

*University of Wisconsin at Platteville
College of Business, Industry, Lift Science and Agriculture
Department of Industrial Studies
INDS 7000 – Final Research Proposal*

*M.S. Independent Research Study:
Gender Equity in the Computer Science Industry*

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Abstract

The gender gap in the area of computing has become a subtle, yet alarming, reality for those within the industry. Having worked for six consecutive summers from 1998 thru 2003 as a Computer Camp Director at universities such as Johns Hopkins University, Arizona State University, DePaul University, and Massachusetts Institute of Technology, the IP of this report has witnessed first-hand the nearly non-existent enrollment of young females in the camps. With Massachusetts Institute of Technology being the largest camp having directed, it became clearly apparent that girls are widely excluded from such enriching opportunities. Each week would enroll approximately one hundred computer campers, with only a select two to five girls making up the total weekly enrollment. On some occasions, only one girl registered for camp, and was painfully made aware of her individuality upon arrival to camp, finding that no other girls were there to create camaraderie with. Often times, a single female enrollee would withdraw from camp only a day or two into the week's session because of the feeling of isolation. The resulting question is posed, why are there so few girls expanding on their interests in the computer field when it appears that girls are equally avid users of computers for general purposes, and use the Internet at comparable rates to their male counterparts?

With similar personal conviction to the content of this report, the IP is a professional in the Technology field, serving as not only an educator of technology, but also as an owner of a computer company offering IT and computer tech services. The IP personal finding is that at this advanced level, as compared to those younger participants of the computer camps, the situation is replicated in terms of the lack of female involvement in the field, as most competitors of the female-owned computer company are again, male-owned companies.

This report supports the inequity anticipated by the IP as a result of her personal involvement in the industry. The goal is to determine the cause of female under-representation, and develop a plan for enticing more females to advance their skills and become active participants in the field.

Gender Equity in the Computer Science Industry

Technology in today's world is a part of everyone's lives. While technology is rapidly changing, and employing more and more members of our society, females continue to be under-represented in the field of Computer Science. While studies have shown the genders to be using computers comparatively, it remains that girls are less likely than boys to enroll in computer science courses, especially higher level computer courses. (NSF, 2001) By whatever subtle barriers that exist to prevent women from advancing in CIS fields, our society loses half of its potential workforce as valuable contributors to the field. The understanding of a woman's perspective is imperative when developing tools for technology and electronic communication. In the Industrial Age of Technology, women have played an important role in the development of new technology tools. Inventive women have created or improved many of the products and practices that support our quality of life. Feminine contributions have given us inventions like the fire escape, windshield wiper, computer compiler, Scotchgard, and liquid paper. (Thimmesh, 2000) In this Informational Age of technology, it is important to recognize the potential women can offer to the field by ways of alternative strategies identified by differing thinking styles between the genders, as compared to the male contributors of this time.

Research suggests men and women do not think about technology the same way. "Women tend to value and perceive technology as a means of facilitating collaboration, communication, and linkages between people. Men, on the other hand, tended to see technology as a means of extending their control over their physical environment. Men also tend to identify strongly with the technical details associated with a given technology, while the females were more attentive to its practical applications. Lastly, men often relate to technology through tinkering, while women connect with technology in the context of solving a problem from everyday life." (Bank Street College, 1991) These different patterns of thinking reinforce the notion that it is imperative to have equal representation in the field of technology, as the products created in the process will naturally relate to the gender-related strategies of implementation of different technologies upon society. An example of the current bias of tools produced by the computer industry for use by the public is the abundance of violent war-like gaming technology, as opposed to the lack of female-oriented gaming materials currently available. It would seem to reason that such enticement into the use of computers and elevation of interest as such would be exacerbated by the cyclic nature of the male developers creating tools for the young male population as opposed to female-friendly software luring girls into its usage. It is necessary to have women's concerns present in all levels of development in order to provide society with an enriched variety of tools to use that technology.

