UNDERSTANDING THE LACK OF MINORITY REPRESENTATION IN GRADUATE PROGRAMS IN COMPUTER SCIENCE AND INFORMATION TECHNOLOGY: A FOCUS GROUP STUDY OF STUDENT PERCEPTIONS

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ABSTRACT

This paper is an effort to delineate factors impacting lack of representation of minority students at the graduate level education in information technology fields: computer science and computer information systems. The research was conducted in three Virginia institutions: Hampton University (HU), Norfolk State University (NSU), and Virginia State University (VSU). The paper examined basic factors impeding interest of undergraduate computer science and information technology students in graduate education. Based on our findings a few strategies are suggested which could possibly lead to higher interest, hence, better recruitment and retention of minority students in graduate programs in these fields.

The research shows that students' lack of interest in graduate education was due to four basic factors. These factors were 1: lack of information about graduate school and admission process to the graduate programs, 2: perceived value of graduate education, 3: financial considerations and 4: perceived educational preparedness. It was also found that undergraduate school supervisors (teachers, advisors, and administrators), family and friends have a direct impact on the students' intention and interest in graduate education. Furthermore, students' interest level decreases as they move from underclassman status to upperclassman status. Based on these findings, a few basic recruitment strategies are proposed.

Keywords: Graduate Minority Students, Graduate Computer Science Education, Recruitment of Graduate Minority Students, Focus Group Study, Computer Science Students in HBCUs.

INTRODUCTION AND LITERATURE REVIEW

There is a growing concern over the under representation of women and minorities in the natural sciences and engineering fields, including computer science. There is a large body of

research material which documents this fact. The focus of this research was to look beyond undergraduate education and to investigate the lack of representation of minorities in graduate and post graduate education in the field of computer science/information technology. Some of the relevant research is included here in the following section.

Grandy (1994) conducted a study among college seniors who registered to take the Graduate Record Examination (GRE) test and who were majoring in natural sciences, mathematics, computer sciences, and engineering (NSME.) A stratified sample of 1,651 such college students was collected. The goals of the survey were to identify some of the factors that may lead NSME majors to change fields for graduate school, analyze differences among ethnic groups remaining in NSME, and analyze differences between male and female NSME majors who plan to remain in NSME. The research mainly focused on gender and ethnic differences in NSME majors planning graduate study in their fields. Results showed that the decision to leave NSME was uncorrelated with gender, race, or GRE scores. Detailed analysis of gender and ethnic differences among NSME majors planning to continue in their fields showed small to moderate differences on many dimensions. There were gender and ethnic differences in salary expectations, importance on making a contribution to society, and preferences for various job activities.

The under representation of women and minorities in information technology (IT) professions is also well documented (National Science Foundation [NSF], 2000). In fact, recent statistics show that the IT workforce is comprised of less than 30 percent female and less than five percent minority professionals (Council of Higher Education Accreditation [CHEA], 2000). The Computing Research Association survey on graduate students shows that, between 1993- 2003, African American enrollment in Ph.D. programs in computer science/computer engineering remained 1% or 2% of total Ph.D. enrollment in these majors (Vegso, 2005). Several recent research studies have been done to determine the reasons why such an employment gap exists despite the relatively high demand and attractive salaries for IT workers (Houston-Brown, 2002; Baylor, 2003), and many more studies have documented the underlying reasons for a similar gap that exists in science, math, and engineering professions in general (Landis, 1985; Cohoon, 1999; Thom, Pickering, & Thompson, 2002; and Armstrong & Thompson, 2003). In a recent publication, Cohoon, & Aspray (2006) reviewed the existing literature for the causes of the gender gap in the information technology field and possible strategies to rectify this problem. These studies point to the well documented "digital divide," which limits minorities' access to computing technology; inadequate K-12 preparation, especially in math and science; and a critical lack of counseling and mentoring as key reasons for lack of recruitment and retention of minority students in IT majors.

Gates, Teller, Bernat & Cabrera (1999) studied the affinity research group model which provides students with opportunities to learn, use, and integrate the knowledge and skills that are required for research with the knowledge and skills that are required for cooperative work. Membership in affinity groups is dynamic, i.e., old members graduate and new members join in; and students come to the groups with different levels of knowledge and skills. Because of this, an annual orientation is needed for new members to facilitate their understanding of the philosophy and

goals of the affinity model, understanding of the research goals of the projects to which they are assigned, learning of the basis of the cooperative paradigm, and awareness of group expectations. More importantly, the orientation develops new members' basic understanding of the research process and provides information about available resources. The orientation is also important for established members. It provides them with an opportunity to renew their commitment to the group, improve their research and cooperative group skills, and processes within the group with the goal of improving the group's effectiveness. The orientation also allows faculty mentors to become aware of members' misgivings and expectations of the affinity group experience. It also provides a chance to the faculty member to reevaluate the goal of the model and its success.

