Gender Preferences in Technology Student Association Competitions

Charles R. Mitts

Significantly fewer female students are enrolling in technology education courses compared with males. According to Sanders (2001), female enrollment in the U.S. was determined to be almost half (46.2%) technology education enrollment in middle school, but fell dramatically in high school to less than one-fifth (17.7%). Data from the North Carolina Department of Public Instruction (2004-2005) showed that only 8.6% of females who enrolled in Exploring Technology Systems in Middle School elected to take the freshmen level technology education course, Fundamentals of Technology (see Table 1).

Background

Society is increasingly dominated by rapidly evolving systems of technology. The goal of technology education, as an academic component of public education, is to ensure that students become "technologically literate" members of society who are able to understand, access, use, manage, and control these technological systems. The course content of technology education is prescribed in standards published in 2000 by the International Technology Education Association (Scott & Sarkees-Wircenski, 2004).

Philosophical Basis of Male Gender Bias

There has been a move to refer to gender differences in the classroom as inequities rather than biases, but bias remains a more accurate word for the technology education classroom, which remains a place for males. This circumstance has deep roots in the development and impact of Western philosophy concerning differences between males and females (Lloyd, 1993).

Impacts of Male Bias on Female Social Status

The 19th century saw the birth of women's struggles for social reform in the U.S. The status of women in the U.S. was still separate and inferior to men. Their roles were limited to the home. Reforms of the period were aimed at

Charles R. Mitts (charlesmitts@aol.com) is a technology education teacher in Kentucky. This study was conducted while he was a graduate student at Appalachian State University, Boone, North Carolina.

freedom in how one dressed as well as and equal rights in marriage, employment, and voting. It wasn't until the middle of the century that higher educational opportunities became available for women (Berg, 1984). In the 20th century, it was not until 1922 that women's right to vote was upheld by the U.S. Supreme Court. As we continue into the 21^{st} century, the status of women is still a major concern. More women are likely to be left to raise children alone, be poor (Ohio State University Extension Service, n. d.), and become victims of violence (Family Violence Prevention Fund, 2007).

Impact of Male Bias on Technology Education

There are too few technology education teachers (Ndahi 2003, Sanders 2001) in general. The fact that there are too few female technology education teachers is partially due to the consequence of an historic split of vocational education into male dominated industrial arts and female dominated home economics, which occurred in the early 20^{th} century at the culmination of a successful campaign to secure Federal funding for vocational education through the passage of the Smith-Hughes Act in 1917 (Scott, 2004). This split signified a victory for those in the profession who believed that the focus of industrial arts should be on skills development, as opposed to the views of some women who had represented a broader and more inclusive perspective (Zuga, 1996).

In the beginning, industrial arts education included significant numbers of women who were influenced by the philosophy of John Dewey. These early programs were seen as part of a liberal education and were intended for all students, girls as well as boys (Zuga, 1996). The emergence of technology education in the 1980s and the subsequent adoption of the *Standards for Technological Literacy: Content for the Study of Technology* (ITEA 2000) represent a return to our profession's general education philosophy. With the ever increasing amount of technological development, "teaching concepts versus specific technology allows technology education to provide the technologically literate citizens needed to survive and advance in a technological society" (Hoepfl, 2003, p.61).

The Technology Student Association is potentially the best vehicle for attracting females into technology education, because it allows female students to work together within the field and to pursue projects of interest to them. However, the emphasis in Technology Student Association chapters on competitive events may represent an obstacle to attracting females into our program because research suggests that females find competitive events less appealing than do males (Weber and Custer, 2005). This research study also suggests that many of the topics in the *Standards for Technological Literacy* are inherently less interesting to female students.

As reported in Table 1, significantly fewer female students are enrolling in technology education courses in North Carolina compared to males. North Carolina is the focus of this study.

