



Early determinants of women in the IT workforce: a model of girls' career choices

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Abstract

Purpose – To develop a testable model for girls' career choices in technology fields based on past research and hypotheses about the future of the information technology (IT) workforce.

Design/methodology/approach – Review and assimilation of literature from education, psychology, sociology, computer science, IT, and business in a model that identifies factors that can potentially influence a girl's choice towards or against IT careers. The factors are categorized into social factors (family, peers, and media), structural factors (computer use, teacher/counselor influence, same sex versus coeducational schools), and individual differences. The impact of culture on these various factors is also explored.

Findings – The model indicates that parents, particularly fathers, are the key influencers of girls' choice of IT careers. Teachers and counselors provide little or no career direction. Hypotheses propose that early access to computers may reduce intimidation with technology and that same-sex education may serve to reduce career bias against IT.

Research limitations/implications – While the model is multidisciplinary, much of research from which it draws is five to eight years old. Patterns of career choices, availability of technology, increased independence of women and girls, offshore/nearshore outsourcings of IT jobs are just some of the factors that may be insufficiently addressed in this study.

Practical implications – A "Recommendations" section provides some practical steps to increase the involvement of girls in IT-related careers and activities at an early age. The article identifies cultural research as a limitation and ways to address this.

Originality/value – The paper is an assimilation of literature from diverse fields and provides a testable model for research on gender and IT.

Keywords Culture, Parents, Communication technologies, Gender, Careers

Paper type Research paper

Introduction

The decline of the dot.com era and increased global outsourcing of IT jobs has retracted the promise of attractive employment in IT and may have filtered out inflated demand. Universities have experienced lower enrollment, particularly of women, in IT-related majors, contrary to the impact of women's movement, wherein more women are entering male-dominated fields. While women represent 46.6 percent of the US workforce, only about 35 percent of the US IT workforce is female (Information Technology Association of America, 2003). Between 1996 and 2002, the number of women in the US IT workforce declined from 41 percent to 34.9 percent (Information Technology Association of America, 2003). More disturbingly, women hold only 10



percent of the top IT positions in the United States and fewer women are rising up the IT leadership ladder than in the past (Gibson, 1997; D'Agostino, 2003). Such trends pervade globally despite statistics indicating that one half of internet users are women and that computer use by women has experienced a steady increase over the past decade (Friedman, 2000; Trauth *et al.*, 2003).

IT, as a field, manifests itself diversely in the form of computer information systems (CIS), management information systems (MIS), and computer science (CS) degrees. Although a popular notion often emerging from CS and CIS is that IT is highly technical, behavioral issues and creativity in problem solving and design are critical success factors for IT professionals. The more diverse the IT workplace and the larger the pool of talent from which to draw, the more likely IT solutions will address a broad range of issues and the needs of a diverse end-user community (Florida and Gates, 2002). The IT profession is missing valuable human resources and women are bypassing rewarding career options. What circumstances lead women to an IT career and, just as importantly, what draws women away from it? While most published studies relate to college women and women in the IT workforce, career-oriented decisions are made much earlier, possibly at ages 11-17 (Barltrop, 1988; Marso and Pigge, 1994). By this age, although girls are not fully exposed to the long-term implications of their career choices, many have already decided against math, science, and technology (MST) (American Association of University Women, 1990, 1992, 1998a, 2000). Their course selections reflect their career orientation and can often block out MST careers.

Factors that influence decisions in early teens versus college and after are different. We examine early determinants of career choice for middle and high school students, particularly girls, focusing on factors that impact the critical years when adolescents can be encouraged to follow IT-related careers. We propose a model that assimilates literature from diverse fields such as math, science, engineering, education, and sociology and suggests that social, structural, and personal variables impact IT career choice (Ahuja, 2002; Beise *et al.*, 2003; Trauth, 2002). Further, the paper examines whether these influences vary across ethnic cultures. We discuss how new technological and social trends may invalidate findings from past literature and suggest revised propositions in light of these new trends. We conclude with a broad research agenda addressing multiple levels of analysis and methodologies. The questions addressed are:

- What is the impact of social influences such as gender stereotypes, role models, peers, family, and media/culture on children's choices of IT as a career?
- What is the impact of structural variables such as teachers/counselors, school and personal technology resources, and same-sex education on children's choices of IT as a career?
- How do social and structural factors manifest across different ethnic cultures?
- How do individual differences impact children's choices of IT as a career?
- How have social, structural, and individual differences influenced children's IT career choices from the late 1990s, particularly in light of the challenges facing the US IT industry?

Understanding early influences of career choice

Much has been written in fields as diverse as sociology, education, psychology, math, and science about the genderization of careers. Few of these studies specifically relate to IT careers. Recently, studies have revealed a gender imbalance in IT (Ahuja, 2002; Beise *et al.*, 2003; Camp, 1997; Trauth *et al.*, 2003; von Hellens *et al.*, 2000). Career genderization occurs early in an adolescent's life, possibly in middle school or the early years of high school. What influences girls' choices for or against IT? Drawing upon Ahuja's (2002) classification of social and structural influences on women's IT careers, the model of Beise *et al.* (2003) of women's career decisions, and individual factors suggested by Trauth (2002), this paper extends literature to children and adolescents with a focus on girls and sets a broad research agenda for IT-related career choices.

Ahuja (2002) provides an initial framework for classifying some early determinants of careers. That study examined factors that influenced women's entry and performance in IT careers and classified these factors into social and structural barriers. We posit that there are social and structural influences that can impact career choices positively or negatively, and we modify Ahuja's model for children. Social influences are biases that impact internal and external gender perceptions. Gender stereotyping, role models, peers, media, and parents are examples of social influences. Structural influences are manifested in the institutional support available such as teachers and counselors, access to technology, and same-sex versus coeducational schools. While both social and structural factors can influence decisions about career choice, early perceptions of children are most influenced by social factors such as parents, peers, and role models. Young adolescents are not exposed to structural factors to the same extent as women and men in professional settings.

When applied to skills, interests, and career options, stereotyping about gender roles can limit opportunities for both sexes and deprive the workforce of talent. While gender defines the essence of being male or female, gender roles carry expectations about how females and males should behave, feel, and think. Gender stereotyping can be inherent in the way a girl perceives her role in society based on subtle societal cues she has grown up with, but can also be influenced by social and structural entities such as parents, teachers, peers, and counselors. Although we classify gender stereotypes as a social variable, it has its roots in both social and structural factors. The same may be true of teachers who are assigned by schools and so are considered structural. On the other hand, a child's interaction with teachers can be social and teachers themselves undergo similar social construction, as do the children they teach. In such instances, social activity occurs within a structural setting. The model also considers individual differences and cultural impact. Inherent personality traits and manifestation of different external influences make children unique. Their individual differences draw their interests to activities and content areas such as problem solving, ability and willingness to interact with people. Finally, ethnic culture can strongly influence social and structural variables or at least emphasize differences for samples across several cultures.

