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FACTORS AFFECTING THE CHOICE OF HIGH TECH ENGINEERING MAJORS FOR UNIVERSITY WOMEN AND MEN IN BANGLADESH

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ABSTRACT

In contrast to western countries which are experiencing declines in female enrollment in high tech engineering (HTE), Bangladesh has experienced a continuous increase in female enrollment in engineering. In order to better understand the factors driving the choice of HTE as a major, survey data was collected from 590 male and female students in HTE majors in Bangladesh. Hypotheses related to gender differences in the influence of various factors on major choice were examined using t-tests. Results revealed that, while several factors had a similar impact for women and men, gender differences in self-efficacy and socio-economic status persist and may represent barriers to women's participation.

Keywords

Gender differences, career choice, high tech, higher education, Bangladesh.

The dramatic increase in women's participation in economic activities since the 1970's, has led to unprecedented changes in the composition of the workforce in almost all sectors. Yet, when we look at women's participation in the high tech industry, a different picture emerges. According to the U.S. Department of Commerce (2009), women make up only 25.6% of computer and mathematical occupations in the United States. Meri (2008) reported that women are underrepresented in the European Union high tech sector with the lowest participation found in Turkey (17.6%), the United Kingdom (25.3%) and the Netherlands (25.4%). Almey (2006) reported that in Canada women constitute only 22% of the total employed in the natural sciences, engineering and mathematics. These statistics indicate a significant gap in the representation of women in high tech fields.

Women's underrepresentation in the high tech workforce has been, and continues to be, of concern for both industry and academia (Ahuja, 2002; Mattis, 2005; Michie and Nelson, 2006; Snir, Harpaz, and Ben-Baruch, 2009; Truman and Baroudl, 1994; von Hellens, Neilson, and Beekhuyzen, 2004). Of greater concern is the dramatic and continuous decline of female enrolment in undergraduate programs in high tech related fields in North America (Campbell, 2005). Vegso (2008) has shown that the proportion of women receiving bachelor's degrees in Computer Engineering and Computer Science in the United States and Canada shows a continuous decline from 19% graduating in 1999-2000 to 12% in 2006-2007. While universities in the Western world continue to experience lower female enrollment in HTE related majors, women's enrollment in a number of Asian countries such as India, China, and Bangladesh is increasing (Simard, 2007). This trend in student enrollment presents a surprising contrast between Western and Eastern cultures – particularly since Western cultures are viewed as being closer to gender equality while many Eastern cultures are viewed as male-dominated. A better understanding of why some Asian countries have been more successful in attracting women to engineering and technology fields may shed significant light on the causes of female under-representation in the global high tech industry.

Bangladesh is an interesting case to examine as it is a leader in Asia and the Pacific region with respect to the political empowerment of women but it does poorly on gender equality overall (Hausmann, Tyson and Zahidi 2010). In Bangladesh, there has been a steady increase of student enrollment in undergraduate program, from 119,807 in 2001 to 387,433 in 2008 (323% increase; BANBEIS, 2010). The proportion of female students overall has remained relatively constant -- within the range of 22% - 24% since 1974 (BANBEIS, 2010; Tisdell and Hossain, 2005). However, in engineering and technology majors, not only has student enrollment increased but also the proportion of female students has increased. For example, the proportion of women in the leading engineering university, Bangladesh University of Engineering and Technology increased

from 13.6% in 1999 to 19.3% in 2009. A similar trend was found in Shahjallal University of Engineering and Technology where, the percentage of women students increased from 14.1% in 1999 to 24.1% in 2009 (BANBEIS, 2000; varsityadmission.com, 2010[i]). Among the top ranking engineering and technology universities in Bangladesh in 2009, the proportion of women students was approximately 20% overall. Thus, current female enrollment in engineering and technology fields in Bangladesh is not only significantly higher than it was in the past; it is also significantly higher than in many Western countries.