Table 1
Students Enrolled in North Carolina Technology Education Courses 2004-2005

Course	Males	Females	Ratio
Exploring Technology Systems	30258	18446	1.64:1
Fundamentals of Technology	11107	1594	6.97:1
Manufacturing Systems	853	27	31.59:1
Principles of Technology I	1943	547	3.55:1
Principles of Technology II	395	49	8.06:1

Note: The researcher selected these courses because they were offered at the Lincoln County High School where he taught during the 2004-2005 school year.

Achieving Gender Equity in Technology Education

Attracting and keeping females in the technology education classroom will require fundamental changes in both course content and instructional practices (Zuga, 1999). Kleinfield (1999) cites research that reveals major differences in career preferences between males and females. According to this report, women prefer fields that involve people and living things, such as law, medicine, and the biological sciences, while men prefer fields which deal with the inanimate, such as physics, chemistry, mathematics, computer science, and engineering.

The issue is not whether or not females can do the work. Females are just as likely as males to use computers, more likely to participate in non-athletic activities after school, have higher educational aspirations than males, and are more likely than males to immediately enroll in college. Women comprise the majority of students in undergraduate and graduate programs, and are more likely to persist and attain degrees (Freeman, 2004). The problem is not that women are being excluded from engineering fields, they are simply not choosing courses of study that lead to careers in engineering. Simply unlocking the doors to these fields and encouraging women to walk through them may not be working for a variety of reasons.

It is a natural response to the discovery that women have been unfairly excluded from educational arenas and occupational fields to now affirm the value of having female contributions within these areas as part of the process of ending sexual discrimination. However, the situation is complicated by the fact that what women believe it means to be a woman has developed over the centuries within the context of and by relationship to a male defined norm (Lloyd, 1993, p.104).

Throughout industry there exists a large disparity between the number of men and women employed in occupations dependent upon a knowledge of science, math, and physics. In 1994 a group calling itself *Women in Aviation International* (WAI) was established to promote opportunities in aviation for women. Twenty-three percent of its 15,000+ members are students. WAI claims that currently only 6% of the 700,000 active pilots in the U.S. are women, with just slightly more than 2% being ATP (Airline Training Program) rated. Women are employed in just over 2% of the 540,000 non-pilot jobs in the aviation industry (WAI, 2006). Technology education may help students identify career interests and aptitudes. Current percentages of women in technical occupations are listed in Table 2 (Bureau of Labor Statistics, 2005).

Table 2
Percent of Women in Technical Occupations 2005

Occupation	**Percent**
Construction manager	6.4
Engineering manager	5.9
Aerospace engineer	11.3
Chemical engineer	15.8
Civil engineer	11.7
Computer hardware engineer	12.7
Electrical and electronics engineers	7.9
Mechanical engineers	5.8

Strategies for Recruiting Females to Science and Technology Fields

A study funded by the National Science Foundation (Whitten, 2003) identified a number of things that can be done to create a warm and female-friendly culture in a university physics program. For female faculty, this study recommends family-friendly policies that allow women to balance work and the responsibilities of children and/or elderly relatives. It also emphasizes the importance of communicating and practicing an open-door policy between faculty and first year students. It encourages the creation of an inclusive environment where team work is encouraged. The study further advises to begin recruitment early by having faculty judge high school science fairs and participate in summer bridge programs, create web sites which emphasize the participation of women, and maintain a network of alumni who can return for career panels and give seminars. The study found a strong correlation between females on the faculty and the number of women who leave academia to become scientists in the private sector and in government.