The outcome variable of interest is career choice. Although two well-established theories, the Theory of Reasoned Action (Ajzen and Fishbein, 1980) and the Theory of Planned Behavior (Ajzen, 1985), make a convincing case for attitudes towards technology as an outcome variable, many intervening factors prevent a direct translation between attitudes towards technology and career choice. While many

adolescents today have positive attitudes towards technology and find the computer and its applications “cool”, this positive attitude does not manifest itself in career choice, as evidenced by declining enrolment at college-level IT programs. Furthermore, an adolescent’s career choice will often be influenced by social, structural, and economic pressures that may have little to do with attitude towards technology. These various elements of the model and their interactions with each other are presented in Figure 1 and are discussed at length in the next few sections.

Social factors influencing career choice

Role models

Career choices are often influenced by role models (National Academy of Sciences, 1997). Women in the workforce, however, have a more difficult time finding role models and mentors to motivate their careers (Scandura and Ragins, 1993; Trauth *et al.*, 2003). Teen role models are often societal figures that promote certain lifestyle, social image, and behaviors that have little impact in motivating career choices other than in music, sports, or movies. Not surprisingly, career choice role models are familial or educational (Dryler, 1998). Prior literature has not recognized this distinctive influence of role models from media versus from family and so separating the two was challenging (Clutterbuck and Ragins, 2002). The proposed model focuses on role models that directly influence academic and career choices.

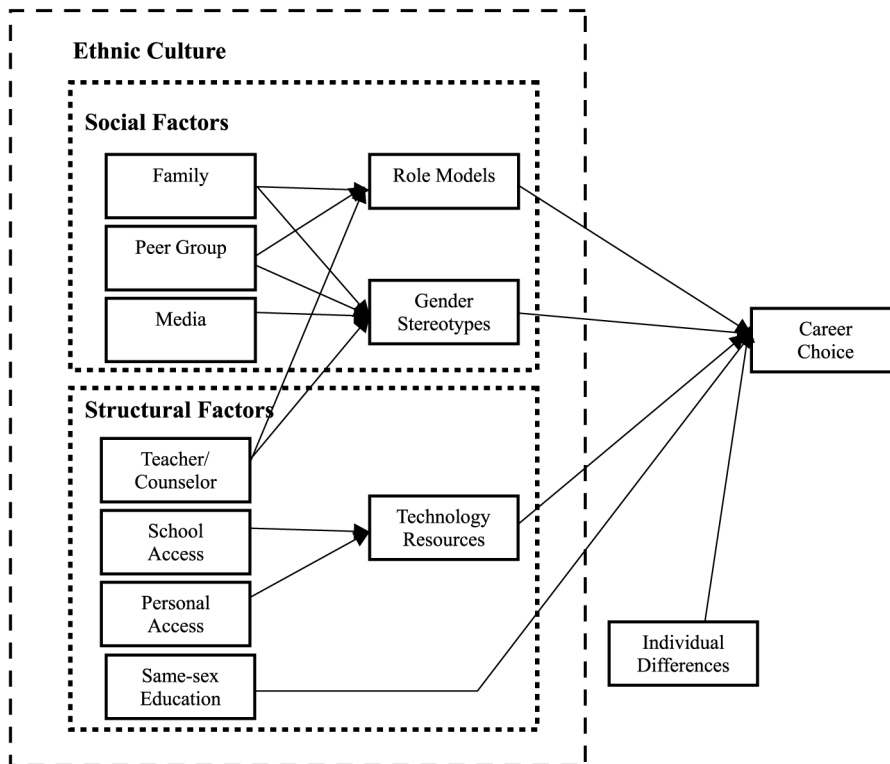


Figure 1.
Factors influencing girls' career choices

Family

Family is one of the most influential contexts of socialization in childhood and adolescence (Dryler, 1998). While the impact of parental guidance is felt unequivocally in choice of traditional and non-traditional careers, it is most strongly observed in choice of non-traditional careers. Direct forms of parental influence, such as the degree to which students see their parents choosing IT careers or having contact with technology, are strong motivators to train for technical jobs (Breakwell *et al.*, 1988; Dryler, 1998). Family members can also motivate career choices indirectly equally persuasively. For instance, a parent may not be an IT professional but may encourage girls to pursue or actively compete in careers perceived to be “masculine”. These parents may still be acting as role models of perseverance and achievement without being IT professionals.

Jackson *et al.* (1993) suggest that women who enter male-dominated fields such as science often come from families where mothers are working, both parents are highly educated, and success is considered critical. Mothers with four-year degrees are more likely to influence career choices than mothers without such qualifications (Smith, 2000). Although college-educated mothers influence both traditional and non-traditional career choices, women choosing non-traditional careers indicate that their fathers have a stronger, more direct bearing on careers choices in nontraditional environments such as MST (Gates, 2002; Trauth, 2002; Dryler, 1998; Leslie *et al.*, 1998; Scandura and Ragins, 1993). One of the subjects interviewed in Trauth (2002, p. 106) reflects on the role of her father:

If I didn't have my father who sat down, and you know, helped me choose the subjects, then I might have chosen the wrong subjects. I might have chosen the ones that I could get good grades in or that wouldn't have led to anything.

Turner *et al.* (2002) found that 73 percent of working women indicated their fathers as strongly influencing their career choice. However, children who are close to their parent of the same sex will often reflect career choices of that parent. Parents must recognize the child's persona in order to provide correct vocational guidance and have a positive impact on career choice. Unlike other factors discussed later, the literature is unequivocal regarding the positive influence of parents, particularly fathers, on career choices.

Siblings can have some influence on career choices. In particular for girls, older brothers can influence the entry of girls into traditionally “masculine” careers (Banks *et al.*, 1995). On the other hand, girls who have only sisters tend to choose careers that are more traditionally “feminine”. Similar sibling influence is found for boys with male siblings.

Peer group

In the absence of mentors, peers may possibly influence careers (Kram and Isabella, 1985). However, in teenage years peers have more impact on social responsiveness, behaviors, fashion styles, and attitudes but little on career choices. During these adolescent and post-adolescent stages, peer influence, particularly of boys on girls, is often observed to impact female self-concept, self-efficacy, classroom experiences, and external goal orientation. Such changes are seen to cause a clear demarcation between boys' and girls' career choices despite the fact that girls still continue to score well on national level testing (Leslie *et al.*, 1998). Findings that discuss teen peer influence on

career choices are, at best, meager. Consequently, we extrapolate from findings at college and post-graduate level, where there is some mixed evidence of peer influence on career choices or computer use. Such peer influences were shown to have both positive and detrimental effects on career choices. Smith (2000) finds that male peers often play an important part in choice of MST as a career choice for some women. Brekke (1997), on the other hand, attributes lack of participation in college-level physics to partly result from peer pressure that steers students away from MST careers.

