Promoting High School Girls’ Interest in Math-Related Careers

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Abstract
In my 9th grade mathematics classes, I observed gender differences in levels of participation. In order to get a better understanding of the problem, I examined grades and administered a survey. While girls were actually outperforming boys in my classes and did not have negative attitudes toward mathematics, only 11% of the girls responded that they would like to pursue a math-related career. I assigned career projects in the hopes that my students would become more aware of the need for understanding math in many, if not most occupations. A review of the projects followed up with focus interviews and further observation indicated that the projects helped my female students to realize the importance of math in their lives.

Table of Contents
Introduction .......................................................................................................................... 1
My Students ....................................................................................................................... 2
Literature Review ............................................................................................................. 3
Procedures ........................................................................................................................... 4
  Reconnaissance ............................................................................................................... 4
  Surveying My Students ................................................................................................... 5
  Career Projects ................................................................................................................ 5
  Follow-Up ....................................................................................................................... 6
My Findings ........................................................................................................................ 6
  Reconnaissance ............................................................................................................... 6
  Surveying My Students ................................................................................................... 7
  Projects .......................................................................................................................... 10
  Follow Up Interviews ................................................................................................... 11
Reflections .......................................................................................................................... 11
References .......................................................................................................................... 13
Introduction

As a teacher of high school mathematics, I realized that there was a significant disparity between the classroom participation levels of my male and female students. I recorded who participated during a few class sessions and found that the boys participated more often. Most of the girls remained very quiet in class. They only spoke when called on and did not ask questions, nor did they offer answers during class. Since the girls were often overshadowed by the boys’ energetic engagement, I became concerned about them. I often wondered if the girls were genuinely enjoying the subject. Did they believe that math would be used in their futures and that they could perform just as well as males? Although there has been some improvement, females are still under-represented in mathematics, science, technology and engineering (National Science Foundation, 2003). I believed that it was my duty as their math teacher to motivate my female students to consider these fields of study. At their present levels of engagement, I feared that they would lose interest and shy away from careers with great potential.

My students

Westerville, Ohio is an economically and socially diverse suburb of Columbus, Ohio. There are approximately 85,000 people residing in Westerville (70.7% Caucasian, 18.7% African American, 2.7% Hispanic, 2.1% Asian, 5.7% two or more races). With more than 14,000 students in 23 schools, the Westerville School District is the tenth largest in Ohio.

Over 1580 ninth through twelfth grade students attend Westerville North High School, where I teach. The students can elect to take honors and AP courses, as well as general and remedial courses. The college preparatory track in mathematics begins with Algebra 1, often taken in middle school, and progresses to AP Calculus. The freshmen at Westerville North have been divided into four teams and I am the math teacher for one of them. I teach Integrated Math A, Algebra 1 and Honors Geometry. All 112 students (67 boys and 45 girls) are freshmen, with the exception of four sophomores and two juniors. The 45 young women that I teach are the focus of my study.
Literature Review

Some alarming statistics were found about women in education and in the workplace:

- In 2003, there were 172,300 female engineers compared with 1,382,500 males. In computer technology careers, men outnumbered women 1,363,700 to 519,700. (National Science Foundation [NSF], 2006)

- 10,267 mathematics and statistics degrees were earned by men and 8311 were earned by women in 2003. (NSF, 2006)

- In 2006, only 28% of the people employed in computer and mathematical occupations were women. Forty-four percent of the scientists in our country were women and only 15% of our engineers and architects were women. (U.S. Census Bureau, 2006)

- In 2006, women earned 29% of the Bachelor degrees awarded in mathematics and computer technology (decreased from 39% in 1984). (NSF, 2006; American Association of University Women [AAUW], 2003)

Women obviously lag behind in careers involving science, technology, engineering, and math (STEM) that offer great earning potential and job security. By the year 2010, it is predicted that one in four new jobs will be of a technical nature (AAUW, 2003). Unfortunately, interest in STEM careers is declining at a time when our nation needs to remain competitive in the global marketplace. Students who develop an interest in these careers in high school are most likely to major in STEM fields in college (ACT, Inc., 2006). It is important for teachers to encourage young women to explore these STEM careers to help overcome this shortage of skilled professionals.