One of the solutions being considered in science courses at the high school level are single-sex classes. Although anecdotal evidence supports that there are benefits from single sex classes, a 1998 report challenges this evidence. It stated that co-education works just as well as single-sex classes and schools when the following elements are present (Sharpe, 2000):

- small classes and schools
- equitable instructional practices
- focused academic curriculum

According to the research done by Weber and Custer (2005) on the preferences of females in technology education, females prefer activities that focus on design and communication. “This is particularly true when the *design* activities include a focus on problem solving or socially relevant issues” (Weber, 2005, p. 60). One of the main purposes of the Weber-Custer study was to identify what types of activities are most preferred by females and males. Their study divided 56 activities into four categories: Design, Make, Utilize, and Assess. Student participants were ask to rate these activities according to their interest level using a five category, Likert-type scale with options ranging from *Very Interesting* to *Not Interesting* at all. The research findings revealed no significant difference between males and females for activities in the Make and Assess categories. However, the research survey did find differences between males and females for activity items in the Design and Utilize categories. Looking at the composite results of all items in the Design category revealed a statistically significant level of variance. However, the composite survey results were not statistically significant for the Utilize category.

Of the 56 activities considered, females preferred those whose focus was on design or communication and that are socially relevant. The top five items selected were:

1. Use a software-editing program to edit a music video.
2. Use a computer software program to design a CD cover.
3. Design a model of an amusement park.
4. Design a school mascot image to print on t-shirts.
5. Design a “theme” restaurant in an existing building.

In contrast to the choices made by females, males picked the following five items as their top choices from the same list of 56 activities:

1. Build a rocket
2. Construct an electric vehicle that moves on a magnetic track
3. Perform simple car maintenance tasks on a car engine
4. Program a robotic arm
5. Design a model airplane that will glide the greatest distance

Method

Gender Preferences among TSA Competitive Events

Based on the Weber-Custer research study, , the researcher chose 14 out of the 33 activities described in the 2005-2006 Official TSA Competitive Events Guide for High School Technology Activities that focused on design and communication. The researcher made no judgment concerning the social significance of the activities chosen. They are:

1. Architectural Model
2. Chapter Team
3. Computer-Aided Design 2D Architectural
4. Computer-Aided Design Animation, Architectural
5. Cyberspace Pursuit
6. Extemporaneous Presentation
7. Film Technology
8. Imaging Technology
9. Prepared Presentation

10. Medical Technology
11. Promotional Graphics
12. Technical Sketching and Application
13. Technological Systems
14. Technology Bowl

The researcher determined the “Event Type Category” by making a judgment based upon the description of each event contained in *The Official TSA Competitive Events Guide* for both Middle and High School levels. From the description of the 64 events included, the researcher developed the following event types categories: Designing and/or Communication (26), Utilizing (26), Design and Utilize (1), Research and Utilize (1), Research and Presentation (2), Writing and Communication (2), Research and Writing (4), Technology Knowledge (1), and Research and Display (1). A Prediction column was included on the coding sheets to indicate the expected gender preference for each event. In addition, in the TSA Chapter Kit are four categories of activities that include ideas that the Weber-Custer study findings suggest should appeal to female students. These categories are: Scholastic/Educational, Professional Leadership, Civic and Community, and Social (Technology Student Association, 2005).

Research Design

The results of the Weber-Custer research pointed to clear differences in gender preferences based upon distinct categories of activities. The validity of the Weber-Custer study and the reliability of the categories in the study as a predictor of gender preferences were tested by examining the gender choices at TSA competitive events. In addition, the criteria in the Weber-Custer study where used to categorize each event by type. Frequency counts of male and female activity choices at TSA competitions formed nominal data sets. Chi-square statistical analysis was used to determine whether a pattern or characteristic is common to a particular event category (Gray, 2005).

Participants and Instruments

This research study included the records of all male and female participants in all the middle and high school competitive events at the North Carolina State TSA Conferences in 2005 and 2006. Datasheets were used to record the data collected. One set of datasheets listed the 31 middle school events and the second set listed the 33 high school events. The data sheets were separated by contest year. Each event sheet included the name of the event, the school name, a list of participants, and the total number of students participating in each event. Most students participated in multiple events. The total number of students participating had to be determined by compiling master lists and then eliminating multiple names. Student gender was also determined by examination of names. Names for which the gender was not certain were tabulated separately. This process yielded 246 males, 187 females, and 113 students of undetermined gender for middles school events and 244 males, 115 females, and 103 students of undetermined gender at the high school level.

