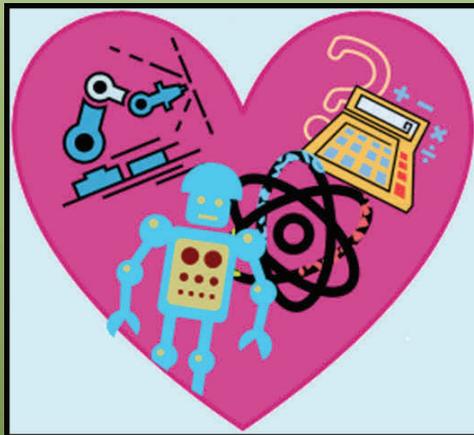




# Recruiting and Retaining Girls in STEM

*a FLATE Best Practices Guide*

[www.fl-ate.org](http://www.fl-ate.org)



*Helping Girls Believe They Can Succeed  
in STEM Courses and Careers*

# FLATE

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## INTRODUCTION

This guide provides general guidelines to best practices that we at the Florida Advanced Technological Education (FLATE) Center and others have found to be effective in engaging and retaining girls in STEM (science, technology, engineering and mathematics). Women comprise 50.7% of the population, but only 10.7% of the engineering occupation field and 24.8% of the mathematical/

computer science field (2009 Bureau of Labor Statistics). It is essential that we work diligently to recruit more women.

STEM-related employment is predicted to increase by 16 %, to more than 8.5 million jobs between 2010 and 2020; a skills shortage of 230,000 STEM employees is projected as early as 2018. Females represent a wellspring of human potential and talent that must be unlocked and utilized to help fill this gap. It is critical that we work diligently to spark girls' interest in STEM subjects as early as elementary school and keep them interested and excited. The hope is that they will then be more likely to continue to pursue STEM courses, and later embark on a STEM career journey.

STEM fields are vitally important to our country. A Senior Vice-President at IBM Systems & Technology Group, Rodney Akins, states that "Only 5% of United States workers are employed in fields related to science and engineering, but they are responsible for more than 50% of our sustained economic expansion." He continues, highlighting the fact that, "according to NSF, the percentage of United States students studying math, science, and engineering has decreased from 21% in the 1980's to approximately 16% today." In this guide, we are keeping the focus on girls, but please keep in mind that these practices work just as well for boys, minorities, special needs students, at risk populations, ESOL students ... just about any student who will benefit from extra support and engagement to help them learn about and explore the exciting world of STEM.

## DEFINING THE CHALLENGES AND BARRIERS

*"If we're going to out-innovate and out-educate the rest of the world, we've got to open doors for everyone. We need all hands on deck, and that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering, and math."*

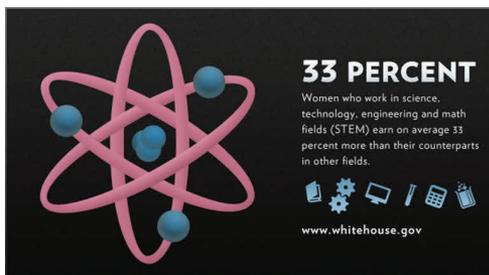
**-- First Lady Michelle Obama, September 26, 2011**

### Current status

Gender bias in STEM fields continues to persist and in spite of decades of progress to reverse this disparity, the number of men in STEM careers, particularly at the higher levels of STEM professions, is much higher than that of women. In 1997, women received one in three sub-baccalaureate awards in STEM fields, and that number has dropped to one in four currently. Gender bias tends to strengthen the notion that women are better suited to fields calling for language skills, whilst men naturally excel in fields in which spatial and quantitative skills are used.

The unfortunate result of this is that women are less likely to enter STEM careers and are most often concentrated in traditionally female-dominated occupations such as health aides, childcare workers and office assistants. These careers typically offer little opportunity for promotion and advancement, and often pay poorly.

Research shows that among first-year university students, women are much less prone to say that they intend to major in STEM, as compared to men. By the time students reach graduation, there are significantly more men than women in nearly every science and engineering field, and in some, such as physics, engineering and computer science, the difference is striking with women earning only 20 % of Bachelor's degrees.



Research also illustrates clearly that girls can perform just as well in mathematics as boys. To achieve equality, girls must be allowed to learn in an environment that fosters success in STEM subjects for all. The constant message should be that with work and effort, anyone can succeed in any field.

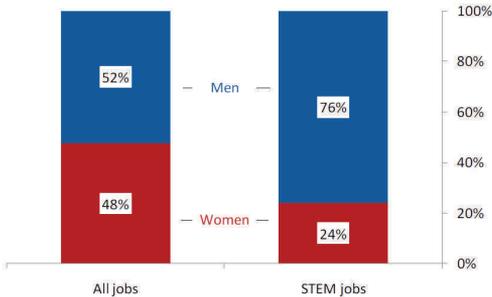
## The Future

The U.S. Department of Labor's workforce projections for 2018 show that nine of the ten most rapidly growing occupations that require at least a Bachelor's degree will need significant science and/or mathematics education and training. A large number of engineering and science occupations are predicted to grow more rapidly

than the average rate for all occupations. Many of the most dramatic increases will be seen in computer- and engineering-related fields – fields in which females currently fill only one quarter (or less) of positions.

