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ABSTRACT

Society's perception of women in the field of mathematics is slowly changing, but strong social messages remain that technology, mathematics, and science are nontraditional arenas for girls, and girls self-select out of these areas. This booklet is directed to both families and educators, because the work of encouraging girls in math begins at birth and continues throughout the school years. The purposes of this booklet are to: (1) provide information about the harmful and lasting effects on girls and boys of gender-role stereotyping; (2) help administrators, teachers, and families as they develop ways to reduce gender-role stereotyping and encourage K-12 girls in math; and (3) offer educators and families the most current strategies that work to encourage both girls and boys in math. Section titles are: "Stereotyping and Math," "Creating a Good Math Climate," and "Six Classroom Strategies." Contains 36 references and a list of 14 resource organizations. (MKR)

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Gender-Fair Math

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Introduction

Society's perception of women in the field of mathematics is slowly changing. In education, some math classes for girls only have been instituted to raise female students' participation. Math and science clubs, computer clubs, and even girls only chess electives have become popular. However, although the presence of girls is no longer uncommon, boys still outnumber girls in upper-level math classes. And while women are not entering careers that need mathematics in equal numbers to men, neither are women a rarity in these fields.

Young women are entering mathematics and science fields at much lower rates than young men and are also dropping out of math and science majors in greater numbers than young men with the same grades. The strong social messages remain that technology, mathematics, and science are nontraditional arenas for girls, and girls self-select out.

This booklet is directed to both families and educators because the work of encouraging girls in math begins at birth and continues throughout the school years. We are a community of teachers who all have an influence on how girls and boys learn, and we must interact in order to equip girls with the best chance possible to succeed at mathematics.

The purposes of this booklet are to

- provide information about the harmful and lasting effects—on girls and boys—of gender-role stereotyping
- help administrators, teachers, and families as they develop ways to reduce gender-role stereotyping and encourage K–12 girls in math
- offer educators and families the most current strategies that work to encourage both girls and boys in math

We know we must learn to teach in ways that engage rather than exclude girls, provide more female math role models for girls to emulate, and boost girls' confidence in their ability to succeed at math. And, as family members and educators, we need a clear understanding of what helps or hinders girls. The strategies and activities suggested in this booklet are focused on equitable math for girls, but they can benefit all students.

Stereotyping and Math

Teachers believe, from the earliest school years, that boys are smarter in math and science, yet it is in the early school years that girls get better grades on tests and equal scores on standardized tests.[1]

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From the earliest years girls and boys are given the message that math is for males. Boys are encouraged to build, to play soccer, air hockey, and chess, and to play with action toys, and as a result learn about math concepts. Young girls are encouraged to express themselves verbally, with little opportunity to experience those concepts (velocity, angles, three dimensional configurations) that become the core of mathematics.

Stereotyping means making generalizations about people based on commonly held beliefs or societal expectations rather than on actual individual characteristics. We are using gender stereotypes when we believe that boys are "supposed to be aggressive" or that girls are "supposed to be quiet." Some people stereotype math as a masculine subject and mathematicians as cold and unfeeling.

There Is No Math Gene

Another common gender stereotype is that there is a biological basis to math differences—in other words, that boys are genetically programmed to be better than girls at math. But we know there is no math gene, and girls are born as capable as boys of mathematical problem solving. Gender differences in mathematics achievement have become small enough in most areas to be considered negligible. While society may change fast enough for this to happen, biology doesn't! Gender differences in traditionally male areas such as spatial relations have been eliminated by changing teaching practices and providing both girls and boys with opportunities to build their skills. Practice can improve many things, but not genes.

Math anxiety and technophobia are learned responses that begin at home. We are taught stereotypes by our families, the media, teachers, peers, and textbooks. As girls reach adolescence, the stereotype about math being only for males is one of the powerful barriers that prevents many girls from becoming interested in mathematics.

What about advanced math courses? Girls' lack of confidence in themselves as math learners, their perception of math as a difficult subject, and their view that math is a male activity can all have an impact on their achievement

and participation in math, especially in advanced math. When young girls feel that math is inappropriate for them, they naturally feel anxious about succeeding in math and have more negative attitudes toward math in general. Research shows it is not only young girls who don't see themselves as mathematicians or scientists, it is also their parents and teachers.

Math-Related Consequences of Gender-Role Stereotyping

Both boys and girls define science and mathematics as male as early as the second grade.[2]

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The gender-role stereotyping of girls as not being interested in or adept at math has created a climate where middle school girls are not choosing advanced math courses. We know it is not a question of ability. Research has found that in the general population women and girls outperform men and boys in math by a very small amount. Females score slightly higher in computation, males slightly higher in complex problem solving, and there are no differences in math concepts. In fact, there are no differences between female and male achievement in math until high school, when there are some differences favoring males.

