GEMS CLUB Toolkit

Creating and managing a STEM club for girls

GEMS
GIRLS EXCELLING IN MATH AND SCIENCE

Laura Reasoner Jones

GEMS Club

www.gemsclub.org

So, you want to start a GEMS club!

Welcome to the wonderful world of GEMS, STEM and encouraging girls to be the best they can be.

GEMS stands for **G**irls **E**xcelling in **M**ath and **S**cience, and STEM stands for Science, Technology, Engineering and Math. As you can see, there is a great deal of overlap. We want to see more children, and especially more girls, in these fields. That's what GEMS is all about.

Girls are vastly under-represented in the STEM fields, both in college and in the world of work.

What does this mean?

It means that your daughters and your young friends are missing out on exciting, challenging careers with opportunities for high salaries and long-term growth potential.

It also means that the world at large is missing out on the dreams and contributions of almost half of the population.

What problems could be solved, discoveries made or diseases cured when more girls and women are working on our world's challenges? We will never know unless we invite and encourage more girls to explore these enticing fields.

In this toolkit, you will find everything you need to start and run your own GEMS club for school-age girls, ages 8-13, and resources to help you explore and investigate with them.

Enjoy your GEMS club. It may be the most rewarding experience you have ever undertaken.

Laura Reasoner Jones

Founder and Director, GEMS clubs

www.gemsclub.org

GEMS
GIRLS EXCELLING IN MATH AND SCIENCE

The GEMS (**G**irls **E**xcelling in **M**ath and **S**cience) clubs were started in 1994 by a parent, Laura Reasoner Jones, who was dismayed to hear her 10-year old daughter Julie opt herself out of attending a magnet school because, "Math is hard, Mom." As parents do, Jones knew that math was not hard for her daughter; Julie had great test scores and good grades. But she seemed to be starting the well-documented pre-adolescent girl-slide into not wanting to appear smart, and Jones, who is also a teacher, knew she had to do something to stop it.

She started the first GEMS club at Julie's school for her and her friends in fifth and sixth grade, and the clubs have spread all over the country. In the spring of 1996, Jones was invited to speak at the AAUW of Reston-Herndon Branch's GEMS conference for girls. (The clubs were named after this conference to give them name recognition and to spark interest in expanding.) Featured on the GEMS Web site, www.gemsclub.org and in the AAUW video *Tech-Savvy Girls*, the GEMS clubs have become well-known for their consistent and effective approach to helping young girls become interested and stay involved in STEM.

GEMS is now part of a nationwide effort to improve opportunities for girls and under-served minorities through multiple efforts such as partnerships forged in the Clinton Global Initiatives—CGI America, Changemakers and others. You and your club join a network of adults committed to helping girls reach their potential.

Welcome to a wonderful adventure!

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Research

Encouraging girls to engage in STEM fields for courses and career has been a long-identified challenge, even as early as the 1980s. The National Science Foundation (NSF) and the American Association of University Women (AAUW) have dedicated time and funding to this effort with the help of many professional organizations, community groups and universities. While some progress has been made, girls continue to be significantly under-represented in the STEM fields in both education and career aspirations.

Girls have increased their SAT math scores over the years; but a significant gap continues to be present between the average boy's score and the average score for girls. Girls also are increasing their enrollment and pass rates for AP classes with the exception of Computer Science, but are not then choosing STEM classes or majors in college.

AAUW's 2010 report "Why So Few?" directly addressed this continuing problem with specific strategies based on research, most of which are addressed in GEMS clubs: spreading the work about female achievement in STEM, exposing girls to successful role models, developing a growth mentality—STEM abilities can grow with work and practice, developing spatial skills, and encouraging advanced classes in high school.

Check the GEMS Web site and the links below frequently for more research.

http://www.nsf.gov/statistics/wmpd/

http://www.ncwit.org/about.factsheet.html

http://www.aauw.org/learn/research/whysofew.cfm

Why Do We Need GEMS Clubs?

Our experience running GEMS clubs since 1994 has shown us that girls function differently in single gender groups, particularly when it comes to learning and experiencing things that are intimidating or possibly perceived as difficult, such as science or technology.

Girls want to learn math and science but can have classroom experiences that put them at a disadvantage. For example, many studies show that teachers pay more attention to boys or students who "call out" answers, rather than choosing students equitably. Other teachers may use girls as behavior management tools, requiring students to sit boy-girl so that the girls act as role models or conversation stoppers.

Group work with mixed genders can be problematic, particularly with science and inquiry learning, with many boys taking over the experimental work, leaving the girls to take data or serve as the "recorder" for the group. Many girls tend to hang back in mixed gender groups, thereby losing the opportunity to "do" the science or technology or engineering. They also tend to stop trying when things become difficult, thinking that they just can't learn it. Presenting STEM as difficult does not challenge many girls; instead it makes these fields daunting and unapproachable.

Many girls come to elementary school with little or no experience with "tinkering"—building with Legos™, helping a parent repair household items or open computers, etc. They also may have received many spoken and unspoken messages about STEM from parents, teachers, and television that math, science and similar fields are not for girls, are too hard or are not valued.

GEMS clubs address all of these concerns and more. When you start a GEMS club, you immediately send the message that girls can do STEM, and that they are valued as a group and as individuals. You provide a risk-free environment where there is no competition other than doing your personal best. Emphasis is on learning and having fun, not being the fastest or loudest. All girls get to do all of the activities, and all girls get to experience success. Girls leave GEMS clubs meeting excited about their experiences and eager to share their learning with others.

Why Should I Form a GEMS Club?

Why not just tell girls to do more science?

Why not buy girls chemistry sets and Lego™ kits?

Why not just tell parents to encourage their daughters to take more math courses?

Our experiences as GEMS club leaders and mothers show us that it just doesn't work that way. Girls need more than one invitation, more than one encouraging voice. And they like to do things with their friends. They also need to feel that they can try new things without risk, without fear of "breaking it." And that is exactly what a GEMS club does for a girl—it gives her the chance to try new things with her friends and to succeed without the pressure of grades, test scores or boys watching,.

You will find that your GEMS club gives many girls their first experience of using tools, mixing chemicals, wearing goggles, and making mistakes and laughing. These are wonderful experiences for every child, and they are the making of scientists and engineers.

You will also find that your GEMS club gives you experiences that you will never regret—the excitement of young girls understanding a difficult concept; the laughter as they experiment and explore the materials, and the eagerness with which they greet you each meeting. Girls are hungry for these kinds of experiences; and you are the lucky one who gets to provide them and share their enjoyment.

You are changing lives!

What does a GEMS girl look like?

Results from NSTA's *Girls in Science* show that girls who pursue studies and careers in STEM fields share many of the following characteristics:

- Confidence to explore new things
- Familiarity with tools
- Persistence in the face of confusion or difficulty
- Resilience in the presence of failure
- Ability to defend a position with evidence

How do adults work best with girls to achieve this goal?

- They encourage student voices.
- They maintain high expectations.
- They share responsibility.
- They make equity explicit—they talk openly about challenges and opportunities.
- They reflect to improve their program.

What do we want girls to learn?

- We want them to wonder about the natural world
- We want them to do the science
- We want them to think critically, logically and skeptically
- We want them to build and participate in a community of STEM professionals

For more information, read *Girls in Science* from the National Science Teachers Association.

Overarching Goals

GEMS has five over-arching goals which drive the planning and execution of every meeting.

These goals are:

- **Invite:** Invite girls to science and engineering and math over and over. Young girls do not see themselves as participants in these fields—many societal messages discourage them. So, you need to make STEM inviting by making it accessible but not easy; fun but not silly, and challenging but not impossible.

- **Entice:** Make your GEMS club **THE** place to be—by marketing it through word of mouth and examples. Make sure that you plan carefully enough so that every girl goes home with good things to say and cool things to show or demonstrate.

- **Encourage:** This may be the hardest change any of us has to make—learning to encourage without giving false praise. It is important that you practice the words to say—change can be difficult and society has created a culture of praise that does not really help kids in the long run. I really like these examples, adapted from this Web site: http://www.noogenesis.com/malama/encouragement.html

Praise	Encouragement
You are the smartest student I have ever seen.	I am very glad you joined GEMS. You really contribute to our fun and learning.
I am so proud of you.	You seem to really enjoy learning
You are the best!	I like the way you figured that out.
You were the first one to finish!	I like the way you keep trying to find the answers—you are determined!

Here is another good example.
http://www.iched.org/cms/scripts/page.php?site_id=iched&item_id=encouragement_praise

- **Explore:** GEMS is place where girls and you can try things that either won't or can't be done in the regular classroom. This doesn't mean that you throw safety out the window, but you can do things that older kids do, because you have more control over the girls. You can explore engineering, a subject that is not touched in elementary science. And you can delve into higher-grade math and science that will challenge the girls without putting them under undue pressure, because they don't have to pass a test on it.

  They can explore and fail and start again without pressure to get the one right answer. They can discover.

- **Experience:** GEMS is also a place where girls can get messy. They can get dirty, use tools, mix stuff up, and generally DO the science that is not possible to do during school. You also are able to ensure that each and every girl gets her hands in the activity, something that teachers struggle with due to time constraints. As educators have learned sadly over the years, you can't learn science or math or technology without **doing** the science, math or technology, and that is what the GEMS experience provides.

Developing a Growth Mindset

Children today have been fed a steady diet of praise and unearned trophies to the point that they have difficulty figuring out how to learn. Girls especially seem to feel that the success they achieve is due more to luck or inborn talent than to hard work or effort. This has a negative influence on their approach to learning to persevere when academic subjects such as advanced math and science become more difficult. Subjects that came easily to them when they were younger become more difficult as the concepts being taught grow more complex and abstract. Students must work harder and may struggle.

Research has shown that girls in general tend to have a "fixed" mindset" while boys in general tend to have a "growth" mindset. What does this mean for you and your GEMS club?

Well, if girls think that success in difficult subjects comes from luck rather than hard work or effort, they may give up more easily and shy away or opt out of these subjects and career paths. After all, luck is a difficult thing to change. And if you are not born with that "math gene," you are never going to understand this stuff. But if girls learn that intelligence can be improved, and that hard work can pay off, they can approach these increasingly complex subjects differently and can move ahead and achieve their dreams.

GEMS can help change the fixed mindset by providing opportunities to both succeed and fail, to learn to grow from failure, and to give girls chances to watch others make mistakes and recover from them. That is why saving time in GEMS meeting to reflect and discuss is so central to the desired outcomes. Yes, doing the science is important, but talking about the outcomes and the expected/unexpected results is essential. It is also imperative to talk with girls about how talents and intelligence change over time. This is where guest speakers and mentors become invaluable. Having that young engineering student who looks like a big sister tell GEMS members that she had to review her math assignments over and over because they were difficult, but she did, and now she is becoming a biomedical engineer, means more to them than your comments ever will. Knowing that other young people keep trying and learn the hard stuff gives a young girl hope.