The purpose of the present empirical investigation is to explore the key factors influencing Bangladeshi women's and men's choice of a HTE majors. Further, we examine whether gender differences exist in the role of various factors. While some past research has examined these influences in Western and European contexts, very little research has been done in the Asian context and ours is the first study to examine these dynamics in Bangladesh. A better understanding of why Bangladeshi students pursue high tech majors can help us to understand not only the factors that influence students' choice of major but also identify the dynamics that are encouraging more female students to select engineering and technology as a field of study in Bangladesh. Thus such a study can enhance our understanding of women's representation in the high tech sector in Asia.

FACTORS INFLUENCING THE CHOICE OF MAJOR IN HIGHER EDUCATION

Drawing upon Ahuja (2002) and Adya and Kaiser's (2005) models of factors affecting young women's interest in technology careers, we explored the extent to which gender differences exist among the social and structural factors affecting the choice of academic major. Ahuja (2002) proposed a stage model of determinants of women's career in information technology (IT) sector. According to this model several social and structural factors influence women's careers in IT at the career choice, career persistence and career advancement stages. Adya and Kaiser (2005) expanded the career choice component of Ahuja's (2002) model and proposed a more extensive list of factors that influence women's choice of technology careers. Social factors include family, peer group, and media. These three factors are believed to influence career choice through the mediating role of gender stereotyping. Structural factors include teachers and counselors, access to technology in school and at home and same-sex education. Teachers and counselors, parents, and peers serve as important role models influencing career choice. Adya and Kaiser (2005) further acknowledge the role of individual differences and ethnic culture.

We adapted the models of Ahuja (2002) and Adya and Kaiser (2005) to the Bangladeshi context. We added parental socio-economic status since in Bangladesh parents generally pay for children's education and in a low income developing country such as Bangladesh, parental socio-economic status may play a major role in students' career choices. We did not include access to computers at school because most public schools do not have computers in the classrooms. We also excluded same-sex education since most Bangladeshi public schools are same-sex for religious reasons. The resulting model included the influence of family, peers, teachers, and role-models plus socio-economic status and self efficacy.

Family influence

Parents' and family members' influence is considered to be one of the most important socializing influences in a young person's life. Researchers have found that parents affect career choice more than counselors, teachers, friends, other relatives, or people working in the field (Kortlik and Harrison, 1989). In many instances, parents' influence extends to pressuring children to choose high tech majors over other less practical fields (Tillberg and Cohoon, 2005). Comparing individualistic and collectivist societies, Auyeung and Sands (1995) found that parental influence played a more important role in children's choice of major in Eastern countries (Hong Kong and Thailand) than in Western countries (Australia).

While parental influences are important in career choice decisions in both traditional and non-traditional careers, parental influence is more strongly related to women's choice of non-traditional careers such as IT (Adya and Kaiser, 2005). Trauth (2002) suggests that parental influence is one of the most significant factors that influence women's decision to choose IT as a field of study in higher education. Many studies conducted on women in IT suggest that women's career choices are strongly influenced by their father in particular (e.g. Turner, Brent and Pecora, 2002; Adya, 2008). Apart from parents, siblings can also influence career choice decisions, particularly for girls, where an older brother may influence her entry into traditionally masculine careers (Banks et al., 1995). Thus, we hypothesize:

H1: Family influences will be greater for female students than male students choosing high tech majors.

Peers' influence

Although the research suggests parents and teachers are most influential in students' career choice decisions, there is evidence of peer influence as well (Linder et al., 2004). Moreover, cultural context affects peer influence with peer influence

being more significant in Eastern countries than Western countries (Auyeung and Sands, 1995). Peer influence may not be equal, however, between male and female students. Basow and Howe (1980) reported that female students are equally influenced by friends of both sexes whereas male students are influenced more by male than female friends. Tillberg and Cohoon (2005) found that girls are more likely to be influenced by their male peers in deciding on majors. These findings from Western countries may not apply, however to Bangladesh which is a predominantly Muslim country. In the Bangladeshi context, it is unlikely that girls will be influenced by their male peers. Same-sex schools are common in Bangladesh and thus same-sex peers are more likely to influence students' career choice. We hypothesize,

H2: Male peers' influence will be greater for male students than for female students choosing high tech majors.