Research suggests that the under-representation of women in math-related careers can be attributed to a low sense of self-efficacy. Girls blame their low intellectual ability for their lack of achievement in mathematics; however, boys will blame an external source, such as not studying (Karnes & Stephens, 2002). Many girls have been convinced that they cannot do math and they should not do math (Gavin, 2000). Girls often avoid taking courses where there will be few females because they lack confidence in their abilities. Females also worry about what others might think if they have a job that is typically held by men (Pajares & Zeldin, 2000; Clark, 2000). Women believe that male-stereotyped jobs are more difficult and that they would not be as successful in them. This misconception is held even for women with strong abilities (Davenport, 1994).

Based on their collection of personal narratives of women in STEM careers, authors Amy Zeldin and Frank Pajares (2000) found that teachers need to be aware of how female students perceive their abilities, since self-efficacy beliefs strongly influence the choice of majors and careers. In a follow-up study (Coyle, 2001), women currently in math-
related careers reported that they relied on their skill, but mostly on their belief in
themselves. Thinking positively can improve a person's self-efficacy and lead to success;
however, these women were also very persistent and resilient and demonstrated a great
deal of effort (Coyle, 2001). If females underestimate what they are capable of
achieving, then they will miss out on a potentially lucrative career which would also
benefit society (Pajares & Zeldin, 2000).

Females who chose nontraditional careers such as mathematics or engineering claim to be
influenced by positive relationships with their teachers who helped kindle their interest
(Gates, 2002). Even women who are skilled in math do not often choose math-related
careers unless specifically encouraged by parents or teachers (Davenport, 1994).

What are some things that teachers can do to make a difference for young women?

- They can provide a classroom environment that is nurturing and encouraging where students' errors are considered to be a natural and useful part of the learning process (Graham & Reis, 2005; Coyle, 2001).
- In his article on gender equity, F. Gross states that males receive more praise from their teachers, and teachers initiate more interactions with male students (Gross, 2000). Therefore, allowing the female students to be heard and understood is necessary (Gavin & Reis, 2003; Graham & Reis, 2005).
- It is important for teachers to praise the females for their ability to solve challenging problems and motivate them by acknowledging their strong organizational skills, attention to detail in their work and noticeable maturity as a student (Gavin & Reis, 2003).
- It is beneficial when math teachers demonstrate the usefulness of math and its connection to the real world (Gavin, 2000).
- Teachers should support career explorations (Gates, 2002) and train students for careers that are considered nontraditional for their gender. Teachers and counselors need to instruct students about the availability and future needs for jobs and should also encourage students to select careers according to their interests and abilities rather than traditional stereotypes (Clark, 2000).
- Most importantly, a teacher's enthusiasm for their subject can be contagious to the students (Pajares & Zeldin, 2000).

Procedures

Reconnaissance

I began my study by simply observing the students in my math classes. I paid close
attention to comments made by the students and the attitudes that they expressed about
math and their ability to do math. I watched who was actively participating and how often, as well as how I was interacting with them. I recorded these observations in a research diary and it became clear to me that my female students had needs that were not being addressed because they were reluctant to participate and made comments about their inability to be successful in math.

I was curious about whether the females were learning the course material. Throughout my life I had heard that, in general, boys were better in math and I wanted to see if that was true of my students. I compared quiz, test, and quarter grades of the males and females to determine if there was a significant difference in their achievement.

**Surveying My Students**

I wanted to hear from the girls in my classes. To gather a lot of information in a short amount of time, I decided to give my students a survey in an attempt to answer some questions that I had. They were given a few extra credit points for their participation, so they were eager to oblige. The students were asked to rate their interest level in math and say whether or not they enjoyed solving math problems. I also asked them which school subjects they enjoyed and excelled in, as well as what their parents did for a living. As a student, I was motivated in math by my father who is an engineer, so I was curious about any connections between student and parent interest. Finally, the students were asked if they saw themselves using math in their future and they were instructed to choose three careers from a list, some math intensive and some not, which interested them the most.

The results of the survey were recorded on a spreadsheet after I assigned codes to each answer. I calculated the average response of the males and females to the question regarding interest level in math. The other answers were analyzed by counting the frequency of the individual responses and then converting to a percentage. I was mostly interested in the responses of the girls, but for the sake of comparison, I also recorded the boys’ responses. I was looking for any correlation between gender, math interest level, other school subjects that intrigued them and types of careers in which they expressed interest.

