Knowledge Volume One: Hands-On Science Projects

By Carolyn S. Carter with Marian Keyes, Patricia S. Kusimo, and Crystal Lunsford

- Can be downloaded in its entirety as a pdf file from the website. Besides the curriculum, there are stories and articles, and a list of online equity resources (including other curricula) available at the site.
- Based on using and developing respect for the wisdom of students' home culture, this curriculum works to dispel the myth that science is for people (i.e., men) in white lab coats. By drawing on the wisdom of family and community elders, students begin to see the science in their world.
- Designed for use in rural areas where few women have work that is obviously based in science or math, and thus girls have few role models, this curriculum strives to make the applications of math and science clear. Thus, the activities are related to quilt designs, food preservation, nutrition, and home health remedies.
- In the sessions that Appalachia Regional Educational Laboratory (AEL) has held, boys have enjoyed participating in the same activities as girls while working to solve some very open-ended science and math questions.

Sample unit—The Science of Nutrition

- This unit, along with the others, can be downloaded from the Internet and begins with a careful introduction. Students study dietary guidelines and their own eating habits in order to learn about balance, they relate nutrition to health, and study the roles of culture, ecology, geography, climate, and sociology in diet and nutrition.

- The unit warns that due to the particularly critical view that young girls (and boys) have of their bodies, extra attention should *not* be focused on calories and the negative impact they have on the body in large quantities.
- Lessons focus on the positive aspects and challenge students to create their own products.
- Students participate in activities to learn about the following:
  - the makeup of foods they eat in relation to the food pyramid
  - the content of familiar foods by testing for starch and Vitamin C
  - nutritious snacks (then students invent their own snack recipes)
  - testing for simple fats and discuss fake fats
  - measuring caloric values
  - caloric requirements
  - healthy fast food
  - decoding food labels
  - connecting nutritional knowledge to cultural foods
  - diet-related illnesses in the community
- The nutrition unit will have obvious areas of interest for the majority of students. It also holds an opportunity for positively impacting students' food choices.
- The unit allows students to explore many career options, especially while they are researching illnesses in the community that relate to food.
- Students develop key science skills in addition to covering required local and national topics.
- The unit also includes ideas for other projects to include during this period of study, as well as readings for the students.
- In summary, this unit and the entire curriculum are excellent examples of redefining the perspective of science so that it is more interesting and accessible. Students can make connections to their family and community, as well as having the opportunity to look beyond their traditional choices. The one area that could be improved is to help students become more exposed to the gender implications of health.
- While the unit does offer good ideas for additional projects, it does not examine gender as a factor in nutrition and health in spite of the fact that it plays a profound role. A thoughtful teacher can easily remedy this, of course, by making simple additions to those projects. One example comes from the project entitled Ethnicity, Place, and Health. This project states that "some health-related problems are particularly common in certain cultures, geographic areas, or ethnic groups. Some of these problems may be related to nutrition. Use the Internet or library to explore relationships among geography, ethnicity, and nutrition-related illnesses." Certainly, adding gender to the list will create an opportunity for students to speak more with their family members and community health experts. In addition, important discussions about drug testing can be addressed.

Gender Equity Classroom Activities: "Infusing Gender Equity into the Core Curriculum Content Standards"

By the New Jersey Statewide Nontraditional Career Assistance Center, The College of New Jersey

- Curriculum addresses the following science standards:
  Identifying systems of interacting components and understanding the relationship between components.
  Developing problem-solving, decision-making, and inquiry skills.
  Developing an understanding of the cultural component of science and technology, and the impact that cultures have had on the advancement of science and technology.
  Understanding that technology is an application of science.
- Activities designed to help students in analyzing classroom materials, instruction, and school activities for gender biases include learning of gender equity terms, development of opinions about gender equity issues, carrying out of toy surveys, and identifying their attitudes toward gender equity.
- Activities designed to help students explain laws that prohibit inequities based on gender include a Title IX situated case study discussion for middle schoolers.
- The activity designed to help students list strategies to overcome gender bias and inequity involves conducting a survey in the school and planning a strategy to rectify biases.
- Activities designed to help students identify nontraditional career opportunities include drawing pictures of the types of people they perceive to perform certain jobs (for younger students), determining if their career interests are nontraditional, and learning what the current statistics are for the workforce.
- Overall, this curriculum is not based on hard science, but the activities are important for any classroom. Due to the inquiry-based methods used, the activities can be helpful for the start of the year especially, or if the class has had some overt situation involving gender inequity or bias. I would also recommend that the activities be used separately throughout the year to reinforce cooperative work and group unity at periods of transition. For many educators, it would be difficult to utilize these activities by themselves (as opposed to as supplemental activities for off days or down time). These are an important resource though, and it is worth obtaining a copy.

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Sanders, Jo (1994). *Lifting the Barriers.* New York: City University of New York Graduate Center, Gender Equity Program.