Media

Printed and electronic media influences and enhances gender stereotypes that focus largely on physical image rather than on motivating career choices. Although such images are often interpreted by girls as being unrealistic, they want to conform to these images in response to social and peer pressures (Milkie, 1999). Pictures in computer magazines and the representation of women in textbooks and software are few and usually presented stereotypically, serving to alienate women further from technology (Na, 2001; Culley, 1988). These representations are passive and do not depict women in positions of power or as active computer users (Brownell, 1992). For instance, analysis of television advertising reported 70 percent of males as central, authoritative roles and having more credibility regarding product knowledge (McArthur and Resco, 1975; Furnham and Voli, 1989). Women, on the other hand, are most often shown against the backdrop of children (Harris and Stobart, 1986; Na, 2001). Awareness of these media-generated biases has put pressure on the press to reduce the gender bias of commercials, but a comprehensive review covering Asia, Australia, Europe, North America, and South America indicates a persistent global problem with gender stereotypes projected on the powerful media of television commercials (Furnham and Mak, 1999; Signorielli *et al.*, 1994). While trade journals and media popular among young and adult women have begun representing women in more professionally active roles, young teens do not focus there. *Seventeen* and *Cosmo Girl*, the two most popular teen magazines, have often been criticized for having content that does little by way of reducing gender stereotypes and more importantly, portraying women in professional, technological careers. Content analysis of these fashion and beauty magazines reveals a strong disinterest in career related issues. For instance, 30 percent of magazine space in *Cosmopolitan* is used for fashion and beauty, 23 percent for sex and relationships, and 34 percent for promotions with little left for discussing career alternatives (Nelson and Paek, 2003). This phenomenon is observed in global editions of *Cosmopolitan* in countries such as UK, India, China, Thailand, and Brazil. We expect similar gender stereotyping effects to exist in television media.

Gender stereotypes

Girls' perceptions of IT jobs may mirror stereotypes that do not represent the dynamic and rewarding nature of the field (von Hellens *et al.*, 2000). The Rhode Island Economic Policy Council (2000) reported that teenagers considered IT "uncool, nerdy, or boring". Such perceptions threaten self-concept and career choices (Steele, 1997). For instance, math has been stereotyped as a masculine field and often is a critical filter that keeps women out of MST careers (Beise *et al.*, 2003; Beyer *et al.*, 2002; Eccles *et al.*, 1990; Sherman, 1982). During math testing women experience a "unique psychological state"

caused by stereotype threat and motivation to avoid confirming the stereotype leading to increased anxiety that can interfere with performance (Spencer *et al.*, 1999). This is especially curious in countries such as Ireland where girls consistently score significantly higher than boys in the national junior certificate exams (ages 15-16) but the gap in math and science careers is inversely significant (Trauth, 2002).

Beliefs about the role-appropriate behavior of others, especially women, often restrict choice of careers in college despite there being no differences between men and women in career decision making styles (Harren *et al.*, 1978). Up to age ten, girls have similar subject interests as boys and are perceived to be better at all or most subjects than boys. Francis (2000) finds in her evaluation of elementary school students in England that neither boys nor girls chose IT as their most favorite subject. As career choices form, students begin taking courses that reflect their choice of college education, narrowing their career options (Miller and Budd, 1999). Examining Scholastic Aptitude Test scores, Sadker and Sadker (1995) found that most girls decided to pursue social science careers rather than natural science. These decisions were lifetime decisions since the girls selected courses that eliminated the opportunity to pursue MST careers.

What causes these gender-biased perceptions of technology careers? While parents, teachers, and peers positively influence career choices, these role models also reinforce gender stereotypical career perceptions. Often role models carry hidden messages about boys' and girls' capacity to work with computers (Volman and van Eck, 2001). Children whose parents have higher levels of education tend to resist gender stereotyping while those whose parents have high school or lower levels of education tend to conform to gender stereotypes (Bouchard and St-Amant, 2000). In the latter cases, children too, tend to conform to gender stereotypes. Where parental perceptions and girls' self-perceptions about their ability and success in mathematics tends to be stereotypical, performance can be negatively affected (Jacobs, 1991).

Teachers influence gender stereotyping of roles and choices through their interaction with students. Studies find that teachers often give students the impression that boys are inherently better at working with computers than girls (Sanders and Stone, 1986). Culley (1988) found that teachers in primary schools often considered boys to be more interested in computers and these teachers tended to enjoy teaching computer-related subjects to boys more than girls. Teachers in such situations often attribute certain expertise to boys and let them have priority over girls in computer use (Volman and van Eck, 2001). This often holds true for both male and female teachers. Possibly the enthusiasm of boys, their spontaneous questions and responses, and their overwhelming presence in computer labs discourages girls (Lipinsky *et al.*, 1986; Lockheed, 1986).

Structural factors influencing career choice

Structural factors represent the institutional support available to women in pursuit of their careers. The role of teachers and counselors in exposing students to technology, access to computer technology both at home as well as in schools, and the nature of the school environment – same-sex or co-educational – are structural factors that can influence the genderization or neutralization of IT careers.

Teacher/counselor

Research findings lean towards the negative regarding the role of teachers and counselors on MST career choices. Dick and Rallis (1991) examined 2,000 high school students, finding that teachers had a strong influence on girls' choices of career in mathematics. Other empirical evidence has not been as encouraging. Teacher/counselor advising tends to reflect a gender bias when directing girls towards traditional careers and boys to non-traditional careers (Gates, 2002). Women in IT are most discouraged by teachers, guidance counselors, and male professors (Turner *et al.*, 2002), although women who moved from non-IT to IT careers often indicated male professors to be a strong influence in that move (Canes and Rosen, 1995). Since most computer science and IT faculties are predominantly male, some students may have had few female professors in these courses.

At issue is also the fact that most full-time counselors devote a small percentage of their time on occupational and job counseling. The National Center for Education Statistics (NCES) found that career and occupational counseling ranked fifth out of eight functions typically performed by high school counselors (National Center for Education Statistics, 2003). Considering that only about 29 percent of girls receive support from career counselors, this directly impacts the amount of counseling provided to girls. Moreover, middle and high school teachers and counselors tend to feel comfortable advising in more traditional fields, possibly because they do not have sufficient IT backgrounds to be aware of its career paths (Freeman and Aspray, 1999). College level professors may have a broader perspective of IT career opportunities to better direct students. Students attaining a higher level of maturity by college are able to make choices based on a broader perspective of social and structural influences on their careers.

Technology access at school

Women IT professionals cite school access to computers as the most prominent reason for their interest in an IT career (Turner *et al.*, 2002). However, many children, particularly in low-income neighborhoods, may not have had this opportunity. While computer access in schools has increased significantly, reports on actual use of computers in school and gender differences in such use, have been mixed. Some studies report that gender differences in the use of computers at school are non-existent or declining (Doornekamp, 1993; Durndell and Thomson, 1997). Others report that boys use computers more frequently at school for a wider range of activities than girls (Comber *et al.*, 1997; DuBois and Schubert, 1986; Huber and Schofield, 1998). Irrespective of these mixed message, the effects of differential computer access has long-term effects.

Technology access at home

The ownership and use of home computers has been divided along gender lines as well as economic lines. At home, boys use computers more frequently than girls and are more likely to own computers or be prominent users of shared computers (Colley *et al.*, 1994; Doornekamp, 1993; Durndell *et al.*, 1995; Harris, 1999). They tend to use computers more often than girls in one another's homes as a social activity (Durndell and Thomson, 1997). Even when young girls and boys play together using computers, girls can be less engrossed in the activity and may let boys continue playing by

themselves. Boys demand more power and functionality from the technology used at home, often asking for better internet connectivity or more capable computer technology (Habib and Cornford, 2002). This effect snowballs to IT use in college, where students with home computers have a significantly more positive attitude towards IT in college (Selwyn, 1998).

