Patching the Pipeline: A Community College Approach

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ABSTRACT

It has long been known that women are a critically under-represented group within the Computer Science community. Since Tracy Camp's (1997) landmark article "The Incredible Shrinking Pipeline", significant research has been done on the enrollment and retention of women in computer-related fields at both the K-12 and within the four-year college and university communities to examine why this phenomenon has continued to occur. However, limited research has been done at the community college level. In addition to many of the reasons cited about why women do not pursue careers in computer science at the community college level, the problem is further exacerbated by the fact that students, both men and women, tend to lack the fundamental math skills necessary to achieve successful careers in the computer and information sciences. Through a National Science Foundation (NSF) grant, The Community College of Baltimore County (CCBC) has established the Grace Hopper Scholars Program (GHSP) to determine whether the key to attracting more women to computer science and related technology fields lies in support for multiple applied learning opportunities, female role models and mentors, mathematics training or a combination of all the above. Project elements include a comprehensive recruitment strategy, bridge programs, specialized tutorial services, social activities, career advice, onsite company visits, and tuition reimbursement for a non-developmental math course.

Keywords: Enrollment trends, recruitment, retention, women in computing, mentoring, tutoring, two-year college programs

1.   INTRODUCTION

To encourage women to enter computer science and other technological fields, CCBC has developed the Grace Hopper Scholars Program in Math and Computer Science. The project is designed to increase the number of women who are qualified for careers in technology related fields by preparing them in the required math courses, providing an environment that will build their confidence and making them aware of the valuable opportunities and the impact they can make in this vital field.

Predictions are that by 2010, 47.9% of the workforce will be women (Bureau of Labor Statistics, 2005). However, other published reports state that women comprise about 20% of the IT professionals and receive less than 28% of the computer science bachelor's degrees (AAUW, 2000). As enrollment figures indicate for CCBC, 27% of the computer science enrollment was female during the fall 03 semester at the start of GHSP. Corresponding numbers lie at 41% for Internet and Multimedia Technology, 40% for Computer Information Systems, 23% for

Computer-Aided Design, and 52% for Computer Graphics and Visual Communication.

2.   ADVISORY BOARD & PERSONNEL

After receiving notice for funding by NSF, an advisory board was set to guide the Grace Hopper team in the decision making process and to inform administrators at the college about project goals. Due to retirement, illnesses, and an internal reorganization at CCBC, we have experienced extensive turnaround in personnel, but after a three-year period, we have a persistent core group of ten advisors in place who have given us valuable suggestions with respect to recruitment strategies, marketing materials and collaborations with four-year institutions.

The principal and co-principal investigators have experience in project management and in teaching computer science, computer information systems and mathematics. Our external advisory board includes representatives from Northrop Grumman Corporation, the president from WILDWOOD Environmental Engineering Consultants, Inc., the Director for the Center for Women and Information Technology at UMBC, the Dean of the School of Information Arts & Technologies from UB, and well respected faculty of Math and Computer Science from local two and four year schools. During the third and fourth year of the grant, we have seen an increased interest in GHSP from local four-year colleges and universities.

3.   RECRUITMENT AND THE APPLICATION PROCESS

Over a period of three years (fall 2004 through spring 2007) project staff has reached out to a total of 4250 college students with an overall response rate of 7.7% (328 out of 4250). Of those 328 students who have initially shown some interest in the program, 74 have applied. By means of the GHSP application form (see Appendix) we have collected demographic data by race, ethnicity and recruitment method. Some of our observations are reflected in TABLE 1.

Our applicant pool has been composed of 36.5% White, 39.2% African American, 21.6% Asian, and 2.7% Hispanic scholars. Figures for the groups of African American

and Asian scholars lie above their corresponding CCBC population percentages. The percentage of African American GHSP students has been 8% higher than the 31% of the CCBC fall 2006 credit enrollment and 3% higher than the percentage of a similar STEP scholarship program at the college (Sorkin, 2007). The GHSP leadership team has positively recognized the significant impact one Asian student has had on the GHSP enrollment. This student became a catalyst, and within one semester she recruited several of her peers as Grace Hopper Scholars. This attests to the importance of student-to-student interaction, which is discussed later on in this paper.

TABLE 1: CCBC Enrollment and GHSP Fall 2004 through Fall 2006 by Racial/Ethnic Group			
Racial/ Ethnic Group	% of CCBC Fall 2006 Credit Enrollment	Number of GHSP Scholars	% of Total GHSP Scholars
White	57%	27	36.5%
African American	31%	29	39.2%
Asian	5%	16	21.6%
Hispanic	2%	2[1]	2.7%
Other	5%	0	0%
TOTAL:	100%	74	100%
1) For purpose of data comparison survey answers from two students who had indicated White and Hispanic were counted as Hispanic.			