Women must be included in all levels of the computer science industry, including high tech positions, in order to contribute their vision to the development process with the fullest potential. According to statistics gathered by the National Science Foundation, 45% of Associate degrees awarded in the field of Computer Science were awarded to females, while only 28% of the bachelor's degrees were awarded to the same gender. (NSF, 2002) The rate of representation declines rapidly in subsequent levels of degree advancement.

In analyzing the data supporting areas of low female representation, one must study the reasons for this decline in degrees sought in higher levels of advancement. This is especially important to closing the gender gap as it relates to income earnings between the genders.

With critical consideration in interpreting the significance of this data, one must question whether this pattern exists in general degree advancement across fields. Data collected from the National Science Foundation illustrates that not only are all degrees in the area of Science and Technology sparsely represented by females as compared to other degree areas, but Computer Science in-particular is grossly under-represented. (NSF, 2001)

The fact that women are awarded degrees in decreasing numbers as the level advancement in degree increases represents a further gap between the sexes as it relates to average to income earning potential. The earnings of IT workers vary greatly, based on their skills and educational levels. For example, the Bureau of labor Statistics (BLS) estimates that in 1998 computer engineers, who typically have at least a bachelor's degree, earned an average of \$59,900. By contrast, lower skilled occupations such as billing, posting and calculating machine operators, which usually do not require a college degree, earned on average only \$21,300. (US Dept. of Commerce, 2000)

In the attempt to create a society of gender equity in this field, the cause of the current inequity must be defined before steps can be made toward positive change in the direction of equal representation. The gender bias needs to be uncovered and the appropriate reforms need to be put into practice; however it is important to note that gender equity, in any context, is a very complex issue.

To determine the causes of gender inequity in computer science, the IP suggests an eight-year research proposal. The goal will be to follow students who display strong interests in computer science in 7th and 8th grade, and track them through their post-secondary educational experiences. This research will include two phases of development. The first phase is a quantitative approach to gathering data from three different urban areas in Wisconsin for testing. First, a collection of data that exists that identify the make up of members in different academic degree areas will be gathered from the educational institutions. The data will be analyzed to determine percentages of male and female representation in each field. Once that quantitative data is collected and analyzed, a second phase of the research process will continue, which will be the qualitative gathering of participants' perceptions and behaviors toward females in the computer science field through the use of surveys.

A test group must be determined for the purpose of tracking. The three test areas will be Green Bay, Madison, and Oshkosh, because of their demographic positioning around the state, and their availability of post-secondary education to their communities. The middle schools will be asked to allow surveying of its student population for the purpose of identifying a test group. This test group will consist of both girls and boys that show high interest in computer science, and a willingness to pursue a career in the computer science field. As the test group proceeds through each level of education, students will be polled yearly to track their any attitudinal changes that take place from one year to the next. Each year, not only will participants be polled for their continuing level of interest in pursuing a career in computer science, but once again, they will be polled on those attitudinal changes that might be occurring. It is predicted that

somewhere in the upper secondary-level, or lower post-secondary level, attitudes will begin to change, and representation will begin to replicate the inequity that is consistent with the data gathered for this study. That is where the highest concentration of interest from the IP will be directed at the test group. Why is this happening? Once this can be determined, a plan for creating change can be devised. The goal is to determine which behaviors and beliefs exist within our society are causing silent barriers preventing women from pursuing successful, high-paying positions in upper level computer science occupations.

Since it is assumed that computer science occupations are not limited by any obvious gender constraints, it can also be assumed that there are subtle reasons for girls to feel that the computer science industry is not a field for women. One must consider then, that subtle societal influences create barriers for certain groups to enter into a field in which one group is dominant. One consideration is that children are being taught that occupations in Science and Technology are male positions. It may be as simple as there being a lack of participants in the field for girls to feel welcomed to the group by matters of apparent modeling of gender participation. When girls look outwardly at how females are represented in the different occupational fields, a non-verbal clue to exclusion arises. If a field is male-dominated, the girls may feel that the field must then be a career choice for boys. The question then would be to figure out how the field became male-dominated in the first place, and offer possible solutions for filling a void with females who could create a generation of role models for following generations to benefit from.