In 2018, our nation will have more than 8.6 million STEM-related jobs available, and as many as three million of those jobs may go unfilled – or at least unfilled with American citizens. Females can help close this gap and help plug the leaks in our

**Figure 1. Gender Shares of Total and STEM Jobs, 2009**



Source: ESA calculations from American Community Survey public-use microdata.  
Note: Estimates are for employed persons age 16 and over.

STEM pipeline. We have to act to increase the number of women in STEM fields – this is essential for our nation to stay competitive in the global economy.

We must work to ignite girls' interest in STEM subjects as early as elementary school and maintain that spark throughout their entire school career. This will greatly increase the likelihood of them continuing on to work in a STEM field.

## EXPOSURE AND IMAGE

Unfortunately girls are still receiving the wrong message about their ability to succeed in science, technology, engineering, and mathematics (STEM) courses and later on, in STEM-related careers. Although women are now almost on a par with men in several formerly male-dominated fields, a dearth of females still exists in the areas of STEM. Research has demonstrated that STEM careers are often perceived as less likely than careers in other fields to involve helping people and working with people (i.e. communal goals). These kinds of misconceptions can significantly affect women's career choices, as women tend to favor communal goals more than men. From infancy, girls are dressed in pink and boys in blue. Boys are offered trucks and building blocks; girls are offered dolls to play with. Growing up, girls are usually tasked with household chores such as washing the dishes and doing the laundry, while boys are tasked with duties such as mowing the lawn and taking out the trash. This socialization trend continues throughout childhood, and into the school years. The end result is gender stereotyping in which certain attributes, opinions and roles are assigned to a specific gender. This often carries over into decision making regarding career choices, with both sexes frequently choosing "traditionally gender appropriate" career pathways.

## The Media

The media continuously promotes gender stereotypes, showing women in television advertisements for laundry soap, mops and vacuum cleaners. Men on the other hand, are predominantly featured in commercials for mechanical equipment and are typically portrayed in beer commercials, with women appearing as provocatively dressed, sex objects. One pioneer working to change portrayals and stereotypes of women in children's entertainment and media is actress Geena Davis. The Institute on Gender in Media ([www.seejane.org](http://www.seejane.org)), which Ms. Davis founded, aims to expose and correct gender inequalities in every media and entertainment company through cutting-edge research, education, training, strategic guidance and advocacy programs.



It's important to remember that not all girls are "girly" girls - some are tomboys, some are a combination of the two, some girls are already intrigued by, and hooked into STEM, and some believe only boys can succeed in STEM. It's important that we market STEM to *all* girls, so that no one group is turned off or alienated by the messages they are receiving about girls and STEM. STEM for girls doesn't have to be "pink". It is worth noting though, that consumers spend a vast amount of money in the "pink" aisles of toy stores.

## STEM-Friendly Toys that Train

Lego's mission is to "Inspire and develop the builders of tomorrow". Lego bricks provide an amazing variety of creative play opportunities. In addition to the huge fun element, for younger children the vibrantly colored pieces and easily interlocking arrangements provide hours of patterning practice and fine-motor development. Sorting skills (which are a key part of the Kindergarten math curriculum), can be developed and improved by searching for that one piece that fits perfectly. Playing with Lego develops children's ability to think in three dimensions. Skills such as problem-solving, creativity and teamwork are all enhanced through Lego play.



**LEGO Friends** – a new line of Lego introduced in December 2011, marketed specifically to girls, featuring a pastel-themed palette and family-friendly scenarios such as the home, beauty parlor and stable, has had spectacular success. In spite of skepticism and some outright opposition, sales surpassed all expectations. Michael McNally, Lego's U.S. spokesman says, "Our data show that we tripled the number of girls who are building with Lego bricks in the U.S. market since the launch of Friends, and we've significantly shifted the gender split among Lego users."

Debbie Sterling is the founder and CEO of **GoldieBlox** – a toy designed to “introduce girls to the joy of engineering at a young age.” Frustrated by the lack of females in engineering, she invented Goldie Blox - a story book and construction kit, targeting girls between five and nine years old, in which the blonde heroine Goldie, meets a series of engineering challenges – assisted by her trusty friends Nacho the dog, Benjamin Cranklin, “a cat with an attitude”, Katinka the dolphin ballerina, Phil the sloth and Flavio the Brazilian bear. Goldie Blox challenges girls to build working machines using belts, cranks, pulleys, wheels, and axles. Sterling’s hope is that, “by designing a construction toy from the female perspective, we aim to disrupt the pink aisle and inspire the future generation of female engineers.”