But we have not been successful in encouraging girls to pursue careers in mathematics and science, or in encouraging low-income girls and girls of color in math and science even at the precollege level. Math is still a critical filter. Low-income students and students of color who take algebra and geometry go on to college in numbers equal to wealthier whites. However, only half as many low-income students and students of color take these important courses.[3]

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Differences in quality of schooling available to minority and majority students are reflected in the differences in content and delivery of instruction in math among schools. Two-thirds of African American students, nearly half of Hispanics, and half to two-thirds of students living in disadvantaged urban communities attend schools in which the average mathematics scores were in the lowest third of schools nationwide.[4]

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Because girls and boys begin to make choices during the elementary years based on the gender stereotypes they have been learning since infancy, it is critical that we begin to intervene during those years to offer some alternative views. We must also target our intervention efforts toward boys, because boys tend to hold more stereotypical attitudes and because negative male peer pressure can be a very powerful deterrent to adolescent girls' positive math attitudes.

The investigation of girls' lack of mathematics achievement continues to focus on why girls don't achieve rather than what it is in the classrooms or the

culture that creates barriers to math success for girls and women. Or, as Borasi asks, "How could school mathematics be changed in order to become more appealing to women and better accommodate their thinking and learning styles?"[5]

Students' needs to establish their masculinity or femininity become extremely important during adolescent years. If at that time girls see math as a male subject, and if they perceive the world of mathematics as a male-dominated place in which they do not belong, they will begin to make educational and career decisions that exclude math.

Creating a Good Math Climate

We *all*—families and educators—can contribute to a climate that makes math interesting and accessible for girls and boys. Each of the following sections—for families, teachers, school administrators, and counselors—gives specific strategies on how you can contribute to the goal of creating a climate that encourages girls in math. These practical suggestions focus on doing and interacting as ways to create change and truly engage all students.

For Families of Girls

High school age boys and their parents are significantly more likely than girls and their parents to feel that math is more appropriate for males and that males' math skills are superior to those of females.[6]

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It can be extremely difficult to involve some parents in their children's education. Parents' and other family members' attitudes and expectations for their children are probably the most important factors in determining students' attitudes, expectations, and mathematics participation and achievement levels. Parents, more than anyone, can encourage their children to take risks and to be fascinated by mathematics.

Start early to prevent gender-role stereotyping. Watch the words you use. For example, use the word *man* to mean man, and use the word *humans* to mean both males and females. Encourage girls as well as boys to explore their environment; introduce both girls and boys to action toys and team sports to increase their spatial visualization skills; and provide examples of both women and men working in mathematics, technology, and the sciences. Talk about how both boys and girls can do this work, and be ready to counter the denials from children—they've already heard the other message.

Find comfortable ways for girls and boys to play together in a variety of active and quiet play. This can break down the stereotyped behaviors that get reinforced later and can open the way for ongoing honest communication.

Use every opportunity to educate yourself about the importance of positive math attitudes and the encouragement of your child or children. If you are interested in tutoring your children in math but don't know how, ask your children's math teachers to hold a help session for parents, or a session on math topics they will be covering in the coming months. Take advantage of any

"math fun" or "math extravaganza" sessions for parents and students. If you can't go with your child, send an older sibling, another relative, or other adult.

Ask your children's teachers to talk with you about your children's accomplishments, as well as problems.

Support your child's school with your leadership ability by offering to teach a seminar or night time class in *any* area you feel knowledgeable about (math, gender equity, computer use), or volunteer your time at school functions such as career fairs. Your visibility as a role model is especially needed if you are female, African American, Asian American, Hispanic, Native American, and/or have a disability.

Get the word out. If there is no school newsletter for parents, suggest one to the school board or to your child's teacher, and then present a sample newsletter to the school board to let them know what kind of information *you'd* like to receive about your child. Make sure the newsletter includes accurate information about the status of mathematics achievement at your school for *all* the different populations—African American, Asian American, Hispanic, Native American, and white, and include a breakdown by gender.

Build Positive Attitudes!