One example I use is from my own experience. I am a latecomer to technology, and was thrown into it by a wonderful job opportunity with Apple Computer in 2001. But even though I am extremely comfortable now, and fairly skilled, I still suffer from what I call "blank screen phobia". You know, when you open up programs like Photoshop or Illustrator and there is nothing but an empty screen with a lot of tools on the top and side. For the longest time, I would just shut the program and sigh. It was intimidating. I have worked hard through tutorials and books to overcome this problem. So, whenever

we do something in the technology area with my GEMS clubs, I always tell them about this problem of mine. I tell the girls how I would open up the screen and be too scared to touch anything. And I always see at least a few girls nod or smile a little as they silently agree with me. And then I work with all the girls to show them that they can't break software and they can click on anything they see and always get back to where they want to be. Developing a growth mindset is not impossible. It takes practice and support, but it is a goal worth achieving both personally and in GEMS.

There is a great deal of research out there around this subject. Reading some of it can help you with the messages you give to the girls, and you can share it with the parents, also.

http://www.aauw.org/learn/research/whysofew.cfm

http://mindsetonline.com/index.html

Spatial Skills

Research has shown that one of the fundamental barriers to success in engineering is the lack of development of spatial skills, particularly spatial visualization, mental rotation, and transforming from two-dimensional to three dimensional and back. Many girls lack this skill set, due in most part to lack of experience, not genetic capabilities, as has been in the news.

Think back. How many girls in your GEMS club were comfortable with tools the first time they tried to use them? How many seemed comfortable assembling things like circuits? And did their skills improve as they practiced? Of course!

We have a unique opportunity in GEMS to change the course of girls' lives by giving them opportunities to tinker and mess around with equipment and tools they may never get to use at home or in school.

Consider bringing in Legos™ as part of your curriculum. Many schools still use the Lego Dacta™ sets as part of their science unit. Call the school system's science department and ask. Other school systems use Lego™ sets as part of the middle school or high school technology department. Many other school systems have these sets setting in warehouses—if you beg, you may be able to borrow them for a couple of meetings. You also can start a donation campaign to have people—friends, family, acquaintances, etc—haunt yard sales and give you old Lego™ sets. For many people, Lego™ sets with lost parts are useless. For you, they are priceless. You want the girls to do free-building—you don't want them to always feel they have to follow the directions.

Blind Building (building Lego™ structures behind a screen while telling a partner how to build the same structure) is a great activity for working on spatial skills. Every time we do this, a girl or two who never knew how good her spatial and communication skills are, discovers building and communicating as strengths. It is gratifying to see this discovery.

For more information, see the research below and the resources on the Resources page.

http://www.engr.utexas.edu/wep/firstsecond/visualization

http://www.engr.psu.edu/awe/misc/ARPs/VisualSpatialWeb%2003_22_05.pdf

http://fie-conference.org/fie2011/papers/1503.pdf

http://www.nsc.ru/EMIS/journals/AMI/2007/ami2007-nagy.pdf

http://www.engineersmedia.com.au/journals/aaee/pdf/AJEE_13_1_Sorby.pdf

Talking with girls about GEMS

Common sense and experience have shown that the best thing to do is explain the presence of GEMS as ordinary, and not as solving a workforce or gender equity problem. We never discuss the shortage of women in these fields. Instead, we talk about what great jobs there are, how much money you can make, and how satisfying these careers and fields can be.

Girls do not need to know that they are a minority in these fields. Informing them of this falls right into the trap of "Stereotype Threat" a well-researched phenomenon that means confirming a negative stereotype or thought pattern about one's self. http://reducingstereotypethreat.org/ . For example, if we told our GEMS members that we started the club because there are fewer girls and women in STEM and because girls in general seem to stop wanting to go into these fields, we are subliminally suggesting to them that this will happen to them.

How much better is it to say, "We are inviting you to join this fabulous club where you can do all these cool math, science and engineering things and meet people who do them for a living? " What girl wouldn't like to be in that club?

So, if you are asked why you started GEMS, think of some good answers ahead of time:

- I love math and science and want to share that with you.
- I love blowing things up.
- Math is the best mystery in the universe.
- Engineering is the coolest job—you are solving problems and helping people at the same time.
- Isn't it fun to build and create?

Chances are they will never ask you. They will just come and have a great time.

And if they ask you why it is just for girls, try turning it gently around and say, "Are you having a good time?" The answer will invariably be "Yes" and you may hear a few stories from the classroom.

Talking With Parents

As a GEMS leader, set aside time to meet/talk with parents as much as you can, even if it is just through handouts you give. Parents want the best for their children, but may not realize the importance of what you are trying to accomplish in GEMS.

Parents are one of the most important influences on their daughters' career plans. Do not underestimate this influence, and work with it. Fathers are even more important than mothers when it comes to developing a girl's self-image. So, you need to provide resources and model appropriate behavior for them with the help of the information on the GEMS Web site.

Some of the first things I discuss with parents:

- Turn off the TV and computer—get your daughter doing things rather than watching things
- If you want to spend money, buy an inexpensive digital camera. This taps right into girls' creativity and social strengths, but opens the doors to deep technology use.
- Let your daughter break things and take things apart. Let her use tools. How can she understand or even wonder how things work if she never gets to touch them?
- Go to yard sales and buy old sets of Legos™, K'nex™ and blocks. Make space so she can use them and build with them. Build with her.
- Let her get dirty. Let her dig by the creek or in the playground. Let her plant seeds and grow them in her room or in your yard.
- Let her DO the math, science, and technology. Don't fall into the trap of canned answers and programs—Use the words "I wonder" -- why you got that answer, why that happened, what would happen if, why this didn't happen.
- Watch very carefully what you say and do about math and science. Mothers who let the fathers do all the family finances send a powerfully negative message about math to their daughters. Telling a daughter to "go get your brother" when the computer malfunctions shows girls that technology is a male domain. Women who joke about never getting their checkbook to balance also tell girls that math is hard and not a 'girl thing.' On the other hand, just quietly running the family finances does not seem to have a positive effect—parents need to do more than model—they need to vocally and actively advocate for women in STEM.
- Allow your daughter to fail. It is ok to fail—it is very important for girls to take risks and learn from their mistakes. So, she wants to try the Science Fair, but you know she won't win? Well, you can help her learn all she can from participating, and maybe next time she will win. And if she never wins, she will still learn and enjoy the experience.
- Work on developing her spatial skills. See Spatial Skills

- Find role models in everyday life. If given the opportunity to choose a new doctor, choose a woman. Ask the female pharmacist (in front of your daughter) about her education. Ask the neighbor who is a computer engineer to tell your daughter about her job, or to take her to work for a day. Look for opportunities for mentoring.
- Give her opportunities to learn and grow in non-traditional fields—encourage her to participate in Lego™ Robotic classes, computer programming, math clubs, etc.

Talking with Teachers

Teachers are your backbone—they will support you 100% as long as you work with them.

Recognize that today's teachers are so busy and so focused on getting good standardized test scores from their kids that they do not have time to do the fun exploratory activities they used to do. Believe me, they want to. No one went into teaching so that they could achieve good test scores.

They also want their kids to enjoy learning and be excited by the natural world. And you get to be the person who does this for them. You are in a wonderful position.

Teachers are also a great resource for you. They have the supplies and the classroom space you need. Cultivate them. Respect their space and supplies. And see if they will co-lead the club with you.

The GEMS Web site has many good resources for teachers who are interested in gender equity.

How Teachers Can Encourage Girls in Math, Science, and Technology

- Start young. Yes, it is great to have the special activities for middle and high school girls, but many girls have opted out before this and won't be moved by these special resources.
- Provide multiple opportunities to "tinker" with materials. This should happen in all grades, not just the math manipulatives in the early grades. Ask parents and community members to donate tools and wood scraps to provide a rich scrap box for building and assembling. And make sure the girls do as much of the work as the boys. Give points for creativity and design as well as technical prowess.
- Watch your pronouns. Is every generic thing or animal a "he"? Do unidentified people in stories automatically become boys/men?
- Watch what you read aloud. Do you choose books with male characters so that boys will be quiet? This is a major teaching opportunity—confront the issue head on and deal with it and then read books with equal numbers of female and male characters.
- Avoid or reword sports analogies or at least monitor how many you use. Pay attention in the math and science books—how many problems use sports as a way to demonstrate a story problem? If there are too many, have a session where you and the other teachers, or you and the kids rewrite them.
- Talk about media messages. Point out to older children that you don't have to sell everything with sex. Point out when commercials are demeaning to a specific group. This all falls under Character Education—building respect for others.
- Talk about careers all the time. Relate what you are learning to how it could be used later in life. Make this a part of every math and science lesson. Let them hear the words "engineer," "scientist," and "researcher" every day of their school year.
- Develop girls' spatial/analytical skills whenever possible. Create opportunities to build and experiment with materials. Make up for the lost Barbie™ years.
- Build your content knowledge. If science and math are not your strengths, take classes or have a study group to build up your own confidence. Kids know when you aren't comfortable with a subject. Girls read this as "This is something girls don't learn well."
- Push the girls—challenge them to learn more. Let them know that hard work does pay off, and that each person can learn how to do the math and science. There is nothing magic about it, and there is no "math gene."
- Encourage discourse about math and science—write and talk about the process. Have them keep math and science journals where they write about how and what they learned.
- Talk to parents. Help them to realize that their daughters can shoot for the high-paying math, science, and technical careers. And even if you get resistance, push the parents to realize that the girls should take as much math and science as possible so that they will have options later in life as their interests change.
- **Assume** the girls are interested.
- Let girls make big interesting mistakes. Expect them to succeed.
- Dispel the myths:
    - 'Girls are not good at math and science.'
    - 'Girls who are smart will not be popular with boys.'
    - 'Scientists and engineers are nerds/geeks/whatever the prevailing term is.'
    - 'Math and science as professions are not family-friendly.'
    - 'Math (science) is tedious.'
    - 'Science and math are only for the brilliant, extraordinary student.'
- Pay attention to and promote attendance at local events that encourage interest in math, science and technology. For instance, when the local science museum has a special event, organize a group to go. Promote the event in the newsletter, and post a signup sheet in your classroom. Invite girls to go. Be sure they have friends to go with them. Send home notices to the parents.

Working with Guest Speakers and Mentors

Consider the purpose of GEMS and the value of guest speakers and mentors for your club.

- Girls can see real women in the field—and possibly see themselves in these careers.
- They can ask questions and get a feel for the everyday life of a STEM professional.
- They can hear about challenges in getting the needed education and suggestions on how to meet these challenges.

But consider also the possible drawbacks of turning over this valuable meeting time to an unknown individual.

- She is unprepared to work with young girls and just lectures them.
- She talks about how hard high school and college are, thereby discouraging the girls.

Be careful to weigh the pros and cons before you decide to have visitors. And prepare any guests you have so that the visits are successful.

Each guest speaker/mentor should:

- Be a woman. Come on, that is what GEMS is about, and unless you are getting Bob Ballard or Stephen Hawking, you should find a woman.
- Be very comfortable talking about her job and her field and do it with great enthusiasm
- Be able to remember what it was like to be an elementary school girl
- Be able to share a hands-on activity with the girls and relate it to her profession. You can always provide the activity but she should run it.
- Talk about her path to her career, how she got there, and what she sees or herself in the future.
- Mention the top three things she loves about her work.
- Mention a problem, but immediately tell how she solved it, with the help of another person, or through education, etc.
- Talk about how hard work got her to where she is today, not genius.
- Bring along specialized equipment or attire used in her work.