User beliefs of perceived usefulness and attitudes about computers have been established as key determinants of IT usage intention and behaviors (Davis, 1989; Venkatesh and Brown, 2001; Venkatesh and Davis, 2000). While having access to computers is one step in familiarizing children with computers, the manner in which they use computers may influence beliefs and attitudes about technological careers. Although the gender gap in access to technology is non-existent, use of computers and the internet is still divided along gender lines. For instance, boys use the internet for a wider range of activities such as games, shopping, and finding information about news, weather, and sports while girls tend to restrict internet use largely for e-mail and access to educational resources (National Center for Education Statistics, 2002). Girls prefer low-threat, high challenging activities as part of their education. However, any form of computer playfulness relates positively with computer competence, computer attitudes, and computer self-efficacy and is shown to reduce computer anxiety (Webster and Martocchio, 1992). Women exposed to more play and collaboration-based assignments in training are more likely to choose MST as careers (Smith, 2000).

Girls' use of computers and the internet for play has been limited by the shortage of relevant software games, and internet sites. Previously most games were geared for boys. Not until 1996 did Mattel offer "Barbie Fashion Designer" for girls to design clothing. The software game industry has responded only after noting young girls as a large lucrative target market. If the only contact girls have had with computers is in school, many do not realize the fun and enjoyment of using a computer. While online use appears to be similar for both boys and girls before age 12, girls' computers use drops as they get older. Media companies have only recently begun determining that girls have different preferences to boys, for example, creating versus killing, and collaboration versus competition (Gorriz and Medina, 2000). The assumption of the cyberspace as gender-free ignores that computers are used in a context. The hope of egalitarian use depends on the society in which girls and boys use computers.

Same-sex versus co-educational schools

Sex-segregated environments inadvertently reinforce gender stereotypes, squander opportunities to address issues of gender inequity, and expose students to teasing from peers in co-educational classes (Vezeau *et al.*, 2000; Viadero, 2001). School environment has no impact on senior students from public school with regard to math (Vezeau *et al.*, 2000). Students attending same-sex high schools have minimal pressures from the opposite sex and have a better sense of belonging (American Association of University Women, 1990, 1998b; Brutsaert and Van Houtte, 2002; Watson *et al.*, 2002). If high school experiences reinforce notions that boys adapt more to technical areas, same-sex students are devoid of comparisons in the classroom (Jackson, 2002; Jones and Clarke, 1995). One might expect that student of same-sex schools would not as likely embrace gender-specific career choices. Another assumption is that parents of all-girl schools expect their daughters to excel in MST, and therefore, they have enrolled them in schools where gender discrimination exists minimally. Danziger, 1998 finds that

intellectual development at same-sex schools is impressive and girls are well prepared for college education.

To understand and filter mixed messages regarding same-sex versus co-educational environments, researchers should examine the impact of these variables and outcomes on perceptions and career-choices in the two school environments. While structural factors may exert the same influence in same-sex and co-educational schools, peer influence could have a differential impact on career choices at these two types of school.

Individual differences

A complex but fascinating emerging theory suggests that individual differences play an important role in forming career choices (Trauth *et al.*, 2004). This theory challenges the essentialist (Venkatesh and Morris, 2000) and social construction (Adam, 2002; Adam *et al.*, 2001) perspectives of gender and IT and explains individual responses of women, and their experience as girls, to the socio-cultural environment. Many individual differences are split along gender lines (Trusty *et al.*, 2000). Personality traits, enjoyment of computers, and overall outlook are some characteristics that account for these differences. Evidence exists regarding how personality traits, classified as feminine or masculine, lead to occupational choice (Holland, 1997; Lyons, 1984; Oakes, 1990; Stevens and Macintosh, 2003). Women in IT reported several personality characteristics that made them the “odd girl out” – powerful, forthright, strong, ambitious, driven, mathematical, logical, and less social than other girls (Trauth, 2002, p. 110). Although female students enjoy using computers less than male students and perceive more problems with software, IT career women report higher levels of enjoyment with computers (Turner *et al.*, 2002; Reinen and Plomp, 1997). Students with non-traditional majors have a more positive outlook on leadership and achievement and are more positively predisposed to computers than those on traditional career paths (Moore, 1983). While external experiences and societal expectations shape these characteristics, they impact occupational choices at young ages. Recognizing that impact of individual differences and personality characteristics on career choice is a complex construct and has only recently begun to gain attention, we introduce individual differences as a variable in our model and expect that future work will provide more insights on its role on career choices.

Ethnic culture

The under representation of women in the IT workforce is a phenomenon that is observed worldwide, but the problem is larger in developed nations such as the USA, Australia, New Zealand, and Ireland (Trauth, 2000, 2002; Trauth *et al.*, 2003, von Hellens and Nielsen, 2001; von Hellens *et al.*, 2000). Trauth (2002) and von Hellens *et al.* (2001), however, find that women from India and China have more positive attitudes towards MST careers. While both India and China are similar in terms of economic environment, low representation of girls and women in education and population demands on resources, both represent a broad population that does well in careers related to MST. For instance, for 2001-2002 India's National Association of Software and Service Companies (2004) found that while currently the percentage of women in the Indian IT workforce is only 21 percent, it is projected to increase to 35 percent by the end of 2005. The figures are even more impressive in IT-enabled services, where the

percentage of women in the workforce is 65 percent. These statistics are interesting in a country where *per capita* income is only about \$90, adoption of computers in homes and schools is slow, and only about 25 percent of the population in India is projected to have access to the internet in 2004. Yet, India's workforce, in general, is considered skilled enough to be one of the leading providers of IT outsourcing. Although market demands are clearly shaping such workforce trends, possibly, ethnic culture provides a more positive MST career-orientation to women in these countries (Trauth, 2002).

Women and girls are grossly underrepresented in schools and colleges in developing and low-income countries such as China and India, and consequently often lag behind boys in access to education (Alderman *et al.*, 1996). World Bank figures from 1990 indicate that 78 girls of every 100 boys receive education in these countries and a much smaller percentage of these women ever reach college. For those that do, gender roadblocks may still exist. Not all girls take to full-time employment upon graduation. The ones that do face a myriad of social and ethnic factors that encourage or dissuade them from pursuing successful careers in non-traditional fields. We do not anticipate that these factors are any different from those faced by girls in the US. Nor do we anticipate that a different set of social and structural variables or individual differences apply to girls in India or China. What then makes the relative impact of these factors be differentially felt on girls in India and China compared to girls in the USA, Australia, or Ireland? Focusing on India, we speculate on how some constructs in our model may be impacted by the socio-economic culture of that country. In doing so, we assume a social location of urban, educated, middle class and upper middle class families, an assumption that is not unfounded since most of the growth in the Indian information society has occurred in corporate and upper middle classes. As Pal (2003) suggests, India gains its power from its vast middle class and it is the under-employed urban engineers who have good English language skills that have gained the most from the boom in India's IT sector.