- Girls more than boys respond to parents' expectations and aspirations for them—have high expectations for your daughter(s). It's true, math can be a difficult subject, but it's no more difficult for girls than for boys—be sure you don't give the impression it is.
- Get across the message that all students—both girls and boys—have to put in some practice to develop their math skills.
- Let your daughter know you think she has the ability to learn math concepts and skills—never indicate you feel she is incapable. Encourage her to do well in math and to invest effort; praise her for her accomplishments, but not just for "trying." Let her know you believe math is just as important and exciting for girls as it is for boys.
- To develop her confidence, make sure your daughter practices math skills. Let her know that persistence is a big part of math success. Then, recognize her abilities and show her you have confidence in her. Ask her questions about what she is learning and engage her in discussions about how to apply what she is learning to her other areas of interest.

Use Math Learning Strategies

- Help set goals that focus on *understanding* math and *learning to apply the concepts*, not just on getting a particular grade or test score.
- Encourage your daughter to be independent; help her feel good about taking intellectual risks. Let her know it's okay to fail and that we learn from our mistakes.
- If your daughter gets frustrated and feels she just can't do math, be calm and supportive while encouraging her to work through the problem. Ask

her questions that focus on what she does know about the problem; don't give her the answer or tell her how to solve the problem.

- Make sure math practice at home has a problem-solving, real-life application. For example, "If you need to get to school by 8:15, and it takes forty-five minutes to get ready and twenty-five minutes to get there, when do you need to get up?" Help your daughter practice estimating and then have her measure or count to check out her estimations for such examples as "How wide is the TV screen?" "Which of two containers holds more?" "Which is farther, school or the movie theater?"

Use Tools of All Kinds

- If possible, give your daughter access to a computer and to a calculator, and help her discover their many uses, and the fun of using them.
- Find software games that teach math concepts and are fun and interesting for girls. (Ask your daughter's math teacher for a list of possibilities.)
- Help her to use tools, build things, and do other activities that teach spatial relationships. Describe activities and skills as being "for people."
- Find books of math puzzles, games, and lateral thinking puzzles; use them to help your daughter learn math concepts and practice skills in an interesting and pleasurable way.

Provide Role Models

- Parents need to model diverse roles so boys and girls see females and males doing nontraditional activities. In many single parent households children benefit by seeing their custodial parent—often their mother—automatically carrying out tasks that would stereotypically be considered male (repairing broken appliances, balancing the checkbook) or female (preparing meals, taking care of the children).
- Use books and stories to highlight the presence of women in mathematics and science, and provide magazines that show women in math-related careers.

For Teachers of Girls*

Classroom Interactions

- Make a conscious effort to call on girls no less than half the time, to give them as much time as boys to answer questions, and to ask them as many "how" and "why" questions as boys. Pay special attention to silent girls who rarely demand your attention, and to children whose first language is not English. Check often to make sure students have comprehended.

*These suggestions are adapted from *Lifting the Barriers: 600 Strategies That Really Work to Increase Girls' Participation in Science, Mathematics, and Computers*. Copyright 1994 by Jo Sanders. Used with permission.

Studies have shown that students who are not fluent in English are still capable of learning advanced math. Like all students, students whose first language is not English will be most successful in learning math if they can link what they are learning to their everyday lives.

- Videotape teachers (including yourselves) to enable yourselves to observe your own gender-related classroom behavior. You could videotape the students as well, and after a discussion of gender-biased behavior in the classroom ask them to watch the videotape with gender bias in mind.
- Think about whom you have in mind when you ask especially difficult questions. Consciously ask these questions of girls.
- If some boys' obstreperous behavior to ask for help-calling out, waving their hands madly-discourages girls from asking for help, distribute red plastic cups to students and require that requests for help be expressed by placing the cup silently on top of the monitor or on the desk or lab table.
- Do not permit boys or girls to make sexist comments or exhibit sexist behaviors in school. (You wouldn't permit racist comments or behavior, would you?)
- Ask a student to keep track of the number of girls and boys you call on, and to let you know if you call on boys disproportionately.
- Pay attention to where the girls are sitting. If they're clustered in the back of the room, change the seating order.

Language

- Use gender-neutral language, avoiding the supposedly generic "he" to refer to females as well as males.
- Encourage students to correct teachers who use the generic "he," and supply them with gender-neutral alternatives.
- Don't say "guys" to refer to girls.
- If girls tell you about sexist, demeaning, or exclusionary comments made in class by other teachers (such as "You girls probably won't be interested in this . . . "), talk to the teachers privately or ask an administrator to do so.

Chores and Tasks

- Ask your female student aides to do more of the technical tasks and your male student aides to do more of the paperwork.
- Insist that girls as well as boys learn to set up and use all electronic equipment: VCRs, video cameras, printers, scanners, and whatever else you have.
- If you find that mostly boys respond when you ask for volunteers for technical tasks, appoint helpers instead.
- Ask girls as well as boys to move equipment and carry things.
- To help you become familiar with new software, ask girls to try the programs first and teach them to you.

