

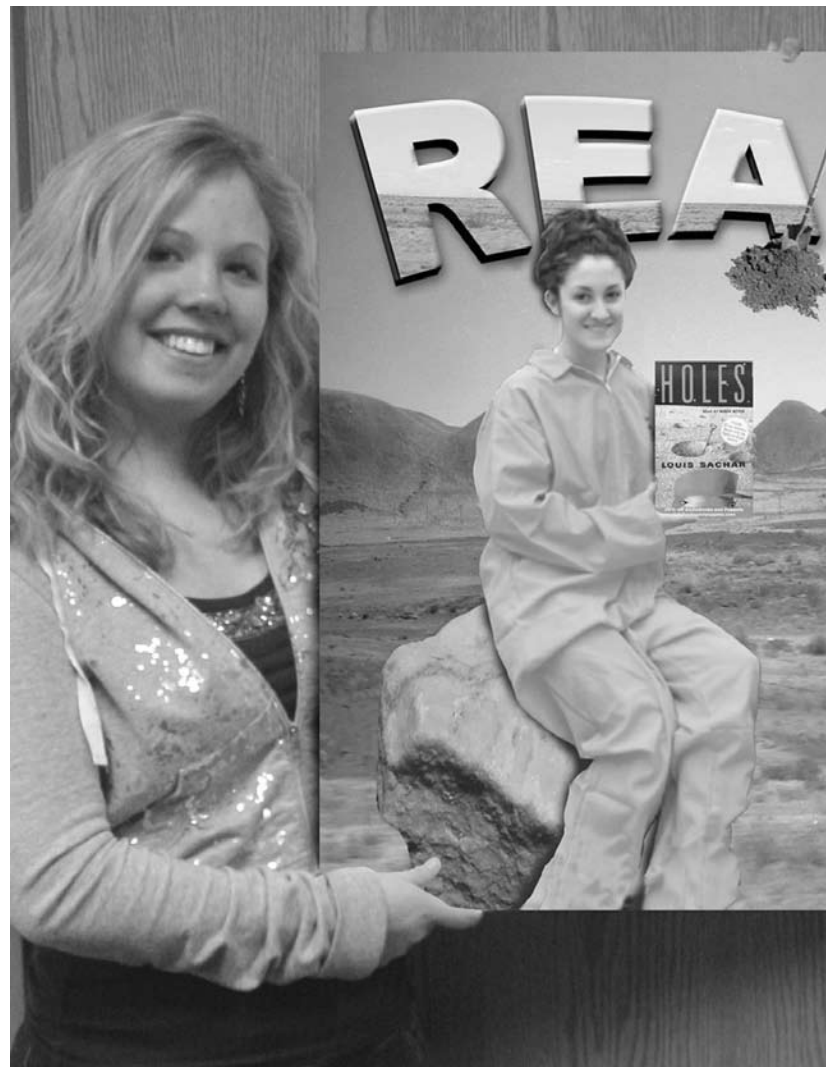
Beyond Smash and Crash: Gender-Friendly Tech Ed

By Ray McCarthy

We cannot afford to have 51% of our population left out of the important decisions that affect us today and in the future.

“This is going to be fun!” said Lucy, a middle school fifth grader, as she completed her first day in technology education class. Lucy and the other young people experiencing technology and engineering are being challenged to use the skills and knowledge they have learned in science, math, language arts, and their own experiences to tackle authentic problems using tools and materials.

The students are the center of their learning experiences in technology education at Monument Valley Regional Middle School. Girls and boys choose and test their own solutions to design challenges while learning how engineers and designers work through the universal problem-solving method. As students transition from fifth to eighth grade, their challenges become more complex in order to emphasize engineering concepts. They learn how to identify a problem, to brainstorm ideas, to plan, and to choose the tools, materials, and processes to create products that might solve the students’ design briefs. Students evaluate their output with the goal of improving their solutions. These solutions could be devices such as gliders, coaster vehicles, machines that send ping-pong balls across the laboratory, “mechanical marvels,” digital images including photographic or video editing, and CADD.



