

Building Their Future: Girls and Technology Education in Connecticut

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Why do a disproportionate number of girls turn away from math, science and technology? Research into the teaching of math and science in schools has identified a number of factors which are critical, but there has been very little attention given to technology education. In *How Schools Shortchange Girls*, the American Association of University Women (AAUW, 1992) reviewed the available literature. Despite the fact that there was no evidence of any innate differences in ability between men and women, they found significant differences in participation and achievement rates in math, science and technology.

How do we explain these differences? Caine and Caine (1991) maintain that traditional teaching practices, classroom organization and performance testing fail to acknowledge the impact of emotions on the ability to learn. They stress the importance of connecting what is taught to the lives and interests of students. While such interconnectedness is important for all students, the authors of *Women's Ways of Knowing* contend that women are particularly disadvantaged by teaching methods that are not connected (Belensky, Clinchy, Goldberger and Tarule, 1989). They found that women respond better to teaching which relates to their own lives and gives them encouragement about their own abilities.

In trying to explain gender differences in mathematics, Fennema and Peterson (1985) seek to explain why males surpass females in high-level cognitive skills, the type that problem-solving tests measure. They contend that to develop these skills an individual must participate in autonomous learning behaviors (ALB). These behaviors include choosing to do high-level tasks, working independently on tasks, persisting on them and achieving success. Fennema and Peterson propose that males have more opportunities than females to pursue ALBs. Conditions outside the classroom give them greater practice, but in-school experiences also affect chances for independent action. In-school experiences include the nature of contact between teacher and students, particularly teacher expectations about different groups of students.

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The AAUW report (1992) found that research spanning the past twenty years consistently reveals that males receive more teacher attention than do females. The issue is broader than the inequitable distribution of teacher contacts with male and female students; it also includes the inequitable content of teacher comments. Myra and David Sadker (1984) conducted a three-year study which found that while males received more teacher comments than females, the difference favoring boys was greatest in the more useful teacher reactions of praise, criticism and remediation.

Alma Lantz (1985) found that beliefs about math and science were also an important factor in the decision of girls not to take advanced courses or pursue such subjects as careers, despite their proven ability in these subjects. She found that stereotypes about subjects which have traditionally been identified as "masculine" are operating to discourage girls from pursuing nontraditional careers.

Since most of these studies focus on the teaching of math and science, we felt a look at the teaching of technology education would be valuable. While participation rates for girls in technology subjects are low and they have traditionally been identified as "masculine" subjects, the teaching methods and classroom atmosphere in technology education differ significantly from math and science classes. As opposed to abstract concepts being presented by the teacher, most technology education classes are taught in a lab setting involving hands-on projects, where students move around the room sharing materials and equipment. There are group as well as individual projects, some of which involve competition, but in a different context from the kind of competitive tests common in science and math classes.

This article reports on the findings of a two-year research project looking at girls' participation in technology education in Connecticut schools. The project was funded by the Connecticut State Department of Education and full reports are available from the Connecticut Women's Education and Legal Fund (Silverman and Pritchard, 1993 and 1994). It was designed to identify viable strategies to change enrollments and attitudes toward the success of girls and women in technology education.

Phase I of the study focused on girls taking technology education in middle school, when all students are required to "explore" a variety of vocational subjects. We wanted to examine whether the same factors which tend to discourage girls from pursuing math and science careers were operating in technology education during the girls' early exposure to the subject, at an age when gender differences first begin to appear.

Phase II of the study explored the reasons for the wide gender gap in participation rates in technology education in high school. We wanted to look at the factors encouraging or discouraging students from choosing technology education as an elective, and in particular to examine the differences between boys and girls.

Methodology

Research Questions

Phase I of our study examined the impact of teaching methods, classroom organization and atmosphere, and teacher interaction on girls in technology education classes in middle schools. In Connecticut, these classes are divided into a number of subjects areas, which vary in different school districts. They generally include some drafting and measurement, some building of bridges, cars or simple machines and some graphic arts and design.

While Phase I of the project focused on middle school girls, we also conducted a survey of both girls and boys taking technology education classes in high school. This survey was designed to explore why students decide to follow up their exploratory programs in middle school by taking further technology education classes in high school. We were also interested in whether there were significant differences between girls and boys in their attitudes toward technological careers.