Student Groupings

- With a colleague, divide students and team-teach your course for three weeks in single sex environments. Afterwards discuss with students the differences they found and try to incorporate the single sex advantages into the coed setting.
- Ask students whether they prefer to work in single sex groups, mixed sex groups, or alone, and let them work this way. Ask again soon so they aren't locked into an inflexible pattern.
- Use cooperative learning environments more often, especially in single sex groupings.

For School Administrators

Your views on the importance of mathematics for students can help or hinder you in promoting math as an interesting and worthwhile subject. It is important that you give math a "high profile" and provide recognition for girls and boys who are high achievers or who have made strong gains in mathematics achievement.

Tracking is detrimental for most students, even though it can be helpful for female students in advanced math classes. Students are sometimes tracked into homogeneous "below average" or low-achievement groups based on standardized test scores. This tracking becomes an almost permanent placement that restricts students from advancing to higher-level math courses. Because they have not had the relevant mathematics background, these students find themselves unable to enter academic college prep math classes in high school. The ideal school situation is one where students are challenged at their own level of ability, and each is allowed to reach her or his maximum achievement in all subjects.

Talk with teachers and other administrators in a nonthreatening way about girls and math. Help them understand the importance of teacher expectations and interaction patterns as well as math confidence-building for girls. Make sure they're aware of how important math is for girls' futures. If elementary teachers feel uncomfortable with math, help organize nonthreatening peer teacher sessions where they can practice and develop their math skills in a supportive environment.

Give elementary teachers time to develop their math teaching skills. Make staff development activities in mathematics a priority for teachers in your school and provide adequate release time for teachers who want to participate.

Support your school/teachers/students with inservice trainings designed to educate about gender equity in general, or about a particular aspect of gender equity. One inservice might be to teach counselors and teachers about gender equity in mathematics; another session could provide general information

about the need for gender equity to be presented to all school personnel (teachers, counselors, office and cafeteria staff, and bus drivers). Yet another might feature different math programs that have been successful in increasing the mathematics achievement of African American, Asian American, Native American, and Hispanic girls.

Support your school/teachers/students with computers and give staff and students the encouragement, training, and skills necessary to use them.

Form a math promotion team of teachers, counselors, and parents in your school. Get together to brainstorm ideas on how you can build a positive school climate for mathematics and how you can provide recognition and reward for students' accomplishments in mathematics.

Use outside contacts. You may have developed excellent ties with people in business and industry. Enlist their aid in selecting and contacting outside speakers who can serve as role models for girls in math, especially women of color and women with disabilities.

Stress computer literacy, it is important to your students' futures. Make it a priority to have a modern computer lab with up-to-date equipment and software.

Help teachers incorporate mathematics into other subjects. For example, use math-related activities in history or geography class; in literature class assign readings about women mathematicians; and in English class ask students to write about how they use math in their daily lives. These activities will help students see how math relates to all the different areas we become interested and involved in, including art and music.

Help your school librarian build a collection of mathematics materials. This could include books about women and mathematics and on integrating math across the curriculum; games and puzzles; and print and audiovisual materials about math-related careers.

Inform the editors of your school district publications and your local newspapers frequently about math news or math club activities in your school.

For School Counselors

School counselors can be valuable partners in encouraging girls to continue studying math and to consider math-related careers. Your first step in encouraging all students in math is to become aware of what level of anxiousness, excitement, or depth of understanding *you* bring to the discussion of mathematics.

Next, learn how important it is that girls feel confident about math, and learn about its usefulness for them and their futures. Talk with the math and science teachers on an informal basis; make them your ally in encouraging girls

in math. Ask them to recommend some reading for you on girls and math, and math and careers. If you have a districtwide math coordinator in your district, some of these suggestions may also be appropriate for that person.

Invite yourself into classrooms. Counselors at the middle school level typically don't have access to students on a regular basis so you may have to ask to be invited into classrooms. If you find that teachers hold stereotypical views about females and math, try to debunk these myths in a nonconfrontational manner.

Enlist the help of teachers and of national resource organizations (see the Resources section) in building a library of math-related career information for students. Make sure your materials show women of color and women with disabilities in an array of math careers. Suggest to teachers that you visit their classes to present lessons on gender and racial stereotyping, and on math and careers. You might ask the teacher to coteach these lessons with you.