While there is extensive gender stereotyping of social roles in India, stereotyping of careers is atypical from Western cultures. As a human resource consultant based in India suggests, "in the US, there is more resistance towards women and minorities and the pay discrimination is more obvious. In India, such things hardly exist" (Baishya, 2004). Careers are classified not as masculine or feminine but rather prestigious or not, and MST careers are considered "respectable". From early school years, children, in general, are encouraged, if not expected, to excel in MST. Parental and family expectations play a significant role in choice of careers and they expect girls and boys equally to take on careers that relate to either the medical profession or engineering. Such behavior has been observed in many parents irrespective of parental educational qualifications or choice of occupation. A child's successful entry into one of these careers becomes a matter of prestige since most medical and engineering schools are extremely selective in admissions and often, students must try multiple times to obtain admission. This non-genderization of education follows through into schools. Teachers have conformed to their teaching role and consequently, most career advising comes from parents. Indian education system sets up career path choices at the end of high school. Once the path is chosen, changes are difficult to implement. There is also an expectation that all education must be completed at a certain age and it is unusual to see a college student beyond the age of 23 to 24 years. With these constraints, poor performance in math or science makes careers in medicine or engineering inaccessible.

Teachers and parents often will consider such low-grade performance as an individual limitation that can be overcome with hard work and discipline.

Individual differences may well be similar across ethnic cultures. Every culture will have a representation of women who are determined, self-confident, and capable of taking on non-traditional careers. In an environment where girls are constantly encouraged to take technical and challenging careers, girls can be raised with the belief that they can take on any careers. There is little intimidation about taking MST subjects. Attitudes towards computers are not different between boys and girls due to the relatively late onset of computer technology in India. Computer technology has only begun to be pervasive in Indian homes and schools since 1996-7 onwards. This delayed growth has been in parallel with the growth in access to and use of the internet. People often purchase computers for homes in order to get access to the internet. In the USA, internet applications, particularly e-mail and instant messaging, have increased girls' involvement with computers and have served to reduce the gender digital divide of the late 1990s. Such a digital divide has only existed minimally in India due to the parallel growth in computer and internet use, and has minimized gender differences in computer attitudes.

Two rapidly changing aspects of the Indian culture are peer influence and the role of media. Indian media do not differ from Western media with respect to portraying women in traditional passive roles of mother, daughter, grandmother, and wife. Where women are portrayed in active roles, these are not in the role of a working woman, much less someone who works directly with technology, but rather as someone who assists others such as her children. A new trend that has emerged since the early 1990s has been the significant emphasis on the physical image of girls, further distorting the stereotyped image of women. As the country's socio-economic status and quality of life improves, girls and women have the resources to conform to the image messages from media. The nature of peer influence may also change as a result of these media influences, possibly putting into play gender stereotyping of girls at a younger age. Much of our discussion above has been contextual and broad. With little literature to support our claims, we identify cultural differences as something that needs significant research momentum.

Discussion of the model

The discussion above identified several factors that potentially influence early career choices. Table I summarizes relevant literature. The model suggests that perceived career choice is directly influenced by role models, gender stereotypes, availability of technological resources, gender-separated education, and individual differences and that career role models primarily emerge from family – mothers, fathers, and siblings – and, to a lesser degree, from among peers, teachers, and counselors. These same influencers, however, may reinforce gender stereotypes that discourage girls from pursuing MST careers. Such gender stereotypes may pervade printed and electronic media. Teachers and counselors may positively impact career choices if they are active technology users and understand IT careers. Same-sex schools may either allay gender stereotypes or further deepen them. Access to technological resources can come from home and school and impact attitudes about computer usefulness and feelings of intimidation. While other sources for access such as libraries exist, most access comes from homes or schools.

Table I.
Summary of research
related to girls' career
choices

Variable	Issue	Reference
<i>Social variables</i>		
Role models	Comprehensive review Science mentors Men more mentors Men mentor women Parent education Technology contact Parents' career choice Mother working Mother education Father as influence	Clutterbuck and Riggins (2002) National Academy of Sciences (1997) Scandura and Riggins (1993) Trauth <i>et al.</i> (2003) Bouchard and St-Amant (2000); Jackson <i>et al.</i> (1993) Breakwell <i>et al.</i> (1988) Dryler (1998) Jackson <i>et al.</i> (1993) Smith (2000) Gates (2002); Leslie <i>et al.</i> (1998); Trauth (2002); Turner <i>et al.</i> (2002)
Family	Mentor alternative Peers dissuade physics Males encourage math Physical image	Kram and Isabella (1985) Smith (2000) Brekke (1997) Milkie (1999); Nelson and Paek (2003); Signorietti <i>et al.</i> (1994)
Peers	Women as passive – computer ads Women as passive – TV commercials	Brownell (1992); Culley (1988); Na (2001) Furnham and Mak (1999); Furnham and Vohs (1989); Harris and Stobart (1986); McArthur and Resco (1975); Na (2001) Rhode Island Economic Policy Council (2000); Steele (1997); von Hellens <i>et al.</i> (2000)
Media/culture	IT negative/nerdy	Beyer <i>et al.</i> (2002); Beise <i>et al.</i> (2003); Sherman (1982) Harren <i>et al.</i> (1978)
Gender stereotypes	Math as filter Decision styles – no difference Women choose social science Threats/anxiety No difference on IT as favorite subject Parent education Math ability Math as male Teachers' perceptions Male response to women in class	Sadker and Sadker (1995) Spencer <i>et al.</i> (1999) Francis (2000) Bouchard and St-Amant (2000) Jacobs (1991); Volman and van Eck (2001) Eccles <i>et al.</i> (1990) Culley (1988); Sanders and Stone (1986) Kane and Frazee (1978)

(continued)

Variable	Issue	Reference
<i>Structural variables</i> Teacher/counselor	Boys' enthusiasm	Lipinsky <i>et al.</i> (1986); Lockheed (1986); Volman and van Eck (2001)
	Math as career choice	Dick and Rallis (1991)
	Girls receive less counseling	National Center for Education Statistics (2003)
	Low knowledge about IT	Freeman and Aspray (1999)
	Traditional careers	Gates (2002)
	Discouraged IT	Kane and Frazee (1978); Turner <i>et al.</i> (2002)
	Male professor negative	Turner <i>et al.</i> (2002)
	Male professor positive	Canes and Rosen (1995)
	Reason for IT career	Turner <i>et al.</i> (2002)
	No difference in use	Doornekamp (1993); Durdell and Thomson (1997)
	Boys use computers more	Comber <i>et al.</i> (1997); DuBois and Schubert (1986); Huber and Schofield (1998)
	Workshop attendance positive	National Center for Education Statistics (2002)
	Boys use computers more	Colley <i>et al.</i> (1994); Doornekamp (1993); Durdell <i>et al.</i> (1995); Harris (1999)
	Boys own computers more	Harris (1999)
	Boys in friends' homes	Durdell and Thomson (1997)
No difference in home use	Habib and Corniford (2002)	
Affects college use	Selwyn (1998)	
Boys wider range of activities	National Center for Education Statistics (2002)	
Girls' e-mail and educational use	National Center for Education Statistics (2002)	
Computer play	Smith (2000); Webster and Martocchio (1992)	
Games for girls	Goriz and Medina (2000)	
Girls play more online games	Jones (2003)	
No difference in video games	Jones (2003)	
Reinforce stereotypes	Vezeau <i>et al.</i> (2000); Viadero (2001)	
Public school seniors no math difference	Vezeau <i>et al.</i> (2000)	
Minimal pressure from opposite sex	American Association of University Women (1990, 1998a, b); Brutsaert and Van Houtte (2002); Jackson (2002); Watson <i>et al.</i> (2002)	
Same-sex school		