H3: Female peers' influence will be greater for female students than for male students choosing high tech majors.

Role model influence

At the career choice stage, the influence of role-models can be significant. Basow and Howe (1980) defined role-model as "someone whose life and activities influenced the respondent in specific life decisions." The extant literature suggests that the lack of female role models is one of the key reasons why females are less likely than males to pursue technology careers (e.g., Ahuja, 2002; Kekelis, Ancheta and Countryman, 2005; Adya and Kaiser, 2005). Basow and Howe's findings suggest that both women and men are influenced by role-models; however, women are influenced more by female role models than men while both are equally influenced by male models. As Bangladesh is a predominately Muslim country, it is likely that same sex role-models will be pivotal in influencing career choices. Based on this, we hypothesize that,

H4: The influence of male role-models will be greater for male students than for female students choosing high tech majors.

H5: The influence of female role-models will be greater for female students than for male students choosing high tech majors.

Socio-economic status

A number of studies have provided evidence that family socio-economic status can have an impact on students' desire to participate in higher education (e.g. Fergusson and Woodward, 2000). Past research has also lent support to the notion that there is a link between family socio-economic status and children's career choices (Tang et al., 1999). In fact, this influence has been found to be greater amongst women who enter male-dominated fields such as science (Jackson, Gardner and Sullivan, 1993). Salami's (2007) research investigating the influence of family, individual differences, and cultural factors on the choice of gendered occupations found that female students who chose male-dominated occupations were from families with higher socio-economic status than female students who chose female-dominated occupations. Several studies have suggested that women who enter male-dominated fields are more likely to come from families where both parents are highly educated – a key indicator of socio-economic status (e.g., Jackson et al., 1993). Thus, we hypothesize that:

H6: Parental socio-economic status will have greater influence on female students than male students choosing high tech majors.

Self-efficacy

Self-efficacy is defined as the degree to which a person believes that he or she can attain a goal (Bandura, 1986). Betz and Hackett (1981) argued that self-efficacy is a strong predictor of career-related behavior for both male and female college students. Particularly in male-dominated occupations, gender differences were found regarding self-efficacy. These differences were primarily due to women's lower self-evaluations of their ability and talent. Self-efficacy has also been linked to pursuing technical and scientific careers (Lent, Brown and Larkin, 1987) and with academic satisfaction among engineering students (Lent, Singley, Sheu and Schmidt, 2007). As female enrollment is steadily increasing in Bangladesh, we hypothesize that there will be no gender differences in self-efficacy.

H7: There will be no gender differences in self-efficacy among students choosing high tech majors.

Teachers' influence

In addition to parents, teachers also play an important role in influencing students' career choices for both genders. However, teacher's encouragement has been found to be more important in influencing girls' career choices compared to boys' career choice - especially in math, science, and technology majors. Dick and Rallis (1991) examined 2000 high school students and found that teachers had a strong influence on girls' choice of career in mathematics. Similarly, Turner et al. (2002) found that 37% of women in their high tech sample indicated a strong teachers' influence on their career choice. Further, Auyeung and Sands (1995) found that teachers' influence was more significant in Eastern countries as opposed to Western countries. Hence we hypothesize the following:

H8: Teachers' influence will be greater for female students than for male students choosing high tech majors.

METHOD

The objective of this study was to compare the influence of each factor on choice of a high tech major. Hypotheses were tested using survey data collected from undergraduate engineering students in five Bangladeshi universities. The five universities included two public universities and three private universities – all of which offer engineering programs. Since the focus of this research is the high tech sector, we included in our analysis only those students pursuing HTE related majors. We followed Frenette's (2007) definition and included the following as HTE majors - computer science, computer engineering, electrical and electronics engineering, software engineering, systems engineering, information communication and technology, and information systems.