Eide & Waehrer (1998) examined the expectations of attendance in a graduate program and its payoffs affect in the selecting the undergraduate major. Results explain why some students choose to major in fields associated with poor job prospects for undergraduate degree holders. The option to attend graduate school is not a significant factor in choosing to major in computer science/engineering. Women are significantly less likely to select majors associated with higher future wages. The research effort is generally concentrated on undergraduate college education, hence, focus is recruitment and retention of K-12 students to science and technology related majors in college.

In addition, a number of research studies have identified “best practices” in programs that seek to address these gaps. Model programs at institutions as diverse as the California State University, Northridge (Landis, 1985), Case Western Reserve University (Boulding, 1985), Texas A&M (Graham, Caso, Rierson & Lee, 2002), Arizona State University (Fletcher, Newell, Anderson-Rowland, & Newton, 2001), the University of Maryland (Armstrong & Thompson, 2003), and the Oklahoma Alliance for Minority Participation in Science, Mathematics, Engineering, Technology and Education (Mitchell, 1997), as well as an ongoing studies at several institutions in different programs that are successful at recruiting and retaining women, have incorporated a number of strategies: summer bridge programs; academic enrichment activities; tutorial services; ongoing peer, faculty, and professional counseling and/or mentoring; and cooperative and internship experiences both on and off campus. However, while all of these studies offer valuable insights into the underlying reasons and possible solutions to the lack of minorities in the IT workforce, few of these programs specifically target African-American students, and most are broadly focused on science, math, engineering, and technology majors. There are also efforts made to educate teachers and counselors about causes of lack of representation of minorities and women in technology related fields (Nicholson, Hancock, & Dahlberg, 2007.) This research focuses on altering teachers’ and counselors’ perspectives that could bring change in the attitude of minority and female students towards technology related fields.

RESEARCH MOTIVATION

All of the above studies are pointing to one fact that there is a shortfall of minority students in the field of science and technology including computer science. This shortfall increases substantially as one starts to look beyond the undergraduate level to the masters and doctoral levels. It is, therefore, imperative to understand the underlying factors that impede the progress towards graduate education among minority students in the field of computer science/information technology. Furthermore, it is important to identify some strategies that encourage minority students to pursue graduate education in these fields.

This study is an attempt to understand the factors which hinder students from pursuing graduate and post graduate education in computer science related fields. Also an attempt is made to provide some possible paths to design strategies to reduce this shortfall. The study was conducted in three Historically Black Colleges and Universities (HBCUs) in Virginia that offer an undergraduate computer science program. The institutions involved were Hampton University (HU), Norfolk State University (NSU) and Virginia State University (VSU.)

DATA COLLECTION

Two different methods were used to collect the data. This study utilized focus groups in the first phase of data collection and a written survey in the second phase of data collection. In the first phase, two focus groups were conducted in each institution involved with the project in the fall and spring semesters of 2004-2005 academic year. It was not possible for logistical reasons to invite a random group of students for 30-40 minutes of discussion on graduate education. Focus groups consisted of junior or senior level classes in which 25-35 minutes of class time was devoted to an open ended discussion of graduate education: its need, its value, their perceptions, etc. The role of the faculty member was limited to ask a probing question, whenever, there was a general pause in the discussion. No audio or video recording was made. The faculty member took notes about the discussion. Total of six informal focus groups were conducted in three institutions. The participation in the focus group was voluntary; students were told the purpose of the research and were given the option to opt out of the discussion if they so desired. The results of these focus groups were summarized to identify the underlying themes.

A written survey was conducted in the second phase of data collection. The survey instrument (Appendix 1) was developed based on available research and the experience gathered from the focus groups. The main objective of the survey instrument was to determine the influence of family members, friends, teachers, mentors and student's background on their interest and intention to attend graduate school. The survey was administered using clustered sampling technique among randomly selected junior and sophomore classes in all three participating institutions in the Spring 2005 semester. As with the focus group, students were given the option not to participate if they so desired. Results from the focus group and survey are discussed in the next section.

RESULTS AND ANALYSIS

Patterns within the focus group results were identified after tabulation of all major points from the three participating institutions. The results of the focus group indicated four major themes for lack of representation and interest among students in the graduate education in computer science/information systems. These major themes were: a) graduate school admission process and awareness, b) job and financial issues, c) perceived value attached to graduate education, and d) perceived level of preparedness.

Graduate School and Admission Process and Awareness

In all three institutions students repeatedly said that they were either not very aware of the process of graduate school admission or didn't consider the graduate school admission processes to be easy and straightforward. Students also mentioned a lack of understanding of availability of funding, and other options available to finance their graduate education. This was one area where more personal contacts and better mentoring/nurturing can help students to consider graduate school as an option while planning for career choices. A summary of the major points in this area is included below in Table 1.