There are many ways you can bring guest speakers/mentors into your clubs.

- Invite local women from the STEM professions to talk about their lives and do a hands-on activity.
- Hold a Skype session or videoconference with professionals in the field
- Join online field trips like those in the Jason Project
- Use the wonderful videos available from Society of Women Engineers, Design Squad, Engineer Your Life, or Nova Science Now

Prepare some questions ahead of time—the girls can have these to use after the speaker has talked for a little while:

- Can you describe a typical day on your job?
- What kind of salary range do _____ earn?
- Do you travel for your job? Where have you been and what did you do?
- What was your absolutely favorite project/product you have worked on?
- What is the hardest part of your job? How do you handle this?
- What did you learn in elementary school that helped you as a _____?
- What do you do in your free time?
- How did you prepare to become a _____?
- IF your child wanted to become a _____, what would you say?
- What influenced you to become a _____?

GEMS Philosophy

- Let the girls take the lead.
- Do the STEM activities; don't just talk about them.
- All girls have the potential to be interested in STEM; this is not a program just for girls identified as gifted.
- Experience—repeat—experience success in a non-risky environment
- All girls can have fun and learn.
- You can't break it. This is especially important in technology.
- Dream big—there is nothing you cannot try.
- Get messy and stop the 'ick' factor.
- Look for that quiet girl who holds back.

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Recruiting GEMS Members

You will want to discuss this thoroughly with the school/organization you are working with. GEMS was started for the average girl, the girls who may not know what they want to do, the quiet girl who only needs to be shaken up a little. GEMS clubs were not designed to be limited to girls who have been identified as "gifted;" on the contrary, some of the best and most interesting responses have come from girls who were never thought to have exceptional talents.

So, be sure to find a mechanism to recruit that includes girls who have limited English, who are observers, and who hang back but watch and wonder.

How do you do this?

Ask the girls. Ask the school/organization for a recruiting meeting or five minutes on their morning news show. Ask to be allowed to visit each room for five minutes during the morning meeting or announcement time. Make posters that invite all girls, not just the ones who always join.

Ask the teachers. Charge them with thinking about the girls in their class who might either benefit because they don't get much help at home, or who can't seem to speak up for themselves. Help the teachers to follow through on the permission forms by making sure the forms are returned to an easily accessible place (front office box, for example.)

Prepare permission forms, and clearly state the dates, times, and place. Be sure to indicate if girls will need to get home by themselves. Be sure to have parent signatures and phone/email on the form, and determine the school's policy for children who are not picked up on time. Allow enough time for distribution and return of forms before the club sessions start.

Time Commitment and Scheduling Options

Choose what works best for you and your schedule, and for the girls and their schedules.

Examples:

- Once a month for two hours on the early dismissal days
- Once a month early in the morning for schools that start late
- Once a month in the afternoon
- Every week for ten straight weeks in the early spring when girls are not in sports
- Every other week during lunch

Each school and group of girls is different. If you have a guest speaker every meeting, you may want to plan to meet after school so that the speakers can work within their own work schedule. If you have girls who participate in many after-school programs, you and the school may want to set aside a block of time that is dedicated to GEMS and does not interfere with other scheduled activities and sports.

The choice is up to you—make it work for you.

Space

Your space can make or break your choices of activities, so seek out the best space possible.

An ideal space includes:

- Easy access to materials
  - This means that you can move around enough to get the materials you bring or the materials the school provides for you. An extra table or two is ideal, so you can place your supplies away from the girls until you are ready for them. Many times you will be doing two or three different related activities during the meeting, and you don't want to have to pass everything out until you are ready for it.
- Water /sinks/paper towels
  - Remember, we want them to get messy. And we want them to be safe and also clean up after themselves as all good scientists do. So, rooms/pods with sinks and paper towels are great. This does not mean you can't use a regular classroom, but a wet/dry area is ideal.
- School supplies
  - You will need standard school supplies to be handy—pencils, scrap paper, scissors, rulers, and markers/crayons. It is great to be in a cooperating teacher's classroom, as she will have all this stuff ready for you to use. But if not, bring a little kit with you that the girls can use.
- Storage
  - If may be too much to ask the school/organization to store things for you—most schools are crowded and have no storage space to store. But if is available, take it and be sure that it locks. You will find that you start to collect many different kinds of science and engineering supplies that you want to re-use, and it is important to have them always handy. Otherwise, be prepared to find a space in your house for all of the cool things you will start to find for your GEMS clubs.
- Room for working, listening, moving and regrouping
  - A great GEMS meeting has the girls moving around and out of their seats at least a third of the time. This may include looking at other groups' results, changing partners, sitting on the floor listening to instructions or reflecting together, and more. You need this kind of room.
  - You will want to mix the girls up, either from week to week or during the session. They will not like this—they prefer to choose their own partners, but it is best to make it clear from the beginning that participating in GEMS means making new friends and helping others to learn.
- The best room we have ever used was an art room. The worst was the cafeteria. No more to be said. Ask for the art room.

Snacks

Snacks are a local decision, with a couple of suggestions based on long experience.

- If you meet after school, the girls are starving. They will welcome drinks and snacks, even if they are water and pretzel sticks, which we offered one lean year.
- Most parents are very willing to provide snacks or drinks for one meeting.
- Don't spend the money you begged and pleaded for on food. It is too hard to get donations from people to be spending it on snacks. If parent donations are not an option, see if a local store will donate snacks.
- Snacks provide a huge social benefit to the meetings. Girls are social beings—they like having time to talk. But you are there with a mission, so snack time satisfies that talking need and you can get control of the meeting back after snack.
- Ask the school about allergies—most girls know their limits but you need to be aware of any allergies.
- Be aware of school rules about snacks.

Supplies

Collect a stash of supplies that you can use or store at the school/organization. You should be able to get most of these from the hosting school, so don't buy them—just have them handy.

- Pencils/markers/crayons
- Scissors
- Rulers
- Clipboards/small whiteboards to write on
- Scrap paper
- Hand sanitizer
- Paper towels

Buy these with money you get donated from the host/PTA/grants you work for

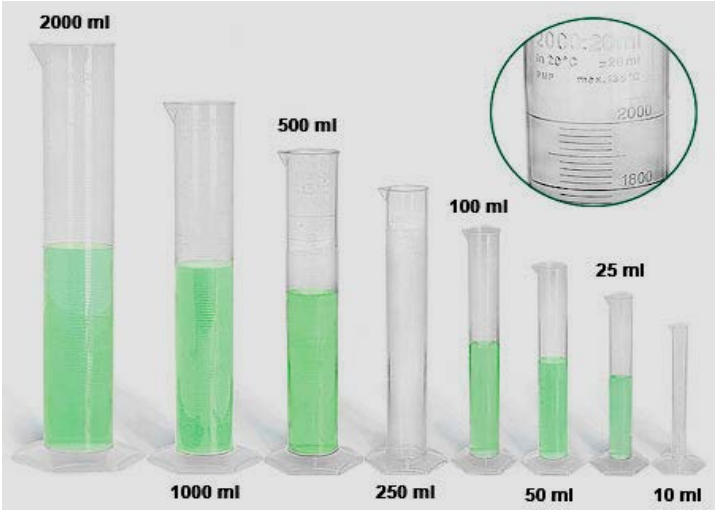
- Goggles—I like the ones that are purchased from a hardware store called 'safety glasses'.

  They are easy to keep clean and don't have that rubber smell.

- A digital camera—this is for you to document the fun, and to market your club. If the school has cameras the girls can use, by all means borrow them and let the girls take pictures too.

- Graduated cylinders—available possibly from the school or from science supply stores.

  The kids like to use them and they teach precision.



- Tools

  - One of the most important investments you can request money for and purchase is tools for the girls to use. We have used these over the years to take apart computers, work on Lego™ Robotics, design and assemble electric circuits, and more. Quality is not the most important thing here—quantity is. Go to the local hardware store and buy the sets of multiple sizes of screwdrivers, needle-nose pliers, and a few small hammers. See if they will donate them to you, or let you have the discontinued ones at a discount. Then guard them with your life.
  - Also find a few inexpensive sets of the very small screwdrivers used for computers—you will need them if you decide to take apart computers for a meeting, a fabulous activity.
  - Ask for donations—a lot of people have extra screwdrivers and pliers setting around and would not mind giving them to you.
  - Lock these up when you are done—they tend to walk and you do not want tools unsupervised in a school.

Staff and Roles

Leader(s):

That would be you. You are the leader, the person or persons who are responsible for the organization and planning of all of the activities, the person who spends nights trolling the Internet for fun science and engineering activities, and weekends begging for supplies and donations.

- The most important thing you can do is be sure to have fun. That is what the girls will remember. Even if the experiment doesn't work, or the towers they build fall off the desks and crush themselves, your attitude toward the activity is what they will remember.
- You don't have to know everything. Keep a running list of questions on the board or a large piece of paper and commit to finding the answer to them.
- You are the planner. You have to be the one who keeps things flowing. Dead time is not good with children; you can lose their interest very easily. So plan and make a list of things to do in order. See Planning for some examples.

Helpers:

- Helpers are great but be sure that you have specific tasks planned for them. Anyone who comes in to help deserves to be valued by being shown that they have a role to play.
- Good helpers are at least three years older that the girls in the club—high school age at least, and who understand what the point of the club is.
- Good helpers ask questions and don't give answers; they say things like, "Why do you think that happened?" or "I wonder what will happen if you….."
- Helpers who are parents are comfortable letting their GEMS child do the activity without jumping to make sure she does it right.
- Parent helpers also know not to discuss other people's children inside or outside of the club.
- Helpers are always on the lookout for good mentors/speakers and great activities and have no qualms about hitting up stores for donations of things like old film canisters, used coffee cans, etc. Helpers become scavengers like you.

Field Trips

This is a decision that you should make in conjunction with the school and is a decision not to be taken lightly. There are pros and cons to field trips:

Pro: Girls will

- see and talk to people they might never come in contact with on a regular basis
- see women working in STEM environments.
- go behind the scenes to some pretty cool places like airport control towers and inside high-tech companies

Con

- Liability—you are responsible for the safety and well-being of many young children.
- Chaperones—you should have one per every six girls at least, and you need to follow school system rules on who chaperones are and their liability on trips.
- Cost—school buses are very expensive and you may want to consider how you spend any money you may get. If parents drive, you circle back to the liability question.
- Fees—do you charge the girls for a field trip?

Options

- Video-conferencing via a free service like Skype—you can make arrangements with a female STEM professional to call into your meeting and talk about her job and her education, and then do the activity while she is still dialed in, or you report back to her as a group at the end of the meeting.
- Using the many videos of female STEM professionals available on the Web.
- Using the many TV show segments available –watching the segment and then doing the activities.
- Creating your own podcasts/web sites for sharing your work with the public.