In my experience, young women and girls love communication-oriented activities. This READ poster teaches digital imaging as well as source capture—scanning, downloading, and digital camera—techniques.

The students are encouraged to explore their world through research, brainstorming, design, material selection, and tool use. However, these activities have a certain cultural bias. Historically, “shop” was seen as an extension of boys’ interests (Braundy, Petrina, Dalley, & Paxton, 2000; Welty, 2007; Zuga, 1999). In the newer “technology education” model, girls and boys need to be supported in discovering their interests and talents in science, technology, engineering, and math (STEM). “I was really nervous at first. But now I just love building things,” exclaimed seventh grader Martha, who was quoted in a recent newspaper article (Smith, J., 2007).

This change of focus from skill development in industrial arts to technological literacy development in technology/engineering education has further reinforced what the literature has stated for the past fifteen years. The United States needs trained engineers and technicians to stay competitive in a global economy (National Science Foundation [NSF] 2002, 2003a & b). Technology and engineering have become such a national issue that the Massachusetts Comprehensive Assessment System (MCAS) tests actually have a test named “Science, Technology/Engineering” for eighth and tenth grade students.

In order to increase participation in STEM fields and careers, one of the problems that needs to be addressed is gender equity of study and careers in STEM fields. In general, women represent less than thirty percent of all STEM students in college. Furthermore, less than one third of professional engineers and technicians are women (NSE, 2002, 2003a & b). Research shows that there are many attempts to create recruiting programs encouraging girls and young women to consider studies and careers in STEM fields, but these efforts seem to have little long-term effect (NSE, 2002 & 2003a & b; Silverman & Pritchard, 1996; Welty & Puck, 2001).

Studies have shown that women find STEM studies and careers satisfying. At the same time, other studies show that girls and young women are dissuaded from pursuing these studies at an early age due to negative cultural messages, restrictive role modeling, and lack of constructive middle and high school guidance (Kandaswamy, 2003; McCarthy, 2007). Studies have also shown that if a girl in fifth grade feels that she is not good at math, then she will not pursue a career in that field even if she finds success in high school math courses (Silverman and Pritchard, 1996). This same self-imposed limitation acts to restrict possible study and career choices in all the STEM fields (Kandaswamy, 2003).

Currently, technology education courses create an intellectually stimulating and welcoming environment for all



Girls using real-life tools and materials create pride and greater understanding.

students who participate. Although the challenges are tough for some students, others voluntarily trade in their recess time to design, build, and test their products. These students report, “It’s Cool.” “I love Tech Ed!” and “Look what I made!” So how do we encourage these girls to continue exploring technology and engineering education course offerings? The next section will describe related literature and research that attempts to answer this question.

Research Findings

The ten participants in my qualitative research project dealing with women in technology education careers noted similar experiences in early childhood and youth (McCarthy, 2007). For example, one of the major keys to finding a pathway to STEM careers cited in the study was an early positive interaction with a male adult such as a father, grandfather, or a technology education teacher. These individuals taught the girls that anyone could succeed using tools and materials to solve real problems. While many of the participants in the study mention that their natural curiosity was a big motivator, all concurred that unless someone had noticed their particular abilities in hands-on learning experiences, they would probably not have considered these study and career choices.

Grant & Ward (1992) wrote that gender role modeling may directly support intellectual and emotional growth. Therefore, these “trailblazers” need to be encouraged to strike out and mark some possible paths so that more women feel empowered to participate in these fields as well (Schlossberg, Waters, & Goodman, 1995). The problem is that there are simply not enough female technology education teachers to portray an equitable role modeling. In 2005, ITEA reported 3,763 total memberships of whom 688 (18.3%) were women and 3075 (81.7%) were men, and further, that there are 25,000 to 39,000 technology education teachers in the United States (private email October 6, 2005). Therefore, it falls to all technology education professionals to encourage, guide, and motivate girls and young women to seek further studies in STEM.

