

AC 2008-2045: GENDER DIFFERENCES IN HIGH SCHOOL STUDENT'S VIEWS OF TECHNOLOGY

Mary Brake, Eastern Michigan University

Dr. Mary Brake is a Professor in Mechanical Engineering Technology. She can be contacted at 118 Sill Hall, School of Engineering Technology, Eastern Michigan University, Ypsilanti, MI 48197 mbrake@emich.edu

Kaninka Bhatnagar, Eastern Michigan University

Ms. Kaninika Bhatnagar is a doctoral student in the College of Technology at Eastern Michigan University. Her address is School of Technology Studies, 121 Sill Hall, Eastern Michigan University, Ypsilanti, MI 48197 kbhatnag@emich.edu

Gender Differences in High School Student's Views of Technology

Abstract

There are significant gender differences between the numbers of undergraduates and graduate students who study technology related fields. For example, although females make up more than half of all undergraduate students, they make up considerably less than half of all students in professional schools and even less in technical graduate schools like engineering.

This research carried out an analysis of high school students' perceptions of technology and their intent to select an engineering/technology major in college in order to determine if there were any gender differences among them. A survey instrument was designed to obtain data on a number of variables, such as the students' general knowledge about various technologies, the influence of their parents, peers, and teachers, as well as their Locus of Control (their perception of control over their life's outcomes) and their intent to major in a technology related field (including engineering, math, and science). The word 'technology' was left undefined for the students so as not to prejudice their answers. The analysis investigated if there were any statistically significant differences between the opinions of boys versus girls. The validated instrument was administered to a sample of 81 students from a high school in a different school district than the pilot study. The data was analyzed using bivariate correlation techniques in SPSS, a statistical software package.

The results of this study are that as a group, boys displayed higher confidence in performing technology tasks, showed more knowledge of technology, were more likely to consider technology work as fun and were more likely to consider technology majors for college compared to girls. However, both boys and girls agreed that teachers encourage boys more than girls to pursue technology majors and careers. There was a strong correlation between girls' sense of control of their lives and choosing a technology major. Parents appeared to have a stronger positive influence in boys' decisions to select technology majors compared to girls. Both boys and girls indicated that their schools were giving somewhat gender biased messages in providing more support for boys to consider technology majors but to a lesser extent than has been reported in the last decade.

Introduction

A gender imbalance, favoring males has consistently been reported in the choice of engineering and engineering technology majors in college.^{1,2} In recent years there has been a sharp decline in the percentage of high school seniors and college freshmen who plan on majoring in engineering. From 8.6% in 1992, the numbers have plunged to 5.3% in 2003.³ In the academic year 2005 – 2006 19.3% of the undergraduate engineering majors were women⁴ and only 10.4% of the engineering technology (ET) were women.⁵ But more than half of all undergraduates are women and female high school seniors are more likely to anticipate graduating from college compared to their male counterparts.⁶ These numbers raise questions and concerns about the continuing presence of a substantial technology gender gap in engineering and engineering technology.

Existing Research

Numerous studies have been conducted to investigate the gender gap in women's choice of science and technology majors. Such research includes studies about women in the education

system^{2, 7, 8} as well as those in the area of motivation and behavior,⁹⁻¹¹ which investigate an individual's decision to follow or reject a certain course of action.

Expectations for success, confidence in one's ability to succeed, and personal efficacy have long been recognized by decision and achievement theorists as important mediators of behavioral choice.¹² Numerous studies have demonstrated the link between expectations for success and a variety of achievement related behaviors including educational and vocational choices⁹⁻¹¹. Arguably the question of major choices for boys and girls might in part be influenced by their expectations for success at various academic subjects and in various occupations. Eccles reports finding consistent evidence of gender differences in expectancies for success and confidence in one's abilities for mathematics, athletics, and English, especially among junior and senior high school students.¹³

Early studies indicated that women were more likely to exhibit what has been labeled as a low-expectancy attribution pattern, and their achievement behavior has been found to suffer as a consequence. Specifically, men attributed their successes to internal stable causes (ability), whereas women attributed their failures, but not their successes, to these causes. In mathematics, girls are less likely than boys to attribute their successes to ability. Instead, girls attribute their successes to effort and hard work, which may undermine their expectations for success as mathematics increases in difficulty.¹⁴⁻¹⁶