The data were collected during the period June to August, 2010. Surveys were distributed by one of the authors and completed during class time. The surveys took 40 minutes on average to complete.

Sample description

A total of 855 students responded to the survey from different engineering and technology majors. Non high tech majors were eliminated leaving a final sample of 590 students of which 23.4% (n=138) were female and 76.6% (n=452) were male. The sample proportions of female and male are consistent with the overall ratio of students enrolled in engineering and technology majors in Bangladesh. The sample also represented all four years in the undergraduate program although representation from first year students was low (see Table 1).

Level	Female %	Male %	Total %
1st year	.8	3.9	4.7
2nd year	6.6	31.7	38.3
3rd year	9.5	24.4	33.9
4th year	6.5	16.6	23.1
Total	23.4	76.6	100

Table 1. Demographics by Gender and Level in the Program

The respondents' age ranged from 17 to 28 years (96% were between 19 to 24 years) with a mean age of 21 years. Using Khan's (2010) categorization of income class, 18% of the students belonged to the low income group, 54% of the students to the mid-income group and 28% to the high income group.

Measures

The survey questions were either developed or adapted for this study from previous literature. It was not possible to use existing measures for two main reasons: 1) many studies that have discussed the variables of interest are conceptual or qualitative in nature, and 2) most of the studies on the factors influencing students' choice of a high tech major have been conducted in a western context and needed to be adapted for use in Bangladesh[ii].

Family influences

The family influence scale (4 items, α=.71) measures the extent of parents' and family member's influence on students' choice of major. Sample items include "the influence of parents and family members is important for generating interest in engineering" and "parents and family members were a most important factor in my decision to choose engineering as my university major". The items were measured on 5-point Likert scales (1, "strongly disagree", to 5, "strongly agree").

Peers' influence

Peers' influence was measured using two items – one to the extent of male peer(s) influence and one to measure female peer(s) influence on choice of major. The items were measured on 5-point Likert scales (0, "no influence" to 4, "high influence").

Role model influence

Role model influence was measured using two items. One item assessed the extent of adult male influence and one item assessed adult female influence on choice of major. The items were measured on 5-point Likert scales (0, "no influence" to 4, "high influence").

Socio-economic status

Socio-economic status is the typically a combination of educational scores and annual family income (Nam and Boyd, 2004). The questionnaire asked for annual family income and information on the educational qualifications of the participants' parents (father and mother). Both parents' educational qualifications and annual family income were transformed into standard scores. A new variable measuring socio-economic status was created by averaging the two *z*-scores.

Self-efficacy

Self-efficacy (3 items, α=.66) measures a person's belief in his or her ability. A sample item is "I chose this major because of my abilities and talents." The items were measured on 5-point Likert scales (1, "strongly disagree" to 5, "strongly agree").

Teachers' influence

Teachers' influence (3 items, α=.72) was measured by 3 items reflecting the extent of teacher's influence on student's choice of major. A sample item is "My pre-university teachers encouraged me to improve my grades in math and science." The items were measured on 5-point Likert scales (1, "strongly disagree" to 5, "strongly agree").

Demographic questions

Information about age, gender, field of study, year of study, family income, and parent's education was collected in the demographic section of the survey.

Factor Analysis

Principal axis factor analysis was used to assess the dimensionality of the research instrument. Three factors with Eigenvalues greater than one were retained – family influence, self-efficacy and teachers' influence. Only items with loadings higher than .4 were retained. The other items were dropped to enhance reliability. To assess reliability Cronbach's alpha was calculated. According to Nunnally (1978), reliabilities of 0.6 are acceptable for newly developed scale. The values for these three factor scales were between .66 and .72 and thus exhibit acceptable reliability. The factor items and loadings are shown in Table 2. Means, standard deviations, and Cronbach's alphas (where available) for each of the variables are shown in Table 3.