**Career Projects**

Anticipating a lack of interest in math-related careers for the females, one intervention that I decided to do (even before finding time to analyze the results of the survey) was to assign a project to my students. I knew about the importance of teachers encouraging females to pursue careers in nontraditional fields and the impact that a teacher can have on career decisions for their students, so the project focused on educating my students about potential careers. All of my students were instructed to choose a career that they could see themselves having after they finished their education. They were to research the career by talking with people that they knew in that career or by reading about it on the Internet. The students were to write about the rewards, challenges and responsibilities involved in their career. They had to find out the educational requirements and possible schools where they could receive training for the job. The next part of the project required the students to give an example of a person in that career,
whether it was someone they knew personally or just read about. They were to write about that person's career experiences, successes and enjoyment. Another part of the project involved the student explaining why they found the job interesting. Then the students were to give examples of how math is used in that particular career. The career assignment was worth 10 percent of the quarter grade and my students were to display their information in a creative way. I encouraged them to use pictures and/or drawings. Most students chose to make a poster, but a few made booklets. Although it was not required, many students really wanted to share their finished product with their classmates, so when time allowed, they did so. All of the posters were displayed on the walls in my classroom over the course of several weeks.

Follow-Up

I was interested in finding out if the career project had any effect on my female students. Did they become more aware of the importance of math in their futures and did the project motivate them to consider careers that are nontraditional for females? I also just wanted a chance to talk with them about their level of engagement in my classroom, so I invited twelve of my female students (in groups of three) to come to my room during our common lunch period. I made sure to include girls from the different levels of math that I taught. They came for our chat (interview) over the course of four days.

Lastly, I found an article by Housley Carr (2006) entitled “You Can Do That with a Science or Math Degree?” It is about the need for young people, especially females, to consider STEM careers. Job opportunities that a degree in STEM fields could lead to were described and median salaries were listed as a motivator. I encouraged my students to read the article and we had a brief discussion about it.

My Findings

Reconnaissance

“In the past three weeks I have been working on learning the names of my 120 students. I'm realizing that the students that I don't know yet are quiet females. The students who participate often are easier to remember. I'll try to call on the girls and draw them out more.” (09/15/06)

A female student claimed, “I've never been good at math. I just don't get it!” (09/23/06)

One boy said, “Guys are way smarter than girls in math.” (10/05/06)

“After our team conference with her mom, Jane is trying to participate more in all of her classes. She hasn't asked any questions, but answers my questions when she feels confident that her answer is correct. Jane earned a 99% on the last unit test which was the highest grade in the class!” (10/16/06)

“I want every student to understand the geometry proofs that we are doing, but I fear that some are a little lost. The confident students (almost all boys) seem to overpower the others.” (11/06/06)
From these and five other entries, I realized that I had an issue in my classes. I counted the times each student participated in class over a span of three days and recorded the results in my research diary. The girls were less participatory by a five to one ratio. Because the males in my classes were more involved, I had a tendency to call on them more often. I began to wonder if the girls were struggling to understand the math that I was teaching, so I checked their quarter grades. To my surprise, I found that the girls had a higher overall grade average (83.1% girls and 80.3% boys). This assured me that the females were indeed learning.

**Surveying My Students**

I gave a math **attitude survey** to my students which queried them on their math interest level, enjoyment of solving math problems and belief in a gender difference in ability. The survey asked the students to rate their top four favorite school subjects and lastly, to choose three careers which interested them the most from a list of various careers, including many STEM careers. The survey revealed mixed results. On a scale of 1 to 5, the math interest level for males and females was exactly the same (2.91). I was expecting the boys to have a higher interest level. When asked how much they enjoyed solving math problems, 6.8% percent of the girls said “always” compared with 7.7% of the boys (Figure 1). The majority of the students reported that they “sometimes” enjoy solving math problems. I was surprised how few boys claimed to enjoy solving math problems because their self-report conflicted with the enthusiasm and recorded participation level that they displayed in class. This question on the survey suggested that girls are more interested overall. The majority of the students (65.9% girls, 64.6% boys) believed that there is no difference in math ability between girls and boys.

**Figure 1**  
Gender Differences in Levels of Math Enjoyment
In another part of the survey, forty-five percent of the girls chose no math-related (STEM) careers and only 2.4% of the girls (1 Honors Geometry female) chose all STEM careers (Figure 2).