Data Analysis

Chi-square (X^2) analysis was used to determine if males and females were biased in their choice of events, if they preferred individual versus team events, and whether or not their selection of types of events was statistically significant. In each of these categories, the number of males and females who would be expected (f_e) in each category, if no bias exists, was compared to the actual number observed (f_o), using the formula $X^2 = \sum [(f_o - f_e)^2 / f_e]$ (Gay 2006, p. 372). Calculations were performed using Excel data table and formula functions. The value X^2 was then compared to a number from a Chi-square distribution table (Gay 2006, p.576.). Degrees of freedom were found by the formula df = C-1 where C equals the number of items in each category, such as "Event Type." An alpha level of .05 was chosen for the study. Thus, selecting "p = .05" on the X^2 distribution table means that statistical significance is 95% certain. The value X^2 is considered statistically significant if it was greater than the value listed in the X^2 distribution table.

Results

Middle School

Out of 31 events from which to choose, the *Dragster Design Challenge* was the only one to have a statistically significant bias for males (45.754 > 43.773). The numbers for males contrast with an X^2 value of only 0.176 for females, against the X^2 distribution value of 43.773. In addition to analysis by choice of event, chi-square analysis revealed a significant difference in three other categories: Individual entrant, Team entrant, and Event Type. In the individual entrant category there was a significant difference for males in two events: *Dragster Design Challenge* and *Flight Challenge.* Similarly, the choice of two events by females was statistically significant for *Digital Photography* and *Graphic Design Challenge*. In the "Team" event type category there was a significant difference for males in four events and females in six events. For "Event Type" females preferred eight events by a statistically significant margin and all of them were "Design and/or Communication" type activities. Males preferred five events, all "Utilizing" type events. The *Technology Bowl Challenge*, which the researcher designated as a "Technology Knowledge," non-utilizing type event, showed a male significant difference in both the "Team" and "Event Type" categories. Table 3 shows the Technology Student Association competitions preferred by males, and Table 4 shows those preferred by females.

Table 3
Statistically Significant Differences in Male Preferences at NC TSA 2005-2006 Middle School Competitions

Event Name	**Event Category**	**Chi-Square** $X^2(df, N), p < .05$	**Distribution of** X^2	**% Male/Female**	**Gender Prediction**
Dragster Design Challenge	Combined Individual Utilizing	$X^2(30, 246) = 45.754$ $X^2(13, 246) = 97.692$ $X^2(11, 246) = 29.280$	43.773 22.362 19.675	85.5/ 14.5	M
Flight Challenge	Individual Utilizing	$X^2(13, 246) = 42.823$ $X^2(11, 246) = 19.675$	22.362 19.675	83.3/ 16.7	M
Problem Solving	Team Utilizing	$X^2(16, 246) = 137.037$ $X^2(11, 246) = 72.305$	26.296 19.675	76.6/ 23.4	M
Structural Challenge	Team Utilizing	$X^2(16, 246) = 64.415$ $X^2(11, 246) = 29.280$	26.296 19.675	63.4/ 36.6	M
Technology Bowl Challenge	Team Tech.-Know.	$X^2(16, 246) = 35.080$ $X^2(18, 246) = 44.664$	26.296 28.869	58.7/ 41.3	N
Manu-facturing Challenge	Team	$X^2(16, 246) = 26.359$	26.296	73.9/ 26.1	M

Nine competitive events showed a statistically significant difference: five by males, two by females, and two events, *Film Technology* and *Technology Bowl*, by both males and females. Only one event, *Dragster Design*, registered a statistically significant preference for males, 79.184 > 24.996 when chi-square was used to analyze data in the "Individual" entrant category. The X^2 value for females in this category was 0.922. Team events were preferred by males in three cases, by females in two, and by both males and females in two. Under the category "Event Type," males chose "Utilizing" type events in three cases, and a non-utilizing type event, *Cyberspace Pursuit*, in one. Females selected non-utilizing type events by statistically significant margins twice; both were designated as "Designing and/or Communication" type events. The events with a significant difference for males are listed in Table 5 and for females in Table 6.