Identify field trip sites and positive role models. You can truly capture students' interest by using interesting and informed role models to answer their questions, and by taking them out of the classroom for a look into the work world. If you can't physically leave the school you can show students videos or CD-ROMs and follow with a group discussion.

Ask teachers to help you involve families in encouraging their girls in math, and in relating that encouragement to future math-related careers. They can help you develop activities for parents, write a column about the importance of math for all students for your school newsletter, or speak to parent groups.

Use a team approach with other counselors, teachers, parents, and administrators. Talk with them in a nonthreatening way about how girls need math as much as boys do. Explain why you (a) expect and insist on as much effort in math from girls as from boys and (b) track at least as many girls as boys into advanced math classes.

Invite counselors from other schools to visit your math classes. Most of your middle school students will go to one or two particular high schools in your community. Visiting counselors can tell students about the transition process, and can answer their questions about the high school curricula and about what math options are available. Make sure these counselors stress the need for four years of high school math for girls as well as boys.

Organize a career exploration course. Students need to make the connection between school subjects and occupational choices, and an exploratory course can help them do this. Bring in professional women of different racial and ethnic backgrounds and ask each one to describe to the students how they balance their professional life with their home life, and how they prepared for their career. Provide a forum where the students can interact with the speakers.

Six Classroom Strategies

Boys in math classes receive more teacher time and attention than girls. Teachers give boys more praise, criticism, and remediation, and are more apt to accept boys' responses. They also respond more frequently to boys' requests for help and talk to boys more about ideas and concepts. Also, teachers typically encourage boys to figure out the answers to a problem; they are more likely to help girls by giving them the answer.[7]

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During their early school years, students develop the skills and attitudes toward learning that form the basis for future academic growth. If students develop a negative learning pattern toward a subject, it is extremely difficult to change. Too often, the gender-role stereotyping they learned in their early years is reinforced. This section will help teachers give girls the ability to withstand societal pressures and continue to study math.

Strategy # 1: Build Math Confidence

Females' lack of confidence is especially apparent in some science and/or math classes and is consistent with the societal expectation that males will be better in math than females. The researcher Jane Kahle has found that teacher-student interactions in science classes are especially biased in favor of boys.[8]

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Confidence in math is directly related to mathematics achievement and decisions to enroll in elective high school math courses. Girls' and boys' self-confidence in their math ability do not differ in the primary grades, but a lack of confidence becomes evident for girls as they reach high school. By the time girls reach middle school and high school—when math becomes more complex—they need to feel they have the ability to achieve.

Generally, girls' aspirations for future math education are lower than those of boys; their expectations for success in math are also lower. In many cases their aspirations and expectations are learned from and reinforced by parents and teachers. Even when girls are achieving on a par with boys they have lower expectations for success in math, and they plan to take fewer courses in math. How can we counter these attitudes and help give girls confidence in their ability to succeed in math?

Acknowledge students' accomplishments (both academic and intellectual), not their effort. Do this publicly and privately. Focus on the intellectual aspects of girls' performance rather than on neatness, organizational skills, or just

"trying." Help students focus on what they've learned and understood, not just on grades. As much as possible, stress a concept mastery approach to math.

No one right way. Incorporate math problems that call for many approaches with several right answers. Stress the idea that, in most cases, there is more than one way to solve a problem, and give your students opportunities for estimating, guessing, and checking.

Let students take turns asking the teacher questions about math. This technique can generate discussion, promote the idea that "there's no such thing as a stupid question," and make questioning become the norm.

Help students set goals for their education and careers. Much depends on how students perceive your (and their families') expectations for them. It is important that you hold high (but not unrealistically high) expectations for each student, and that you encourage them to aim as high as they want (once they have the necessary information) when considering their future education and/or occupation.

Use peer tutors in math. Tutoring helps both students gain increased understanding.

Strategy # 2: Make Math Careers Interesting and Relevant!

Much evidence indicates that teachers and parents reinforce boys for learning math and for planning math-related careers more than they reinforce girls for these activities.[9]

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Many students—girls and boys—do not see how math is relevant to their daily lives or how they can use what they are learning in future careers. Girls in particular lose interest early because they see math as a "guy thing." The way we teach math does not often emphasize its usefulness to students, yet we know if students do not see math as valuable for themselves in some tangible ways, they will not choose elective math courses in high school!

Career discussions are very important. Students are generally poorly informed about the actual uses of advanced math, and their perceptions of the math requirements of their career choices may be inaccurate. Typically, teachers at all levels—elementary through college—spend little or no class time discussing the careers where math is important. As a result, many students make uninformed career decisions.