Appendix

Resources

Following are many of the resources that have been referred to throughout this guide as resources. We recommend them highly for your professional development collection, as they go into more depth on the strategies outlined in this guide. Please also check under Selected Resources at the end of several of the sections. Note: When prices are mentioned, they are for orientation purposes only and are subject to change without prior notice. Please check with the publisher for actual price.

Recommended Curricula and Lessons

Available through the WEEA Equity Resource Center. Call the distribution center at (800) 793-5076 to order. Product ordering address: WEEA/EDC-C00, P.O. Box 1020, Sewickley, PA 15143-1020. E-mail: EDCorders@abdintl.com.

Blackwell, Peggy J. (1982). *Spatial Encounters: Exercises in Spatial Awareness*. University of New Mexico.

Campbell, Patricia B., and Jennifer N. Storo (1996). *Math and Science for the Coed Classroom*. Campbell-Kibler Associates. Series includes pamphlet "Teacher Strategies that Work for Girls and Boys," among others.

Campbell, Patricia B. (1992). *Encouraging Girls in Math and Science.* Campbell-Kibler Associates. Series includes the pamphlets "Nothing Can Stop Us Now: Designing Effective Programs for Girls in Math, Science, and Engineering," and "Working Together, Making Change," among others.

Conwell, Catherine R. (1990). *Science EQUALS Success*. Charlotte EQUALS.

Cotera, Martha P. (1982). *Checklists for Counteracting Race and Sex Bias in Educational Materials*.

Franklin, Margaret (1990). *Add-Ventures for Girls: Building Math Confidence (Middle School)*. University of Nevada. A manual for elementary school is also available.

Sanders, Jo (1994). *Lifting the Barriers: 600 Strategies That Really Work to Increase Girls' Participation in Science, Mathematics, and Computers*. City University of New York Graduate Center.

Warren, Rebecca Lowe, and Mary H. Thompson (1996). *The Scientist within You: Experiments and Biographies of Distinguished Women in Science.* Vol. 1. Eugene, OR: ACI Publishing. Available through WEEA while supplies last, or contact ACI Publishing (P.O. Box 40398, Eugene, OR 97404-0064; tel.: [800] 935-7323).

The following recommended resources are not available through WEEA. You may order them directly from the publisher or from your bookstore. Contact information has been provided for those publishers/distributors that mainstream bookstores may not be familiar with.

Association for the Promotion and Advancement of Science Education (1994). *Unmixed Messages*. APASE, Suite 200 – 1111 Homer St., Vancouver, British Columbia

V6B 2Y1, Canada. Tel.: (604) 687 –8712. E-mail: info@apase.bc.ca. Web site: www.apase.bc.ca/unmixed/unhome.html

Carter, Carolyn S., with Marian Keyes, Patricia Kusimo, and Crystal Lunsford. *Uncommon Knowledge: Hands-on Science Projects.* "Food for Thought: The Science of Nutrition," "Eyes on Herbs: The Science of Folk Medicine and Natural Dyes," and "The Science of Food Preservation: Crocked Cabbage, Jerked Beef, and Pickled Pigs' Feet." All three can be downloaded from the website at: www.ael.org/eric/voices/science.html.

Education Development Center (1997-98). *Insights—For Grades K-8*. Series. Dubuque: Kendall-Hunt Publishing. Kendall-Hunt Publishers, 4050 Westmark Drive, Dubuque, IA 52004-1840. Tel.: (800) 770-3544. Web site: www.edc.org/CSE/insights3.html.

Karnes, Frances, and Suzanne Bean (1995). *Girls and Young Women Inventing: Twenty True Stories about Inventors Plus How You Can Be One Yourself*. Minneapolis, MN: Free Spirit Publishing. Free Spirit Publishing, 217 Fifth Ave., Suite 200, Minneapolis, MN 55401-1299. Tel.: (800) 735-7323. Web site: www.freespirit.com.

New Jersey Statewide Nontraditional Career Assistance Center. *Gender Equity Activities for Science*. Ewing, NJ: New Jersey Nontraditional Career Assistance Center. Can be obtained as part of a series entitled "Infusing Gender Equity into the Core Curriculum Content Standards," available for approximately $30. New Jersey Statewide Nontraditional Career Assistance Center, The College of New Jersey, P. O. Box 7718, Ewing, NJ 08628-0718. Tel.: (609) 771-2816. Fax: (609) 637-5106.

Samuels, Linda (1999). *Girls Can Succeed in Science: Antidotes for Science Phobia in Boys and Girls*. Thousand Oaks, CA: Corwin Press. Tel.: (805) 499-9774. E-mail: order@corwinpress.com.

Samuels, Linda, and Rebecca Flanagan (1997, April). "Dance Science." Available online at http://www.tufts.edu/as/wright_center/fellows/linds/dance.html, or contact Linda Samuels at Msamu50@aol.com for more information.