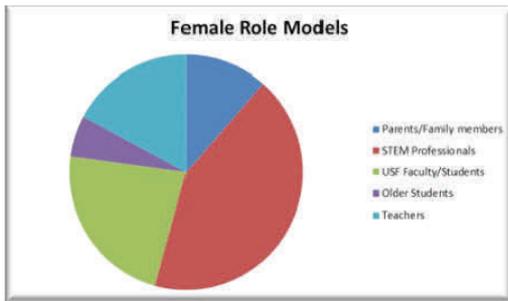
The Roominate toy line was designed by two engineers from Stanford with the goal of getting more girls interested in engineering. Roominate consists of “a kit of wooden building pieces and circuit components with which a child can use her creativity to design, build, wire, and decorate her own unique interactive room.” Roominate allows young girls to have fun with STEM, while building STEM-thinking, hands-on skills and confidence.

Some view these progressive, girl-friendly toys with a certain level of skepticism; some with outright disdain, believing that all these attempts at banishing gender stereotypes are only reinforcing them by feminizing boys' toys and presenting those same toys in pinks and purples and adding ribbons and cutesy blond dolls (think Architect Barbie!). The bottom line is – anything that raises awareness and gets us all thinking about the STEM careers that exist, is a good thing – a step in the right direction.

### **Role Models: Highlighting Girls' and Women's Achievements in STEM**



Career day presentations featuring women in STEM careers (if possible find a graduate from the school who can highlight her experiences in school and her journey to her current high-tech career), can go a long way toward changing female students' beliefs about their ability to succeed in STEM courses and careers. It is so powerful for students to meet real-life, female STEM professionals and be able to speak with them face-to-face. Students love hearing about these women's school and career journeys and the obstacles and roadblocks they had to navigate along the way. Be sure to include plenty of time for questions.



In a study conducted by FLATE, teachers were asked what types of female role models they would use to inspire and encourage girls to pursue STEM careers. The results are illustrated in Figure 2. The majority indicated that they would use female STEM professionals, followed by local university (USF: University of South Florida) faculty and students, teachers and parents and/or family members.

When they were asked **how** they planned for the female role models to be involved, they gave the following responses:

- Guest speakers
- Mentors/Advocators
- Shadowing Opportunities
- Research Projects
- Video Clips showing Female Professionals
- HGTV Channel
- School closed-circuit TV – female teachers demonstrating various science experiments and math magic

These responses illustrate the wide range of opportunities teachers see for purposefully integrating role models into the school curriculum and environment.

### Include Parents

Securing parents' support and "buy-in" is an excellent way to break down gender barriers and increase the number of girls in STEM. Parents play a key part in their child's educational and later career choices. Socialization of parents and gender stereotypes held by parents can drastically affect how they encourage or discourage their child from pursuing a certain career path.

There is hard research showing that even small interventions with parents can have significant effects on the academic courses their children enroll in. In a 2012 study published in *Psychological Science*, a journal of the *Association for Psychological Science*, researchers mailed parents of high school students two informational brochures – one at the beginning of the students' 10<sup>th</sup> year providing information about the importance of math and science courses, and a second brochure at the beginning of their 11<sup>th</sup> grade year, more focused on STEM careers and providing a link to a website dedicated to showcasing STEM careers. Their results clearly demonstrated that the intervention had a noticeable effect on the courses that the students enrolled in: students whose parents received all the materials as part of the experimental group took more science and math classes in the last two years of high school than those who received no materials.

This result corresponded to roughly an extra semester of advanced math or science, including courses such as algebra II, trigonometry, pre-calculus, calculus, statistics, chemistry, and physics. It is well documented that students with more educated parents take more STEM courses in high school, but this study provides evidence that even small interventions can have just as strong an effect as the parent education level effect.

Educators and school counselors can help by providing parents with information and literature presenting nontraditional career fields, job descriptions, accompanying salaries and career pathways. They can also suggest and encourage parents to communicate with their daughters about traditional *and* non-traditional careers equally.



Parental support is also essential for the success of your initiatives targeting girls. Parents can help with transportation, provide mentoring and encouragement, and offer a supporting learning environment at home. They can accompany their daughters on high-tech tours and see for themselves the many opportunities available for females in high-tech industries.

Researcher Ann Jolley suggests creating a list of ideas and ways parents can get their kids excited about STEM and encourage them to become STEM thinkers. Children start off life as STEM-thinkers – they ask endless questions and are filled with curiosity about everything. They eagerly observe the world around them and others' behaviors and actions. They take in as much information as possible. They are naturally good at connecting ideas. Children are experimenters and excitedly try new things. They love to draw and sketch. They enjoy building models, destroying them and then rebuilding. In a nutshell, children are innate learners. They are exactly the type of thinkers and learners needed for STEM careers (and in fact, any career).

Jolley stresses that the most significant motivation for kids will be parents' enthusiasm and level of interest in STEM.

Jolly, Ann (2012). [STEM Tips for Parents](#). A MiddleWeb Blog.