In Phase II, we focused on high school girls and asked why so few elect to take technology education in high school. We decided to follow up the high school survey, which was limited to students already in technology education classes. In order to explore the reasons why some students chose not to take technology education, we needed to talk to high school students and let them express their thoughts and feelings directly. Therefore, the major emphasis of this stage of the research was a series of focus group interviews with high school students.

We conducted focus group interviews with both boys and girls, some of whom were taking technology education and some who were not. This strategy enabled us to look at the factors encouraging or discouraging all students from choosing technology education as an elective, and in particular to examine the differences between boys and girls which could account for the huge differences in participation.

Sample Selection

The sample of school districts was chosen to provide the widest range possible in terms of regional characteristics, size, and student population. For Phase I, we were able to gain access to three school districts in different parts of the state. These included one rural district whose student population was predominately White, one urban district with a predominately African-American and Latino/a population and one suburban district with a mixed population. For Phase II, we visited four school districts, of which three were consistent with the sample from Phase I. We also added a fourth district, which was in a medium sized industrial town with a mixed student population.

Research Instruments and Data Collection

Classroom observation in middle schools. We decided that classroom observation would provide one source of information about teaching methods, classroom organization and atmosphere and teacher interaction. While students and teachers were aware that we were in the classroom, we attempted to

minimize the interaction of observers. This type of observation was designed to capture as much as possible of what was going on in the classroom, following the model developed by Leacock (1969).

We developed a protocol for classroom ethnography which included a physical description of the classroom, a chronological log, and a ratings form for each class. In the log, the observer recorded how the class was organized, what the teacher did, how students reacted or participated and the responses of the teacher in chronological order. After the class, she filled out a ratings form in which she evaluated the content, atmosphere in the classroom, student participation, and teacher expectations and attitudes.

We observed from two to four technology education classes in each of three middle schools for a period of three weeks, for a total of 77 observations. The technology education classes were offered as exploratory sessions of varying length, in one school as short as 20 days. We observed sixth, seventh and eighth grade classes in a range of different subjects, including construction, manufacturing, communication, woodworking, and drafting.

Focus group interviews with female middle school students. In order to determine whether girls in technology education classes were being influenced by the same factors which have been documented in research on math and science classes, we decided to interview girls in focus groups. We wanted the chance to explore girls' attitudes toward their technology education classes. Were they influenced by stereotypes about "masculine" subjects? Did they find the content too abstract or unconnected? Did they lack confidence in their abilities? Did they feel that teachers gave more attention to the boys?

The researchers conducted focus group interviews with the girls in each of the middle school classes which they were observing. We interviewed a total of 58 girls in these focus groups. We asked girls how they felt about their technology education classes and the possibility of a career in a technological field. We asked girls whether they felt there were differences in ability between girls and boys and about what subjects they liked best.

Interviews with middle and high school teachers, guidance counselors and principals. We also interviewed teachers and other school staff, at the middle and high school level. We interviewed 13 technology education teachers, 6 principals and 18 guidance counselors. We were interested in how teachers felt about the recent changes in technology education and whether the curriculum was related to students' experiences and the real world of work. We asked whether girls responded differently to various teaching methods and the kind of atmosphere the teachers wanted to create in the classroom.

Survey of high school technology education students. The high school survey provided an opportunity to examine the attitude of students who decided to take further technology education classes in high school. By surveying both girls and boys, we could compare their attitudes toward technological careers and the various influences on their decision to take technology education. We

developed six questions for a pilot survey which was tested in one school and reviewed by an outside academic consultant before being finalized.

In the three high schools associated with the middle schools in the study, we gave the survey to all technology education students. We surveyed a total of 737 students, including 133 girls and 604 boys in grades 9-12. The questions centered around the reasons for their choice of technology education, the major influences on that decision and some information about their attitude toward technological careers. The students were quite evenly mixed in terms of grade level, with 22 percent in 9th grade, 24 percent in 10th grade, 23 percent in 11th grade and 30 percent in 12th grade.

Statewide Vocational Enrollment Data. As a base line, we wanted to know how wide a gender gap already existed in participation rates in technology education classes in high schools, so we also looked at enrollment data across the state. This data is based on vocational enrollment by gender and course for 1990-91, compiled by the State Department of Education, Bureau of Evaluation and Student Assessment.