Figure 2
Math-Related Careers Chosen by Females on Survey

The top four favorite school subjects reported by the females in order of preference are social studies, language arts, science and math (Figure 3). For the males, the top four were social studies, math, science and physical education (Figure 4). Thirty-six percent of the boys and 29% of the girls said that math was the subject that they performed best in. When asked about whether they would want to have a career that involves math, only 11% of the girls and 23% of the boys said yes. This information confirmed for me that I had work to do. These girls needed to be encouraged to consider careers that are not traditionally chosen by women.
Figure 3
Favorite Subjects (Females)

Figure 4
Favorite Subjects for Males
Projects

My students were instructed to choose a career that interested them. Only 29.5% of the girls chose a STEM career, but I expected this to be lower in consideration of the survey results. Some of the non-traditional careers chosen by the girls were: architect, pediatrician, veterinarian, neurosurgeon, forensic pathologist, psychologist and audio technician. Through this career project, my students were made more aware of the importance of math in their futures. The following are some quotations taken from the written narratives on the girls' projects:

“Math is used in being a neurosurgeon a lot more than normal jobs. Math surrounds you when being a neurosurgeon.”

“Math and pediatricians go hand in hand.”

“On the contrary to what I thought, fashion design does contain math.”

“In photography math is actually used quite a lot.”

“Math is very important in this job, especially when analyzing clinical research. You need a heavy background in statistics and an analytical mind.”

Figure 5
Career Projects of Female Students
Follow Up Interviews

I gained some interesting insights while interviewing 12 females (in groups of three) from my classes. I asked them what it meant when they did not participate often in class. Three girls said that “we are afraid of giving the wrong answers and appearing stupid.” They said they were more likely to participate in a class where the answers were more opinion based. In math there is only one correct answer to a problem. Two girls said that “math is just not that interesting to me.” Most of the girls said that they were just naturally quiet and would rather learn by listening. One female student said, “I learn more by being quiet.”

When asked why they thought women are under-represented in STEM careers, the girls offered some thoughtful possibilities. They said that although females can perform as well as males, they may not be interested in “getting their hands dirty.” They claimed that women have so many interests and skills that they often do not choose a math-related career. One girl said that “math jobs sound hard and require too much thinking.” Another female stated that she “plans on using math to some extent, but doesn't love it enough to study it intensely.” I was pleased with the contrasting reply of one girl who said that she “loves math and enjoys finding solutions to problems.”

I also asked the girls if the career project had any impact on them. The response was positive. One student said, “I enjoyed doing the project because it made me realize the importance of math in my future career.” Several girls claimed that they were more motivated to work hard in math because they learned that they would need it to succeed.

Finding out about the level of education required for the career that they chose was enlightening for many of the girls. Several girls enjoyed the project and said, “It’s fun to have assignments that we can be creative with.” Many of the posters were quite colorful and included pictures and drawings.

I used the opportunity to encourage each girl that I interviewed to keep their options open by working hard in school and striving to learn more math and science. I stressed the fact that they were just as capable as the boys to succeed in a non-traditional career and that girls were really needed. I also shared with them that their grades were actually better than the boys' so they had no reason to feel inferior to them.

Reflections

Before I began this study, I thought that my female students were achieving less than the boys and they were less interested in math. This was based on my observation that the girls were participating less. It turned out that I was incorrect; however the girls did express less interest in attaining math-related careers.
After the follow-up interviews, I noticed that several of the girls began raising their hands in class and offering answers. I believe our discussion, along with the career projects, helped motivate them to participate more in math. I cannot claim that this study completely solved the problem of under-participation of the females in my classes, but I think it did make a small difference. They are more aware of the importance of math in their lives and will hopefully embrace the challenge of continuing the study of it.

Since a girl's decision to pursue a career in science, technology, engineering or math can be impacted by a female role model such as a teacher; I plan to continue encouraging my female students toward that goal. They need to feel confident in math, so I will include them in classroom activities by calling on girls as often as boys. I would also like to try same-gender cooperative learning groups, so the girls can comfortably learn from one another. In order to help my female students become more engaged in class, I will show them real-life applications that they can relate with.

I believe that it is important for parents to nurture mathematical talent in their daughters. They should embrace the importance of math in our technological world and promote math-related careers for their daughters. Women in nontraditional careers often claim that they were most influenced by male role models, especially their fathers (Brown, 2001; Gates, 2002). Therefore, I plan to share with my students' parents some of my findings from this study at next year's Open House.

Just knowing that another woman has been successful makes achievement seem more of a possibility (Graham & Reis, 2005), so in the future I plan to expose my students to the accomplishments of females who were pioneers in STEM fields. Additionally, educating my students about potential STEM careers will become a priority in my teaching. This study resulted in a shift in my thinking. Not only will I teach math, but I will do what I can to correct the under-representation of women in math-related careers.
References