There have been many studies investigating why girls harbor negative feelings towards engineering and the physical sciences but there have been very few studies that have examined what young people think about "technology". One of the largest research projects to address students' technology perceptions was the 1986 Netherlands study conducted by the Eindhoven Institute of Technology: Pupils' Attitude Towards Technology, PATT.⁷ Even though it is 20 years old it is relevant to this study because, like this study, it specifically dealt with 'technology' as opposed to science, engineering or math. Also, the scope of the PATT study was large as it was initially offered to 2,600 thirteen year old students in the Netherlands. This was expanded to include 11 countries. This study found the following attitude and impressions of students regarding technology:

"Boys are interested in technology, girls are rather neutral; Pupils (girls more than boys) think that girls are apt for technology; Pupils (boys more than girls) are aware of the diversity of technology; Pupils (boys more than girls and pupils with a technical father and/or mother more than other pupils) think that technology is important; Pupils are not very acquainted with technical appliances; girls are less acquainted with these appliances than boys are; In general pupils are not aware of the role of creativity and designing in technology; Pupils think they do not hear much about technology at school; Pupils with a technical father an/or mother more than other pupils do think technology is too difficult for them; It is hard for pupils to give a description of what technology is; the relation between physics and technology is not clear to them" (p. 29).

These results are very interesting because the PATT study had framed an elaborate working definition of technology which was broad enough to be applicable today. There are two distinct definitions of technology that make it strikingly similar to the present study. The PATT study defined technology as "a specifically human activity, the implications being that technology is for women as well as for men." Further, it defined the technology skill set as constituting: "designing, practical-technical skills and handling technical products."⁷

Research Background

Technology is an often used, but ill defined term. We define technology as an application of engineering, science and math to consumer goods, manufacturing methods, medical advances and new research methods to name a few. But most teenagers view technology as those things related to their personal lives: MP3 players, cell phones, DVDs, the Internet, and electronic games. But they are also exposed to new technology in consumer goods like global positioning systems in cars, microwave ovens, and even more mundane advances like automatic ice makers in refrigerators. New technologies are based upon advances in science and engineering. Based upon analysis of survey data of a summer camp for girls (at another university) who, in theory, were interested in computer engineering (unpublished), we found that engineering was an abstract concept to high school students, even at the end of a residential one week engineering camp. We noticed that many of our most successful engineering technology (ET) majors generally have had “hands on” experience in high school. They report that the “hands on” opportunity was the major influence in their decision to major in ET. Technology is an important part of a student’s life and there appeared to be antidotal evidence that having experience with working with technology increases the likelihood that students will major in engineering/engineering technology. We decided to study how high school students view technology in their lives to understand if there is a correlation between intending to major in science, technology, engineering or math and their experiences with technology in their lives.

We knew from informal conversations with teachers and teenagers that teenagers usually view technology as strictly electronic devices such as computers and everything related to microelectronics. But science, technology, engineering and math (STEM) majors encompass many more subjects than electronics. We, therefore, framed our questionnaire so as to include a broader knowledge base that went beyond digital electronics to everyday know-how and practical skills. We did not define technology on the survey for the students because we did not want to influence their opinions. And we only included questions regarding technology with which they would be familiar.

We noticed in teaching freshmen engineering students and more recently freshmen engineering technology students that students did not really understand what engineers do on the job despite having chosen engineering or engineering technology as a college major. And as mentioned, an interesting commonality among engineering technology students emerged when asked why they chose their respective majors. The answer, regardless of gender, was invariably, “I want to work with my hands!” In other words, they want to fix, make and design things. Their answer begs the question, “When they were in high school, were they the students who liked to cook, fix the car engine, or design web pages?” So they hoped to pursue a career where they could use their skills even if they didn’t know what they would do on the job, just that they hope to have a career where they can use their practical skills. Other than the PATT⁷ study described above, there has been very little research regarding students’ opinion of technology and how this opinion correlates to their intent to pick a science, technology, engineering or math major.