Focus group interviews with high school students. Phase II of the project concentrated on focus group interviews with high school students. We asked students what they liked and disliked about various subjects, particularly technology education, and how they decided what electives to take. If some girls were discouraged from taking technology education, we wanted to explore the reasons. The focus group format allowed us to follow up statements with more detailed discussion and exchange of ideas. We were interested in whether boys and girls chose to take technology education for different reasons and the important influences on their choices. We wanted to assess the impact of teachers and guidance counselors on their decisions, as well as parents and other factors outside of school.

In our focus group interviews, we tried to give students the opportunity to speak for themselves. Often education research fails to ask the people most directly affected about their feelings and beliefs. We had some heated and enthusiastic discussions, often with disagreements between students about controversial issues. In our full report (Silverman and Pritchard, 1994) we quote students directly as much as possible. In this article, we try to give a sense of the most common attitudes and comments.

In the available time frame, we determined that we could interview students in four classes in each of the four high schools we visited. In order to compare the attitudes of students who decided not to take technology education with those who did, we divided the classes evenly. We picked two technology education classes, usually drafting or graphic arts, because they tended to have the most girls enrolled. We picked two academic classes which were required courses for all students, mainly English or social studies. We conducted focus group interviews with the boys and girls separately, typically in groups of eight or nine students. We conducted a total of 32 interviews with 241 students, including 134 boys and 107 girls.

The scarcity of girls taking any technology education class was brought home to us immediately on trying to set up the interviews in the four participating high schools. There were only one or two classes in any of the high schools with as many as four girls and most classes had at most two girls. As a result, we talked to considerably more boys taking technology education, a total of 60 boys and 22 girls, although we talked to both boys and girls in academic classes who were also taking technology education.

Quiz on Women in the Workforce. In our focus group interviews with girls in Phase I, we were struck by the lack of connection between what students were doing in class and the world of work. They lacked basic information about careers, including any sense of salaries or promotion prospects. While boys and girls may have shared this lack of information, for girls it was combined with stereotypes about technology as a male occupation, which reinforced their reluctance to consider nontraditional careers.

To follow up this finding in Phase II, we decided to test high school students' understanding of the economic realities involved in earning a living and the paying for further education and training, as well as the relative earnings and promotion prospects of various occupations. We developed a short quiz about the economic realities facing women in the workforce. It covered such issues as the salary and promotion prospects of traditional versus nontraditional careers for women and the length of time women spend in the workforce. A total of 516 students in both academic and technology classes took the quiz, including 320 boys and 196 girls.

Findings

Phase I

We found that in middle school, girls appear to enjoy technology education and have confidence in their abilities, but emerging sexism among peers begins to differentially affect participation on the basis of gender. Classroom observation and focus group interviews showed that hands-on activities were very attractive to the girls. Most of the teachers we interviewed felt that the transition from industrial arts to technology education makes the subject more attractive to girls, since there is less emphasis on the use of heavy equipment. While girls may come into class with less experience using tools and machinery than the boys, they learn quickly and do not seem to be at a disadvantage.

In our classroom observation, girls did seem to have confidence in their ability to succeed in technology education and this was confirmed in focus group interviews. We did not find evidence that teachers called on boys more often than girls, but since most of the class time is spent at worktables engaged in hands-on projects, teachers must move around the room, helping each individual or group who needs it. While many students had to wait for the teacher to assist them, we did not observe that teachers gave more help to the boys or took less interest in the girls' work.

Because students engaged in building projects must move around the room to get materials and use machinery, the atmosphere in these classrooms is clearly different from the atmosphere in classes where students basically remain

at their desks. Whether students are working in groups or as individuals, they are encouraged to help each other and must share tools and equipment. In the lab setting, teachers allow students to talk and move around and the students seem to enjoy the informal atmosphere in all the classes we observed.

In this kind of informal atmosphere, however, the dynamics of boy/girl interactions can cause problems if the teacher does not establish clear guidelines and rules for behavior. We found evidence of growing sexism among peers. For example, on two occasions during our classroom observation, the boys monopolized the tools. In focus group interviews, girls complained that the boys always rushed off to get supplies and made fun of girls trying to use equipment, and the teachers sometimes let them get away with it. They described how the boys would sometimes criticize girls, resorting to stereotypes about girls' lack of technological skills.