### 10 Tips to Help Your Child Be a STEM Thinker

1. Be alert for opportunities to talk with your child about STEM-related topics
2. Encourage curiosity and questioning
3. View science and technology TV and videos with your child
4. Make your home a STEM-friendly place
5. Organize groups of kids to participate in a STEM Invention Club  
[Time to Invent](#) website has all the information needed to guide kids in exploring and experimenting together.
6. Promote cooperation and teamwork
7. Search out STEM-related recreational activities
8. Stay in touch with your teacher and offer to help with STEM activities at school
9. Direct your child to these websites for information and STEM fun:  
[Design Squad](#) – This PBS site features creative activities, engaging video, interactive games, and exciting contests.  
[Discover Engineering](#) – This site features videos, interactive games, and children can design “Cool Stuff.”  
[National Geographic Education](#) – This website features educational activities and videos, including some STEM activities.
10. Display curiosity about things you see and show your own interest in learning

## Open House Events

School Open Houses provide a great way for everyone to become acquainted. Be sure to:

- Provide information, visuals, food, and activities.
- Include female student hosts and teachers to explain activity stations.
- Offer hands-on activities and examples of what the girls will be doing.
- Provide a feedback area to give parents an opportunity to write down what they consider important for their daughters in your school (or collect information verbally and take notes).
- Obtain good contact information for parents and keep them apprised of upcoming activities and schedules well in advance.
- Keep in close touch with parents – let them see student work in progress and post completed projects on a website, blog, newsletter, social networking media, or email.
- Reassure parents that students will be in a safe environment if activities take place outside of regular school hours.
- Make sure to know parental preferences regarding photos, interviews, etc.



Connecting with parents and educating them about the importance of STEM, and about the many exciting careers out there for girls, can help increase enrollment in STEM courses and facilitate the process of closing the gaps in female student enrollment and pursuit of STEM careers.

## **Mentoring**

Mentoring plays a vital role in recruiting girls and keeping them excited and interested in STEM. It's meaningful for female students to see and hear passionate, successful professional women, happily and profitably employed in a STEM field. By connecting girls with STEM professionals, the number who pursue and excel in STEM areas will increase significantly. Mentoring can open girls' eyes to the many high-tech and lucrative careers available to them and raise their awareness of the many opportunities out there, just waiting for them.

### **Fantastic Jobs for Female STEM Graduates!**

#### **Electrical Technician**

Annual Salary: \$47,700

Educational Requirements: Many electrical technicians complete a four-year paid apprenticeship program

#### **Radiologic Technologist**

Annual Salary: \$54,800

Educational Requirements: A two-year degree along with a passing score on your state's radiologic licensing exam

#### **Nuclear Technician**

Annual Salary: \$68,000

Educational Requirements: A two-year degree in nuclear science or a nuclear-related technology and extensive on-the-job training

#### **Air Traffic Controller**

Annual Salary: \$113,600

Educational Requirements: must be a U.S. citizen, complete an air traffic management degree from a Federal Aviation Administration certified school; earn a qualifying score on an FAA pre-employment test; and complete training at the FAA academy

#### **Computer Support Specialist**

Annual Salary: \$45,000

Educational Requirements: A two-year degree (though some jobs in the field require a four-year degree)

#### **Registered Nurse**

Annual Salary: \$67,700

Educational Requirements: Bachelor's degree or two-year degree

#### **Software Developer**

Annual Salary: \$55,100

Educational Requirements: Bachelor's degree

#### **Computer and Information Research Scientist**

Annual Salary: \$58,800

Educational Requirements: Bachelor's degree

#### **Marine Architect**

Annual Salary: \$57,800

Educational Requirements: Bachelor's degree

#### **Industrial Engineering Technician**

Annual Salary: \$50,980

Educational Requirements: A two-year degree

#### **Sources:**

Smith, J. (2013). Forbes  
[The 10 Best-Paying STEM Jobs For Recent Grads](#)  
STEM Jobs (2013).  
[8 High Paying STEM Jobs that Don't Require a Bachelor's Degree](#)

### **MENTORING BENEFITS MENTORS, TOO**

MentorNet is an online mentoring network for women and underrepresented minorities in science. Between 2008 and 2009, the site hosted 2,804 mentor-protégé pairs. In a recent survey, they found that many protégés were hired by their mentor's company, and mentors claimed the experience helped them become better leaders.

Mentoring can be one-to-one or can be formalized through a class, teacher or school. Institutions can tap into online mentoring programs that virtually connect industry professionals to students

(e.g., [www.mentorNet.org](http://www.mentorNet.org)).

Mentorships are an excellent vehicle to help carry girls from their STEM education at school and smoothly on to a STEM career pathway. Mentors can provide firsthand, relevant advice and encouragement to girls and young women. They are up-close, real-life examples of successful STEM professionals. Other benefits of mentoring include helping students make professional contacts and connections for careers, raises, promotions, internships and apprenticeships.

**“Mentors play a critical role in bringing new people—and particularly women—to careers in STEM. Female leaders must be role models to advocate for the possibilities of STEM education and support programs that inspire more of our best and brightest students, especially those from underrepresented or disadvantaged groups, to study in STEM fields. ... Industry mentors—particularly women in positions of influence—are one important link to increasing the pipeline of talent.”**

*Heidi Kleinbach-Sauter, Senior Vice President, Global Foods R&D, PepsiCo©*

Techbridge is a program that provides training for mentors (“role models”) to build local programs focused on girls in grades 5 – 12 in science-related fields. Since 2000, Techbridge has served approximately 10,000 girls in grades 5-12, offering after-school and summer programs with hands-on projects, role model pairing, and academic and career guidance. A 2011 study showed significant increases in girls’ skills and confidence as a result of participating in the Techbridge program. Eighty-three percent of participants surveyed were more interested in STEM careers, 87% felt more confident trying new things and 90% of participants said they believed engineering is a good career for women. Mentoring is only one part of the solution to the predicament but research demonstrates clearly that it works.