This is especially true for girls, who tend to choose traditional careers very early in their lives, before they have even had the chance to consider, and either reject or get excited about, all the possibilities. Give your students a sense of purpose about each math concept they learn. Show how the math they learn relates to real-life situations, and how people can and do use it.

When students are able to see what they are learning applied to the real world in the form of different careers and have role models to talk with, the math learning process becomes more fun.

Relate math study to science careers. Children enjoy the discovery of hands-on science study, but few teachers use science as a way of raising students' career aspirations. Point out that scientists are detectives who continually explore how our world is connected. This makes students consider these careers exciting. Make them aware of career opportunities through ample discussion of the work and lives of biologists, chemists, geologists, doctors, and engineers. Encourage them to ask questions and speculate about each job's activities, and about how that job might expand their horizons. Encourage them to consider lots of choices for "what they want to be when they grow up."

Look in the newspaper. Your local newspaper can provide the basis for many interesting and timely math and science activities that are also related to careers. For example, articles about environmental concerns, such as protecting wetlands or hunting and fishing rights, may relate directly to what students are hearing their parents discuss at home, and can lead to a discussion of what the experts involved do for a living (for example, water engineers or forest service workers).

Invite a series of interesting speakers, both male and female and of different racial and ethnic backgrounds and abilities, who are enthusiastic about their work, to speak to the class about how they use math in their jobs. Afterwards, tie the math topics they discussed to your current curriculum and to math courses your students can take in high school. In general, take every opportunity to discuss math- and science-related occupations and to encourage students to work toward them. Whenever possible, highlight the work of women employed in these fields.

Display posters on careers in math and ensure an equitable representation of women, people of color, and people with disabilities. Take a few minutes at the beginning or end of the class period to make the poster a game. Assign students to research careers at the library and report back to the class. Ask what a particular career is. Have the students speculate about what a person in this career does and which math courses they needed in high school and college. Ask if any of your students are considering this occupation.

Invite school counselors to make presentations to your classes and to target girls for careers in science and mathematics areas. Interview the counselors before you invite them to make sure they are aware of gender bias, especially their own.

Strategy # 3: Teach Cooperation and Use Creative Teaching Strategies

Many teachers have been taught to use competitive instructional strategies in the classroom. These can work to the disadvantage of female students who may feel more comfortable and perform at higher levels in cooperative situations.[10]

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The goal of this approach is for students to become self-motivated. Recent studies have shown that all children learn more readily in cooperative situations.

Competitiveness can interfere with learning because it (1) makes students anxious and interferes with their concentration, (2) doesn't permit them to share talents and learn from each other as easily, and (3) distracts them from what they are doing—they concentrate on the reward or on winning instead of on what they are learning.

Cooperation

Assign tasks on some basis other than gender. Every participant has resources useful to the group's problem-solving efforts.

Don't allow any single group member to dominate the group, activity, or the most desirable spaces in the group (e.g., head of the table). Males are more likely to control discussion through introducing topics, interrupting, and talking more than females. Females talk less, often take supportive rather than leadership roles in conversation, and receive less attention for their ideas from the group. Both males and females may expect group members to follow gender-role stereotypes that can limit each individual's contributions (e.g., males as leaders, females as secretaries).

Talk about cooperation and focus on the process of the cooperative activity. Recognize and share with students the results of cooperative efforts.

Maintain control in the classroom when there is a lot of student interaction. Ask the students to figure out a "quiet" signal for you to use. When you are not getting a good mix of student responses as a result of girls and boys calling out their answers, ask the students to raise their hands to respond. Explain that you want to get more equal response from both girls and boys.[11]

Place girls in leadership roles and monitor their performance to confirm there is equity in the group interaction, and in the selection of discussion topics. Are boys dominating the discussion? Are at least half of the discussion topics those suggested by the girls?

Get the very talkative student to quiet down. Speak to the student outside of class about the importance of letting others speak. You can set up signals—a code word or a hand signal—between the two of you to let the student know when to "cool it." The signal, if necessary, should only be between the two of you; the rest of the class does not need to know. If you sometimes give the student the attention he or she needs, that will usually satisfy them. Otherwise, be honest about why you can't give them the attention.[12]

Creative Teaching

Stress real-life problems in math. Explore your classroom environment for math-related problems that are relevant to students' immediate lives and needs.

Teach different approaches and strategies for problem solving—especially visual/spatial strategies—and encourage girls to use them when they are unable to solve a problem using traditional methods. Girls often use verbal

strategies to solve problems when spatial strategies such as diagramming, organizing the information into charts, or working backward would be more helpful, and more fun.