Teachers have not necessarily thought about the best way to deal with this problem and its impact on their choice of teaching methods. We encountered teachers who were aware of the need to control sexist behavior but who didn't know how.

In our classroom observations and focus group interviews, we also found evidence that girls may respond more positively to some projects and be more interested in some aspects of their technology education classes. We did not observe these differences between boys and girls in all classes, but we did notice that girls found the design aspects of their projects appealing. While some teachers spoke of projects which were "gender neutral", many of the objects being built are more likely to be attractive to boys. Because of differences in early socialization, boys are often more interested in cars, planes and bridges. (Skolnick, Langbort and Day, 1982). One teacher had students build houses, giving them some leeway from a basic design and letting them go on to decorate it if there was time. The girls in this class showed more enthusiasm than girls in a similar class who complained that building bridges was "boring".

We also found that middle school girls are discouraged from taking more technology education in high school because of two major factors which tend to reinforce each other. First, technology has until recently been a field dominated by men. We found evidence that traditional stereotypes about male/female occupations are still operating and are strong enough to outweigh girls' positive feelings about their experiences in technology education classes.

Second, we found that girls were uninformed about economic realities and the world of work. They lacked basic information about careers, including any sense of salaries, promotion prospects or the amount of education and training needed to pursue different occupations. While boys and girls may share this lack of information, for girls it is combined with stereotypes about technology as a male occupation, which reinforces their reluctance to consider nontraditional occupations.

In our focus group interviews, girls did not reveal a lack of confidence in their ability to do any kind of career. The girls who spoke up said they were just as good as the boys in all areas, including math, science and technology. However, if girls by eighth grade are not informed about the requirements of

different careers, don't make the connection between what they are doing in the classroom and the world of work, and are unaware of the kind of technology classes they can take in high school, they may close off options that could lead to high wage careers.

This lack of knowledge about different careers is also reflected in the high school survey. Findings suggest that while girls who go on to take technology education in high school are ready to challenge the traditional identification of technology as a male occupation, they have less confidence in their abilities and are thinking less in terms of well-paid careers than the boys in their classes. When asked why they decided to take technology education, only 11 percent of the girls chose "I am good at it" compared to 24 percent of boys. Only 14 percent of girls chose "I want a job that pays well" compared to 24 percent of boys.

More girls than boys reported being discouraged from taking technology education. The nine percent of girls who said they were discouraged listed a number of different people who had done this, including peers, siblings, teachers, counselors and parents. When asked who had most encouraged them to take technology education, 43 percent of all students chose to write in an answer under "other", instead of picking one of the more obvious choices of family, teachers, friends or guidance counselors. Of all the girls, 28 percent wrote in "myself" as the sole response, which we found surprising, considering the expected role of parents or school staff in discussing options with students. Teachers and guidance counselors were mentioned by only 36 percent of all students. Fewer females reported that they were encouraged by their middle school experiences than boys, with more females indicating that their classes in middle school had no effect on their decision to take further technology education.

Phase II

For the second phase of this project, we wanted to explore the reasons for the wide gender gap in participation rates in technology education. In our focus group interviews, we found that while both boys and girls are attracted to technology education for many of the same reasons, there were significant differences between girls who take technology education and girls who don't. Our findings can be summarized in terms of two basic questions.

Why do some students decide to take technology education? Both boys and girls are attracted to technology education because they enjoy working with their hands and like the independence and chance for creativity provided by these classes. An interest in technology education was often encouraged by relatives or friends outside the school. This kind of encouragement was particularly important for girls, because boys are more likely to have experience with technology.

Girls taking technology education shared a sense of being "pathbreakers" who could prove that girls were as good as boys at nontraditional subjects. They didn't mind being one of the few girls in a class and did not feel the boys made it difficult for them, although they did worry about teachers treating them

differently. Girls taking technology education rejected stereotypes about appropriate subjects or jobs for women, but discussions with boys and girls revealed that stereotypes are still powerful. While both boys and girls rejected the idea that males are inherently better at some subjects or jobs, the fact that there are few females in nontraditional occupations was often cited as a reason for girls not to take technology education or consider a technological career.