**“We need to do more than just tell young girls that they can be engineers, rocket scientists or computer programmers. Mentors can inspire girls and give them an insider’s view of what it’s like to work in STEM. ... Career options in STEM disciplines are endless, but we won’t reach our full potential as a nation until women and underrepresented groups are fully included.”**

*-Linda D. Hallman, Executive Director and CEO of the American Association of University Women*



## Tours and Guest Speakers

A national poll of teenagers conducted by Nuts, Bolts & Thingamajigs (NBT) and the Foundation of the Fabricators and Manufacturers Association (FMA) revealed that 61% of teens have never set foot in a factory or other type of manufacturing facility. This is unfortunate as industry tours have

proven to be a very effective way to expose students to STEM fields. Tours also emphasize the importance of STEM and its connections to high-tech careers. Industry guest speakers in school are also very valuable in addition or as an alternative to tours (if tour logistics cannot be worked out). Face-to-face experiences provide students with a chance to see the application of STEM subjects come to life in a high-tech world. Industry tours can be especially important for high school students, where they have the opportunity to see, hear, and learn about different jobs and careers that people have in high-tech industries. Ask tour hosts if it would be possible to have a female employee conduct the tour, or seek out opportunities to talk to females who can act as role models and communicate to girls that it is possible for females to be successful in high-tech careers. Tours have the potential to provide a “spark” to ignite future high-tech careers and give students a point of contact for summer jobs and internships as well as technologies they might explore.

## Attract Girls to High-Tech and STEM Programs

Emphasize opportunities which appeal to girls such as:

- Bringing along friends and making new friends
- Socializing and working in teams on fun projects
- Using creative ability and skills
- Going on field trips
- Career day presentations featuring women in STEM careers (if possible find a graduate from the school who can highlight her experiences in school and after on her journey to her current high-tech career)



## Develop an identity that appeals to girls:

Think about marketing a “brand” – What will it look like? Will it appear attractive to the majority of girls?

This may include logos, club names, slogans ... anything you can use to appeal to girls and heighten their interest in STEM curriculum and help develop pathways to high-tech college and careers.



- Decide what “message” you want to convey
- Appeal to artistic talent and engage girls to help design the brand
- Try out your new brand on a focus group of girls before committing
- Include your brand on promotional materials such as flyers, blogs, brochures, websites etc.



## Robotics

Robotics activities are a proven high-tech “hook” to engage and encourage students to expand their math, engineering, and technical knowledge and to learn how these they are applied and used in today’s high-tech industries.

Robotics:

- is a good fit for problem-based learning (PBL) curriculum applications.
- provides a popular platform for cooperative competitions – consider starting an “all girls” team.
- offers plenty of hands-on opportunities to provide girls with a chance to improve technical knowledge, skills and abilities (KSAs) as well as spatial visualization skills.
- is also a great platform for learning and using teamwork skills.
- provides a good opportunity to focus on logical thinking and organization.

## sTEm Tournaments

Consider spearheading and adding additional sTEm (emphasizing **I**technology and **E**ngineering) tournaments and post the “winning girl” and “winning boy” (pictures if allowed) inside the classroom or in your school paper. Many educators fail to realize that an essential and key factor in retaining female students in the STEM classroom is to make sure they integrate lesson plans and activities designed to instill and build confidence to encourage female students, right from the get-go.

Research shows again and again that confidence is a major predictor for success of female students in science, technology, engineering, and trades classrooms. Females don't drop out of STEM classes because of poor grades, but because they lack confidence in their ability to succeed. They often judge their abilities as being poorer than that of their male counterparts, even in the face of grades that are better, or just as good as those of the male students in the class. Donna Milgram, *the Executive Director of the National Institute for Women in Trades, Technology and Science (IWITTS)*, states, "Educators, whether at the secondary, 2-year college, or 4-year university level, need to instill confidence in female students, right from the start - in the first few weeks of class."

### **Self-Assessment**

Research shows girls and boys are equal in math and science ability. The way girls perceive their ability in STEM courses, and how that perception affects their confidence, is a key determinant in predicting the probability of them continuing on in STEM, and on to a career in a STEM field. Many girls still buy into the stereotype that boys are better at STEM – that they are just "born" that way. They believe/perceive that hammers are not for them to use.



The good news is that research shows clearly that with positive reinforcement and encouragement from teachers and parents, girls' performance and interest in STEM subjects can and will increase. If girls constantly receive the message that their intelligence and skills can be expanded and enhanced with hard work, experience and learning, they perform much better and are more likely to pursue STEM study and possibly careers in the future.