Sprung, Barbara, Merle Froschl, and Linda Colón. *Playtime Is Science: An Equity-based Parent/Child Science Program*. New York: Educational Equity Concepts. Educational Equity Concepts, 114 East 32nd Street, New York, NY 10016. Tel.: (212) 725-1803. Fax: (212) 725-0947. E-mail: information@edequity.org.

Women of NASA Project: Women of NASA. Find it on the web at: http://quest.arc.nasa.gov/women or http://quest.arc.nasa.gov/space/frontiers/activities/desk/over.html.

Other Highly Recommended Books about Science and Gender-Fair Teaching

Grayson, Dolores A., and Mary D. Martin (1997). *Generating Expectations for Student Achievement: An Equitable Approach to Educational Excellence.* GESA Manual for Teachers. Canyon Lake, CA: GrayMill. Tel.: (909) 246-2106. E-mail: graymill@iinet.com.

Harding, Jan (1996) "Girls' Achievement in Science and Technology—Implications for Pedagogy?" In Patricia F. Murphy and Caroline V. Gipps (eds.), *Equity in the Classroom: Towards Effective Pedagogy for Girls and Boys*. London: UNESCO.

Horgan, Dianne D. (1995). *Achieving Gender Equity: Strategies for the Classroom*. Boston: Allyn and Bacon.

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Mastny, Aleta You, Sami Kahn, and Sharon J. Sherman (1992). *Science Teams Teacher's Manual*. New Brunswick, NJ: Consortium for Educational Equity. Rutgers, The State University of New Jersey, Bldg. 4090, Livingston Campus, New Brunswick, NJ 08930. Tel.: (908) 932-2071.

Mid-Atlantic Equity Center (1993). "Beyond Title IX: Gender Equity Issues in Schools." Available online at: http://ww.maec.org/beyond.html. Mid-Atlantic Equity Center, 5454 Wisconsin Avenue, Suite 655, Chevy Chase, MD 20815. Tel.: (301) 657-7741.

Rosser, Sue V. (1993). "Female-Friendly Science—Including Women in Curricular Content and Pedagogy in Science." *The Journal of General Education 42(3)*: 191-220. A good abstract available is online at: wysiwyg://145/http://onlineethics.org/ecsel/abstracts/femfriendsci.html.

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Shaffer, Susan Morris, and Jill Moss Greenberg. *Gender & Disability: A Manual for Educational Training*. College Park, MD: Vocational Equity Technical Assistance Project. Contact: Dr. Donna Hart, Director, Resource Center for Non-Traditional Careers, University of Maryland, 3106 J. M. Patterson Bldg., College Park, MD 20742-2211. Tel.: (301) 405-7367. Fax: (301) 405-7138. E-mail: serc@umail.umd.edu. Web site: http://www.inform.umd.edu/ERC/Catalog/Order_Form.html.

Skolnick, J.; C. Langbort, and L. Day (1982). *How to Encourage Girls in Math and Science: Strategies for Parents and Educators*. Palo Alto, CA: Dale Seymour Publications.

Additional Materials and Resources for Math, Science, and Technology

American Association for the Advancement of Science (AAAS). Has an excellent resource web site for teachers in math and science. Web: http://www.AAAS.org/HER/HER.htm. Contact: AAAS, Directorate for Education and Human Resources, 1200 New York Avenue N.W., Washington, DC 20005.

Association of Science-Technology Centers (ASTC). Has a great web site with a list of centers around the nation and internationally at http://www.tryscience.org/fieldTripFASC.html, and with preparation tips at http://www.astc.org/members/tips.htm. Interactive web site gives many ideas for using centers effectively for all students. Also has other resources. According to the site,

The ASTC Resource Center contains articles and reports of interest to professionals in the science center and museum field. “Accessible Practices” addresses the interests and needs of underserved groups in general, and people with disabilities in particular. “Behind the Scenes” includes profiles of professionals working in the science center field. “Education” contains a variety of resources dedicated to informal science education. The “Trading Post” is a place where professionals can trade surplus objects or materials that are no longer of use to them or their institutions. “Youth Programs” supports the development and implementation of youth programs in science centers and children's museums.

Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) has a wonderful catalog of curriculum resources which teachers can search by topics including women, role models, female, and equity, or look for subjects relevant to equity (women in science, African-Americans in science, and so on). There are also career exploration materials that address equity. Find the catalog online at www.enc.org or call for a CD-ROM version at (614) 292-7784.

Hulme, Marilyn (1995). *Equity Materials in Mathematics, Science & Technology: A Resource Guide*. Philadelphia: Research for Better Schools. Contact: Research for Better Schools, 444 North Third Street, Philadelphia, PA 19123. This is a great resource guide for print materials, career information, and videotapes and films.