Practical Application

Technology education teachers can have an important influence on our students. Here are five keys related by my study’s participants to improving the technology education learning experiences for girls and young women:

- Attitude
- Language
- Reframing or changing goals of learning experiences
- Choice of learning experiences
- Marketing

Attitude

Students notice teacher attitudes and opinions very quickly. The participants of my study recounted how the climate of classrooms and labs made them feel included or made them feel unwanted. Make sure that all students feel welcomed and valued. Find time to find out who your students are, what activities they like to do on their own time, and what they hope to discover while in your class. Providing students with choices in design briefs encourages them to invest more time and effort. By giving students choices (see page 20) we validate their interests and support positive inquiry.

Language

The participants of my study often stated that what we teachers say and do in class really does affect how students feel about their classroom experiences. Several women remembered awkward situations in technology education courses that were the result of thoughtless jokes or comments by teachers as well as male students. Try to avoid saying “guys” in a classroom setting, and use his/her and he/she in your communications. Fairness counts as we invite everyone from any background, ethnicity, and developmental ability to learn technological literacy in our classes.



A quote from a fifth grade student on her first day: “This is gonna be fun!”

Reframing

Many technology education concepts can be taught without “crash and smash” activities. Kenneth Welty wrote that much of the technology education “curriculum itself might be biased towards males by virtue of the fact that it is a [mostly] male construct... [and in spite of this perhaps]... we are trying to recruit young women into a boys’ club (technology education)” (Kenneth Welty, private email, February 2007). However, email and verbal discussions with Karen Zuga, Jerianne Taylor, Yvonne Spicer, and other female technology educators stress that many girls do indeed like the competitive learning experiences in which either a race, crash, or destructive test evaluates the students’ projects. However, these educators point out that many students—both female and male—do not find much satisfaction in destroying something that the students have spent many hours constructing.

So, try to reframe experiences (see page 20). Testing in this context is more about evaluating to improve than to see how much destructive force is necessary to demolish a device. In my classes, students look at their early solutions as engineers/scientists and generate hypotheses: What can be done to improve our understanding and our output? As a bonus, most of my students proudly bring home their completed products to display or even give as gifts.

Choice of Learning Experiences

Most states have frameworks for technology education. These leave room for teachers to create, share, purchase, and modify many learning experiences. I have gladly borrowed from any and every source in my 31 years of teaching. With 45-day courses in middle school, I choose what I call “steak over popcorn.” I could cram many neat design briefs into 45 days, but instead my students are encouraged to choose problems (see page 20) to solve that include engineering principles, research, technical drawing, and writing while using tools and materials to test their hypotheses. None of our challenges are destructive in nature. Competition is friendly and not required. My students try to improve their products, not to best one another but to better understand and improve their final solution. When my fifth graders fly their gliders, everyone cheers, whether the plane went far or not. As one student said, “I flew my plane and realized I needed more weight on the nose!” Self-evaluation is encouraged along with brainstorming with cohorts. I base student evaluation on many factors; the rubric I compiled is an evolution from many sources. Criteria include the use of engineering concepts, safe and proper tool and material use, demonstration of acquired knowledge and skills, and classroom citizenship.

Marketing

Many middle schools offer technology education to all of their students. Typically girls drop technology education classes as they enter high school. Many electives draw students away from technology education. However, my study’s participants identified two keys to recruiting females into high school programs. The first key to improved female participation in high school technology education programs is to involve people we all know, need to educate, and need get on our team—guidance, or career and education counselors. These professionals need to see the value that technology education adds to students’ learning and transcripts (McCarthy, 2007). Furthermore, ITEA and the state technology education associations need to connect with the higher education community to market the real learning that our students bring to STEM studies.