While some students were encouraged to take technology education as a result of their middle school experience, the most common response was that it had little impact, because what they did in middle school was not comparable to the range of classes available in high school. Girls were generally not aware of what was available in high school and were not being encouraged by their middle school experience to challenge stereotypes and explore nontraditional subjects.

Many students reported getting little advice or information about technology education from their guidance counselors. This lack of information was particularly difficult for girls to overcome, since they are less likely to have experience with technology outside of school and must be willing to fight stereotypes about appropriate subjects for girls. Some girls reported that they were discouraged from taking technology education.

Why do some students decide not to take technology education? Girls who chose not to take technology education were often reluctant to take classes where they would be one of the few girls. While only a few girls openly accepted stereotypes about appropriate careers for women, many of the girls felt uncomfortable with the picture of themselves in nontraditional jobs. They lacked confidence in their abilities and worried about the reaction of friends and family. Better information about technological careers could have broken down stereotypes about "male occupations" and fears expressed by some girls about the physical demands of jobs, since high tech areas like computer-aided design and manufacturing do not involve heavy lifting or high risk of injury.

Many students lacked a sense of economic realities which could inform their choice of careers and help them make reasonable plans for further education and training after high school. Girls seemed unaware of salary or promotion prospects of traditional careers for women and less concerned with economic realities than boys. The quiz results demonstrate that boys and girls share misconceptions about how long women are likely to spend working, the level of earnings they can expect and the relative salaries of traditional jobs for women.

Conclusions

Looking at the findings from both Phase I and Phase II, we are encouraged by the fact that girls in middle school appear to enjoy technology education and have confidence in their abilities. But the positive aspects of their experiences in middle school do not lead most of them to take more technology education in high school. We have uncovered a number of important factors which contribute to this gender gap.

In middle school, teachers have not necessarily considered the importance of emerging sexism among peers or thought about the best way to deal with this problem. The culture of the school and the attitude of teachers is important in insuring that boys do not get away with sexist behavior and girls are not forced into stereotyped roles.

Because technology education has traditionally been such a male-oriented subject, teachers need to be aware of the differing interests of girls and consider ways of making the environment and the subject attractive to them. Decisions about what kind of objects to build and what aspects of technology should be considered valid are important for attracting the interests of both boys and girls. The principles of technology can be learned as well from building a house as from building a bridge.

Looking at the factors which discouraged both boys and girls from taking technology education, we found that many of these factors had a particularly strong impact on girls. The lack of knowledge of technological careers, the failure to connect what students were doing in class with future careers and the lack of a sense of economic realities were particularly discouraging to girls because they had less information about technology from experiences outside of school. Even more important, they had to overcome stereotypes about "appropriate" careers for women.

We found a major difference in attitude between girls who choose to take technology education and those who do not. Only a few girls are willing to be "pathbreakers" and challenge stereotypes about nontraditional careers for women. Most girls could not picture themselves in technological jobs and were reluctant to be in classes where they were one of the few girls. They had never seriously considered taking technology education in high school. The fact that most girls could not picture themselves in technological jobs reflects the barriers set by sexism and the failure of schools to provide role models and positive programs to overcome stereotypes.

In noting the lack of information about technological careers, we are not suggesting that technology teachers should be concentrating on job preparation, which involves the teaching of skills needed for specific jobs. The new vision for technology education is an experience-based program involving the application of math and science concepts in technological systems. There is an emphasis on thinking processes and problem solving rather than developing particular skills. The provision of career information is not job preparation but is rather the opportunity for students to explore options and see the connection between what they are learning in class and possible future careers. If this kind of career exploration is structured in such a way as to challenge stereotypes about appropriate careers for women, it can help girls who might not otherwise consider nontraditional options.

Recommendations

Based on the findings of this research project we feel that actions can be taken to improve enrollments of girls in technology education and change attitudes about careers for girls and women in technological fields. As a first step, we believe schools must put a high priority on hiring more female

technology teachers, who can be important role models for girls interested in technology.

Strategies for Teachers

Technology education teachers need to meet together and discuss gender equity through a number of different forums, including workshops with outside facilitators and in-school meetings to discuss guidelines. High school teachers need to consider strategies to attract more girls to their classes. These strategies could include curriculum revisions or reorganization of labs. Teachers may need to attend training sessions or obtain new materials.