### **Mantras**

Some educators recommend creating mantras for their female students to repeat aloud several times a day, even if they don't believe them at first! Research reports that it can make a difference. Ann Jolley, a science educator and author of STEM Imagineering blog on [MiddleWeb](#) uses the following mantras with her students:

I like learning about science, technology, math, and engineering.

I am good at science/math/technology.

I like using the design process that engineers use to create a product.

I want to be a scientist or engineer or work in technology when I grow up.

Hairmath – is an innovative, informal STEM education program involving engineering, physics and chemistry, designed to introduce girls to fractal geometry. Its confidence building mantra is “girls have a head for math.”

Girls need to believe that it is possible for them to grow intellectually. Therefore, we need to banish negative stereotypes! Creating a “growth mindset” will help make it possible for female students to become whoever they want to be.

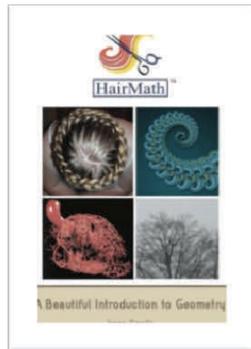
### **Encourage and Build Confidence**

It is essential to incorporate activities that will capture and hold female students' interest and instill and boost confidence right from the start of the semester. Research has shown unequivocally that confidence is a key predictor for success of female students in science, technology, engineering, and trades classrooms. Low grades are not the main reason that females drop out of STEM classes, but rather a lack of confidence in their abilities. Female students often believe that they are not performing as well in class as their male peers, even when their grades show that they are.

In a study conducted by FLATE, teachers developed implementation plans to recruit girls to STEM in their schools after attending a one-day workshop and being provided with an implementation plan template. As a part of this task, teachers were asked how they would encourage their female students to enroll in STEM courses and programs and to consider STEM careers later.

Responses included:

- Highlighting successful women in STEM careers during Women's History Month and at Career Days
- Inviting female STEM professionals to come and speak to their students
- Using “girl-friendly” lesson plans for students (e.g. a study of successful women in STEM)
- Science Fair support
- Mentoring
- Lunches and breakfasts with mentors
- Clubs (such as robotics and engineering)



Due to rigorous testing schedules, finding time for students during the school day to participate in the types of activities listed above has traditionally been a problem. Although some students may have transportation difficulties, after-school or weekend clubs may be a good solution for many students. In these types of settings, "all girls" programs flourish, encouraging girls through teamwork, praise, camaraderie, and learning opportunities.

## **EFFECTIVE INSTRUCTION AND CURRICULUM**

### **Spatial skills**

The National Academy of Sciences states that "spatial thinking is at the heart of many great discoveries in science, that it underpins many of the activities of the modern workforce, and that it pervades the everyday activities of modern life" (National Research Council, Committee on Support for Thinking Spatially, 2006, p.1).

Males' and females' cognitive abilities differ significantly in terms of their spatial skills. Men and boys consistently outperform women and girls on spatial skills tests. Robust spatial-visualization skills, particularly the ability to see objects in three dimensions, are correlated with success in science, technology, engineering and mathematics (STEM) fields. To interpret diagrams and drawings in science and mathematics text books successfully, students need well developed spatial skills, as early as elementary school.

Research suggests that this discrepancy between males and females may occur as a result of boys' greater exposure to construction and mechanical toys, 3-D video games, certain sports, mechanics and shop drafting as they grow up. The good news is that females' spatial skills *can* be dramatically improved in a relatively short time, with training. Sheryl Sorby, a professor of mechanical engineering and engineering mechanics at Michigan Technological University, has conducted extensive research on the role of spatial-skills training in the retention of female students. In a pilot study, Dr. Sorby found that middle school girls who took a spatial-visualization course enrolled in more advanced-level math and science courses in high school than did girls who did not take the course. Sorby recommends that this training happen by middle school or earlier to make a difference in girls' choices. Girls must be provided with opportunities to improve their spatial visualization skills through training and grow up in an environment fostering success in science and math. Through development of their skills, their increased confidence and belief in their ability to succeed in STEM will result in a greater likelihood of them pursuing STEM coursework and later careers in a STEM field. We must continue to stress to girls that intellectual skills can be strengthened and enhanced with effort (i.e. anyone who works hard can succeed).

## Hands-on Activities

Today's high-tech industries continue to highly value employees' ability to work with their hands. One "hands-on" challenge that needs to be addressed is summarized in a Nuts, Bolts and Thingamajigs (NBT) Poll. The results demonstrated that young people are "non-tinkerers". The data clearly shows that teens don't have enough role models to encourage them to repair and build things themselves, nor have they experienced the pride of building or repairing something useful. This is especially true for females and may result in them feeling "left behind" from the start of their STEM class. For this reason, it's very important for educators to integrate hands-on lessons from the very first day of class. Through hands-on activities actively involving students in manipulating objects, students can learn by "doing." By emphasizing the real-life applications of STEM subjects, teachers can help students see the relevance of what they're learning.