Use guessing activities to help students develop estimating skills. Be careful not to reinforce wild guesses, but you can use wrong answers as a way of learning. Probing questions can both engage the interest of students and guide them in restructuring their thought processes. Girls often seem afraid to guess, and they tend to dislike estimating activities. This kind of interaction will help boost students self-concept—an area in which girls more than boys need help.

Make it okay and never embarrassing for students to give a wrong answer! De-emphasize right and wrong answers. Help students to identify their errors and focus on their specific areas that need improvement. This approach will help reassure students of their ability to master math skills. Build a safe environment in your class where everyone can take intellectual risks without fear of embarrassment.

Model making a mistake. Then have the class help you think it through until you find the correct solution to the problem. This can have a positive effect on your female students by letting them know that everyone makes mistakes, and that we can often learn more from our errors than from our successes.

Encourage all students to figure out the answers to problems; don't give them the answers or do the work for them. Let students know their understanding is very important; it's not okay if they just "try." When some students don't seem to understand, search for alternative ways to explain. Make sure that, if the class has to move on, those students who have not mastered the concept aren't left in confusion. While they study the next topic, give them additional help and practice with that concept outside the regular math classes until they catch up with the rest of the group.

Teach that math is for everyone. Help students understand that math is *not* a subject in which "either you catch on immediately" or "you don't catch on at all." Let them know that some topics in math are difficult, and it takes persistence and practice to master math skills. Also let them know that even the top mathematicians in the world are working on problems they can't solve or understand yet. If you encountered and overcame difficulties in math, this is good information to pass on to your class.

Strategy # 4: Provide Positive Female Role Models for Girls and Boys

We know that when girls read about successful women, they have higher expectations of success and spend more time on school tasks.[13]

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One of the significant ways we learn is by watching and emulating the behavior of role models. Yet if children are only exposed to women in traditionally female careers, they will "learn" that some careers—many of those involving mathematics and science—are not for women. Appropriate role models for

girls are definitely underrepresented in society today, and this lack of role models discourages some girls from choosing math-related careers and reinforces stereotypical views held by boys.

Use stories about actual women working in math-related careers to interest your students in math and to provide role models. Stories do help eliminate stereotypes. However, women in these stories may be pictured as solitary people who overcame great difficulties in order to "make it" in a male-dominated world. If you use stories with this heroic element, balance them with readings about women who have math or science careers while maintaining friends, family, and outside interests. Girls need to learn they don't have to be "outstanding math stars" or give up families and other activities in order to be scientists or mathematicians.

Prepare a bulletin board (or have students do it) of women who are mathematicians or scientists and successful in their professions. Be sure to discuss it and place it on a prominent wall. Make sure the bulletin board includes women of color and women with disabilities. To reinforce students' attention to the board, let them know you will add a question or two about the material on an upcoming test.

Invite female guest speakers to visit the class and talk about how they use math in their careers. If you don't know where to find such women, use professional directories (of engineers, architects, accountants, etc.), and/or contact your local university and the equity coordinator at your state Department of Education. Student contact with role models involved in math and science careers (especially female role models) is very important, but interview guest speakers beforehand to make sure they will communicate positively and effectively to children. Help your guest use vocabulary and definitions that your students will understand.

Organize a community math support group with the help of other teachers. The support group might include potential role models and people who would give tours, sponsor internships, or serve as mentors. This could become your school's Math Booster Club.

Discuss how people in the media—on the radio, on television, and in movies—become role models for young people. Point out how these portrayals may be gender stereotyped and help students find models that present a balanced picture of women's roles.

Use peer role models. Elementary students also look to middle school and high school students as role models. Ask other teachers to select some good, confident male and female math students to make a brief presentation to your class about the math they are studying and how they plan to use it in the future. You can also have female college students who are working toward math-related careers talk with your students about their studies and future plans.

Strategy # 5: Improve Test-Taking Skills

Many educators prefer to de-emphasize the use of standardized tests; however, in today's educational climate, tests can have a great impact on students' futures. In some school systems, elementary students are tracked based on standardized test scores that will eventually impact their placement in advanced or enriched programs, entrance to particular colleges, and awards of scholarships or other forms of financial aid for postsecondary school. Even as we work toward better ways of assessing student achievement, we still need to ensure that students do as well as they can on standardized tests.

Vary the format of tests; give objective math tests.

(a) Design a test supplying all the answers. Students need to work the problems to eliminate the incorrect answers.
(b) Design a matching test. This works well, especially when teaching properties in math.
(c) Design a multiple choice test. Include choices of "not here" or "none of the above" if you want to prevent guessing.