Table 4.
Statistically Significant Differences in Female Preferences at NC TSA 2005-2006 Middle School Event Competitions

Event Name	Event Category	Chi-Square X^2(*df, N*), *p*<.05	Distribution of X^2	% Male/Female	Gender Prediction
Challenging Technology Issues	Team Design/ Commu-nication	X^2(16, 187) = 40.091 X^2(18, 187) = 49.905	26.296, 28.869	33.3/ 66.7	F
Chapter Team	Team Design/ Commu-nication	X^2(16, 187) = 36.364 X^2(18, 187) = 45.503	26.296, 28.869	35.4/ 64.6	F
Cyberspace Pursuit	Team Design/ Commu-nication	X^2(16, 187) = 61.455 X^2(18, 187) = 74.966	26.296, 28.869	40.3/ 59.7	F
Digital Photography Challenge	Individual Design/ Commu-nication	X^2(13, 187) = 57.183 X^2(18, 187) = 98.673	22.362, 28.869	30.5/ 69.5	F
Environmen tal Challenge	Team Design/ Commu-nication	X^2(16, 187) = 29.455 X^2(18, 187) = 37.307	26.296, 28.869	38.3/ 61.7	F
Leadership Challenge	Team Writing & Commun.	X^2(16, 187) = 52.364 X^2(18, 187) = 64.332	26.296, 28.869	30.0/ 70.0	N
Graphic Design Challenge	Design/ Communi cation	X^2(18, 187) = 45.503	28.869	27.9/ 72.1	F
Video Challenge	Team Design/ Commu-nication	X^2(16, 187) = 29.455 X^2(18, 187) = 37.307	26.296 28.869	42.0/ 58.0	F

Table 5
Statistically Significant Differences in Male Preferences at NC TSA 2005-2006 High School Event Competitions

Event Name	**Event Category**	**Chi-Square** $X^2(df, N), p<.05$	**Distribution of X^2**	**% Male/Female**	**Gender Prediction**
Cyberspace Pursuit	Combined Team	$X^2(32, 244) = 134.940$ $X^2(17, 244) = 47.801$ $X^2(18, 244) = 53.628$	46.194 27.587 28.869	83.0/ 17.0	F
Dragster Design	Combined Individual Utilizing	$X^2(32, 244) = 245.238$ $X^2(15, 244) = 79.184$ $X^2(13, 244) = 60.872$	46.194 24.996 23.685	87.7/ 12.3	M
Film Technology	Combined Team Design/ Communication	$X^2(32, 244) = 171.265$ $X^2(17, 244) = 64.008$ $X^2(18, 244) = 71.253$	46.194 27.587 28.869	68.3/ 31.7	F
Flight Endurance	Combined	$X^2(32, 244) = 69.022$	46.194	90.9/ 9.1	M
Structural Engineering	Combined Team Utilizing	$X^2(32, 244) = 280.995$ $X^2(17, 244) = 114.856$ $X^2(13, 244) = 72.601$	46.194 27.587 23.685	79.1/ 20.9	M
Technology Bowl (Written & Oral)	Combined Team Design/ Communication	$X^2(32, 244) = 635.940$ $X^2(17, 244) = 287.823$ $X^2(18, 244) = 312.050$	46.194 27.587 28.869	78.3/ 21.7	F
Technology Problem Solving	Combined Team Utilizing	$X^2(32, 244) = 496.265$ $X^2(17, 244) = 218.805$ $X^2(13, 244) = 146.741$	46.194 27.587 23.685	85.0/ 15.0	M

Table 6
Statistically Significant Differences in Female Preferences at NC TSA 2005-2006 High School Event Competitions