The second key, noted by the women in the study and proclaimed by Mel Brooks in the movie *Spaceballs*, is “merchandizing.” Every high school technology education department has to let the student body know how these programs help the students get ready for life. At Somers High School in Somers, Connecticut, female enrollment for communications and CADD courses tripled when students instead of teachers gave presentations for the “step-up night” for the future freshmen. Young women

and men told the eighth graders how cool and important technological literacy was to their futures in language that students understood. This resulted in five more sections of communications being offered. The ratio of female to male students went from 4:10 to a complete reversal of ten girls for every four boys in class. Recently, four times as many students at Somers High School elected to take the Research and Development course. Early indications show that the updates and marketing on the R&D web page encouraged students to select this challenging course. Ironically, many digital graphics courses in Connecticut and other states teach marketing; we just have to apply it.

Conclusions

Students need to know that we are living in the most technologically driven era in human experience. We, the United States and the planet Earth, need a population that is able to function with a great degree of flexibility in the face of all these technological challenges. We cannot afford to have 51% of our population left out of the important decisions that affect us today and in the future. To that end, here are some suggestions to increase gender equity in your school:

- Get your guidance or career counselors on board. Invite them into your classes often. Give them a copy of this article. Check out the MassTEC website (<http://masstec.org/>) and learn how the Massachusetts Technology Education consortium is working to get a high school technology education course considered a science course with acceptance by the higher education community.
- Start a technology education club that allows high school students to mentor middle schoolers.
- Create presentation days during which the high school students show elementary and middle school students how technology connects to their everyday world.
- Hold a technology education open house at the high school for all your community, and have fun activities planned for the children who visit.
- Get your technology education students, female and male, into the local newspapers.
- Have informal get-togethers in the labs where kids who did not sign up can get a quick glimpse of what you have to offer.
- Encourage your students to come up with even better ideas. Whatever a student creates, he or she will support.

So get out there, communicate to all the students that STEM careers are cool as early in their educational careers as possible. Technology education: It is important for everyone! 🌟

Reframed Learning Experiences

1. Aircraft Carrier Landing: This is a quick filler/reward when beginning a new course or between one major learning activity and another. Kids love this (it works with fifth graders through adults in workshops).

Goal: Land a paper airplane on a six-foot-long table after a flight of approximately fifteen feet.

Points: Land on carrier (a six-foot-long table) – three points; Skim the carrier – two points; Hit the carrier edge – one point.

Winners: Anyone who scores at least one point.

The reframe: The pilots are returning from a humanitarian mission, dropping food, water, and medicine to people who survived a natural disaster. The pilots need to land on the carrier to refuel and resupply.

Neat twist: Photocopy a plan for the plane, and have cohorts of three or four students work together so everyone knows how to build this type of plane. (Builds communication and collaboration skills; gets students who are shy into the mix; girls and young women find this challenge to their liking especially when they can work in a cohort.)

State Frameworks: Connect to math with statistics, chance, and patterns. Connect to science with air resistance, aerodynamics, and forming and testing hypotheses. Connect to language arts by accurately describing the style and design of the plane as well as the entire start-to-finish of the design challenge as a student journalist. Connect to technology education with a transportation, manufacturing, product evaluation, and universal problem-solving system.

2. Foam and Pine Glider Challenge: Foam Winged Glider

Engineering Constraints:

1. The glider must be made of foam, pine, and common adhesives.
2. The maximum wingspan allowed (from wing tip to wing tip) will be 18 inches.
3. The minimum mass of the glider is 10 grams.
4. The wings must be made from foam.
5. The wings may be attached to the fuselage by adhesives.
6. Must be safe for a four-year-old to touch.
7. You may “cohort,” but each student must build her/his own product.
8. No parts may cause a choking hazard.
9. The successful glider must fly at least ten feet.

3. Renton Guppy Vehicle Challenge:

Engineering Constraints:

1. Your car will be made from a block of spruce 1 ½”x 2 ½” x 8”.
2. Axles will match wheel-hole diameter.
3. 2” diameter wheels will be supplied.
4. All cars must be safe for a four-year-old to touch.
5. Vehicles must fit on the Renton Guppy Track in order to race.
6. Vehicles may be finished and decorated as you wish, but must be safe!
7. You may “cohort,” but each student must build her/his own product.
8. Vehicles must be able to run on the 30-foot long track many times without breaking down.