Teachers need to discuss:

- the affect of different kinds of competitions, whether there should be group or individual projects, etc.
- guidelines and ground rules on acceptable behavior for both boys and girls to insure that girls play an equal role in the classroom and are not forced to take stereotyped roles, boys are not allowed to take over, etc.
- how to make the classroom and subject matter more attractive to girls, including choices about what kind of projects to pick, whether design and decoration can be given credit on a project along with mechanical aspects, etc.

Teachers need to consider how to make the connection between school and work clearer:

- providing information to students and their parents about the world of work designed to challenge stereotypes about careers for women. Videos and other materials designed to show students how the skills they are learning are used in the workplace and the contribution of women in technological fields need to be incorporated into the curriculum.
- teaching students more about economic realities, particularly about the role of women in the work force. Students need to learn about the economic consequences of choosing careers and the relative salary and promotion prospects of different occupations. These discussions could be developed as interdisciplinary programs with social studies or other departments.
- efforts could be made to make technology education classrooms more attractive and welcoming to girls. Pictures showing women working in technological jobs and products made by female students could be displayed in the classroom. Teachers could consider some kind of forum where girls taking technology education could talk to prospective students considering what electives to choose. Support groups for girls in technology education could be organized.

Scheduling Changes

Efforts could be made to try to maximize the number of girls in a particular technology education class. The current random distribution of girls in technology education classes could be examined with the view of combining as

many girls as possible in one class. Once numbers get over 3 or 4 girls in a class, other girls will not be as likely to feel uncomfortable about taking technology education.

Role Models for Girls in Technology Education

In both middle school and high school, girls need to meet and talk to successful women who work in technological fields.

- Technology education teachers could arrange for successful women to visit their classes and talk about their jobs and the kind of preparation and training they needed.
- Careers days or programs presented by schools must be designed to include women in nontraditional occupations.
- High schools can provide more opportunities for students to participate in job shadowing or work experience. Programs with local employers in technological fields could be designed to allow girls to meet successful women and learn more about technological careers.
- Schools can encourage the development of team teaching programs with female teachers in math or science.

Better Information for Students About What is Available in High School

- visits to high school technology education labs to see the kind of work is being done, with participation by high school girls who are currently taking these classes (using "pathbreakers" as role models)
- Elective Fairs with the participation of high school teachers and students (particularly girls) to inform middle school students about the kind of programs which will be available to them.
- Product Shows which display the kind of projects which students have the chance to create in technology education classes.

Strategies for Guidance Counselors

Guidance counselors need to provide more information to students about what electives are available and how they might fit in with various career options. Girls need to be encouraged to consider taking technology education, particularly if they are not sure whether to go to college or express interest in engineering or a technological career. Guidance activities could include:

- establishing clear links between guidance programs in middle schools and high schools, including meetings with technology education teachers to learn more about what is available in their classes. Guidance counselors could schedule presentations by high school teachers in middle schools to tell students and staff about their programs.
- providing more information to both students and parents about the necessary preparation and promotion prospects of various kinds of technological careers.
- working with technology education teachers in the classroom to get more information to students and make the connection between what students are doing in class and technological careers.

- organizing programs for students who do not plan to go to college to give them a chance to explore different options and obtain more information about further education and training. These programs should include information about nontraditional careers for women and/or the participation of women as role models. They could also include the participation of parents and/or relatives.

Reaching the Critical Mass

Many different strategies are needed to attract more girls to technology education. These strategies will need to attack the problem from as many different directions as possible. Action needs to be taken not just by technology education teachers, but in cooperation with administrators, guidance counselors and parents.

Because stereotypes about appropriate subjects or careers for women are still powerful, schools need to provide better information to all students about the options for technological careers and the role women can and do play in such occupations. Teachers and guidance counselors need to help students make the connection between what they are doing in class and the world of work. Our research results clearly show that girls are not well informed about what is available in technology education classes in high school before they have to choose electives. Because they have less experience with technology outside of school and they must fight stereotypes, girls need encouragement from teachers and guidance counselors and much more detailed information about what is available.

If we look only at the girls taking technology education, we might conclude that everything is fine and girls are doing well. The real picture is revealed in the enrollment numbers, which are reinforced by our interviews with girls not taking technology education. As long as participation is limited to a few girls willing to be "pathbreakers", the critical mass needed to convince the majority of girls that technology education is really for them will not be reached.

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