Accept different methods. There is usually more than one right way to do a math problem, so accept a student's alternative procedure if it and the solution are correct.

Don't always push for speed in solving math problems. Quickness doesn't ensure correctness, and most good, interesting math problems require considerable time for solution. Encourage students to take time to work problems out with paper and pencil.

Teach students test-taking skills—examining problems for key words, using a process of elimination, and so on. Cover key topics before test-taking time.

Help students learn to solve word problems. Have them rewrite problems and let them write their own problems for other students to solve. Make sure the terms are clear, especially for students whose first language is not English.

Strategy # 6: Increase Computer Access for Girls

When both boys and girls are sharing computers, boys often monopolize the computer, refusing to take turns; girls then become passive rather than active participants.[14]

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Girls are often channeled into lower-level computer activities such as wordprocessing or typing letters and other materials onto the computer. Girls are more likely to use computers for word processing, while boys are more likely to use it for programming. Boys have much more positive attitudes toward computers than do girls; they find computers more "enjoyable," "special," "important," and "friendly" than girls do.[15]

Computers are often linked with math and science, long considered male domains; girls are less encouraged to learn computer skills. Especially in secondary schools, computers are more often clustered in math and science departments. Also, because math and science teachers are usually male, girls lack female role models who use computers.

First, assess the computer learning climate for girls at your school:

Is there a lack of encouragement for girls to use computers?
Is the potential value of computer learning more apparent to boys than to girls?
Is there a shortage of software that is interesting to girls?
Is there limited computer access for girls during free time?
Are girls underrepresented in computer leadership roles?
Do you see pressure from girls' peers not to participate in computer activities?
Are girls well represented in computer clubs?
Is there a shortage of computer personnel for computer learning?
Is there a shortage of computer time?
Do boys dominate during computer time?

The following classroom strategies and activities include suggestions for dealing with these problems.

Eliminate materials oriented toward one sex, such as aggressive games with male aggressors as heroes. Use open-ended and exploratory programs, and software that teaches students to become problem solvers and is interesting for girls as well as boys. Some researchers have found that boys are more interested in competitive games such as the software in video arcades while girls are more interested in the computer when they are working with word games, logic puzzles, art, music, "story" programs, and adventure games.[16]

Provide access. Make special efforts to provide access to computers for students who do not have home computers; demonstrate the value of computers by encouraging their use for extracurricular activities. If your computer center is thought of as primarily a male game-playing area, change that image to one of a learning center for all students.

Stress application programs and problem-solving activities rather than pure programming in introductory computer courses. If students see the usefulness of computers first, they will become more interested in learning the mechanics of programming later. Provide a wide range of computer experiences for students.

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Organizations

American Association for the Advancement of Science
Education Human Resources Programs
1333 H Street, NW
Washington, DC 20005
(202) 326-6400

Association for Women in Mathematics
4114 Computer and Space Sciences Building
University of Maryland
College Park, MD 20742-2461
(301) 405-7892

Educational Equity Concepts, Inc.
114 East 32nd Street
New York, NY 10016
(212) 725-1803

Educational Resources Information Center (ERIC)
Clearinghouse on Information and Technology
Syracuse University
Center for Science and Technology
4th Floor, Room 194
Syracuse, NY 13244-4410
(315) 443-3640; (800) 464-9107

Educational Resources Information Center (ERIC)
Clearinghouse on Science, Mathematics, and Environmental Education
Ohio State University
1929 Kenny Road
Columbus, OH 43210-1080
(614) 292-6717

Family Math
Project EQUALS
Lawrence Hall of Science
University of California
Berkeley, CA 94705
(510) 642-1823

Girls Inc.
Operation SMART
30 East 33rd Street
New York, NY 10016
(212) 689-3700

Math Science Education Network
University of North Carolina
201 Peabody Hall, CB 3345
Chapel Hill, NC 27599-3345
(919) 966-3256

Math/Science Network
Mills College
5000 MacArthur Boulevard
Oakland, CA 94613
(510) 430-2222

National Action for Minorities in Engineering
3 West 35th Street
Third Floor
New York, NY 10001
(212) 279-2626

National Black Child Development Institute
1023 15th Street, NW, Suite 600
Washington, DC 20005
(202) 387-1281

National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091
(703) 620-9840

Society of Women Engineers
120 Wall Street
New York, NY 10005
(212) 509-9577

Women's Action Alliance
370 Lexington Avenue
Suite 603
New York, NY 10017
(212) 532-8330

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