The socialization process has a profound impact on the ways both boys and girls think about potential occupations. Throughout the formative years, children are bombarded with subliminal messages about what kind of work is thought to be most appropriate for men and what kind of work is thought to be appropriate for women. The family plays an influential role in shaping a child's thinking about potential occupations. One study found parents tended to talk to their children about careers that were consistent with their perceptions of what is gender appropriate. (Morgison, 1995) Consequently, children begin to eliminate potential occupations based on gender stereotypes between the ages of 6 and 8. By the time they reach adolescence, they have often limited their career options to occupations that they believe are appropriate for men and women (Basavage, 1996).

Research indicates that role models and mentors, especially family members, have a powerful influence on females who pursue careers in technology. Careful attention must be paid to how role models and mentors can be used to open up technological careers to young women. Girls and young women still see mostly men teaching classes related to mathematics, science, and technology. Although these male teachers work hard to be inclusive, there is still a perception that the absence of women means that women are not as welcome to pursue technology (Owen, 1998).

“Exposing children to successful women in technology can provide inspiration and role models for young women” (Dorman, 1998). These role models can provide the inspiration they need to entertain nontraditional classes and career paths. Seeing other women making a difference in technology suggests to girls and young women that advanced study in computer science isn't “just for boys.” Girls and young women need to be introduced to women who have successful careers in high-tech computer science fields. Girls and young women are being told that they can have a career and a family.

Some of the women featured in the popular press and in recruitment campaigns have dedicated their lives to their careers and have not made time for families. These leaders argue that these role models can be counter productive because they suggest to girls and young women that they have to make significant sacrifices to become accomplished technologists. Therefore, instead of relying on people that might be perceived as “super women,” these leaders recommend using women from the community who have careers in technology and lead ordinary lives. Hence, some of the more promising role models are the architects, engineers, computer programmers, and plant managers that live in one’s community and just happen to be women.

Mentoring has also become a popular concept among teachers who are interested in supporting girls and young women in the study of computer science. Just like a role model, an effective mentor does a lot of his or her teaching by example. More specifically, the mentor models what it means to be a master student and a life-long learner on a daily basis. A good mentor is aware of the career opportunities in computer science, understands the protégée’s strengths and weaknesses, and is able to help his or her protégée identify appropriate career goals and identify strategies for achieving those goals (Shea, 1994).

Another possibility for exclusion is simply the suggestions by their parents directed their children toward certain career choices, as children begin to vocally express those choices. Children begin to construct their identity at a very young age through their interactions with people and their environment. Parents also play a very important role in the development of their children’s gender identity. (Morgison, 1995) There is some evidence that suggests parents tend to encourage achievement, competition, and independence for their sons. In several studies, boys tended to receive positive feedback for engaging in exploratory activities. Conversely, mothers tended to restrict and supervise their daughters more than their sons. Girls were often given positive feedback when they asked for help or when they helped others. Both parents tended to react favorably to their children when they engaged in behaviors that were perceived to be gender appropriate. Inversely, parents tended to react negatively when their children behaved in ways that were perceived to be inappropriate for their gender. In short, boys are expected and encouraged to behave like boys and girls are expected and encouraged to behave like girls.

Girls are less likely to participate in mathematics, science, and technology classes even if they have a talent in these areas and are performing well in other ways. Teachers must consider how interactions between students can create a chilly classroom climate for girls and young women. Given the disproportionate amount of attention given to males over the years, it is easy for people to see computer science classes as a “boys’ club.” Young women report that they feel uncomfortable and perceive themselves as being on display in a male-dominated environment. (Silverman & Pritchard, 1993). The signals sent to young women through the physical environment, teacher-student interactions, and student-student interactions can create a chilly message to females (Sandler & Hoffman, 1992). Teachers must carefully manage their interactions with students, as well as interactions between students, to create a positive climate for all students.