Survey Instrument Design

The study reported here used a survey instrument designed to determine influences and perceptions of technology in order to investigate gender differences. The knowledge of

technology for the purpose of this study consisted of practical, technical skills and knowledge of technical products. Undoubtedly the one major change in technology since the PATT study in 1986 is the ubiquitous presence of computers at all levels of our society and the education system. Therefore the knowledge and the comfort level of working with computers becomes a major aspect of defining technology. In today's society the two are often found to be synonymous however we have used a broader definition to reflect the interdisciplinary nature of technology that applies to more careers than that of computer science.

This research investigated the reasons behind a student's perception as well as their intent to not only attend college but major in a technology field. The survey instrument did not rigorously define 'technology' for the respondents; instead it was stated before the survey was administered that for the purpose of the survey the word 'technology' meant all/anything that the students understood by the words science, math, engineering and technology. The definition of technology was internal to our project, just as in the PATT study, and was not defined for the respondents so as not to prejudice their answers.

To investigate the question of gender differences in high school students' perception of technology this research looked at a variety of factors: The survey considered students' general knowledge about various technologies, the influence of their parents and teachers, as well as their Locus of Control.¹⁷

We included questions that indicated a student's perception of control over their life (locus of control) as it is related to self-esteem and we wanted to know if this was a factor in determining their college major regardless of actual knowledge or skills of that major or the careers that may result. Chan et al.¹⁸ found that young men have higher self confidence in their perceived ability in STEM careers as compared to women regardless of performance in related subjects.¹⁸ Even technology that many take for granted differs between genders. Research indicates that female college students are less likely to have home computers and that they spend fewer hours using them compared to their male counterparts.¹⁹

The survey instrument reported here was developed from two pilot studies. The first of these was from the analysis of data from another university's survey of high school girls who had attended a one week computer engineering camp. For the second pilot study we modified the original survey, which mostly asked engineering related questions, to technology so that technology not engineering was its focus. We then administered the instrument to a co-ed group of 50 biology students, most of whom were about 16 years old. We consciously chose students who were not in their senior year and who were taking a required class that did not use computers. Then we developed the final survey by analyzing the pilot data from the biology classes and the summer computer engineering camp and tested the survey for statistical reliability.²⁰ The final instrument was designed along a 5 anchor point Likert scale that gave the respondents the option to pick 'neutral' if they chose. Each variable under study was a composite score of 5-7 questions previously tested for reliability and statistically significant correlation. There were 40 total survey questions. The variables were a measure of students' LOC, their knowledge about technology, their confidence in technology classes, their perceived signals about technology choices from teachers and parents, their interest in choosing a technology major in college and their perceptions about technology as being hard, or fun, or easier for one gender than the other.

For example, ‘Working in technology would be fun’; or ‘Most jobs in technology are monotonous and boring’.

As the two pilot studies showed, students only appeared to stay on task when filling out the survey for about 10 – 15 minutes. So, the questionnaire was edited for length and duplication. Ambiguous questions were also removed, and as far as possible they were checked for clarity of interpretation. Moreover it was found in the pilot studies that very few students cited peers or friends as possible influences in choosing a technology major so the survey results reported here concentrated on the influence of parents and teachers.

The validated instrument was administered to a sample of 81 students (50 girls and 31 boys, also mostly sophomores from a high school in a different school district than the co-ed pilot study. In the co-ed pilot study as well as the study reported here, the students were surveyed in a required class, either Theater or Argumentation (5 classes total were surveyed). The data was analyzed using bivariate correlation techniques in SPSS, a statistical software package.

Discussion of Results

Several statistically significant correlations were obtained for boys and girls. The results are shown in the tables below.

Table I: Variable Definitions

SMET	Intent to choose a tech major in college
WORK	Working in technology is fun
CONF	Confidence working with technology
FAM	People in technology have no family life
LOC	Perception of control over one’s life’s outcomes
TECH	Knowledge about technology
GRAD	Confident of graduating from H.S. and entering college
GTP	Perception that boys are better at technology than girls
GSS	Messages from school that technology is more suitable for boys than girls
DIFF	Gender differences in opinions about technology (not better or worse)
PRNT	Importance of parents’ opinions about their ability to work in a technology

Table II: Bivariate correlation results

Variable1	Variable2	Boys	Girls
SMET	WORK	.562**	.623**
SMET	CONF	.128	.297*
SMET	FAM	-.376*	.115
LOC	TECH	.507**	.415**
LOC	GRAD	.285	.313*
TECH	WORK	-.133	.354*
WORK	CONF	-.022	.540**
GTP	CONF	-.0175	-.312*
GTP	GSS	.396*	.512**
GTP	DIFF	.382*	.305*
CONF	FAM	.175	-.295*
CONF	PRNT	.479**	.014
GSS	GRAD	-.116	-.331*
GSS	FAM	.058	.286*
GRAD	FAM	.191	-.367**

** Significant at alpha = .01 level, or there is a 99% probability that the result is not by chance.

* Significant at alpha = .05 level, or there is a 95% probability that the result is not by chance.