In the end, consider the value of the trip vs. the costs and liability issues. Our group has only taken one kind of field trip—to the USA Science and Engineering Festivals on the National Mall. We decided that this was too good of a trip to miss—that the girls could see more science here than in a lifetime of science field trips. We wrote grants to cover the costs, and recruited parent and teacher volunteers so that we had a ratio of two girls to one adult. And it was great. But I would never spend club money on a regular field trip unless it was outstanding and not available any other way.

Safety

You are going to be doing some things in GEMS that are not normally done in a classroom.

That said, you just need to be very aware of safety and be careful.

Rules to live by:

- Know the school rules.
  - **No fire, obviously.** Not even to demonstrate something. Even if you think that you can control an experiment, you can't. A room of 24 perfectly behaved girls still is a hazard, so don't even consider fire.
  - **No truly dangerous chemicals.** You may find something very cool on the Internet you want to try, but heed the warnings. If you have to buy it from a science supply store, it is probably not good for elementary school.
- Have soap, paper towels and water readily available. Immediate cleanup of any spill is essential.
- Have Band-Aids™ ready. I have seen kids cut themselves using those little elementary scissors—a seemingly impossible feat, but yet they did it.
- Use goggles and gloves whenever you think you should. The kids love them, and you will be protecting them.
- Review the rules before you start, and stop the group and review them in the middle.
- Jump on infractions right away. It seems harsh, but if you have said "Don't walk around with the scissors, " then you need to stop the class the second you see a girl walking around with the scissors. They get very excited about the projects and rule-following goes right out of their heads. And girls love to share what they are doing or run to see what others are doing, meaning there is always a lot of moving around.
- Do not use tools, such as screwdrivers or hammers, until you know the girls and feel that you have control of the group. After a few meetings, you and the girls will know each other well enough to be able to get their attention and give clear directions.

Examples?

Computer Tear-down

Every other year in GEMS we collect old desktop computers from the schools or businesses and take them apart. The girls suit up in goggles, and, armed with screwdrivers and pliers, they take these apart down to the microprocessors on the mother boards. But I usually save this activity for the last or next to last meeting of the year so that they understand my teaching style and know that I mean business.

We sit down in a group on the floor and I wait until I have their undivided attention. And then I lay out the rules of the day:

1. Every single person puts on goggles and does not remove them until the meeting is closing.
2. All tools remain on the table where the leaders can see them unless they are in a hand; i.e., no sharing by tossing them from table to table or even walking them to another table.
3. Only one person has her hand in the computer at a time. Partners can work on taking apart the pieces they have removed from the desktop, like the hard drive.
4. Do not go anywhere near the power supply. (I point this out).
5. Consequences for violating these rules? The girl(s) will sit out the rest of the meeting and watch from the edge of the room. I have never had to enforce this.

You get the idea. And during this meeting, as with all meetings, the leaders circulate throughout the room all during the computer disassembly to be sure that girls are safe. And even with all the tight regulations, this is one of our very favorite activities.

Chromatography T-shirts

This activity came from a high school chemistry teacher, so it immediately becomes one that you know you have to monitor carefully. But it is also one of the favorite things we do. More information is on the GEMS Web site. www.gemsclub.org

We use 90% isopropyl alcohol to break down the chemicals in permanent markers to create gorgeously colored T-shirts for the girls to keep. But again, there are strict rules to follow:

1. When the directions say “Make sure the room is well-ventilated,” they mean it. Open windows and run fans.
2. Goggles are required throughout the entire activity.
3. The girls use small cups with eyedroppers and the super-strong alcohol. I sit them down at the beginning and review the goggle rule. Then I show the eyedropper, and tell them that if I see an eyedropper pointed in any direction but down (toward the cup or shirt), they are out for the rest of the meeting.
4. Again, I have never had to enforce this—they understand the rules and follow them well. But I make the rules clear for their safety.

Use your best judgment. You may not be able to do an activity that you want to due to the girls’ ages, but you can always send it home as a link for them to try at home, as things can be done at home that can’t be done at school.

Top GEMS Ideas

Please don't limit yourself to these—but they are one that we repeat every two years for sure—they are really fun and informative. And there is information on each of these on the GEMS Web site www.gemsclub.org

- Chromatography: Using permanent markers, the girls make designs on white t-shirts. Then we use eyedroppers of super-strength alcohol to make the permanent marker ink "give up" its colors and spread over the shirt. It is fun!

- Building bridges out of candy: There are many bridge-building activities out there, but this one was the most fun. We used many different forms of candy to build bridges that would span a sheet of 8 ½ by 11 paper and support a full can of soda. The girls had to work with the strength of the candy and the span of the bridge to make a successful project. As with most activities, the girls worked in pairs.

- Estimating: Over the years we have done many estimating activities. This is one of the best and the easiest, and is a good one to start out the year: We went onto the M&Ms™ web site and found the approximate number of colors in each size and type of bag of M&Ms™. We then give each girl her own bag to count. We record data and graph it using the classroom computers.

- Carbonation Celebration: Each year the girls are fascinated with a little mild destruction. We combine baking soda "bombs", Wintergreen Lifesavers™ in Coke™ bottles, and Alka-Seltzer™ into a fun-filled afternoon talking about pressure.

- Legos™-Hydraulics: We borrow these sets from the middle school technology labs, complete with the picture directions. The girls had a great time. I plan to borrow even more difficult sets next time. My school system owns many of these sets and most girls don't get much Lego™ exploration time in their childhood. It's a great activity.

- Crystals-growing your own: We used a high school chemistry student, a former GEMS member, to come in and demonstrate how to write names in crystals, how to use magic crystals (provided by the chemistry teacher) and how to grow a crystal garden.

- Making paint from scratch: This activity lead out of an activity on polymers. When the Pittsburgh Paint research center in Maryland said this was too hard for elementary students, I decided that the hunt was on! I found a recipe in a Virginia history book. We used colored chalk and a glue/water mixture. The girls donned goggles and used hammers to pound the chalk into powder. Then they mixed their paints and painted little charms to take home.

- USGS Map treasure hunt: We combined a visit from a cartographer from the National Geographic and a treasure hunt. I laminated maps of the local area purchased from the USGS store. The girls, in pairs, had to find 20 landmarks on the maps and mark them. This was a great contest. You could also use Google Earth if you don't want to purchase the maps.

- Recycling paper: We used the instructions found on the Beakman and Jax site, but these instructions can be found anywhere. The extra things we added were to use cotton lint from the craft store and to mold the paper into cookie molds: the girls created a really nice final product.

- Taking apart computers: It took two years to beg old computers from friends, but it was worth cluttering up the garage to see the girls tear into the towers with screwdrivers. They were absolutely fascinated with the inner guts of these items and took home most of the contents to share with their families. Now I get computers donated from the schools or businesses.

- Mailing Pringles™: Armed with one Pringle™, and a limited amount of other material, we each wrapped and mailed a Pringle™ to the school and measured the results to see which girls designed the best and safest packaging.

Resources

Please use the GEMS site and feel free to suggest new resources. www.gemsclub.org

The summer activity sheet that is always on the front page of the GEMS site has massive amounts of information and numerous resources and technology downloads.

Other fabulous sites include

PBS' Design Squad

Engineer Your Life

The Exploratorium

The Jason Project

Engineer Girl

SciGirls

Dragonfly TV

American Chemical Society education portal—Science for Kids

Any science museum

Resources in your school—many times these individuals will have access to tons of fun stuff that they are dying to try out

The technology specialist/teacher

The science teacher/team leader

The math teacher/team leader

Parents who are STEM professionals—ask the PTA or classroom teachers

Contacts/Funding

You are going to need both. And it is pretty easy to get them both at the same time, especially the contacts. You are going to need either money for supplies, or access to an incredibly well-stocked science cabinet at your school. So, investigate the resources in your community:

AAUW—the American Association of University Women has a long successful history of supporting girls and women in the STEM fields. Check their Web site for the local chapter www.aauw.org and talk to the women involved. Many times they will support you without you having to go through the national grants procedure.

Local businesses: Getting more girls and women into STEM fields is a workforce issue—we need their contributions to be a successful country—so businesses large and small are interested in supporting this effort. Meet with the local manufacturers and see if they would be interested in a $100 donation to expose girls to the world of engineering. Meet with the local small computer companies and see if they could give you $100 to expose girls to computer programming. You get the picture. You also might get offers of guest speakers along with the donation.

Ask the **school PTA** for $100. This is a program serving the girls in your school. That is what the PTA does. You can do a lot with $100.

Does your community have active **Women's Clubs**? They might be interested in donating a little money.

Are there local **professional organizations** such as Society of Women Engineers? Women in Technology?

Contact your local **community college or university**. Go to the STEM departments—the sciences, architecture, mathematics, computer science, etc. Talk with the department heads to see if there are either professional organizations or student groups who could help, either with money, supplies or speakers.

Contact the **community relations** department of the school system. Somewhere there is someone who controls the flow of news in and out of the system, and he/she is staying on top of companies who are supporting your schools.

Don't be afraid to ask. People want to help, and they will be inspired and impressed by what you have taken on. Women professionals are fully aware of the obstacles facing girls in these fields; after all, they have lived through and overcome them. They will be glad to help.

One recommendation: always plan a short thank-you—a note from the girls with a picture, or a fun video—have a standard thank you that is easy to make, but be sure to send it. That way when you want to ask again, you are a welcome visitor.

Registration

Before you ever mention this club to the girls, have your registration plans in place.

Talk with the school. Find out how they handle registration for other clubs/events—Do they send out papers to everyone? Do they allow you to come to the classes and speak? Do they prefer to hand-pick students? Remember—you are the guest in the school—it is a good idea to follow their procedures.

Use the sample registration forms in this toolkit and modify them to meet your needs. Be sure to set a clear cut-off date and stick to it. Also be clear about what will happen if the number of students who enroll exceeds the capacity. If you end up with more girls than you have room for, follow the plan to the letter, as you will have parents question your decisions.

Notify the girls who are enrolled, and keep an email list of the parents so that you can notify and remind them of meetings. This is also a good way to get snack donations.

Save these forms from year to year. You may want to have GEMS alumnae volunteer or do a follow-up study, as I did.

http://gemsclub.org/yahoo_site_admin/assets/docs/gems.42154150.pdf

Jr. GEMS is enrolling

(**G**irls **E**xcelling in **M**ath and **S**cience-- www.gemsclub.org)

Attention third and fourth grade girls!

You are invited to **register** for the Jr. GEMS club at (your school) Monday afternoons beginning October 31. This club is fashioned after the GEMS club for older girls and will introduce you to many fun activities and careers in math, science, engineering and technology.

If you are interested in joining and can commit to one meeting a month for the rest of the school year, please complete the form below including your parents' information and signature and return it to (teacher) in (room) by Friday, October 7.

Due to space limitations, only **24** girls will be chosen randomly on Tuesday, October 11 . There are no guarantees of acceptance—it is purely random. You will be notified if you are chosen on Friday, October 14.

Questions? Email (teacher .)

Name: _____ Grade: _____

Teacher: _____ Jr. GEMS member last year? _____

Parent Name and Signature: _____ _____

Parent Email: _____ PRINT NEATLY

Walk home ? _____ **OR** Picked up by parent? _____

First meeting—Monday October 31—12:45-3:00 P.M. Girls will be dismissed to room 151 with the buses.You must be picked up at 3:00.This club is free.Meetings will be once a month on Monday afternoons—dates will be sent home on first meeting date.