It is important for young women to be able to identify with women from the mainstream of society who became leaders in technological endeavors. An ideal scenario for developing a new generation of female technologists would be to pair talented young

women with established professional women. Unfortunately, there is a shortage of potential female mentors due to the modest number of women who hold leadership positions in male dominated fields, including technology education. (Sandler, 1993). Girls and young women need to see women actively engaged in technological endeavors. Furthermore, they need to see women in leadership roles. Review course materials like textbooks, multimedia programs, and videotapes to ensure that they depict women in technical situations and in a positive light.

Upon completion of this study, it would be recommended that further research go into the possibility of changing societal behavior, and incorporating tools for increasing enrollment of women in high-tech IT positions. Proposals for funding of such things as summer computer camps for girls, targeting middle school to high school-aged students to become more involved in furthering their interest in computing while they are still within the group of equal representation. This may provide them with the tools to overcome the barriers that exist at higher levels of degree advancement in the field.

Local businesses and industries often have talented women in positions that require an understanding of technology. Invite these women to serve as guest speakers during appropriate units of instruction.

Girls and young women often feel more comfortable pursuing an interest in technology with other girls and without the watchful eyes of their male peers. Consider establishing a club for young women in technology. Summer computer camps for girls only might be a viable opportunity for girls to engage in computer science within a safe environment for inclusion.

Since social contacts play such an important role in the development of female identity, it not surprising that role models, mentors, and peers can influence the choices that girls and young women make about their lives and how they relate to the world around them. Providing appropriate role models, mentors, and peer networks for girls and young women is extremely important. Together, they can encourage and support participation in technology education and ultimately, the pursuit of technical careers. Adolescent girls form very strong social bonds with female peers. They tend to go from one class to the next in groups and prefer activities that provide them opportunities to work together.

The point of departure for this research project is to explore the reasons why girls, who apparently participate in computer activities proportionately to their male peers, choose to not explore the profession computer science beyond entry level. The field is an attractive choice in terms of average salary, yet the inequity increases at each level of educational achievement. With the discovery of what causes the girls to disengage from the opportunities the field presents, suggestions can be made to increase their level of participation. The study must be ongoing to calculate success of research and implementation on increasing female enrollment in Computer Science.

The near future promises to require even greater levels of technological literacy from its citizens to function in an increasingly technologically sophisticated society. The goal is to provide a working population that will contribute to the field of computer science with equal representation.

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Associate and Bachelor's Degrees Awarded by Sex 1990 - 1998				
Year	Bachelor's degrees		Associate's degrees	
	Men	Women	Men	Women
1990.....	19,321	8,374	3,942	3,898
1991.....	17,896	7,514	4,032	3,938
1992.....	17,748	7,210	4,723	4,909
1993.....	17,629	6,951	4,695	4,837
1994.....	17,533	7,020	4,947	4,921
1995.....	17,706	7,063	4,996	4,631
1996.....	17,773	6,772	4,862	4,539
1997.....	18,490	6,903	5,720	4,912
1998.....	20,235	7,439	7,137	5,762

Women, Minorities, and Persons With Disabilities in Science and Engineering: 2002
 associate level 45% women - bachelor level 27% women

**Computer/Information Science
 Bachelor's Degrees Awarded, by Sex**

Year	Degrees awarded		
	Total	Men	Women
1986	42,195	27,069	15,126
1987	39,927	26,038	13,889
1988	34,896	23,543	11,353
1989	30,963	21,418	9,545
1990	27,695	19,321	8,374
1991	25,410	17,896	7,514
1992	24,958	17,748	7,210
1993	24,580	17,629	6,951
1994	24,553	17,533	7,020
1995	24,769	17,706	7,063
1996	24,545	17,773	6,772
1997	25,393	18,490	6,903
1998	27,674	20,235	7,439
2000	37,388	26,914	10,474