Table 1: Summary of Focus Group Themes Related to the Admission Process

No.	Comments on the Admission Process Theme
1.	Applying to grad school is too long a process – application, GRE, letters, applying for funding, etc. GRE preparatory courses were attended only by 3 students. Some mentioned the hassle of application—long process, preparation for exams, GRE, etc. or Grad school application process is long. Involves separate preparation. Students say that they don't have that much time.
2.	Preparation is important, mostly on the strategies for taking the graduate admission tests. Graduate admission tests (both GMAT and GRE) are perceived as a major hurdle "…you know these tests are skewed against minorities…", "…we do not test well on these types of exams…", "…I heard that if you retake it, they still use the lowest score…", "…a friend of mine told me it was impossible to prepare for it [GMAT] since it [GMAT] does not test knowledge…", "…I was advised to take it 'cold' [without any preparation]…"
3.	Students in general are not aware of the number of opportunities for graduate school support. Lack of information about graduate school or students not being aware of graduate school support: RAs, TAs, LAs, etc.
4.	Perception of graduate school being very hard; it requires a lot of reading and research work. Undergraduate education is challenging enough, not ready for more academic work. Struggled at undergraduate and hence do not think attending graduate school is possible.
5.	Lack of research experience.
6.	Their undergraduate school does not offer graduate program.
7.	Affirmative Action set asides for graduate school admissions for minorities are gone "…see what has happened at the University of Michigan…", "…the current administration [federal government] has an agenda to destroy Affirmative Action, especially in higher education…"

Table 1: Summary of Focus Group Themes Related to the Admission Process	
No.	Comments on the Admission Process Theme
8.	Most graduate programs are in majority institutions. Some minority students feel they might be shunned or kept apart from the majority. Other schools have a lot more resources, which translated to some fear of other schools being harder or superior. Perceptions as of other schools are teaching more at the undergraduate level as these other schools have more resources to prepare their students better. Department's ranking was also an issue in the mind of a few students. Perception that they are not prepared adequately. Certain cutting edge courses are not taught or are not part of the curriculum in these schools (for example information security.)
9.	Difficult to connect with other schools in graduate program.

Job Market/Financial issues

Students also indicated that the cost of college (undergraduate education) was high and they wished to start earning money. Furthermore, they were very aware of the fact that the average salary in their discipline was higher than many other disciplines as well as the job market was very good. That is, they would find a job easily and they would be able to command a decent salary. This is an indication of a major obstacle for promoting graduate education to our students. Graduate schools have to compete directly with the job market in CS/IT area. In other words, computer science graduate programs have to provide more incentives including better financial support to attract students. A summary of major points in this theme area is provided in Table 2.

Table 2: Summary of Focus Group Themes Related to the Job Market	
No.	Comments on the Job Market Theme
1.	Going to graduate school in CS/IT is not as necessary to secure a good job compared with other majors in education or liberal arts. Salaries are good enough after undergraduate degree; why bother with more education. Postpone graduate education from the immediate future after undergraduate degree. Currently, main goal is to find a job and start making money and become financially independent. Main motivator is earning enough money to become independent – we need to ask about influence of parents here. Most of the time what you learn at undergraduate school is enough to get a job.
2.	"…the opportunity loss of delaying employment in lieu of higher education…" Loans are too much to pay after undergraduate or cannot afford more loans for graduate education. The concern about repaying student loans for undergraduate education while accumulating more debt for graduate school. .
3.	Some students are first-time family graduates from a college. Why bother to extend my education? Why wait to finish my education when there are jobs waiting for me?
4.	Learning can take place at the workplace; why go to grad school. You will learn more on the job. Experience is more important than academic work.
5.	Corporate world needs mix of business education and technical skills; MBA is more important for career than masters in CS/IT. Graduate degree in business is more valued in their mind as that is considered a ticket to moving up on the corporate ladder. "Will I get a job after master's degree or will I get a better job after masters? Master's degree may be an overkill of education."

Table 2: Summary of Focus Group Themes Related to the Job Market	
No.	Comments on the Job Market Theme
6.	Financing grad school is an issue. Want to go to grad school only if employer pays for it and can be done on a part time basis. "I don't want to pay for the education; will consider grad school only if it is paid for."

Perceived Value Attached to the Graduate Education

This was the most recurring theme. Students on several occasions mentioned that graduate school in computer science was not going to add much market value to their careers. Two main factors which were heavy on the students' minds were salary potential and skill building potential of graduate education. The differential in salary with one or two years of experience compared with one or two years of advanced college education was not in favor of the latter. Second, students were clearly indicating that education other than a graduate or post graduate degree in computer science was more financial rewarding (e.g., MBA or professional/technical certifications.) Table 3 has a summary of major points in this area.