GEMS Club

Back again for its 17th year!

Girls Excelling in Math and Science (www.gemsclub.org) is back at (your school)

With more exciting math and science activities for **5th and 6th grade girls**.

Dates

3:15-4:30 in Room ____

Interested? Complete this form and return to (teacher)—GEMS fills up fast.

_____

Name: _____ Teacher: _____

Parent Name: _____ Email:_____

I will pick up my child or allow her to walk home. (Circle one)

Parent Signature: _____ Phone for emergency: _____

Questions? Call or email (Teacher) (phone) (email)

WWW.GEMSCLUB.ORG

Certificates

We always give out certificates. We do this because we realize that life today is competitive and certificates of participation can help a girl who is trying to enroll in a summer program or a magnet school. It also gives the girl a reminder of her hard work and fun times in GEMS.

We also have a little certificate ceremony the last meeting. We want the girls to recognize achievement in themselves, and so we do a post-GEMS survey, have really good snacks and call each girl up to get her certificate. The other leaders and I try to find something individual to say about each girl—maybe this girl is the one who was able to pry the motherboard out of the desktop with brute force, or maybe that one was the girl who saw beautiful designs in her strawberry DNA extraction—you get the idea.

Here is a sample. I always buy those notary seals to stick on—they love them.

GEMS 2011

Girls Excelling in Math and Science

This is to recognize

_____(name)_____

For her active participation in airplane design, computer disassembly, chromatography, circuit creation and paper engineering.

_____ _____

Evaluation/Assessment

Although GEMS is for the girls, it is essential that you plan some kind of pre and post evaluation. You need to decide what your goals are, and measure your work to see if you are meeting or at least approaching those goals.

For me, my goals were to try to improve or maintain interest in the STEM fields. I tried to measure this through surveys on attitudes and future plans. I did not do a very good job, at first.

Then I found the surveys and tools on this Web site: Assessing Women and Men in Engineering.

http://www.engr.psu.edu/awe/

I highly recommend using these surveys for both your own personal reflection after a GEMS club year, and for your funding needs. If you can show potential funders that you are using standardized instruments for evaluation and have a consistent and effective evaluation plan is place, you will be considered more seriously.

The next pages contain an example from this site that we adapted for our use in Jr. GEMS.

This gives us the data we need to plan the rest of the year and also gives us an idea where we need to start in attitudes and feelings. At the end of the year, we will give another survey based on the ones in AWME and look at both our progress and the activities we did.

Jr. GEMS 2011-12
Pre-Season Survey
Fall 2011

Write your initials here. _____

1. Please mark how much you agree ☺ or disagree ☹. (😐 Means that you are not sure)

	☹	😐	☺
a. I am good at science.	☐	☐	☐
b. I am good at math.	☐	☐	☐
c. I am good at engineering.	☐	☐	☐
d. I like learning how things work.	☐	☐	☐
e. I am creative.	☐	☐	☐

2. What do you think engineers or scientists might make that could make a difference in your life (either good or bad)? Draw a picture with a label or make a list in the space below.

3. Please mark how much you agree ☺ or disagree ☹. (😐 Means that you are not sure)

	☹	😐	☺
a. I would like to be a scientist.	☐	☐	☐
b. I would like to be an engineer.	☐	☐	☐
c. I would like a job where I invent things.	☐	☐	☐
d. I would like to design machines that help people walk.	☐	☐	☐
e. I would enjoy a job helping to make new medicines.	☐	☐	☐
f. I would enjoy a job helping to protect the environment.	☐	☐	☐
g. Scientists help make people's lives better.	☐	☐	☐
h. Engineers help make people's lives better.	☐	☐	☐
i. I know what scientists do for their jobs.	☐	☐	☐
j. I know what engineers do for their jobs.	☐	☐	☐

4. How old are you?

☐ 8 ☐ 9 ☐ 10 ☐ 11

Were you in Jr. GEMS last year?

☐ yes ☐ no

Take-Home Sheets

It is essential that every girl takes something home with her from the GEMS meeting. Whether it is a list of links for follow-up or an instruction sheet on how to recreate the activity, retaining the information is essential for extended learning. The GEMS Web site has many of these sheets created for the activities we do. Most of them have two sections:

- A brief description of the activities and their purpose, with some follow-up activities or deeper information to use at home and
- A set of links designed to help the GEMs members look into careers that might intrigue them if they liked the meeting.

Here is an example:

Today we experimented with surface tension. If you liked this activity or want to know how it applies to a career, try these links.

http://exploratorium.edu/ronh/bubbles/sticky_water.html

http://physics.about.com/od/physicsexperiments/a/surfacetension.htm

http://www.bugsurvey.nsw.gov.au/html/popups/bpedia_09_tol_wa-st.html

http://www.enchantedlearning.com/subjects/insects/bugs/waterstrider/Wsprintout.shtml

http://web.mit.edu/newsoffice/2003/robostrider.html

http://www.kidsbiology.com/

http://dnr.wi.gov/eek/

http://kids.niehs.nih.gov/

http://www.epa.gov/kids/

Careers:

http://www.spsnational.org/cup/

http://www.physics.org/careers.asp?contentid=381

http://www-marine.stanford.edu/careers.htm

To find these activities/links, use the GEMS Web site or the many sites linked to it. If you are just not finding what you want, type the scientific term into a search engine like Google and be sure to add "for kids" after the term. You will be surprised and pleased how much good information there is out there, and you can pick and choose the best links.

One word of advice:

I try to stay away from sites that have a lot of ads. It is too hard to ensure the safety of the girls when you get away from sites that are run by museums and educational organizations. I also put a disclaimer at the bottom of every sheet I give the girls to protect myself:

This page contains links to web pages that are outside the school network. Our school system and the GEMS club do not control the content or relevance of these pages. Please use caution and common sense on the Internet.

You will enjoy finding these resources and will soon have your favorites as we all do. I also try to give credit to the organization or book where I find the activity we do. Girls need to see that you give credit to people, as they begin to do their own research and learn about plagiarism. You can set a good example for them.

Technology Programs to Download and Share

It is easy in GEMS to get swept up into science, engineering and math and ignore the technology component of STEM. Luckily there are several wonderful free programs that families and schools can use to encourage children, especially girls, to explore the wonders of computer science and CAD. I highly recommend these.

It may be difficult for you to get access to computers in the school you are using. Computers must be supervised and protected, and many systems do not allow teachers or visitors to download programs that are not purchased by the system. You might want to consider using the resources from NCWIT http://www.ncwit.org/unplugged called **Computer Science in a Box** to explore computer science in GEMS and then send home the links for the programs to be used at home.

Here are the programs to share

- **Scratch** from MIT

http://scratch.mit.edu/

Scratch was designed at MIT to encourage elementary school students to explore computer programming and to have success and fun in doing so. We use this to design games and stories, and it taps right into the creativity of girls. It is also very well supported and documented, meaning that any question you may have can be answered online. There is also a large educator community available with lessons and tutorials for you as leader to explore.

When I introduce Scratch to girls, I use the example I mentioned in Developing a Growth Mindset about being intimidated by the blank screen. But I show them one thing—how to change the cat so she moves around the screen by changing the code on the left, and then I let the girls go. Another thing I do to tear down apprehension is show the examples already built into the program and show them how they can adapt them by changing one thing at a time. This strategy usually erases all fear and the girls just jump in. It is amazing what they do with this program.

- **Alice** from Carnegie Mellon

http://www.alice.org/

Alice was also designed to encourage young students, especially girls to explore computer programming. It differs from Scratch in that it is 3-D—students use “camera” points of view to explore the universe they create. Girls can create games, stories and animations in this program, just as in Scratch. It is more complicated than Scratch, and I would recommend introducing it second, but it is more challenging, which appeals to many girls.

Alice opens with the built-in examples with the computer code below, so that the girls can see how things work. I encourage them to work with the already loaded programs and adapt them so that they won't be worried about starting with the blank screen.

Alice also is very well supported and documented with many resources and tutorials available. I use this with older girls and find that they will turn to it in their spare time for fun instead of going onto social networking sites at home.

- Lego™ Digital Designer

http://ldd.lego.com/

Although this is a marketing tool for Lego™, it is the perfect tool to build spatial skills in young students. Use of this tool has succeeded in getting my GEMS girls to play and build with Legos™ when standard approaches did not work. A free download, I close as much of the marketing as I can and encourage the girls to use this in tandem with real Lego™ blocks. We practice designing, then building, and then reversing this by building and then designing in LDD.

I built an entire year of Junior Lego League around this tool, having the girls learn to use the program and then build their competition design in LDD before creating it for the showcase. I also adapt this for Blind Building, having the girls do a partner build by having one girls build using LDD and the partner build it in 3-D using Lego™ blocks.

As with Scratch and Alice, this free download has many examples already built into the program so that reluctant or timid programmers/builders can use the examples and adapt them until they feel comfortable building their own.

- Google SketchUp

http://sketchup.google.com/

Another free download, this is free CAD software that is easy yet so advanced professionals can use it. To avoid the blank screen fear, I just click on the person in the screen, press delete, and he disappears. Once again, the anxiety level in the room drops considerably. Then I start clicking around using the push-pull tool at the top.

This program is so well-supported and documented that any novice can use it. The kids really respond to it—they can build cities and parks and houses. I find girls spending their lunch hours designing rooms for themselves.

Google SketchUp has every kind of construction element you could desire built-in or downloadable from the online warehouse. Girls will find this fascinating; we are very lucky to have this free resource available to kids.

Choosing Activities

- Try to plan about 4-5 meetings at a time, or at least choose the subject area. That way, you don't get accidentally stuck in a pattern or always doing chemistry or mental math, for instance. Sometimes it is easy to find a group of resources that lend themselves to GEMs meetings, and you don't realize that you have not touched on other parts of STEM until it is too late.
- For example, when we plan out 10 Jr. GEMS meetings, the monthly club meetings for 3rd and 4th grade girls, we make sure that at least one of the meetings is directly related to math, and at least one is directly related to technology. Those two areas seem to be harder to plan for, and need a great deal more preparation, especially the technology one, so we work hard to ensure that those areas are covered.
- We also have at least one meeting where our emphasis is on building and working on spatial skills, an identified weakness of many girls. That meeting can take a lot of planning, as materials must usually be brought in.
- On the other hand, biology, chemistry and physics are easy and fun to plan for, so we rarely have any trouble getting ideas and finding time to prepare.
- We also try to include at least one activity each year that looks like art, but is really STEM, like origami or paper engineering in the form of pop-up books.
- Be sure to choose things that are active. Make sure that girls are not sitting and listening for more than 5-10 minutes at a time. It is fine if you explain/discuss at the beginning, do some active work, then reconvene in a circle for more explanation/reflection/discussion in the middle. It is good to get up and move around, and it gives everyone a chance to talk.
- Some clubs let the girls set the agenda. We do not. It is up to you, but the over-arching goal of exposing girls to STEM fields means that you are exposing them to things that they may not have ever heard of, so how can they choose them?
- We try to choose activities that are about two years harder than what they do in science or math, and then we take them through them step by step. Even if the girls in your club are not identified as gifted, they are here because they are interested and interest goes a lot farther than test scores. GEMS is a risk-free environment, and this is place to try hard things.
- I always start out a meeting by reminding the girls that everyone has strengths and we are going to find people who have strengths they never knew about. "This just might be the day," I will say. I also point out that if this activity is hard for you today, it may be that this is an area that you just haven't had a lot of experience in yet, and that you can learn it, even if now is not them time to master it.