From student answers in the application form we know that recruitment has mostly occurred through faculty referrals (70.3%), followed by mailings (16.2%), news article/literature (6.7%), classroom visits by project staff to Intermediate Algebra, a remedial course, and non-developmental math courses (2.7%), and the GHSP website (2.7%)[4]. Only 1.4% of the students have left the question "How did you hear about this program?" in the GHSP application form unanswered. A minimal number of scholars came to GHSP through the Career Center, Student Success Center, and Project Start or Turning Point programs.

We have been increasingly successful in attracting new students by closely collaborating with a NSF-funded CSEMS (Computer Science, Engineering, and Mathematics) scholarship program (DUE-0422225) at CCBC. Application forms for both the CSEMS Scholarship and the Grace Hopper Program

were routinely distributed together, and recommendations of students from one program to the other were highly successful. From fall 2004 through spring 2007 14.9% (11 out of 74) of the Grace Hopper Scholars have received CSEM scholarship money for at least one semester, and 5 returning students have taken it to their four-year transfer institutions.

Recruitment of scholars through Accuplacer placement testing on the other hand has not been successful. Only 1 of the 74 scholars who came from the group of students whose test scores indicated readiness for College Level Math (CLM), applied to GHSP. At CCBC, these students tend to show a strong preference for careers in nursing, pharmacy and business. In addition, GHSP faculty have represented the program at several area high school Open Houses and Career Fairs, and the program brochures have been provided to several community organizations to support women.

Students who want to participate in the program are required to fill out an application form and sign a participation agreement. Through experience, we have found that a clear explanation of the program's benefits and a simplified list of student expectations greatly shortened the application process. In turn, this left prospective students at ease to sign on and commit to GHSP. Although commitment can come at many levels, in order to qualify for a $300 tuition reimbursement, the participation agreement originally required scholars to agree to attend a summer and winter bridge program, at least one social event per semester and to communicate with their mentor at least twice a semester. Due to the increasing number of students who already had experience in developing web pages, the winter bridge requirement was subsequently dropped. Over time we have revised the application requirements, which currently ask for a three hundred-word essay and only one letter of recommendation instead of two. In the essay students are asked to describe themselves, their strengths and what characteristics they feel they possess that will make them successful in the program. The majority of women who applied to GHSP felt driven and passionate about working with the computer. Many viewed GHSP as a stepping-stone to the next level of their career and were eager to reach that goal. The

letter of recommendation generally commented on the scholar's motivation, desire and ability to collaborate with others.

4. MENTORING

Mentoring is a key component to student success. An extensive internal support structure has been established to assist students in achieving their goals. Each scholar is assigned a mentor from business or academia, and every attempt is made to match scholars with mentors in the same field. However, some of the more successful pairings came when the mentors and scholars had more personal things in common, such as working out at the gym or watching sports. Most of the mentors have completed a mentor training session conducted by the Maryland State Mentoring Resource Center. Guidelines for interaction between GHSP mentors and mentees have been outlined in a mentor directory posted on the GHSP website. Although more frequent communication is encouraged, communication between scholars and mentors must occur at least twice a semester. The first time is usually a few weeks into the semester to make sure the student is not struggling with academic activities. The second contact is usually towards the end of the semester, in order to plan future class schedules. Mentors are also required to keep a log of communication between themselves and their scholars. An excerpt is printed in TABLE 2 located in the Appendix. For privacy reasons, the names of mentors and mentees have been omitted.

5. TUTORING

Being a community college, CCBC has an open enrollment policy. Therefore, it is not surprising that seventy percent of students entering CCBC require at least one developmental math course. Since many of the computer related programs require more than one non-developmental math course, it was important to offer support, in the form of tutoring, for all math courses related to technology fields. Face to face tutoring is available at no cost to any CCBC student. However, schedules have made it increasingly difficult for students to come on campus for help. Working with the Coordinator of Tutoring, we have established an online tutoring site for every math course associated with every technology degree or certifi-

cate program, as well as all remedial math classes.

Since we have been unable to find tutors that are both willing and qualified to tutor courses beyond Calculus, we do rely on faculty tutoring for our Discrete Math and Linear Algebra courses. Faculty are not paid for tutoring, however it serves as part of their service to the college for their annual review. We currently have seven volunteer faculty as part of CCBC's online Math tutoring. By working within CCBC's existing structure, we are able to utilize trained tutors and experienced faculty to enhance learning for all CCBC students at no additional cost to the college.

6.   STUDENT-TO-STUDENT SUPPORT

Quoting Astin (1993), Felder (1993, p.398) noted "...the student's peer group is the single most potent source of influence on growth and development during the undergraduate years." Therefore, we felt it was essential to give our scholars an opportunity to get together as a group. We achieved our goal through several bridge programs and social events.