Table III: Pearson Correlation Matrix for the Entire Sample

N=81

		1:SMET	2:WORK	3:CONF	4:FAM	5:LOC	6:TECH	7:GRAD	8:GTP	9:GSS	10:DIFF	11:PRNT
1	SMET	---										
2	WORK	.629**	---									
3	CONF	.263*	.342**	---								
4	FAM	-.067	-.125	-.108	---							
5	LOC	.088	.152	.307**	.022	---						
6	TECH	.126	.224*	.151	.136	.474**	---					
7	GRAD	-.179	-.023	.065	-.166	.290**	.136	---				
8	GTP	.040	-.009	-.212	-.023	-.128	.059	-.139	---			
9	GSS	-.046	-.160	-.181	.188	-.182	.101	-.253*	.435**	---		
10	DIFF	-.125	-.015	-.160	-.067	-.024	.097	.245*	.241*	.068	---	
11	PRNT	.143	-.058	.250*	-.068	.199	-.181	.044	-.092	-.243*	-.136	---

The results showed numerous statistically significant differences among boys and girls. Some results applied to both genders, but several were significant only in the case of one and not the other. The variable SMET (choosing a technology major in college) showed a statistically significant positive correlation with the variable WORK (working with technology is fun) both in the case of boys and girls. The variable SMET was also positively correlated with the variable CONF (confidence working with technology) but only in the case of girls. This was an interesting finding as it points to confidence being one of the decisive factors in the case of girls but not boys when they make their career choices. In other words, girls appear to be more influenced by their perceived confidence in their ability to work with technology. This supports the findings from literature.¹⁸ It was also found that the variable SMET showed a statistically significant negative correlation with the variable FAM (people in technology have practically no family life), but only in the case of boys. In other words those boys who intend selecting a technology major do not think that technology will interfere with having a family. No significant

correlation was observed with girls. In the case of both boys and girls the LOC (self esteem) and TECH variables (knowledge about technology) were found to be positively correlated with each other and this was statistically significant at the .01 alpha level. Thus the higher a student's self esteem, (or confidence that they had control over their lives) the more likely they were to understand various technologies and technology products.

Several of the results indicated a statistically significant correlation only in the case of girls but not boys. It was found that LOC correlated positively to GRAD (confident that they would attend college) in the case of girls but no correlation was found in the case of boys. Similarly the variable TECH correlated positively with WORK and the variable WORK correlated positively with CONF only in the case of girls. Interestingly the variable GTP (perception that boys are better at technology than girls) was found to be negatively correlated to CONF, but only in the case of girls. Further CONF was also found to be negatively correlated to the variable FAM, again only in the case of girls. In other words the lower their confidence in technology, the more likely girls thought that boys were better than girls at technology. Similarly, the higher the girls' confidence in working with technology, the less likely girls thought that technology interfered with family life. Also among girls, the variable GSS (the messages they received from school that technology is more suitable for boys) was found to be strongly correlated to FAM. In other words those girls who received strong exclusionary messages from their teachers or counselors at school regarding technology and technology careers were also more likely to think that people in technology had no family life.

A very interesting finding was the statistically significant positive correlation between the variables CONF and PRNT (my parents' opinion about my future is important to me) but only among boys. It appeared that boys' confidence levels were strongly correlated to their parents' opinions of their technology competency. However no such relation was found in the case of girls. (A related finding from the co-ed pilot survey was that girls reported talking to their parents more frequently than boys, but boys reported a more positive feedback from their parents regarding technology majors and careers. Thus the influence of parents was found to be significant and different for boys and girls in the co-ed pilot study.)