- As mentioned before, try to do science activities that are in their future. There is nothing more frustrating than planning a slime project and have the girls say, “We did that last month with Mrs. _____.” If you want to do something that is going to be taught in science that year, try to make it much more advanced so that when they get to it in school, each girls can be very comfortable and know that she both has experience and knowledge to contribute to her class. For example, when we did a fun activity using batteries and bulbs and circuits, I knew that they would be doing this in class in the spring, but I also knew that each child would not get much time to mess with materials. So, our GEMS time consisted of giving each girl a bag of supplies, a partner with the same bag, and a few simple instructions. Their combinations of supplies were amazing, as they experimented with chaining circuits and stacking the bulbs to light in sequences. It made their later study of circuits much more meaningful due to their practice in GEMS.
- Always plan to group and regroup. Girls are happy when they are with other girls they know, but we make a point of randomly grouping them for at least half of the meetings. We justify this to them, as they whine and pout a little, by reminding them that they can make new friends and find other girls who have the skills they might need to succeed in a partnership. It is a good idea to set this as a rule/accepted structure at the very beginning of the club sessions. Regrouping then becomes less and less of an issue.

Three phrases to live by:

Show, don’t tell.

Do, don’t show.

and

Process and reflect.

Tips for Leading

- Practice "Wait Time." New teachers have to practice this, and you will to. Try to wait at least 15 seconds (count them in your head) before calling on a girl. Look around the room during this time. Let them see that you are waiting for all girls to process the question.
- After the comment or answer by one girl, wait again. Ask if anyone has something to add. Wait and listen to them.
- Look around and give eye contact all the time. It is easy to fall into the trap of calling on the first or loudest hand up, but give each girl a chance to think.
- Practice some conversation helpers such as, "Tell me a little more." Tell me what you mean." You are saying that _____. Can you expand on that?"
- Understand that there will be mistakes and misunderstandings in the concepts you are trying to share. Always have chart paper or a white board so you can write as the girls talk—writing their ideas on a board give them value and sometimes you will see them see a mistake as it goes up, and they correct themselves. Your goal is to create an atmosphere of trust, in which girls can risk making a mistake without fear of shame or ridicule.
- Connect what they are doing for the activity to the real world or to a career. I never start the session with a video of a real person, but I like to end it or use a short clip as a transition so that the girls are always thinking that real people do these things.
- Model for the girls that it is OK not to know everything, but that you will help them find out or will find out and bring it back to them. For example, one meeting we were working on designing cars and making changes on small Matchbox™ cars to see if we could speed them up. We started to talk about "spoilers" on the backs of cars, and no one, including the leaders knew exactly why they were there. It seemed counter-intuitive as we made our experiments on the small cars we were racing. We made an assignment to ourselves that we would find out and bring it back to the next meeting, and we did. It made for a much more effective discussion when we reviewed it at the following meeting, because most of the girls had been watching out for cars with spoilers and had a theory to offer.
- If you start to plan an activity and can't get excited about it, then don't do it. No matter how important the concept is that you want to teach or explore, it won't be fun if you can't even find the excitement in it as you plan. The best meetings come when you have thought about the activities for nights beforehand.
- Science and math and engineering are all around us. See if the school will let you have some bulletin board space or room in their newsletter to place articles or cartoons or interesting information. There are many funny examples of math and science in cartoons every day—in the paper, in *The New Yorker*, and on the Internet. Find these for the girls and help them stretch their thinking.

- Remember, the point is to make it fun. If the experiment doesn't work as planned, talk about what happened. Figure it out with the girls. If it is too hard, stop and talk about it. Be ready to roll with whatever happens—and tell them that science and engineering is like that--problems occur and you figure out what to do. Relax! Providing a good place to explore STEM is the goal, not the perfectly controlled experiment.
- Model and talk about making mistakes as discovery. Engineering and science in particular are about problem-solving. Design some of your sessions as identifying problems to be solved, and use this as a springboard to exploring engineering and scientific problems that have been solved. Good resources for this kind of exploration can be found in Family Engineering.

Sample GEMS Meeting Schedule

First 5-10 minutes—

Girls arrive, places coats and backpacks out of room, find seats.

10 minutes—snacks—cleanup

Hold to a short snack time—they love to talk, and can easily use up 20-25 minutes of your precious time.

5 minutes—intro to activity

Sometimes it is a 'discovery time'—with naming the activity at the end, but most of the time I lay out the purpose and instructions at the beginning.

10 minutes—Discussion, questions and answers

Talk about the new vocabulary involved, the demonstration, questions and review of process—I always tell them that when we get started, I will not interrupt unless it is a safety issue, or if I have been asked the same question 5 times and feel that everyone needs to understand the issue/question.

30 minutes—Hands-on activity—stop for discussion and questions if you need to, but try not to.

Circulate around the room constantly.

10 minutes—Stop, come together in the middle and discuss what they found.

10 minutes—Clean up.

10 minutes—Reflect and evaluate what happened, go over the take-home sheet

Talk about what they might want to find out more about.

Sample GEMS Club Activity

Topic—Building circuits and LED Throwies

Goal—to let the girls explore circuits and wires, voltmeters, switches, buzzers, and anything you can find/afford at Radio Shack or online.

Supplies needed:

Note: Every school in this country has the supplies for the basics of this lesson—do not invest a lot until you ask the science people.

Circuit-building

Battery holders
Mini-light bulbs and holders
Insulated wires and alligator clips
Buzzers
Switches
Volt meters
Batteries to fit the holders—buy new batteries
Anything else that looks like fun

LED 'Throwies'

LED lights
Small button batteries
Duct tape or electrical tape
Scissors
Small button magnets

Preparation:

Divide up the circuit-building supplies into bags so that girls can work in pairs. Make sure that each pair can complete at least one circuit, but add miscellaneous supplies so that they can try new configurations and build complex circuits.

Count out the LEDs so that each girl will get at least two, and have enough batteries and magnets to match the final number of 'throwies.'

GEMS Club Meeting:

Introduction:

I introduce these activities by asking the girls if they know the word "circuit." I write it somewhere on the board so they can see it. Older girls may know, but younger girls probably will not. I ask them to think of other words that are similar—you may get circle, circus, circuitous, and you can relate them all to the word "circle". Starting with this pays off, because as they start to create and connect wires, you can always refer them back to word **circuit** to see if they can trace the wires.

I then ask them if they know what is in a battery. Most girls do not have any idea and I make sure that I have a diagram ready that shows the core. This also gives you a chance to warn them about not breaking open batteries.
http://electronics.howstuffworks.com/everyday-tech/battery.htm
http://www.energizer.com/learning-center/pages/how-batteries-work.aspx

We do a quick review of parts of an atom, and then practice acting out the flow of electrons in a battery.

- Form a circle, with girls kneeling
- Each person holds a small object in her hand that will be passed to her neighbor. I talk about how electrons move in a battery and that they have to keep flowing to have the current continue to pass and light the bulb or sound the buzzer. They begin to pass the objects (I use pennies).
- I then designate a girl to be the light bulb. She stands up and passes the pennies also, but the instant someone drops a coin, she drops to her knees, indicating that the current has stopped flowing. We laugh and try to get back in sync, and then I designate another person to be the switch. Electrons continue to flow until the switch decides to turn off, stopping the flow again.
- This is a silly little exercise, but the girls get the "flow" concept much more easily than be referring to a diagram. They also have a visual representation about what happens when the circuit is interrupted.

Circuit Exploration

We then discuss the exploration of circuits. Before we divide up into pairs and distribute supplies, we talk about what you need to complete a circuit and light the bulb or the buzzer, and what can go wrong. The girls may suggest dead batteries, disconnected wires, and burnt-out light bulbs. Talking about what may not work puts them in the mindset of being able to figure out how to fix what may go wrong.

Charge the girls with making their bulbs light, making the switches work, making the buzzers buzz, and figuring out what else they can do with their supplies.

Spend at least 30 minutes circling the room letting the girls explore the materials and build circuits. Be prepared to sit down and work through the wiring with a couple of pairs of girls, but also be prepared for a couple of pairs to build complicated devices that astound everyone. Give a five-minute warning and stick to it. At the end of that time, have everyone share their findings, even if their circuits were very simple or troublesome. It can be very interesting to figure out why a switch works backwards, or hear the girls theorize that they need two different colors of wire to make their light work, and have other girls disagree. I find these discussions to be stimulating.

LED 'Throwies'

These are LED lights attached to button batteries and magnets that wild and crazy teenagers build and throw onto steel bridges and other outdoor structures in the winter. I don't tell this to the girls—I just tell them how much fun they can have putting these on their refrigerators and watching the battery last for a long time. This activity comes from Instructables, a fabulous resource for fun things to make using science.

Show the girls how to assemble the "throwies"—using the directions on the attached page. Warn them also about the small battery size, and that this is a hazard for small children. Talk them through the circuit that is formed in this light, and be sure that they understand that unlike the batteries and bulbs, these circuits must be assembled correctly. And warn them about the small size of the batteries—not to be around little children!

Distribute the supplies and support the girls as they assemble the "throwies." They may need help taping the magnets and leads tightly enough. When they are all done, be sure to document the light show with a camera—it is a beautiful sight.

Discussion/Reflection:

Pull the girls together to talk about what they learned. One easy strategy to do this is to ask three students to "Name one thing you learned." Then ask three students to "Name one thing you would like to learn more about. " Finally, ask three students to "Name something you might have done differently."

Take notes during the reflection, or immediately after for your future use. And take notes on what you need to bring to the next meeting to answer the big puzzling questions, like "Why did the switch work backwards?" "Does it really make a difference what color wire you use?"

1+2+3 LED Throwies

By Graffiti Research Lab

Make and toss a bunch of these inexpensive little lights to add color to any ferromagnetic surface in your neighborhood.

You will need:

10mm diffused LED, any color(s) 20 cents each from HB Electronic Components (hebeiltd.com.cn).

1" strapping tape
One roll will make many throwies.