The winter bridge program allowed scholars to learn fundamental web design principles. They also could chat with each other in an online chat room and post messages on the online discussion board. After the first year, the online discussion board was monitored by one of the GHSP scholars. Scholars who attended the winter bridge were expected to create two web pages. The first was about themselves and how the GHSP has enhanced their learning. The second was about their mentor. This gave the students another opportunity to connect with their mentors and learn about them in a more personal way.

Annual summer bridge events were held in consecutive years from August 2004 through August 2006. We started out on the Essex Campus and then expanded to CCBC's Catonsville Campus. Schedule dates were carefully planned, and events, when possible, promoted and coordinated with staff from the School of Applied and Information Technology.

Each summer bridge event began with students interviewing each other in groups of no more than three people. Once the ice-breaking session was completed, topics went

on to include help with general college life such as meeting with the director of the Student Success Center to learn about test anxiety and particularly math anxiety. This led to sessions on Learning Styles and how the same lecture can be presented in different ways. Scholars who participated in this activity also took ELSIE or the Edmonds Learning Styles Identification Exercise (Reinert, 1997). Many students did not realize that people learn in different ways. This led to a discussion on how students can modify any classroom setting to their own personal learning style.

During our first two summer bridge programs, faculty also taught sessions on calculator usage, algebraic skills, conducting research on the web, and using Multimedia tools such as Camtasia. Since our scholars have diverse goals, we allowed our summer bridge program to evolve. During the third year we provided them with the opportunity to meet CCBC's Director of Internships for a session on interviewing skills. We added career panels and round tables led by female role models and student peers from four-year colleges to the agenda (see TABLE 3 located in the Appendix).

As the summer bridge program evolved, so did our survey questions as a means to elicit feedback. Despite slight modifications each time, the commonalities in all surveys were several open-ended questions and responses to statements such as "Overall I found the sessions useful" and "Overall I found the sessions interesting". (See TABLE 4 in the Appendix - Sample GHSP Summer Bridge Questionnaire administered during the bridge event on the Catonsville Campus on June 23rd, 2007).

Data show that from a pool of 16 students, who had completed the questionnaire, all agreed or strongly agreed that the summer bridge sessions were useful. Fifteen of the 16 agreed or strongly agreed that the sessions were interesting. Answers to other questions revealed that Grace Hopper scholars rated the input from career panels and discussion groups highly and appreciated hearing about the different paths female role models had taken to establish their successful careers in technology. Students loved the opportunity to network, and for some scholars networking has proven beneficial in securing job referrals. When asked "what

would you like to change in a future summer bridge?" one student in particular suggested that it would be nice to listen to former Grace Hopper Scholars talk about their experiences as the program takes off.

To make sure scholars had fun, social activities, such as pizza nights, movie nights, visits to four-year schools, and field trips to local businesses were also arranged. Many of the best practices we used can be found online in "One Hundred One Ideas for a 'Women in Computing' Group" (Townsend, 2004). For many of the social activities, participants were invited to bring their children. While attendance at the summer bridge events was around 50% or higher, unfortunately only about 10% of our scholars came to any one given social event.

7.   CONCLUSIONS

Over the past four years several dedicated faculty and staff have implemented the Grace Hopper Scholars Program at The Community College of Baltimore County (CCBC) to address the shortage of women and underrepresented groups in computer science and related technology fields. Many of the techniques used by four-year schools have met with some success at CCBC. Mentoring and summer bridge programs are among our successes. However, having organized social activities, such as movie nights have met with limited success. We attribute this in part to the fact that we are a commuter school and therefore do not have students who live on campus. Our students tend to work at least twenty hours a week at off campus jobs, have a wide variety of work schedules, school schedules and family obligations, making attendance at social events difficult.

Until the Grace Hopper Scholars Program, CCBC had never attempted to implement a recruitment strategy specifically geared toward women and technology. Some of our initial recruitment strategies have not given us the results we desired. Each year from 2003 – 2005, a different faculty member from the Women's Studies program was in charge of recruitment. During 2005 – 2006, recruitment was done by the same faculty members from the Mathematics and Computer Information Systems departments. From fall 2003 to fall 2005 enrollment for both genders took a sharp decline in com-