## Embrace Diversity

Classroom support for student success in STEM comes from the realization that not all students come to the classroom from an equal technology background. Transferring schools, for instance, may cause some students to be behind in math when they arrive at your school. Or, language difficulty may play a role. Parents with high-tech or STEM jobs or who use tools on a regular basis and share the experience with their children, will enable them to enter school with a higher level functional skill set than others. The suggestion that extra time be allotted to girls for technology work and practice, or that girls may benefit from remediation in STEM subjects in no way suggests that all girls need this type of support...but some will. Ideas shared in this guide work for both male and female students.

## Consider these steps to help level the STEM playing field:

- Make sure to provide girls with opportunities to work with tools and technology that they may not have been afforded before
- Ensure that group work challenges all students, but does not leave anyone behind
- Make additional lab time available for girls where they may engage in extra hands-on practice time
- Build single gender cohorts for remediation and send the message that students are "in this together"
- Allow girls with stronger tech backgrounds to take a leadership role (peer-teach), in groups to avoid frustration with slower learners
- Address different learning styles and stages of development
- Identify female mentors and tutors from higher grade levels (photo of camp mentor)
- Share "success stories"

## The “T & E” side of sTEm

Science, technology, engineering and math (STEM) subjects are popular course listings in K-12 school curriculum. However, while many curriculum activities are centered around science and math, there are significantly fewer offerings focusing on technology and engineering, or the integration of STEM subjects in general. Integrating the “T & E” side of STEM requires collaboration at the educator level. Technology and engineering need to be emphasized for today’s students. FLATE has stepped up to fill this gap, and has curricula including complete lesson plans and presentations, all focused on the “T&E” side of sTEm, and ready for K-20 educators to download and use free of charge.

## CAREER COUNSELING

Raising awareness about STEM “helping” careers is particularly important when recruiting women and girls to STEM-related careers. We need to help female students see that they *can* help make a positive difference in the world. It is important to re-frame and better include technology and engineering as belonging to the “helping” sectors when talking about STEM education and careers. Such discussions uncover innumerable opportunities that may not have occurred to many female students. Targeting the softer side of STEM careers like those that require creativity, focus on sustainability and green aspects, or focus on helping people, appeal to many females’, (as well as others’), sense of social responsibility. Research clearly supports this. A recent report from the Girls Scout Research Institute - “Generation STEM: What Girls Say About Science, Technology, Engineering and Math”, found that girls are typically more interested in “helping” careers such as teaching, child care and working with animals. Indeed, the 2008 National Academy of Engineering study “Changing the Conversation” suggests that many girls leave engineering because they don’t realize engineering is a profession for social good. We must work hard to dispel this misconception and educate girls about STEM careers and how they contribute significantly, and in so many diverse ways, to improving our world and our lives.

A few ideas:

- Green Living – Alternative energy, energy efficiency, sustainability, recycling, horticulture
- Robotics – Nano robots played an important role in 9/11 for instance, or artificial limbs
- Biomedical Technology - Development and production of health aids, bionics, medical and safety devices and surgical robots
- Civil Technologies – Continuous improvements of infrastructure (drinking water, roads, building design and construction)

It is also crucial to have STEM college and career explorations early on in girls' academic experience so that appropriate mathematics and science coursework can be included. "All girl" cohorts for gifted as well as remedial work bolster and encourage girls. Experts recommend extra "lab time" for practice and attention to learning styles so that no girl is left behind. Certainly male as well as female teachers have the opportunity to provide praise, support, and make a positive difference for female students. Occasionally, an educator will feel like boys are left out when there is a focus on girls. The erroneous idea occurs when fearing that "more girls" in STEM programs means "fewer boys." This is simply not the case. What we hope for is "more students" in STEM overall, with a growing proportion of girls.

According to a 2012 report from the Girl Scout Research Institute, independent of interest level in STEM, there are still obstacles that need to be overcome to recruit and retain more girls in STEM:

- More than half (57%) of all girls say that girls their age don't typically consider a career in STEM.
- Nearly half (47%) of all girls say that they would feel uncomfortable being the only girl in a group or class.
- Further, 57% of all girls say that if they went into a STEM career, they'd have to work harder than a man just to be taken seriously.

We know that girls are interested in STEM subjects and careers but in spite of this, they continue to choose other, more traditional career choices such as teaching or social work. Research shows that although more than 80% of girls are interested in a STEM career, only a small percentage of those (13%), cite a STEM career as their number one choice. So we have work to do – we need to educate and raise awareness of the many lucrative and exciting STEM careers available to women. We need to educate everyone involved in our girls' education – parents, teachers, career counselors, and of course, the girls themselves.