Two of the other three measures – peers' influence and role model influence – were not multi-item scales and thus factor analysis was not run on these two constructs. Also, socio-economic status is an index rather than an internally consistent scale (that is, we would not expect the components to be highly correlated) and therefore factor analysis was deemed inappropriate for this construct.

Hypothesis Testing

Our hypotheses regarding gender differences were examined using independent samples t-tests. The results of t-tests are presented in Table 4. Pooled variance estimates were used in calculating the t-statistics only when Levene's test for the equality of differences was not significant. T-tests revealed that there were no significant gender differences related to family influence (X_m = 3.04, X_f = 3.08, t = -.40) and therefore H1 was not supported. Significant gender differences were found related to peer influence. As hypothesized male peer influence was greater for male students (X_m = 3.11, X_f = 2.50, t = 3.95, p<0.00) and female peer influence was greater for female students (X_m = 2.19, X_f = 2.67, t = -3.15, p<0.01) supporting H2 and H3. There were no significant gender differences related to male role-model (X_m = 2.86, X_f = 2.66, t = 1.33) and thus H4 was not supported. However, significant gender differences were found for female role-models (X_m = 2.15, X_f = 2.47, t = -2.21 p<0.05) lending support to H5. Gender differences were also found significant for self-efficacy (X_m =4.20; X_f =4.02, t = 2.21, p<0.05) and socio-economic status (X_m = -0.08, X_f = 0.30, t = -5.56, p<0.00) thereby providing no support for H6 but supporting H7. Finally teacher influence was found to be insignificant (X_m = 3.26, X_f = 3.23, t = .31).

Items reflecting influence on choice of high tech major	Factor 1 "Family Influence"	Factor 2 "Self-Efficacy"	Factor 3 "Teachers' Influence"
Influence of parents and family members is important	.548		
Parents as role-models inspired interest	.680		
Importance of parents and family members in choice	.733		
Parent's pressure	.420		
Ability and talent		.697	
Believe in success		.716	
Interested since childhood		.532	
Inspiration from teacher			.787
Teachers encouragement for math & science			.531
Influence of teachers			.700
Percent Variance Accounted for by each Factor	20.2%	11.2%	8.3%

Note: Factors with an Eigenvalue greater than one were included. Only significant loadings (.4 or above) are shown.

Table 2. Factor Analysis – Items Related to Influence on Choice of Major

Factors	M	SD	Cronbach's alpha
1) Family influence	3.05	.91	0.71
2) Male peer influence	2.97	1.52	
3) Female peer influence	2.30	1.55	
4) Male role model	2.81	1.57	
5) Female role model	2.22	1.45	
6) Socio-economic status	.01	.75	
7) Self efficacy	4.16	.83	0.66
8) Teacher influence	3.25	.91	0.72

Table 3. Means, Standard Deviations, and Reliabilities (where available) for the Factors

Factors	Male Mean (X_m)	Female Mean (X_f)
Family influence	3.04	3.08
Teacher influence	3.26	3.23
Self-Efficacy**	4.20	4.02
Socio-Economic Status*	-0.08	0.30
Peer influence male*	3.11	2.50
Peer influence female*	2.19	2.67
Influence of female role-model**	2.15	2.47
Influence of male role-model	2.86	2.66