(continued)

Variable	Issue	Reference
<i>Individual differences</i>	Intellectual development positive	Danziger (1998); Jones and Clarke (1995)
	Feminine/masculine traits	Holland (1997); Lyons (1984); Oakes (1990); Stevens and Macintosh (2003); Trusty <i>et al.</i> (2000)
	Girls enjoy computers less than boys	Reinen and Plomp (1997)
	Women in IT enjoy computing	Trauth (2002); Turner <i>et al.</i> (2002)
	Girls' anxiety with computers	Venkatesh and Morris (2000); Brock and Sulsky (1994); Gattiker and Hlavka (1992)
	Technology perceptions and acceptance	Venkatesh and Brown (2001); Venkatesh and Davis (2000); Venkatesh and Morris (2000)
	Essentialist perspectives	Adam (2002)
	Social construction	Adam <i>et al.</i> (2001)
	Theory of individual differences	Trauth <i>et al.</i> (2004)
	<i>Ethnic culture</i>	Positive IT attitudes – India and China
Girls lag in education access		Alderman <i>et al.</i> (1996)
Korean high school course selections		Na (2001)
India – women in IT workforce		National Association of Software and Service Companies (2004)
Indian legislation for working women		National Association of Software and Service Companies (2004)
Family impact in Ireland		Trauth (2000)
Gender stratification – science		Hanson <i>et al.</i> (1996)
Media		Furnham and Farragher (2000); Furnham and Mak (1999); Karahanna <i>et al.</i> (2004); Na (2001)
Cross-cultural comparisons		Srite <i>et al.</i> (2003)

Finally, ethnic culture serves as an umbrella over social and structural factors. It impacts girls' relationships with their parents, peers, counselors, and teachers. Media often reinforces the beliefs of a culture and reinforces attitudes and perceptions. Similarly, access to and use of computers at home and school is differential in its bearing on career choices. The model is exploratory and while our summary of the literature provides some suggestions regarding the nature of these relationships, we expect that empirical validations of this model, particularly against the backdrop of multiple cultures and school environments, will reveal the true relationships.

Changing times

Research over the past three decades may not reflect the how IT has pervaded homes and schools. Home computer use is now equally divided between male and female users: 41 million men and 39.7 million women in 1995 to 68 million men and 70 million women in 2001 (National Center for Education Statistics, 2002). Computer training is integrated in kindergarten to high school (K-12) curriculum. Computers used for instruction in US public schools rose from 5.6 million in 1995 to over 10 million in 2001 (National Center for Education Statistics, 2000). As represented in Figure 2, the percentage of public schools accessing the internet rose from 50 percent to 99 percent in the same time (National Center for Education Statistics, 2001).

Social influences of fathers and peers as role models should remain stable over the next generation of college students. The change may come from the impact of mothers on girls' career choices as more women achieve higher levels of education and join the workforce. This increased presence of women in the workforce as well as in leadership positions in male-dominated fields should reduce the effect of gender stereotyping and male peers, and in turn, related careers. While the assumption here is that of an intact

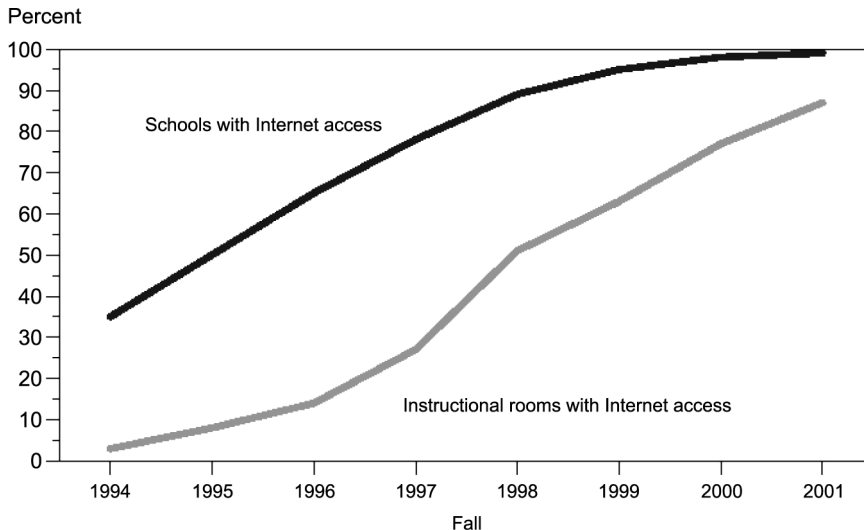


Figure 2. Percentage of all public schools and instructional rooms having internet access, Fall 1994 to Fall 2001

Source: U.S. Department of Education, National Center for Education Statistics, Fast Response Survey System, Internet Access in Public Schools and Classrooms – 1994-2001

family structure of one male and one female parent, the results may manifest differently for children raised in single-parent or same-sex parent families.

- P1. Fathers will continue to exert a positive influence on their daughters' choices of technology careers.
- P2. More girls will cite their mothers as role models in their choice of technological careers.
- P3. Male peers will have no significant influence on girls' choices of technological careers.

The influence of teachers and counselors will likely not change over the next generation. Despite the pervasiveness of computers and internet usage in the K-12 system, surveys by the National Center for Education Statistics (2000) indicate that only about 60 percent of teachers reported using computers for instruction and only 41 percent gave assignments requiring computers. Only 23 percent of teachers felt prepared for using computers and the internet in teaching. Teachers who report being technologically prepared are more likely to use technology in class and assign materials that requiring computer use for problem solving and data analysis (National Center for Education Statistics, 2000). Moreover, the current generation of teachers and counselors, while more knowledgeable about computer use for personal productivity, may not still be aware of the wide range of IT career choices.

- P4. Teachers and counselors will continue to steer girls towards traditional career choices.

The influence of the media will likely not differ over the next generation of students. While most professional and trade journals have begun to more evenly represent women in professional settings, most middle and high school students prefer to read popular magazines such as *Seventeen* and *Cosmopolitan*. Popular television channels such as MTV only serve to perpetuate these gender stereotypes (Signorielli *et al.*, 1994). These continue to focus largely on messages relating to fashion and superstars.

- P5. The media will continue to perpetuate stereotypes that will be detrimental to the choices of girls' technology-related careers.

Increased accessibility to computers in home and school, integration of technology in K-12 curricula, the popularity of internet gaming and instant messaging are trends that reduce the difference between the time that boys and girls spend with computers. While the nature of their computer use still differs significantly, time spent with computers reduces the intimidation effect of technology on some individuals.