Table 3: Summary of Focus Group Themes Related to the Value of Graduate Education	
No.	Comments on the Value of Graduate Education Theme
1.	Students had a view that college education (at least higher level education) is not as important as obtaining certificates in the technical skills. Certificate programs are more valuable than grad school.
2.	Learned enough "why bother with more education?" "How will it help? Programming is an art so experience is more important." One can teach a lot of programming and other technical things to oneself, once you have a baseline understanding. Why do you need grad school?
3.	"What is the motivation of going to grad school?" Want to work and make money. Is it worth the difference in salary vs. assistantships over the long term?
4.	Long term perspective is missing. Education is equated to what you can make, what you can afford to buy and buy it now.
5.	Not passionate about any further education. Field is too broad and is difficult to stay focused.

Perceived Level of Preparedness

Students also showed some lack of confidence. They indicated a fear of graduate education and research. They also indicated that they don't see many role models at the graduate level. Lack of knowledge about graduate programs also was a factor here. It seems that students who were interested wanted more information along with some role models who could alleviate their fears about difficulty and rigor of graduate school education. A summary of major points in this area is included in Table 4.

Table 4: Summary of Focus Group Themes Related To The Level of Preparedness	
No.	Comments on the Perceived Level of Preparedness Theme
1.	Department's ranking was also an issue in the mind of a few students. Students are not aware of the number of schools accredited by the same organization as theirs.
2.	There was a general lack of information about grad schools. This may be due to the fact that they are not considering graduate school or recruitment efforts for graduate schools are not very strong. "It is my opinion that we do not have an abundance of role models we could emulate." "We need to create a "graduate school" mentality among our students."
3.	Perception as if other schools with more resources are teaching better and preparing their students at higher level. Other schools have a lot more resources; some fear other schools are very hard/ superior.
4.	Students are not aware of the general education focus placed on the undergraduate programs versus the special knowledge developed at the graduate level.
5.	Lack of emphasis on research at the undergraduate level. Students do very little guided research. Most schools do not offer a research methods undergraduate course. The closest they get to experimental design is in a second course of statistics which is compressed with management science topics into a single course offering (DSC 376 -- Statistics and Quantitative Methods). Lack of research preparedness. This had to do with perceived (or perhaps very real!) quantitative skills weakness. This affects the students' performance in calculus, statistics, management science, operations management, and other quantitative courses which serve as a foundation to do research.
6.	GPA isn't high enough/Afraid of GREs. Difficult to connect with other schools in graduate program.
7.	Undergraduate is challenging enough/Graduate school is too challenging

At the next step survey analysis was performed. A total of 153 surveys were collected. 18 surveys were excluded from the analysis as nothing was filled on those surveys other than the college name and other demographic information. The statistical analysis was done using SPSS 12.0.1. Summary of demographic information is provided in Tables 5 through 10. Most of the survey participants (68%) were junior level students. There was no significant difference in the sample composition according to classification of the students from three institutions. Over 90% of the sample respondents were between 20-24 years old. The majority of students were from urban areas (58%) and there was no significant difference based on urban-rural mix among three schools under study. Gender distribution (approximately 50% male and 50% female) was very homogenous. 38% of students reported their GPAs between 2.51-3.50; approximately 28% reported GPAs below 2.50 and 29% reported above 3.51 GPA. GPA distribution among the participating schools was very similar as well, however, VSU's students reported slightly lower overall GPAs.

This indicated that samples from the three different schools under considerations were very similar according to age, gender, urban background and GPA. Hence, it can be assumed that the overall sample was homogenous for statistical purposes.

Table 5: Frequency Count by Schools		
School Name	Type	Frequency
HU	Private	45
NSU	Public	46
VSU	Public	44
TOTAL		135

Table 6: Distribution of Classifications by Schools				
School	Freshman	Sophomore	Junior	Senior
HU	3	13	28	1
NSU	1	13	32	0
VSU	1	7	32	4
TOTAL	5	33	92	5

Table 7: Distribution of Age by Schools					
School	Under 20	20-22	23-24	25-26	over 26
HU	2	36	5	0	1
NSU	0	30	10	1	4
VSU	0	33	7	0	3
TOTAL	2	99	22	1	8

Table 8: Distribution of Urban-Rural Background by Schools		
School	Urban	Rural
HU	29	14
NSU	22	18
VSU	28	14
TOTAL	79	46

Table 9: Distribution of Gender by Schools		
School	Male	Female
HU	27	16
NSU	18	26
VSU	23	20
TOTAL	68	62

Table 10: Distribution of GPA by Schools					
School	2.00-2.50	2.51-3.00	3.01-3.50	3.51-4.00	Over 4.00
HU	10	6	8	17	2
NSU	9	12	13	4	5
VSU	19	7	5	8	3
TOTAL	38	25	26	29	10