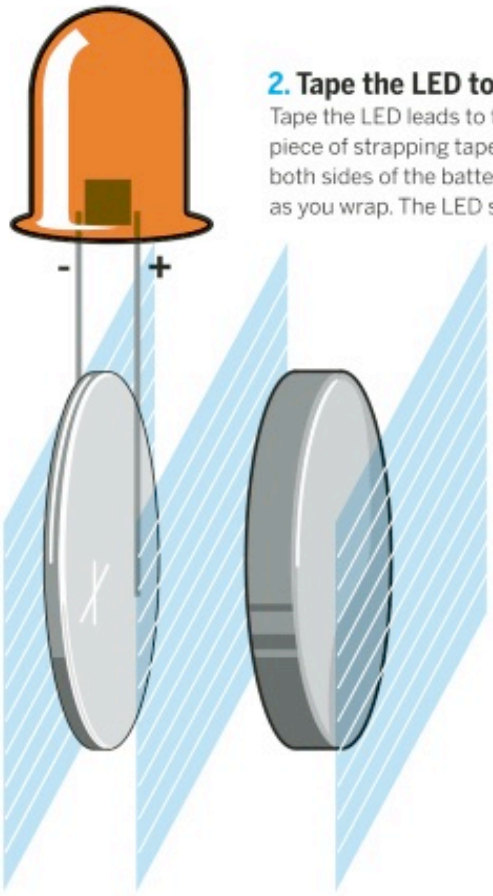
CR2032 3V lithium batteries
25 cents each from CheapBatteries.com.

½"x1" NdFeB disc magnet, Ni-Cu-Ni plated
25 count for $13 from Amazing Magnets (amazingmagnets.com).

Conductive epoxy (optional)
Weather-resistant alternative to tape. Available from Newark InOne (newark.com).

1. Test the LED.

Pinch the LED's leads to the battery terminals, with the longer lead (the anode) touching the positive terminal (+) of the battery, and the shorter lead (the cathode) touching negative (-). Confirm that the LED lights up.



2. Tape the LED to the battery.

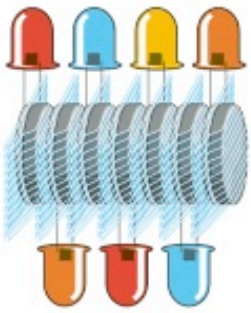
Tape the LED leads to the battery by cutting off a 7" piece of strapping tape and wrapping it once around both sides of the battery. Keep the tape very tight as you wrap. The LED should not flicker.

NOTE: The battery's positive contact surface extends around the sides of the battery. Don't let the LED's cathode touch the positive terminal, or you'll short the circuit.

3. Tape the magnet to the battery.

Place the magnet on the positive terminal of the battery, and continue to wrap the tape tightly until it's all done. The magnet should hold firmly to the battery. That's it — you're ready to throw (or make a few dozen more). Throw it up high and in quantity to impress your friends and city officials.

Throwies naturally chain together in your pocket, making multi-segmented throwie bugs, which will also stick to metal surfaces if they aren't too long.



A throwie will shine for about 1-2 weeks, depending on the weather and the LED color. To get one off a ferromagnetic surface, don't pull it, or it may come apart. Instead, apply a lateral force to the magnet base, and slide it off the surface while lifting it with a fingernail or tool.

Graffiti Research Lab (graffitiresearchlab.com) is dedicated to outfitting graffiti artists with open source technologies for urban communication.

Sample GEMS Activity

Topic:—Predicting and Analyzing Data with M & Ms™

It can be difficult to find fun different math activities in some schools because the girls can be at such varied levels of understanding. We use this club plan at the beginning of the series of meetings to introduce thinking differently about math, and using many resources to explore math.

GEMS has been doing this for years, but now I find it as an activity on the Science Buddies Web site, so I will add their activities to ours.

Goal: to predict, measure, compare and graph data about the color variation of M & M™ candies.

Supplies Needed:

- A small bag of milk chocolate M & Ms™ for each student—currently selling at $1.69 oz (they are going to eat these later, so you want to avoid contamination.)
- Worksheet with table for recording data
- Computer and LCD projector for creating and showing the statistics in Excel
- Pencils
- Hand sanitizer
- Paper plates

Preparation:

- If time is short, prepare a small bag for each girl with the worksheet, pencil, paper plate and bag of M & Ms™.
- Prepare the Excel chart to match the table on the worksheet—see example attached.

GEMS Club meeting:

Introduction:

- Begin by introducing the concept of data, statistics and probability. Ask the girls if they have ever made predictions? What were they? How did they turn out?
- Ask them to think about a time when it is helpful to predict, even if your prediction is wrong? Try to steer them away from the weather—we are looking for another type of prediction.
- Then ask them if they can think of a time when they can predict something based on gathering data. You can see where we are going with this.

The activity:

- Set up the problem/question by introducing some of the vocabulary:
  - Prediction
  - Frequency
  - Graph

- Then set up the activity. Discuss each of these questions with the group and write their predictions on the board.
  - How many M&Ms™ are in each bag?
  - How many of each color are there in a bag?
  - Which color is there the most of or the least of in a bag?
  - Do all of the bags have the same number of candies?
  - Does each bag have the same mix of colors?
  - What is the distribution of colors over the bag?

Lay out small bags of M&Ms™ and paper towels on the tables, and have the girls use hand sanitizer before they open their bags and start counting. Remind them that they are allowed to eat them later, not now!

First have them count the total number of candies in the bag and enter them on the worksheet table.

	Red	Yellow	Blue	Green	Orange	Brown	Total
Name							

Then have them enter their data into the Excel chart.

Here is a sample Excel chart for the kids to complete. You can set up two or three laptops for them to use, or have them each put their data into the same chart, which makes it easier to make charts on. If you pre-fill the formula for calculating percentages (but show the girls how you did it), they will be able to enter their data and see the percentages fill. Elementary girls don't get to use Excel much, but I find that they are fascinated by its power.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1							M & Ms							
2	Name/Color	Red	Percentage	Blue	Percentage	Yellow	Percentage	Green	Percentage	Brown	Percentage	Orange	Percentage	Total in Bag
3	(Girl)													
4	(Girl)													
5	(Girl)													
6	(Girl)													
7	(Girl)													
8	(Girl)													
9	(Girl)													
10	(Girl)													
11	(Girl)													
12	(Girl)													
13	(Girl)													
14	(Girl)													
15	(Girl)													
16	(Girl)													
17	(Girl)													
18	(Girl)													
19														
20	Total													
21														
22														
23														

Before you run the charts and graphs in Excel, discuss each of the predictions with the girls.

- How many M&Ms™ were in each bag?
- How many of each color were there in a bag?
- Which color was there the most of or the least of in a bag?
- Did all of the bags have the same number of candies?
- Did each bag have the same mix of colors?
- What was the distribution of colors over the bag?

Then run the charts and see how their predictions came out. You will all be surprised by the results, which are never the same from group to group or year to year.

Analyze and reflect

- What patterns do you see?
- How accurate are your predictions?
- How wide was the variation between the bags?
- What is the most commonly found color of candy?
- What is the least common?
- What are some possible reasons for variation in the bags?

According to this article on eHow, http://www.ehow.com/how-does_4970368_how-candy-mms-made.html the Mars Company predicts this distribution of colors. How did your data stack up?

And now, they can eat them!

Sample GEMS Club Activity

Topic -- Build Me a Boat!

Goal-- Build 2 small boats that will hold at least 25 pennies for at least 10 seconds without sinking. Compare materials used and make a judgment about the better material for the job.

Supplies needed:

- Duct tape
- 20 straws
- 1 10-inch square of plastic wrap
- 1 12-inch square of aluminum foil
- 8 8 oz. paper cups
- 25 pennies/washers
- Lots of towels/paper towels
- Tub of water

Vocabulary:

- Buoyancy
- Disperse

Preparation:

Collect all the supplies and lay them out so the girls can see them. Challenge them with the idea that they are going to build two different boats and determine which material will make the better boat—the boat that will hold more weight and float longer.—the boat that is more buoyant.

GEMS Club Meeting:

Introduction—the challenge:

Use this little story, or something similar that has meaning in your local area:

Your friend's family has a house near the river. One weekend it rained and rained, and they went to the house to discover that the river had risen so high that it flooded their house. They looked in the windows to find that some of their furniture and food were floating on the water from the river. Some of the things in their house did not float, however and were covered with water. How can you help your friend figure out why some things floated and some didn't?

Ask the girls what they know about floating. See what preconceptions they have, and how they determine if an object floats or not. See if they can name/describe things which surprised them—objects or substances that floated or sank when they thought they would do the opposite.

Making Predictions:

Scientists make predictions/hypotheses about what will work in order to design experiments. The girls will predict what kinds of material will hold weight and be more buoyant before they begin experimenting.

After presenting and discussing the challenge, each girl will design a proposed solution to the challenge on the data sheet. She will predict which will work better to hold a defined amount of weight—plastic wrap or aluminum foil.

Boat Building

Plastic wrap boat

1. Pass out the following supplies:
    a. 1 sheet of plastic wrap-10 inches long
    b. 10 straws
    c. 4 plastic cups
    d. 1 yard duct tape
    e. Scissors
    f. 25 pennies/washers
2. Build the boat.
3. Test each boat by placing it into the tub of water and observing using the data sheet:
    a. Does it float without any weight in it?
    b. Put in 2-3 pennies/washers at a time, waiting 10 seconds between additions. Note on the data sheet what happens with each addition
    c. Does the boat stay afloat each time? When is the tipping point?

Discussion/Analysis:

What happened? Whose boat was able to hold 25 weights without sinking?

What does the design of the successful boat look like? How could you change your boat to make it more buoyant?

Foil boat

1. Pass out the following supplies:
    a. 1 12-inch square of foil
    b. 10 straws
    c. 4 plastic cups
    d. 1 yard duct tape
    e. Scissors
2. Build the boat.
3. Test each boat by placing it into the tub of water and observing using the data sheet:
    a. Does it float without any weight in it?

a. Put in 2-3 pennies at a time, waiting 10 seconds between additions. Note on the data sheet what happens with each addition of pennies
b. Does the boat stay afloat each time? When is the tipping point?

Discussion/Analysis

What happened this time? Whose boat was able to hold 25 pennies without sinking? What were the differences between the plastic wrap boat and the foil boat?

What does the design of the successful boat look like? How could you change your boat to make it more buoyant?

Which material is more successful in creating a safe boat? Why?

How did the results match your predictions?

Reflection:

What would you suggest to the friend whose family lives near the river? What about people whose houses are flooded every year? How could your discoveries help them in the future?

Flooding resources

http://www.floodsmart.gov/floodsmart/?cid=Search_Google_Adwords_Flood_Standalone

http://www.pbs.org/wgbh/nova/lasalle/buoyancy.html

Adapted from Design Squad:
http://pbskids.org/designsquad/parentseducators/resources/watercraft.html

Build me a boat!

Your challenge: Your friend's family has a house near the river. One weekend it rained and rained, and they went to the house to discover that the river had risen to high that it flooded their house. They looked in the windows to find that some of their furniture and food were floating on the water from the river. Some of the things in their house did not float, however and were covered with water. Why did some things float and some things sink?

Your supplies:

- Duct tape
- 10 straws
- 1 10-inch square of plastic wrap
- 4 8 oz. paper cups
- 25 pennies

Challenge one: Build a boat with these supplies and see how many pennies it can hold before it sinks.

Given these supplies, draw or describe a boat design that will hold 25 pennies before sinking.

Build and test your boat: Write or draw what happened and explain why.

Challenge Two: Change it up

- 1 12-inch square of foil
- 10 straws
- 4 plastic cups
- 1 yard duct tape
- 25 pennies/washers

Using these supplies, what do you think will happen? Draw or write this below:

Build and test your second boat. Show what happened with this challenge. What was different? What was the same?