- P6. Increased access to technological resources in home and at school will have a positive influence on girls' choices of technology careers.

Offshore software development has changed the landscape of some countries to emphasize IT more than they used to. The tight labor market in the USA and some European nations has caused India and China to provide offshore outsourcing. Western Europe, for instance, is projected to face a shortage of IT professionals by 1.7 million by 2005 (West and Bogumil, 2001). India's emphasis on excellence and a rich system of educational institutions has encouraged unprecedented growth in software

(West and Bogumil, 2001). Such market changes make IT a more viable career than ever before, which in turn affects families' work habits, education, and interactions.

- P7. Girls in countries experiencing increased IT exporting will be more inclined to select an IT career than those girls in those countries where IT industry is facing challenges from offshore outsourcing.

Proposed research agenda

The proposed model calls for multiple levels of analysis and level-appropriate methods to better understand how social, structural, and individual factors influence career choices. Using longitudinal observations and cross-cultural comparisons where possible, research in this area can be conducted at three levels:

- (1) the individual child and nuclear family level;
- (2) school and district level; and
- (3) the macro-level, where population trends and behaviors are examined.

Research at the individual and nuclear family level as well as school districts will extend to same-sex and co-educational schools and to comparisons among urban, suburban, and rural schools. The model can also be tested in its entirety using survey-based methods with middle and high school children, their families and peers. Several instruments tested with adults are adaptable to adolescent populations. The following sections discuss how researchers can operationalize the proposed constructs.

Family influence

Our research assessment strongly indicates that parental education and choice of careers are strong motivators for children's career choices as well. We expect these two items to be key measures of the family influence construct, as Dryler (1998) has suggested in her study of the Swedish education system. We suggest using items that measure parental influence on choice of major or career because there may be non-working parents who may influence career choices. An assessment of the adolescent's relationship may be important in order to determine whether the relationship between parents and the child is strong enough for parents to motivate career choices. Tang (2002) suggests items that assess an adolescent's independence or dependence from parents which can be adapted to career choices. In this context, one could measure a child's perception of their parents as role models. Researchers must also recognize that career influencers in the family may be siblings or other relatives.

Peer influence

Most operationalizations of peer influence relate to drug use and other similar negative behaviors. However, these studies have much to contribute in terms of assessing peer influence factors. For instance, Jang (2002) suggests that studies must measure actual behaviors of peers rather than perceived behaviors. To that extent, items can be designed to measure whether male and female peers have chosen IT careers, whether peers actually encouraged the choice of technology careers, whether a particular peer is considered a role model, and whether peer advice is more valuable than family advice. We suggest the inclusion of one perception measure – the perception of geekiness or nerdiness when an adolescent has made a technology career choice.

Media

The key assessment in this section is the choice of key media that students view or read. Researchers should identify popular media for adolescents and build these into the survey and interview questions. For instance, one could evaluate subjects about the extent to which the media they access provides valuable career advice and the exposure of women as active users of technology in these media. Such questions may indirectly reveal the gender stereotyping influence of media on girls and boys. Questions related to role models from media can be included in this construct as well.

Access to technology at home and school

Access to technology should measure some of the following aspects:

- presence of computers in home and schools;
- hours spent on computers at home and in school;
- the nature of usage at home and at school;
- teacher use of technology at home; and
- parental and sibling use of technology at home.

Norris *et al.* (2000) provide an instrument measuring teachers' home access to technology. Items from this construct can easily be adapted to the child and family's home computer use. Brecker (2000) provides similar measure of technology usage and access at home. The National Center for Education Statistics (2003) contributes survey items that specifically assess children's use of computers.

Teacher/counselor influence

Research indicates that students do not adequately utilize teacher and counselor time for career advice and that teachers and counselors may not have sufficient knowledge about technology careers (Freeman and Aspray, 1999). We suggest these two to be key measures in this construct. The extent to which teachers and counselors have influenced career choice and stereotype certain professions are also important measures. Children's perceptions of teachers as role models will provide additional insight.

Individual differences

The least mature construct – and the most malleable due to its nature and scope – is individual differences. These differences range from socio-economic status to perceptions about technology, personality preferences, and use of technology to name a few. Of immediate interest to us are three aspects of this construct:

- (1) personality differences;
- (2) perceptions of general self-efficacy; and
- (3) attitudes towards computers.

Trauth (2002) suggests several personality traits that women IT professionals believe make them distinct:

- strong and driven;
- logical;

- less social; and
- aggressive.

Many personality measures, such as the Myers-Briggs Type Indicator (MBTI) (Myers and McCaulley, 1985), the Kolb Learning Style inventory (KLSI) (Kolb, 1984), and the Big Five Factors (Digman, 1990) can assess personality characteristics. Self-efficacy measures by Judge *et al.* (1998) can be used to determine perceptions of general self-efficacy. Researchers can adapt many computer attitude questionnaires, such as those by Lee (1970), Rafaeli (1986), Dambrot *et al.* (1985), Nickell and Pinto (1986), and Popovich *et al.* (1987). Table II provides a sample of constructs for research about the perception of IT by youth.

Using survey-based methods with adolescents poses certain challenges. Children may respond to surveys in a socially desirable manner and may experience interpretation bias based on their experiences. Surveys will not capture rich social cues that are more visible in face-to-face settings. On the other hand, individual interviews could intimidate some 10-14 year olds. We therefore recommend the use of small focus group interviews to understand student experiences. Such interviews, when conducted with peers, can provide rich insights into peer influence on career choices as well. Francis (2000) used semi-structured interviews and observations to understand subject preferences for 14-16 year olds. Trauth (2000) and Trauth *et al.* (2003) have relied on semi-structured interviews of women IT professionals. These techniques can be used for longitudinal observations of families to understand the progressive impact of social, cultural, and economic changes on career choices. Habib and Cornford (2002) successfully used interviews with adolescents and families to understand computer usage behaviors. They closely followed home computer usage of seven families over two years, describing their progression into gender domestication around the computer.

Unit of analysis	Construct	Suggested survey instruments
Adolescent	Technology acceptance	Davis (1989)
	Attitudes/ beliefs about computers	Brock and Sulsky (1994); Lee (1970); Dambrot <i>et al.</i> (1986); Popovich <i>et al.</i> (1987)
	Attitudes and performance	Gattiker and Hlavka (1992)
	Microcomputer playfulness	Webster and Martocchio (1992)
	Computer use by children	National Center for Education Studies (2003)
	Access to computers at home	Norris <i>et al.</i> (2000)
	Individual differences	Digman (1990); Kolb (1984); Meyers and McCaulley (1985)
Family	Parents as role models	Dryler (1998)
	Parental influence – drug use	Jang (2002)
Peer group	Peer influence – drug use	Jang (2002)
Impact of media	Impact of media on self-concepts	Milkie (1999)
School	Same-sex/co-educational schools	Brutsaert and van Houtte (2002)
Teacher/counselor	Access to computers in school	Brecker (2000)
	Access to computers at home	Norris <i>et al.</i> (2000)
	Self-esteem	Rosenberg (1965)
	Ability	Francis (2000)

Table II.
Survey instruments
adaptable to girls' career
choice model

Possibly the most challenging construct to measure in this model is gender stereotyping. Survey-based methods may elicit socially desirable responses from parents and teachers. Items measuring this aspect would need to be carefully designed in order to minimize self-report bias. The blatancy of some of these questions may, however, be masked in small group settings, but the researcher must be careful that her questions do not lead the respondents. Multiple methods may need to be combined to obtain an objective assessment of this construct.