*"In-a-Nutshell"*

## **HOW TO: Recruit and Retain Girls in STEM Fields**

- **Encourage, Build Confidence** – capture and hold girls' interest in STEM - Encourage them to challenge themselves with higher level STEM courses
- **Empower Girls** - to believe in their abilities and that with hard work, they can do and be whatever they want to
- **Involve Parents** – the number one influencer on high school students' choice of courses - Design your own STEM brochure to educate and inform parents
- **Start Early** – A new study by the Girl Scout Research Institute points out that girls start losing interest in math and science during middle school
- **Exposure to STEM fields** – role models, tours, mentors, career days, guest speakers
- **Informal STEM experiences** - field trips and extracurricular activities to give girls contact with STEM-related fields - science museums, camps, clubs
- **Spatial Skills** - utilize challenging hands-on, exciting and "fun" lessons and activities in the classroom
- **Make your classroom a risk-free "I can do it" STEM adventure ground**
- **Work to eradicate gender bias**
- **Careers** - educate girls about the many lucrative, high-tech careers available in STEM fields and stress the "helping" career areas to appeal to their nurturing side
- **Share your passion**, enthusiasm and excitement for everything STEM with your students

***Let's make it possible for girls to believe in themselves and their abilities  
- that they can be all that they want to be***

# Appendices

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## Resources List

**National Institute for Women in Trades, Technology & Science | [IWITTS](http://www.iwitts.org/)** - The National Institute for Women in Trades, Technology and Science: helping educators close the gender gap. [www.iwitts.org/](http://www.iwitts.org/)

**STEM Equity Pipeline** – Resources and free online webinars on research and recruiting best practices. [www.napequity.org/stem/stem-equity-project/](http://www.napequity.org/stem/stem-equity-project/)

**National Girls Collaborative Project** – Collaborative of organizations and activities throughout the US focused on recruiting and retaining girls in STEM professionals. [www.nacproject.org/](http://www.nacproject.org/)

**American Association of University Women (AAUW)** – Advocacy organization for women equity resource page for STEM for girls. [www.aauw.org/what-we-do/stem-education/](http://www.aauw.org/what-we-do/stem-education/)

**Resources for Women in Science and Engineering** – a huge variety of great information and resources. [www.engineeringedu.com](http://www.engineeringedu.com)

**National Women's History Project** - Founded in 1980, the NWHP is an educational nonprofit organization whose mission is to recognize and celebrate the diverse and historic accomplishments of women by providing information and educational materials and programs. <http://www.nwhp.org/>

**Women in Science: Why So Few?** – A great video from the Huffington Post. [www.huffingtonpost.com/2012/02/06/women-in-science\\_n\\_1256479.html](http://www.huffingtonpost.com/2012/02/06/women-in-science_n_1256479.html)

**Girls like STEM! Introduce a Girl to Civil Engineering during Engineers Week.** Article. <http://blogs.asce.org/girls-like-stem-introduce-a-girl-to-civil-engineering-during-engineers-week/>

**Girl Start** – Resources for girls, parents, volunteers, and educators. [www.girlstart.org](http://www.girlstart.org)

**Nanooze** - Explore the science and technology of nanotechnology. [www.nanooze.org](http://www.nanooze.org)

Engineering - Go for It! <http://pbskids.org/fetch/>

**PBS Design Squad Educator's Guide** - Hands on challenges, which bring engineering alive for kids. Designed for 9-12 year olds. <http://pbskids.org/designsquad/parentseducators/index.html>

**Tri-IT** - A unique, high-tech initiative designed to provide high school girls opportunities to participate in interactive technology experiences and cultivate their interest in information technology (IT) careers. Visit the t3girls web site for a wealth of information and curriculum resources. [www.t3girls.com/](http://www.t3girls.com/)

**NOVA The Secret Life of Scientists and Engineers**  
[www.pbs.org/wgbh/nova/blogs/secretlife/](http://www.pbs.org/wgbh/nova/blogs/secretlife/)

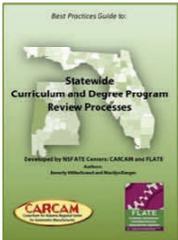
**O\*NET OnLine STEM Career Clusters**  
[www.onetonline.org/find/career](http://www.onetonline.org/find/career)

**Science Buddies: Careers in Science**  
[www.onetonline.org/find/career](http://www.onetonline.org/find/career)

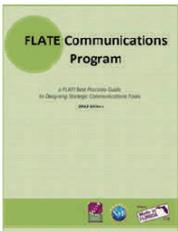
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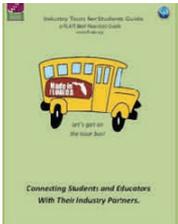
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### *Industry Tours for Students Guide*



### *The Robotics Camp Survival Guide*

All FLATE Best Practices Guides are available as online resources, or for download at <http://fl-ate.org/best-practices/>

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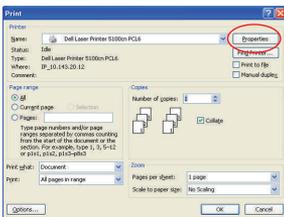
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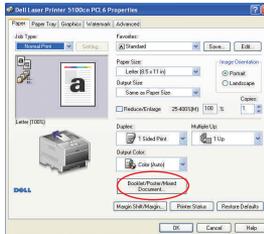
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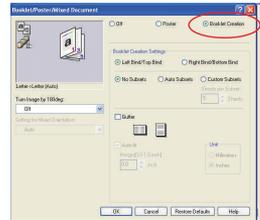
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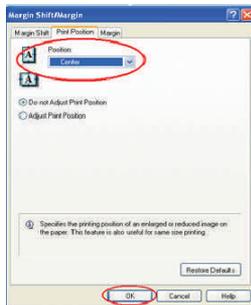
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