*The Renton Guppy is named in honor of Mr. Tom Renton, the former technology education teacher at MVRMS.

4. Pong Chucking Challenge:

Engineering Constraints. Your machine:

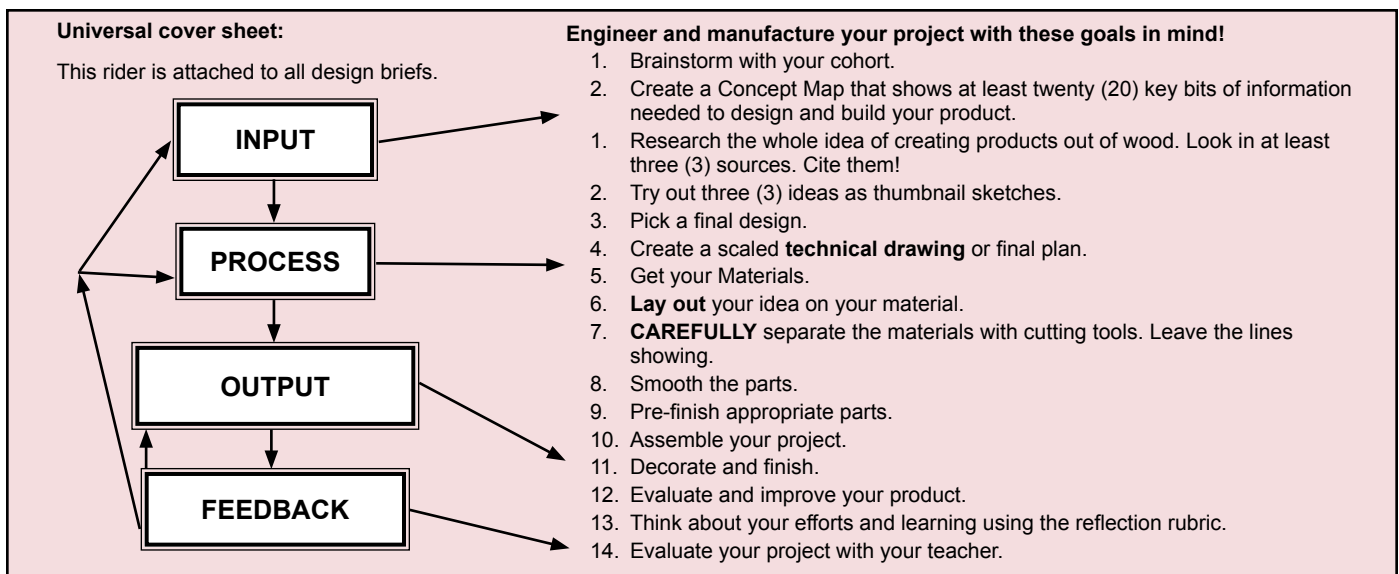
1. Must be able to fit into a closed “shoebox”: 16” x 16” x 16”.
2. Must mechanically throw a ping-pong ball for distance and/or accuracy.
3. Must be triggered by no more than the exertion of one inch of human finger downward pressure.
4. Must have a triggering device.
5. Must have at least five (5) parts before assembly.
6. Must be able to fire repeatedly without adding additional new materials.

Remember: You may “cohort,” but each student must build her/his own product. No explosives, chemical reactions, fire, gerbils, electricity, life-threatening devices, or items illegal in the state of Massachusetts may be used. No animals shall be harmed in this experience!

5. Mechanical Marvel Challenge:

Engineering Constraints. Your machine:

1. Must be able to fit into a closed “shoebox”: 6” x 8” x 16”.
2. Must have a real use.
3. Must have at least five (5) parts before assembly and must be safe for a four-year-old to touch.
4. Must have moving parts as part of its “mechanical marvelousness,” but these must not break off.
5. Can be made of materials that include wood, paper, cloth, metal, and plastic.
6. Remember, you may “cohort,” but each student must build her/his own product.



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