Earlier focus group gave us some indications that students showed a lack of confidence in their preparation for graduate school. To further investigate this, we added four questions in the survey about their interest and understanding of mathematics and pure sciences and their relationship with computer science and related fields. Approximately 55% of students responding saw no relevance of mathematics courses with computer science courses (Table 11.) 90% of the responding students saw no relevance between pure sciences and computer science/information technology courses (Table 12.) This was a very high proportion of students who saw foundation courses (mathematics and physical sciences) for computer sciences being irrelevant to the curriculum. Although it is also clear from this fact that mathematics and physical sciences were not contributing to their perceived lack of preparedness. It needs further investigation to better understand the causal relationship as to why student feel they are not well prepared for graduate level education with various curriculum components.

Table 11: Distribution of Relevance of Mathematics by Schools			
School	Yes	No	Don't Know
HU	21	22	1
NSU	16	28	0
VSU	18	24	0
TOTAL	55	74	1

Table 12: Distribution of Relevance of Pure Sciences by Schools			
School	Yes	No	Don't Know
HU	6	31	7
NSU	9	34	2
VSU	2	37	3
TOTAL	17	102	12

The survey asked several questions about family, advisor, friends and teachers to determine their influence on student's inclination to attend graduate school. The instrument had a set of questions that were designed where students could indicate that they at least would consider graduate school as an option (see question numbers 40-44 in Appendix I). For further analysis a composite variable 'interest in graduate level education' was created. This composite variable had three levels for students' interest in the graduate education in computer science/information technology: 'yes', 'no', and 'no preference.' The positive interest was indicated via five separate questions on the questionnaire (Appendix I: question numbers 40-44), definitive lack of interest for graduate school was based on a larger question set of 16 questions in the instrument (Appendix I: question numbers 23-38) and the rest of students were considered to have no preference. A summary of interest in the computer science/information technology graduate school is provided in Table 13. Approximately 33% of students showed some level of interest in graduate education.

Table 13: Interest in Computer Science Graduate Education		
Interest Grad School	Frequency	Percentage
No Preference	19	14.1%
No	71	52.6%
Yes	45	33.3%

The cross tabulation of the interest in the graduate education data with students' classification showed a different picture (Table 10.) There was a significant drop in the "interest in graduate education variable" from sophomore to junior level. The drop was even more significant as they reached the senior level; however, sample size for the seniors was very small.

One of our objectives was to establish whether interest in computer science/information technology graduate education was influenced by family members, friends, advisors, teachers and administrators. There were nine different questions on the instrument asking students to describe their parents', siblings', professors', advisors', administrators', and friends' attitudes towards graduate education. These questions gave respondents wide latitude: seven levels ranging from "never discussed" to "insisting upon going to graduate school." After tabulation of responses for

the attitude towards computer science/information technology graduate education question for each group, a composite variable 'group member attitude toward graduate education' was created for each subgroup. The composite variable reduced the seven levels for attitude into two levels reflecting a positive attitude towards computer science/information technology graduate education and absence of a positive attitude towards computer science/information technology graduate education. Positive attitude was defined as the following response from the student about a group members' attitude: "think it would be good for me," "expect me to go" or "are insisting I go." If respondent selected any other choice for attitude towards computer science/information technology graduate education, then it was not considered positive. These choices included the answers "never discussed," "think I should not go," "leave it up to me" or "want me to go into a different field in graduate school."

Table 14: Distribution of Interest in Computer Science/Information Technology Graduate Education by Classification

Interest in Graduate School	Freshman	Sophomore	Junior	Senior
No Preference	60%	9.1%	14.1%	0.0%
Yes	20.0%	42.4%	31.5%	20.0%
No	20.0%	48.5%	54.3%	80.0%

To establish relationship between attitudes of different group members with students' interest in computer science/information technology graduate education, Pearson's bivariate correlation coefficients were calculated. Table 15 summarizes these correlation coefficients and shows the statistical significance (p-value) for a two-tailed test. Every peer group (siblings and friends) and every superior group (parents, and school officials) have statistically significant relationships with the students' interest in the computer science/information technology graduate education, except the college-graduate siblings. The result in the college graduate sibling subgroup may be influenced by the small sample size of that group (18% of surveyed students indicated having a college graduate sibling.)

It is important to note that a much higher degree of correlation exists between the interest in graduate education and positive attitude of professors, advisors and college administrators compared with any other group. It suggests that students who observe a positive reinforcement about graduate education from professors, advisors and administrators have a higher likelihood of considering graduate education. Among the family and friends, father's attitude has the highest influence on the student's interest in graduate education.