Boys had a higher mean value for the variables CONF, TECH, SMET, and WORK. As a group they displayed higher confidence in doing technology tasks, showed more knowledge of technology, were more likely to consider technology work as fun and were more likely to consider technology majors for college compared to girls. However, boys also scored a higher mean on the variable GTP indicating that they were more likely to think that technology was more suitable for boys than for girls. The correlation between GSS and GTP indicates that both boys and girls agreed that teachers encourage boys more than girls to pursue technology majors and careers. Results indicated that confidence and sense of control over one's life's outcomes are very important for girls who indicated they would choose a technology college major, but not for boys. Parents appeared to have a stronger positive influence in boys' decisions to select technology majors. Both boys and girls indicated that their schools were giving somewhat gender biased messages in providing more support to boys for technology majors, but this is much less than has been reported in the last decade.^{8, 20}

Summary

There was statistically significant evidence to support the following conclusions:

Both Genders

- The opinion that “working with technology is fun” is strongly correlated to thinking about choosing a SMET major in college.
- The higher the students’ LOC (control over one’s destiny which is closely related to self esteem) was strongly correlated to knowledge about technology and technological products.
- Both boys and girls reported that schools, in general, and teachers specifically encourage boys more than girls, to some extent (statistically significant) to pursue careers that use technology.

Boys

- Boys reported that a career in technology would not interfere with having a family.
- The higher the boys’ confidence in working with technology, the more likely the boys reported that their parents’ opinion about their future was important to them.

Girls

- Girls’ confidence in working with technology is statistically correlated to the intent to major in a technology field in college.
- The higher the LOC (related to self esteem) the more likely the girl was to report that she would attend college.
- The more strongly a girl reported confidence in working with technology, the more likely she considered that a technology career would be fun.
- The higher the score in confidence in working with technology the *less likely* girls thought that boys were better than girls at technology.
- The higher the score in confidence in working with technology, the less likely girls thought a technology career would interfere with having a family life.
- But, girls who perceived that technology careers were more suitable for boys were more likely to think that technology careers would not be compatible with having a family life.

Conclusion

Gender disparities in education and workplace have been a subject of long standing debate. Compared with conditions fifteen years ago^{13, 19} this study highlights some of the changes that have occurred. Both girls and boys exhibit a reasonable understanding of technology jobs and its rewarding nature. Girls have been thought to dismiss SMET careers because these careers did not ‘help people’, did not require ‘creativity and imagination’ or ‘social interaction’. The lack of these attributes was attached to the image of a technology geek, usually a boy. However, our results show that girls no longer harbor these misconceptions about technology work and technology education.²¹

The gender differences that emerged from this work are the importance of self confidence and a sense of having control over one’s destiny. Girls displayed lower level of confidence in technology, compared with boys, regardless of high scores in technology knowledge, and regardless of being aware of subtle gender biases from their schools. Furthermore the influence of parents appeared to play a part in boosting the technology confidence of boys. The conclusion

is that there are no major reasons why students may choose or reject technology majors in college but rather subtler issues. Knowledge (or lack of knowledge) by itself is not the barrier anymore, however, confidence in one's ability and the accumulation of even small signals of gender discrimination appear to affect the confidence level of girls quite disproportionately. (The more an individual girl thought that boys are better at technology than girls, as measured by GTP, the lower was their confidence as measured by CONF, at the $\alpha = 0.05$ level.) This leads to the issue of recruitment and retention of students in technology majors.

This study points to the need not only for greater clarity in talking about technology and technology choices to the students, but also shows that there is a significant issue of confidence with respect to the girls that must be addressed. There may be subtle and often unintentional messages that teachers and parents might be conveying to this highly impressionable age group, that affect their decisions about choices of college major. The choice that students make, girls or boys, must be dictated by a realistic assessment of their abilities and interests, and not conditioned by biased messages that could potentially undermine their self confidence.

This study highlights the need for a greater understanding of technology perceptions and the way they relate to students' self confidence, their knowledge about technology and the messages, both direct and subconscious, that they receive at school about technology. High school years serve as a threshold to college and adult life where they make major choices based primarily on their perceptions, however inaccurate or biased. Therefore it is important to ensure that there is no gender bias in the way 'technology' is being communicated to students. Educators need to pay attention to technology perceptions of students and building self confidence in working with technology in the high school years, particularly for those students who would be successful in technology careers but don't consider themselves capable due to misplaced perceptions and lack of self confidence.

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