puter science, general information technology, multimedia technology, computer-aided design, and computer graphics and visual communication. As data from internal CCBC reports indicate, male enrollment went down from 963 to 598 students (a 37.9% decrease), while female enrollment had an even higher decrease from 625 to 303 students (a 51.5% decrease). From fall 2005 to fall 2006 male enrollment increased slightly by 1.5%, while female enrollment still showed a moderate decline of 7%. Although the Grace Hopper Scholars Program has not achieved its goal of increasing the number of women in technological fields, we seem to have at least been able to greatly lower the decline in enrollment, and have supported women in technology in achieving their goals. Over time, our recruitment strategies have improved. As stated earlier, students who enter CCBC prepared to take college level math tend to be interested in nursing, pharmacy and business. Having recruitment done by faculty within the fields of Mathematics and Technology has given us more access to students who are inclined to be interested in technology. Of our 74 scholars, 26 either transferred to four-year institutions and/or received an Associate's Degree. The GHSP transfer rate of 34% is about 10% higher than the overall CCBC four-year transfer rate in 2002 (MHEC, p. 26). Twenty-two out of 74 students (29.7%) have completed at least 45 credits towards their career goal and/or have received an AA/AAS Degree, but did not transfer. Twenty-six are still enrolled in the program, but have completed less than 45 credits. These students are not among those previously accounted for by transfer. Being a community college, we were not surprised by this number due to the percentage of part-time students we have at the college. At the present time, one student has transitioned into full-time employment in a computer field, several are near graduation at four-year institutions, and three scholars have started their own businesses.

8.   ACKNOWLEDGEMENTS

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APPENDIX:

TABLE 2: CCBC Grace Hopper Scholars Mentor Program Updated: November 16, 2005 Excerpt of Mentor Log			
Mentor Name	Mentee Name	Number of Contacts with Mentee	Mentor Concerns or Comments about Mentee's Progress
Mentor 1	X	2	X really is doing well. She emailed me about Dr.C's broken ELMO link for practice exams. She is a bit worried about Linear Algebra. We have had emails (2 each) so far this semester. We are having lunch on Tuesday to talk more. 11/3-- I just wrote X a letter of recommendation for UMBC. She said she was doing fine.
Mentor 2	Y	1	Y is not taking any classes this semester. She intends to take classes next spring.

TABLE 3: GHSP Summer Bridge 2006 Schedules CCBC Catonsville Campus	
June 16th, 2006	June 23rd, 2006
- Icebreaker Breakfast - Introductions - Grace Hopper Web Search Activity - Student Panel (Transferring to a University) - First Grace Hopper Mathematics Engineering Computer Science Club Organizational Meeting - Picnic lunch with SAIT faculty	- Meet and Greet Breakfast - GHSP Program Expectations - Election of Grace Hopper Mathematics Engineering Computer Science Club Candidates - Career Panel - Lunch - Introduction to WEB Pages - Job Interviewing Skills - Wrap up

TABLE 4: Sample GHSP Summer Bridge Questionnaire CCBC Catonsville June 23rd 2007					
	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Overall I found the sessions useful.					
Overall I found the sessions interesting.					
The topics discussed by the career panel motivated me to stay the course in my career.					
The exercises and the picnic helped me bond with other participants.					
The web design workshop gave me a good introduction and the confidence for the design of my own webpage in the winter bridge.					
In the interviewing session I learned techniques and insights how to master the last step to getting a job.					
Open ended Questions:					

1. What did you like BEST?

2. What presenter(s) did you find most stimulating?

3. What did you like LEAST?

4. What would you change in a future summer bridge?

Grace Hopper Scholars Program (GHSP)

Personal Data

Name: _____   Date: _____

Street Address: _____   Apt. #: _____

City: _____   State: _____ Zip code: _____

Phone #: _____   Email: _____

Social Security #: _____   Gender: ☐ Female   ☐ Male

Date of Birth: Month: _____ Day: _____ Year: _____

The following information is needed for reporting to the National Science Foundation:

Ethnicity: ☐ Hispanic or Latino   ☐ Not Hispanic or Latino

Race: ☐ American Indian or Alaska Native   ☐ Asian   ☐ White

☐ Black or African American   ☐ Native Hawaiian or Other Pacific Islander

Disability Status: ☐ Hearing   ☐ Vision   ☐ Mobility   ☐ Learning   ☐ Other _____

Are you currently employed. If so, how many hours per week? _____

How did you hear about this program? _____

The following information is required for our selection committee in order to assess your eligibility:

Are you currently a student at CCBC?   ☐ Yes   ☐ No   Campus: _____

G.P.A.: _____

How many credits have you completed? _____

How long since you last attended an educational institution? _____

What is the name of that institution? _____

Applicants to the GHSP must have completed the Accuplacer Math Exam. What was your Accuplacer score? (If you have not taken the Accuplacer exam, please contact the testing center on your campus.) _____

What is the highest level math course you have completed? _____

Requirements for all GHSP applicants:

1. Attach on a separate sheet of paper a typed, double-spaced essay (maximum 300 words or one page) about your strengths, highlighting characteristics that you think would make you a successful applicant to this program.

2. Include two letters of recommendation commenting on 1) your persistence and motivation and 2) your desire and ability to collaborate with and assist others.

I understand that as part of the GHSP, there are several required bridge programs held during the summer in the weeks before classes begin and during the winter intersession. I will receive further information about these if I am selected.

Signature of Applicant: _____