Table 15: Bivariate Correlation Coefficients Between Interest in Computer Science/Information Technology Education and Attitude of Various Groups		
Groups	Pearson's Correlation Coefficient.	Significance (2-tail)
Mother's Attitude	0.189	0.028
Father's Attitude	0.280	0.001
College_Graduate Sibling's Attitude	*0.108*	*0.213*
Non_College_Graduate Sibling's Attitude	0.173	0.044
Advisors' Attitude	0.328	0.000
Professors' Attitude	0.338	0.000
Administrator's Attitude	0.316	0.000
Close Friends' Attitude	0.200	0.020
Other Friends' Attitude	0.221	0.010

A similar correlation coefficient analysis was conducted to establish the relationship between four major theme areas identified during the focus group stage (Table 16). These factors were 'knowledge of graduate programs,' 'education preparedness,' 'need to work/financial considerations' and 'perceived value of graduate education.' All of the correlation coefficients were highly significant. These factors have negatively influenced the interest in graduate education. That is, if financial considerations are more important, then that student is unlikely/less likely to consider graduate education, at least, in near terms. Financial factors were at the top of the list in influencing the students' considerations regarding graduate school. However, the second most influential factor was knowledge of graduate schools' process and programs. The education preparedness was ranked third.

The survey analysis confirmed the focus group findings. However, during the focus group discussions students repeatedly question the value of graduate education in computer science/information technology compared with work experience and technical certifications. This factor had the lowest value of correlation coefficient with interest in graduate education. This factor needs further investigation.

The survey collected data on several demographic and other variables as well. The correlation coefficients between interest in the graduate program and these demographic variables were also calculated. The interest in graduate education was not significantly correlated to any of these variables. These factors were type of institution (public-private), age, gender, background and type of high school attended showed no significant relationship with interest in the graduate programs. More importantly, grade point average (GPA) and relevance of mathematics and science to computer science/information technology graduate curriculum had insignificant relationship with the dependent variable. The only other factor which showed significance was the education level

of father. A student whose father had no college diploma showed strong conviction towards finding a job rather than considering graduate education.

Table 16: Bivariate Correlation Coefficients between Interest in Computer Science/Information Technology Education and Other Independent Variables

Factors	Pearson's Correlation Coefficient.	Significance (2-tail)
Knowledge Graduate Schools and Programs	-0.500	0.000
Education Preparedness	-0.386	0.000
Want To Work/Need Money	-0.542	0.000
Value Technical Education/Experience	-0.303	0.000

CONCLUSIONS AND FUTURE RECOMMENDATIONS

Based on the results of the focus group and survey, several factors were identified that influence students to consider or not consider graduate education in computer science/information technology. These factors include both positive and negative factors. The positive factors include attitude of college superiors (teachers, advisors, and administrators), peer groups and family, especially father. The negative factors include a strong job market and highly compensated jobs in computer science/information technology, lack of information about graduate schools including the process of application, lack of perceived preparedness and poor market value (perceived or real) of graduate education. It was also found that factors like grade point average, age, gender, urban background, interest in mathematics or science do not have strong relationship with graduate education plans. Furthermore, the interest in graduate education drops significantly from sophomore level to junior level. Data showed significant drop at senior level as well but sample size was too small to confirm it.

It is evident from the data analysis that graduate education in computer science /information technology currently faces stiff competition from a strong job market in the IT sector. However, there are strong indications for possible steps which can be taken to increase students' interest in graduate education. We can make several recommendations. These recommendations include that schools should provide more information on graduate schools and admission process, organize frequent information sessions for family and if possible, simplify the graduate admission process. The graduate schools should facilitate aggressive mentoring programs through teachers, advisors, and administrators. These mentoring programs should start early like sophomore year. The schools should increase interaction with "peer-group" role models to alleviate the fear about preparedness and to enhance confidence level. It is important that students learn about graduates from their own schools or areas succeeding in graduate school to put to rest.

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REFERENCES

Armstrong, E., & Thompson, K. (2003). Strategies for Increasing Minorities in the Sciences. *Journal of Women and Minorities in Science and Engineering.* 9 (2).

Baylor, S. J. (2003). *Pursuing Critical Mass: The Coalition to Diversify Computing*. Retrieved January 5, 2004. Web Site: http://www.npaci.edu/envision/v14.3/cdc.html.

Boulding, M.E. (1985). Recruitment and Retention. In Landis, R.B. (Ed.), *Handbook on Improving the Retention and Graduation of Minorities in Engineering*. New York: The National Action Council for Minorities in Engineering, Inc.

Council of Higher Education Accreditation: CHEA (2000). *Research and Information*. Retrieved March 12, 2005. Web Site: http://www.chea.org.

Cohoon, J. M. (1999). Departmental Differences Can Point the Way to Improving Female Retention in Computer Science. *ACM: SIGCSE Bulletin*. 31 (1).