NOTE: Data not available for 1999

SOURCE: Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey

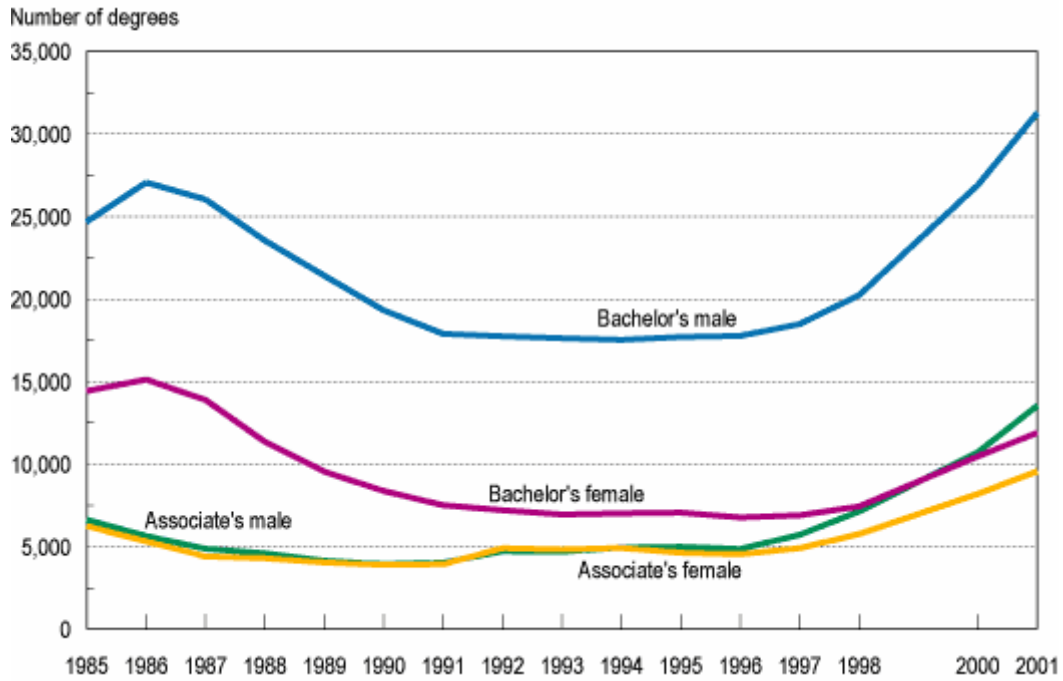
**Computer/Information Science
 Master's and Ph.D. Degrees Awarded, by Sex**

Year	Master's degrees	Ph.D. degrees	Women	Men	Women
	Men				
1986	5,658	2,412	351	48	
1987	5,985	2,496	385	65	
1988	6,702	2,464	459	56	
1989	6,773	2,626	504	108	
1990	6,968	2,675	595	110	
1991	6,563	2,761	679	117	
1992	6,980	2,675	747	120	
1993	7,554	2,795	737	138	
1994	7,817	2,729	762	137	
1995	7,777	2,786	808	186	
1996	7,763	2,850	776	139	
1997	7,510	2,979	744	150	
1998	8,338	3,414	763	159	
1999			690	156	
2000	9,661	4,868	717	142	