Note: * $p<0.01$; ** $p<0.05$

Table 4. Gender Differences in Choice of Major

DISCUSSION AND CONCLUSIONS

One of the more interesting findings of the present study was that there were no gender differences in the role of family influence. This is in sharp contrast to a number of studies that have suggested greater influence of family in women's choice of technology related majors in higher education (e.g., Tillberg and Cohoon, 2005; Trauth, 2002; Turner et al., 2002; Dick and Rallis, 1991; Adya and Kaiser, 2005). One possible explanation for the lack of gender differences in family influences on the choice of major in Bangladesh may be the structure of the education system. All three Bangladeshi education systems (public, private and religious) conduct centralized, standardized, and anonymous exams. Admission to university programs is based on ranked merit lists derived from exam results. The highest ranked students are given the first choice of program major. Because of the competitive nature of the admission system only the most talented are given the opportunity to choose their major and typically those students take advantage of that opportunity to choose the most prestigious and lucrative majors. There is a strong norm that students select the highest ranked major for which they are eligible. As a consequence, the gendering of university majors does not occur in Bangladesh. This system of centralized examinations and admissions seems to support a more gender neutral image of the majors and thus offer greater opportunities to high tech careers for women (Küskü, 2007). Future research contrasting this approach to major assignment to the self-selection approach typical in western universities would be beneficial. A second related explanation for the lack of differences in family influence may have to do with the role of engineering and technology careers in developing societies. Engineering and technology majors are viewed in Bangladesh as a means of achieving financially rewarding and prestigious careers, and so parents and family members may encourage both sexes equally to do well in math and science courses to gain admission to engineering and technology majors. In fact it is common practice in Bangladesh for parents to have their children tutored for math and science courses.

Regarding peer influence, male students' reported higher influence from male peers and female students reported higher influence from female peers, with both differences reaching statistical significance. Bangladesh is predominantly a Muslim country where cross-gender friendships are not common. Also most of the schools at secondary and higher-secondary levels are same-sex institutions; hence it is possible that many of the students may not get an opportunity to develop cross gender friendships until they are in university. With respect to role model influence, our findings lend support to Basow and Howe's (1980) findings that, female students are influenced more by female role models than male students while both are equally influenced by male role models in their choice of high tech major. Looking at the pattern of same sex influences, it would be interesting to investigate the factors influencing the choice of major from a sex role perspective.

Gender differences were also found to be statistically significant for socio-economic status. Parental socio-economic status had a greater impact on choice of major for female students. These results are consistent with previous research which found that women from higher socio-economic strata are more likely to choose male-dominated occupations (Salami, 2007). It should be noted, however, that the largest group of both women and men (53.5%) enrolled in high tech majors belong to the mid-income bracket, followed by 28.2% from high income bracket.

Contrary to our predictions, there was a significant gender difference in self-efficacy with female students having a lower mean score than their male counterparts. This study supports the earlier finding by Betz and Hackett (1981), that women have lower self-evaluations of their abilities and less confidence in their success than their male counterparts. However it is important to note that both men and women in the sample have relatively high mean self-efficacy scores (female = 4.02; male = 4.20). These generally high means are congruent with earlier findings by Lent et al. (1987) indicating that individuals with high self-efficacy are more likely to pursue scientific and technical careers.

Finally there was no gender difference in teachers' influence on student choice. Both Ahuja (2002) and Adya and Kaiser's (2005) conceptual model identified teachers' influence as a key factor influencing girls' choice of an IT major. The lack of gender difference in this area may be a result of the structure of the education system in Bangladesh.

Overall the results suggest that men and women are influenced by a similar set of factors with the exception of self efficacy and parental socio-economic status. The relative gender-neutrality of major choices coupled with better career prospects makes HTE an attractive academic program for both women and men in Bangladesh. The results suggest that the significant effort to increase the representation of women in high tech in Bangladesh (USAID, 2005) may have had positive results already. On the other hand, despite the increasing representation of women in high tech majors in some Asian countries, the present findings suggest that some of the factors that inhibit the participation of women in the high sector in western countries (e.g., self-efficacy, parental socio-economic status, and same gender influence) can have a similar impact in an Asian context. This study is one of the first to explore these factors in this context.

There are a couple of caveats to keep in mind in interpreting the results of this study. First, while Bangladesh represents an interesting context in which to study the dynamics of HTE major choice, further research will be needed to determine the

generalizability of our results. In addition, the survey was administered to students who are already studying engineering, and who are thus perhaps less likely to see high tech as a gendered domain. Nevertheless, the results draw attention to the possibility that high tech can be made attractive to women under the right circumstances.

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[i] All the numbers pertaining to female male enrollment for technology and engineering majors for 2009 were obtained from varsityadmission.com

[ii] The survey questionnaire can be obtained by contacting the first author.