Cohoon, J. M., & Aspray, W. (2006). *Women and Information Technology: Research on Under-Representation*. Cambridge, MA: MIT Press.

Eide, E., & Waehrer, G. (1998). The Role of the Option Value of College Attendance in College Major Choice. *Economics of Education Review.* 17 (1).

Fletcher, S. L.; Newell, D.C.; Anderson-Rowland, M.R. & Newton, L.D.(2001). The Women In Applied Science And Engineering Summer Bridge Program: Easing the Transition For First-Time Female Engineering Students. In *Proceeding of 31th ASEE/IEEE Frontiers in Education Conference*, Reno, NV, October.

Gates, A. Q.; Teller, P. J.; Bernat, A. & Cabrera S. (1999). A Cooperative Model for Orienting Students to Research Groups. *In Proceedings of the 29 ASEE/IEEE Frontiers in Education Conference*, San Juan, PR, November.

Graham, J.M., Caso, R., Rierson, J., & Lee, J. (2002). The Impact of The Texas LSAMP on Under-Represented Minority Students at Texas A&M University's College of Engineering: A Multi-Dimensional Longitudinal Study. In *Proceedings of the 32nd ASEE/IEEE Frontiers in Education Conference*, Boston, MA, November.

Grandy, J. (1994). *Gender and Ethnic Differences among Science and Engineering Majors: Experiences, Achievements, and Expectations*. (GRE Board Research Report No. 92-03R) Princeton, NJ. (ERIC Document Reproduction Service No. ED388502).

Houston-Brown, C. K. (2002) Perceived Barriers To African Americans And Hispanics Seeking Information Technology (Doctoral Dissertation University of La Verne, La Verne, CA). *Dissertation Abstracts International,* 63, 06A.

Landis, R.B. (Ed.) (1985). *Handbook on Improving the Retention and Graduation of Minorities in Engineering.* New York: The National Action Council for Minorities in Engineering, Inc.

National Science Foundation (2000). *NSF Workshops Report on Underrepresentation of Women and Minorities in Information Technology*. (National Science Foundation Report Number NSF PR 00-40 - June 7, 2000.)

Nicholson, K., Hancock, D., & Dahlberg, T. (2007). Preparing Teachers and Counselors to Help Under-Represented Populations Embrace the Information Technology Field. *Journal of Technology and Teacher Education.* 15 (1).

Mitchell, Jr., D. (1997). Oklahoma Alliance for Minority Participation in Science, Mathematics, Engineering, Technology, and Education. (1997 Report for "Program Effectiveness" Reviews, NSF). Retrieved January 11, 2004. Web Site: http://ls-okamp.biochem.okstate.edu/images/stories/97PER.pdf.

Thom, M.; Pickering M., & Thompson, R.E. (2002). Understanding the Barriers to Recruiting Women in Engineering and Technology Programs. In *Proceedings of the 32nd ASEE/IEEE Frontiers in Education Conference*. Boston, MA, November.

Vegso, J. (2005). CRA Taulbee Trends: Ph.D. Programs and Ethnicity. Computing Research Association Survey. Retrieved April 15, 2006. Web Site: http://www.cra.org/info/taulbee/ethnicity.html.

APPENDIX I.

Survey Questionnaire--Interest in Graduate Study in Computer Related Fields

This questionnaire is part of an attempt to determine reasons why undergraduates decide to attend or not attend graduate school in computer-related fields of study. Your responses will help focus faculty efforts in the three schools engaged in this project to encourage graduate study. Please complete the following to best of your abilities.

1. What is your major?_____

2. What is your classification? Sophomore_____, Junior_____, Senior_____, Other_____

For Questions 3 and 4
Choose from the following descriptors for the highest educational level of your parents:

(1) non-high school graduate	(2) high school
(3) college but no degree	(4) technical school
(5) specialized military training	(6) associate's degree
(7) bachelor's degree	(8) post-graduate non degree
(9) master's, degree	(10) certificate of advanced graduate study
(11) doctorate	(12) post-doctorate
(13) other.	

Enter the appropriate number in the space provided.

3. Father____ Describe if other_____

4. Mother____ Describe if other_____

5. How many older siblings do you have?_____

6. How many preceded you in college?_____

For Questions 7 and 8
Which of the following best describes **your parents'** attitudes toward graduate school in a computer-related field for you:

(1) never discussed (2) think I should not go (3) leave it up to me
(4) think it would be good for me (5) expect me to go (6) are **insisting** I go
(7) want me to go into a different field in graduate school (8) other.

Enter the appropriate number in the space provided.

7. Father____ Describe if other_____
8. Mother____ Describe if other_____

For Questions 9 and 10

(1) never discussed (2) think I should not go (3) leave it up to me
(4) think it would be good for me (5) expect me to go (6) are **insisting** I go
(7) want me to go into a different field in graduate school (8) other.