NOTE: Master's degree data not available for 1999

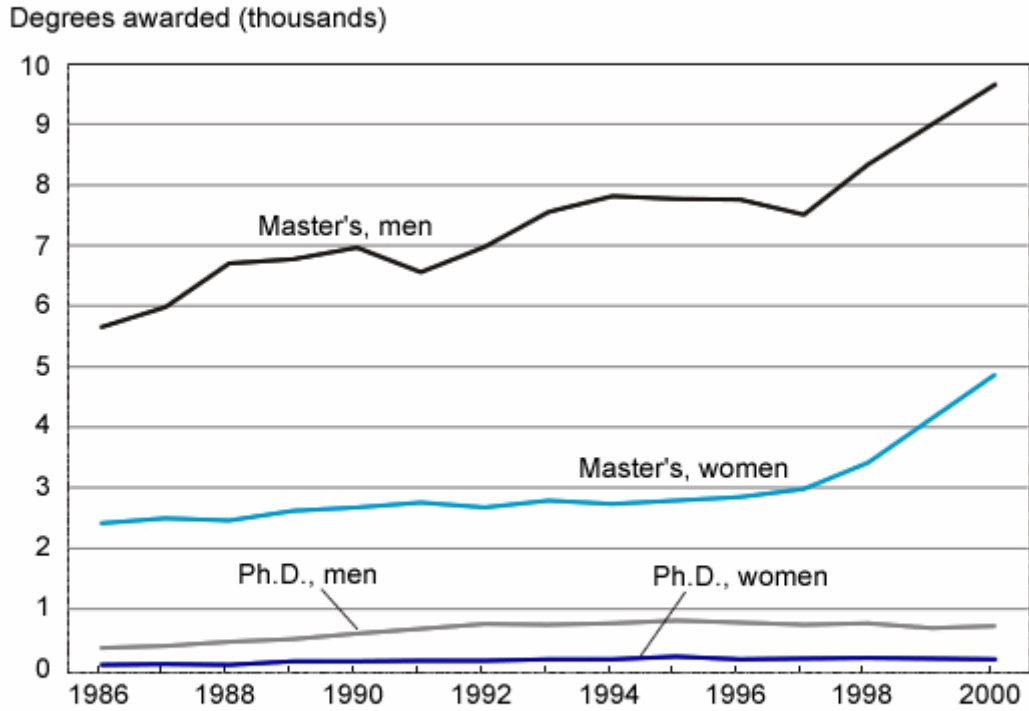
SOURCES: Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; National Science Foundation/Division of Science Resources Statistics, Survey of Earned Doctorates.

Computer/Information Science Bachelor's and Associate Degrees Awarded, by Sex 1985-2001



Source: Department of Education/National Center for Education Statistics: Intergrated Postsecondary Education Data System Completions Survey; National Science Foundation/Division of Science Resources Statistics, Survey of Earned Doctorates.

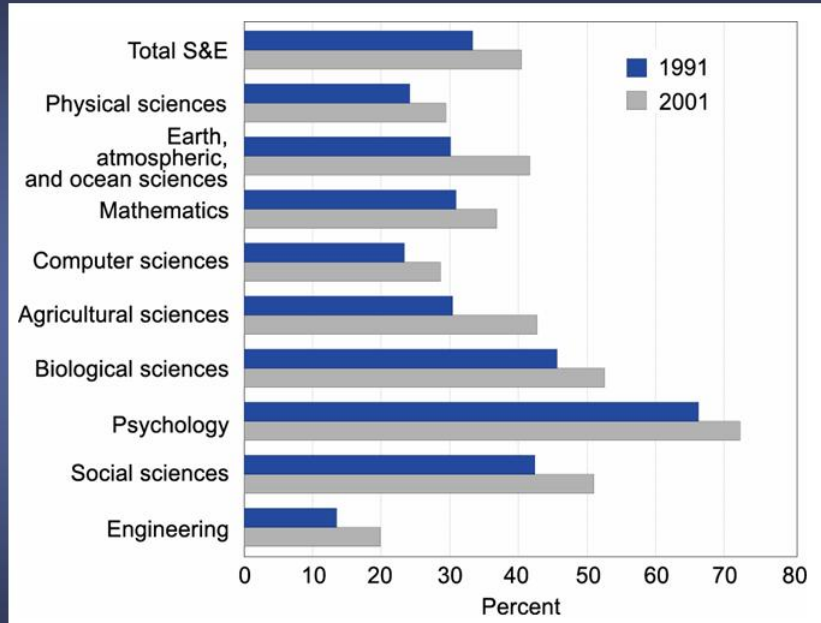
Computer/information science master's and Ph.D. degrees awarded, by sex



Note: Master's degree data not available for 1999.

Source: Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; National Science Foundation/Division of Science Resources Statistics, Survey of Earned Doctorates.

Female share of S&E graduate students, by field: 1991 and 2001



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, 1991 and 2001.