Event Name	Event Category	Chi-Square $X^2(df, N), p<.05$	Distribution of X^2	% Male/Female	Gender Prediction
Chapter Team (Written and Oral)	Combined Team Design and/or Communication	$X^2(32, 115) = 144.643$ $X^2(17, 115) = 60.180$ $X^2(18, 115) = 65.786$	46.194 27.587 28.869	42.2/ 57.8	F
Film Technology	Combined Team Design and/or Communication	$X^2(32, 115) = 77.786$ $X^2(17, 115) = 28.988$ $X^2(18, 115) = 32.166$	46.194 27.587 28.869	68.3/ 31.7	F
Medical Technology	Combined Team Design and/or Communication	$X^2(32, 115) = 340.071$ $X^2(17, 115) = 156.368$ $X^2(18, 115) = 168.728$	46.194 27.587 28.869	35.6/ 64.4	F
Technology Bowl	Combined Team Design and/or Communication	$X^2(32, 115) = 87.500$ $X^2(17, 115) = 33.404$ $X^2(18, 115) = 36.943$	46.194 27.587 28.869	78.3/ 21.7	F

Conclusions

Male and female TSA members differ in their preferences for types of competitive event activities. These different preferences are clearly reflected in data Tables 3-6, which list all events for which statistically significant differences were found. Males clearly have a strong preference for utilizing type activities such as *Dragster Design* (7 out of 9 events), while females have an even stronger preference for non-utilizing, design and/or communication type events (10 out of 10), such as *Medical Technology*. These results are consistent with the findings in the Weber-Custer (2005) study. Using the gender preference criteria in the Weber-Custer report, the researcher made a correct prediction of gender preference for TSA competitive event activities in 20 out of 21 cases (95%) for which statistically significant results were found. In addition, the data clearly suggest that both males and females prefer team activities; by a margin of 77%. Just as in the Weber-Custer research study, the researcher found that the female preference for design and/or communication type activities was statistically more pronounced than the male preference for utilizing type activities. *Film Technology* and *Technology Bowl*, appealed to both males and females by statistically significant margins.

Discussion

This study clearly reveals that strong gender preferences motivated male and female choices of activities at the 2005 and 2006 middle and high school TSA State Conferences in North Carolina. Males preferred activities where the creation of an artifact, such as a dragster, was an end in itself. On the other hand, females preferred activities such as *Medical Technology* that had some social significance. The roots of this difference in gender choices can be found in the philosophical tradition of Western culture: abstract thought was held to be an exclusively male province while females were restricted to those activities in and around the home. This tradition in Western culture is reflected in the history of vocational education in the U.S. by its split into industrial arts for males, and home economics for females.

The emphasis of technology education on “hands-on,” utilizing type lab activities, such as such as making dragsters, may be a major reason for technology education’s failure to adequately attract and keep female students in programs. Table 1 documents a decline of 16,852 female students between middle school and high school who enrolled in technology education in North Carolina, a decline of 91.4%. In the North Carolina Technology Student Association data for the 2005 and 2006 state conferences, female participants declined by 38.5% between middle school and high school. This study suggests that, in order to attract and keep female students, an emphasis in technology education programs should be placed on activities that appeal to both genders. These kinds of activities are already incorporated into TSA specifications and programs of study.

The Technology Student Association should consider collecting and analyzing gender-based data from competitive activities from all of its state and national conferences. The technology education curricula should be analyzed to determine the extent to which “Utilizing” type activities, that appeal primarily to females, are incorporated compared to “Design and/or Communication” activities, that appeal primarily to males. Technology education course updates and revisions in North Carolina and across the nation should be based on knowledge of gender preferences and interests, with the goal of significantly improving the number of female students who are attracted to, and remain in, technology education programs, including the pursuit of careers as technology education teachers.

Acknowledgment

The author wishes to recognize Dr. Marie Hoepfl, Professor in the Department of Technology at Appalachian State University, Boone, North Carolina, for her guidance and support in the conduct of this study.

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