Enter the appropriate number in the space provided.

9. College graduate sibling(s)____ Describe if other_____
10. Non college graduate sibling(s)___ Describe if other_____

For questions 11, 12, and 13,
In general, which of the following best describes **your professors'** attitudes toward graduate or professional school for you:

1) never discussed (2) think I should not go (3) leave it up to me
(4) think it would be good for me (5) expect me to go (6) are **insisting** I go
(7) want me to go into a different field in graduate school (8) other.

Enter the appropriate number in the space provided.

11. Advisor____ Describe if other_____
12. Professors who know you well ____ Describe if other_____
13. Administrators who know you____ Describe if Other_____

For Questions 14 and 15,
In general, which of the following best describes **your peers'** attitudes toward graduate or professional school for you:

1) never discussed	(2) think I should not go	(3) leave it up to me
(4) think it would be good for me	(5) expect me to go	(6) are **insisting** I go
(7) want me to go into a different field in graduate school		(8) other.

Enter the appropriate number in the space provided.

14. Closest friend____ Describe if other_____
15. Other students____ Describe if other_____

For Question 16,
As of today, list as many of the following that describe **your own** position toward attending graduate school in a computer-related field:
(1) I have not given it much thought
(2) I want to go to work
(3) I am not sure what I want to do after graduation
(4) I would like to go but I am afraid I will not qualify
(5) I would like to go but can't afford it
(6) I will definitely go
(7) I want to go into a different field in graduate school
(8) other.

Choose as many as applicable.
16. ____,___,____,____,____,____,____,___. Describe if other_____

Do not complete items 17-39 if you are definitely going to graduate or professional school in a computer related or other field. If you are planning on graduate study in a computer related field, please go to question number 40.

If you are currently not planning on graduate study in a ***computer science or related*** field, select a descriptor(s) from the list below that best reflects your reasoning. Please check as many as applicable.

___17. I do not have knowledge regarding graduate programs.
___18. I do not like complexity of grad school application process.
___19. I do not think I'll meet graduate school entrance requirements.
___20. I do not want to deal with the graduate school workload and difficulty.
___21. My undergraduate program did not prepare me for grad school.
___22. Graduate school is beyond my ability.
___23. I can get a job with a bachelor's degree where the pay is good, and I don't think grad school will pay off.
___24. I need to begin earning a living.
___25. I need a change of pace/lifestyle from college life.
___26. I am tired of going to school
___27. I believe my undergrad program will provide me with the skills needed to get a good job and that grad school will not add that much.
___28. I can't afford grad school.
___29. There are not enough scholarship opportunities from colleges and federal government.
___30. My family wants me to go to work.

___31. I am no longer interested in working with or studying computer-related topics.
___32. I should not have majored in a computer-related field.
___33. I value experience more than graduate education.
___34. I think management education is more important after my undergraduate degree.
___35. I don't see many good graduate computer science programs in the Historically Black Colleges Universities.
___36. I don't see many minorities' students in the graduate CS programs.
___37. I believe that technical certifications are more valuable than graduate school.
___38. I don't see many minorities' role models in computer sciences.
___39. Other, please describe_____

Please respond to questions from 40-44, **if you are currently planning graduate study in a computer related field**. Select all the applicable from the list below.

___40. Have you done guided research as an undergraduate?
___41. Have you written extensive research papers or technical reports other then course related papers?
___42. Have you had an internship while in college?
___43. Have you attended special programs for graduate school preparation?
___44. Have you had a cooperative education experience while in college?

Tell us something about yourself:

45. Gender M F

46. Age Under 20 20-22 23-24 25-26 Over 26

47. State of domicile_____

48. Your high school district is best described as: Urban_____ Rural_____

49. You have attended
(1) regular public high school (2) private/faith-based high school
(3) science and technology high school/program (4) magnet high school/program
(5) charter high schools (6) other.

Please select one of the above that describes your high school education the best _____
Describe if other_____

50. College GPA (1) 2.0-2.50 (2) 2.51-3.00
(3) 3.01-3.50 (4) 3.51-4.00 (5) Over 4.00

51. Number of courses you have already completed in an IT, CS, MIS etc. environment_____.

52. Do you think all mathematics classes required in the program have direct relationship with your current major?
Yes_____ No_____ Don't know _____

53. Do you think all pure science classes required in the program have direct relationship with your current major?
Yes_____ No_____ Don't know _____

54. Degree of your interest in the highest level of mathematics course you have taken, can be best described as:

Very high____ High____ Acceptable____ Low____ Very low____

55. Degree of your interest in the highest level of pure science course you have taken, can be best described as:
Very high____ High____ Acceptable____ Low____ Very low____

56. Are there any comments regarding the topics and issues referred to in this questionnaire that you would like to discuss?