After your discussion, what would you do differently? What would you suggest to your friend who lives by the river?

Build Me a Boat Data/Observations

Name: _____

Plastic Wrap:

Number of Pennies	Float or Sink	Comments

Total number of pennies boat will hold before sinking:

Foil Boat

Number of Pennies	Float or Sink	Comments

Total number of pennies boat will hold before sinking:

Sample GEMS Club Activity

Topic: Extending Your Reach—Long-distance Hands

Goals: To use understanding of magnets, force and friction to pick up items

To use angles to determine best methods of construction

Supplies needed per girl:

- Stiff cardboard (index cards) 3 x 5 inches
- 1 straw
- Tape/scissors
- 20 feet of string
- 1 magnet
- Small metal objects (washers, nuts, screws, paper clips etc.)

Vocabulary:

- Angle
- Diagonal
- Magnet
- Attract
- Repel
- Friction

Preparation:

Collect all the supplies and have them ready for the girls. They can share the metal objects. Set up the room so that there is an area called the “lab” where the contamination has taken place, and a work area where they can build their ‘hands’.

GEMS Club meeting

Introduction:

Use this story to set the scene, or use something similar from your local area:

You are a scientist in a large lab that has dangerous and hazardous materials. You come to work one morning to find that a mouse has entered the lab overnight and spilled many of the hazardous objects. You cannot pick them up with your hands or even gloves for fear that you will touch something dangerous and you only have 30 minutes to design and pick up the objects before the rest of your staff gets there and is exposed. What can you do?

Making Predictions:

Read the challenge to the girls. After presenting the problem and discussing the question to be sure that each girl understands the problem, ask each girl to make a suggestion/prediction on how to solve the problem. Each girl should write/draw her proposed solution on the attached data sheet.

Creating the Long-Distance Hands

Lesson: Long-Distance Hands

Goals: To use understanding of magnets, force and friction to pick up items

To use angles to determine best methods of construction

Supplies needed per girl:

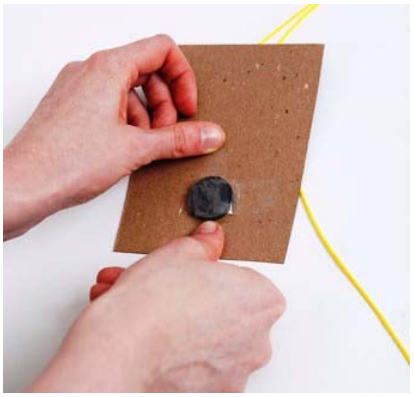
- Stiff cardboard (index cards) 3 x 5 inches
- 1 straw
- Tape/scissors
- 20 feet of string
- 1 strong magnet
- Small metal objects (washers, nuts, screws, paper clips etc.)

Active Learning: Making the Long-distance Hands

1. Cut two pieces of straw about 1-2 inches long.
2. Tape them to the index card/cardboard at an angle, forming a V about an inch apart at the point. Use a lot of tape to be sure they are stable.

3. Thread the slider onto the string by feeding one end of the string through one of the straws. Make sure that the string can move smoothly inside the straw. Then thread the other end of the string through the other straw.

4. Move the slider by first pulling one string and then the other. Notice what direction it moves in. How can you make it move in the opposite direction?



5. Add the magnet. Tape it securely to the non-straw side of the slider. Which location will work best? Near the front? Near the back? In the middle?

6. Move to the field of contamination. Loop the string around something heavy on the floor on the far side of the contaminated area (a chair or table) so that the string rides over the contaminated objects. This allows the scientist to stay outside of the contamination area while picking up the spilled items.

7. Move the slider along the string toward the table/chair. Let the magnet pick up the objects, bring them back and drop them into a safe container. How many objects can you carry at once? How can you pick up more?

Discussion:

What is happening here?
Why does the slider work? What are the variables? What are some things you could change to make it work differently? Were you able to pick up everything?

Points to discuss:
Friction makes the slider work—the force of one string playing off the other keeps the slider from falling backward unless you make it move.
How did the angle of the straws affect the movement of the slider?

Challenge 2-- Unfortunately some of the spilled items are not metal. How can you adapt your long-distance hands to pick up things that are not attracted to magnets?

Additional supplies:

- Paper clips
- Rubber bands
- Pipe cleaners
- Small objects that are not magnetic—pennies, erasers, etc

Discussion:

What happened differently? What adaptations worked best? What was needed to make this work? Could you have designed the original tool to collect both magnetic and non-magnetic items?

Reflection:

Go back to the predictions. Have each girl write about her prediction, how it was true or not true and why. Ask them to turn and talk to a tablemate about what happened and then share out. Ask the teams to share the most effective/least effective designs and discuss what are the pros and cons.

How could this be important in the real world? Where could something like this be useful or important?

Video—but don't watch until they have tried at least once.

http://pbskids.org/designsquad/video/ --search 'Treasure Grab'

http://science.howstuffworks.com/prosthetic-limb.htm

http://www.nlm.nih.gov/medlineplus/artificiallimbs.html

Adapted from Design Squad

Long-distance Hands data sheet

You are a scientist in a large lab that has dangerous and hazardous materials. You come to work one morning to find that a mouse has entered the lab overnight and spilled many of the small hazardous objects. You cannot pick them up with your hands or use gloves for fear that you will touch something dangerous and you only have 30 minutes to design and pick up the objects before the rest of your staff gets there and is exposed. What can you do?

Challenge One Supplies:

- Stiff cardboard (index cards) 3 x 5 inches
- 1 straw
- Tape/scissors
- 20 feet of string
- 1 magnet

Prediction: To solve this problem, I can:

Results: After building my long-distance hand, this is what happened:

Challenge Two: Unfortunately some of the spilled items are not metal. How can you adapt your long-distance hand to pick up things that are not attracted to magnets?

Additional supplies:

- Paper clips
- Rubber bands
- Pipe cleaners
- Other non-magnetic items

Show what happened differently with this challenge:

After your discussion, what would you do differently?

Sample GEMS Club Activity

Consumer Testing—Which one is best?

Goals: To use principles of scientific investigation to determine which product is best and inform the public through letter-writing

To look at advertising and refute or confirm claims

Supplies needed:

- Five different brands of paper towels, including the school system's brand. Tear off three towels per girl of each brand, labeling each one with a number. For example, 48 sheets of Bounty would each be labeled "1", 48 sheets of Wegman's brand would each be labeled "2", etc. Each girl will use two sets of 1-5 (with a numbered spare for mistakes), but we will use one number at time so that the tables are dried between tests. Keep a spare roll at the tables to keep things clean and dry.
- Eye droppers
- Small tub of margarine, divided so that there is a chunk available to each table
- Plastic knives
- Water in small cups—to use for the drip tests
- Extra paper towels to clean up between tests
- Clipboards, if available and pencils

Vocabulary:

- Consumer
- Absorbent
- Strength
- Hypothesis

Preparation:

As described above, get the sets of paper towels ready for the girls. Each girl also needs a small cup of water, an eye dropper, a plastic knife, and access to the butter.

GEMS Club Meeting:

Introduction—the challenge:

- Read the challenge:

  Your mother insists that it is better to buy the store brand of paper towels because "there is no difference." Your father watches the ads on TV and thinks that one brand is better because he sees the paper towel wipe up everything from spaghetti to volcano eruptions. You are tired of the arguments. How can you settle this?
- Explain to the girls that they are going to test the paper towels and then write letters to the companies that make them and inform them of their results.

Section One--Making Predictions and Testing:

Ask the girls to remember the names of the paper towels they see advertised on TV, or use at home. Tell them that they are going to test paper towels and ask them to give some ways to test paper towels. Do not identify any of the brands you are using for this experiment. Ask them to choose which is the best paper towel and why. Write these comments on the board. Remind them that their predictions are their **hypothesis.**

Instruction:

Review the attached data sheet. Explain that they are going to test each of the paper towel samples in the same manner. Remind them that it is essential to use the same procedures for each sample so that they get accurate results. Offer to the girls that they can work in teams of two. This lesson lends itself well to teamwork, but you know your girls best.

Pass out the five numbered samples of paper towels. Remind the girls to keep the untested samples away from the water.

Demonstrate the procedure—dropping the water onto the table, letting the towel soak it up, writing down the observations, etc. The first two tests go together.

With the smear test, you should use the plastic knife to smear the butter on the table so that approximately the same amount is used each time. Each girl or team of girls works through the data sheet on their own, writing down their observations and data, including comments. These comments are important, as they form the basis for the letters they will write in the second part of the activity.

Discussion/Analysis:

- When all of the experiments are done and data noted on the sheets, discuss which number was the best and identify the brands. Allow for comments, discussion and arguments if needed.
- If the girls can come to a consensus, great. If not, have them divide into groups to prepare for the letter writing.

Section Two—Informing the Producers:

Goal: Write letters to the winning paper towel companies informing them of the results of the experiments.

Materials needed:

- Notebook paper
- Pens
- Addresses of paper towel companies—easily found on the packages or by searching the internet—on paper for the girls to copy into their letters

Gather the girls into the teams they were in during the data-collection phase and have them discuss their results again. Tell the girls that they are going to do one of the most important parts of consumer testing—informing the producers of their results.

Active Learning:

- Review the results and make sure the girls know which company they are writing to.
- Distribute the addresses to the girls.
- Review the parts of a business letter—use a template if you want for the draft (attached)
- Have the girls write a draft in teams.
- Review the draft quickly and allow them to copy it over while they are in the meeting. Remind them to use the school address as the return address and not to use their last names.
- Enclose pictures if you want. Companies love that.
- Mail them off and see what you get back!

Reflection:

Before the end of the session, go back to the challenge and discuss it with the girls.

- What is the purpose of advertising?
- Is all advertising true?
- How can we choose the best option for ourselves?
- Have you ever been fooled by advertising?

If you get letters back from the company, be sure to share them with the girls.

Resource: http://www.goodhousekeeping.com/product-reviews/home-products/paper-towels/how-we-tested-paper-towels

GEMS—Product Testing and Evaluation--Paper Towels

	BRAND 1	BRAND 2	BRAND 3	BRAND 4	BRAND 5
SOAK—drop 10 ml water on table. Lay paper towel on wet spot. Wait 1 minute. Draw or describe results					
WIPE—using the **same** paper towel, lift up the wet paper towel by the corners. Does it hold together? Can you then clean up the rest of the spot with it or do you need more towels? Is the table dry? Write results.					
SMEAR—spread 1 tsp. butter on table. Lay 1 new paper towel on top. Can one paper towel clean it?					
Comments					

What is your choice for the best brand? _____

Sample Consumer Testing Letter to Company

_____School

_____

_____

_____Company

_____

_____

Dear Sir or Madam:

(Description of our test)

(What happened)

(How I (we) feel about your product)

(In the future, I (we) will)

Sincerely,

First names only

Contacts

For more information about GEMS, please contact Laura Reasoner Jones at info@gemsclub.org

Enjoy your club and your girls. This is an exciting and enriching time in their lives, and in yours.

Thank you.