Access to children creates two challenges:

- (1) obtaining parental and administrative approval for student access; and
- (2) getting student and parental commitment to participate over time.

Parental consent may be more easily obtained once the school administration has approved participation. Even then, middle school children are often involved in extracurricular activities that may limit participation. Participation during school hours will be construed as distracting both by parents and school officials.

School and district level research

Structural factors can best be examined using school and district level data. Access to and use of computers in the home and school can be obtained from students using small group interviews and observations and from teachers using survey, interviews, and observation. Brecker (2000) provides a survey instrument, Teaching, Learning and Computing (TLC), that examines instructional use of computers in schools, particularly the extent to which teachers use computer and laboratory facilities. Norris *et al.* (2000), on the other hand, measure teachers' home access to technology. Items from Rosenberg (1965) can be adapted to assess teacher self-esteem with regards to computers. Francis (2000) provides survey items to evaluate teacher attitudes towards use of computers. Self-reporting bias and social desirability issues suggest that survey or interview-based techniques be complemented with observation about technology use, comfort with technology, and counseling/guidance behavior. For instance, Webb *et al.* (1997) used observation to examine how teachers grouped students during science instruction. The prevalence of technology resources and professional development of teachers and counselors depends on schools' resources advising a sample of different types of schools such as urban, suburban, rural, and private, reflecting varied socio-economic levels as well as in sex-segregated and co-educational institutions.

Macro-level research

Secondary sources such as government and professional organizations can provide data at the macro level about IT career and market trends such as children's and households' computer and internet usage from the National Center for Education Statistics in the USA and from NASSCOM in India. Other sources include the World Bank, the International Monetary Fund (IMF), and National Statistics, which provides online UK statistics. Macro level data combined with school and district level data can extract meaningful relationships, such as in Dryler (1998), where data gathered by the Swedish Governmental Commission on Education Inequality and was used and matched with school-level data about parents to understand how parents as role models affect educational choice.

National level data can help examine cultural comparisons of structural factors and social influences. Hanson *et al.* (1996) conducted a comparison of seven countries regarding gender stratification in science using data gathered by the Second International Math Study (SIMS) and Second International Science Study (SISS). Global sources such as the World Bank and the IMF will often be able to provide comparative multi-country data.

Longitudinal assessment

Research conducted at multiple points in an adolescent's life span – middle school, high school, and early college – can provide a robust assessment of career influences. Although career choices begin forming towards the end of middle school and early high school, social and structural influences that shape these choices must be understood earlier. Research begun in fourth or fifth grade will capture early formative factors. The same students can be tracked periodically. Recognizing that years of exposure to college resources, a wider set of peers and professors can change career orientation, there may be value in testing this model on college students as well. Freshmen students, just out of high school, will closely represent the adolescent thinking that shaped their college course selections. The proposed model could be tested each year of their college education to determine if college experiences have brought about any career choice changes, the nature of those changes, and factors that have influenced them.

Cross-cultural comparison

The model's value lies in its transferability to multiple cultures. Although language may be a potential barrier, in many countries most urban middle class adolescents and young adults have a working knowledge of English. Where language barriers do exist, measures must undergo rigorous translation and testing, first from English to the native language and then from the native language back to English. Karahanna *et al.* (2004) indicate that language translation is only one issue in cross-cultural research. Conceptual, construct, item, and scalar equivalence must be achieved before an instrument can be tested across cultures. This involves the identification of potential sources of bias both in the instrument as well as the measurement methods. Findings from a cross-cultural context can illustrate cultural change across nations. Insights from such findings can be used to make small, consequential changes to social and structural environments. Researchers will need to apply the same research techniques across cultures customizing language and ethnic idiosyncrasies. Care must be taken that methods are appropriate to flush out cultural differences (Srite *et al.*, 2003).

Implications for stakeholders

The research addresses IT workforce issues with regard to recruitment and retention. IT educators and policymakers can play a role in establishing environments conducive to technological careers. The misperception of what IT professionals do and what skills they need to succeed can deter many college students from choosing an IT-related major, and therefore a career in that field. Some of the problem may be marketing what IT professionals do and what skills help them perform quality project management and software development. School district administrators can establish policies and

allocate resources that support ongoing technological training of their teachers and counselors.

Before teachers can provide gender-neutral counseling, they need training to understand technology themselves as well as the career options provided by IT. Such training must begin at the licensing stages. Teachers report that they do not have adequate access to computers, adequate release time for technology training, as well as lack of good self-instructional software (National Center for Education Statistics, 2000). Such infrastructural support is critical in training veteran teachers who tend to use computers less often than those with less experience. Over 93 percent of teachers report that their main source of technological training is independent learning or support from colleagues. K-12 systems need to provide an environment where teachers can become comfortable with their technology preparedness and convey enthusiasm about it to students. Administrators can build incentives for merit into evaluations. The onus for teachers is to be able to provide equal access to computers; create an environment for computer use that is non-competitive, non-threatening, and engages children in social interaction; supply software that appeals to girls as well as boys; and provide students with female models of competent computer use (McNair *et al.*, 2001). Teacher awareness of IT career opportunities can help convey this information and encouragement adequately to students. Schools can provide opportunities for teachers and counselors to interact with industry to obtain better insights into IT careers. Careers fairs and internship opportunities should be actively encouraged in middle and high school children and these students should be encouraged to actively evaluate the impact of their career choices.

Parental involvement clearly has a positive bearing on choice of IT as a career. While educated mothers have a strong bearing on general career direction and are more consistently and deeply involved in academic lives of their children, fathers may have greater influence in choice of computing careers. As more mothers enter the workforce and earn higher levels of education, the positive impact of parental involvement continues to motivate daughters. School involvement through parent-teacher organizations, school board positions, and curriculum review are other outlets.

The technological outlook today is changing, and this change is optimistic. The awareness of pre-teen and teen girls as a viable software game market holds some promise for engaging girls in technology as long as the messages do not reinforce the traditional roles. Other media may influence girls indirectly. For example, Crime Scene Investigation (CSI) is presently one of the most popular television shows in the United States and may or may not have a strong teen audience. The two versions of the show have several non-nerdy women who spend significant time behind a microscope and discussing chemistry in addition to human behavior.

This research has extended prior work that has largely relied on examining college students and women in the IT workforce to schoolchildren. It is widely believed that social and structural factors shape adolescents' career choices. Our model provides specific factors within a socio-cultural context that can potentially explain adolescents' perceptions of IT careers. If we can successfully identify and manage student perceptions of IT careers at a young age, women may be better represented in the IT workforce and enrollments in IT programs may increase. Empirical research on our proposed model will serve to understand career influences and propose policy changes that may serve to increase the enrollment of women in MST careers.

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