Peer Mentors and Their Impact for Beginning Programmers

Ken Hartness
hartness@shsu.edu

Li-Jen Shannon
Lys001@shsu.edu

Sam Houston State University
Huntsville TX

Abstract

The Computer Science department at SHSU is currently employing student mentors to assist with recruitment and retention. The primary purpose of these students is to help frustrated new majors in the beginning programming course realize that they are not alone in their struggles and to assist the students over hurdles in their learning and skill development. We examine the impact of peer mentors on students, including a breakdown of that impact across underrepresented groups.

Keywords: mentoring, retention, tutoring, social networks

1. INTRODUCTION

The Bureau of Labor Statistics in the U.S. Department of Labor predicts 34% growth in software engineering and 17% growth in IT management positions between 2008 and 2018 (Bureau of Labor Statistics, 2010a, 2010b). Enrollment in computer science, computer engineering, and information systems is increasing, although evidence suggests that work still needs to be done on recruiting and retaining capable students who will complete these degrees (Zweben, 2009). However, the reported number of majors does not begin to match the predicted growth of the field, even without considering the retirement and promotion of current IT workers.

Efforts need to be made across the education spectrum to attract and retain individuals to help fill this need. At the college level, we can take steps to ensure that capable majors do not become unnecessarily frustrated and discouraged without lowering our expectations; some of these same steps can create an environment that will attract students who did not, at first, consider a computer science or information systems major.

In 2009, the Texas Workforce Commission awarded SHSU the Texas Youth in Technology grant as part of an effort to recruit and retain students in technology-related majors. In addition to scholarships and travel money to bring us to high schools and bring high school teachers and counselors to us for workshops, the grant included a payroll budget for up to ten students who would act as peer mentors and support our recruitment efforts.

Students who are programming for the first time may view coding errors as a personal failure on their part, getting frustrated as hours pass without success. Some students, upon seeing a correction increase the number of reported syntax errors, will immediately re-introduce the

original error to make the numbers go back down (D'Souza et al., 2008). They need to be reassured that errors are normal and that they have someone to which they can turn if they are unable to make progress. Students are more likely to seek assistance from a fellow student closer to their own age than they are a graduate student or, especially, a professor (Miller & Kay, 2002). The authors disliked "bothering" professors with questions, often thinking that they expected us to be able to design a solution without their assistance. However, we welcomed and occasionally sought advice from our fellow students. Asmar et al. (2000) stated that Freshmen view their peers as their most important support system; also, new majors will often change to a different major if no peer interaction is easily available (Barker, McDowell & Kalahar, 2009).

The department is very excited about the mentoring program, and the students appear to view it as a very positive addition to our program. A number of majors, including the mentors, themselves, have expressed regret that peer mentors were not available when they were starting the major.

We have conducted surveys of students before and after they have participated in the mentoring program and present our findings regarding the perceived impact of the mentoring program across gender and ethnicity. In addition, we share some lessons learned and ideas for the future.

2. CURRENT DUTIES OF MENTORS

The CS major at SHSU begins with a course in beginning programming using the Java programming language and includes a lab for hands-on work. A second course introduces basic data structures and deepens their understanding of algorithms and Java. Ten undergraduate students, many of whom are within a year of taking these courses, work with the students currently enrolled in these courses to help them understand course material, assist them over a mental block that is preventing them from completing assignments, and simply assure them that problem solving is sometimes difficult for everyone.

The ten more experienced undergraduate students are employed primarily as mentors. One to three mentors are assigned to a lab so that students get to know them and can ask for assistance without having to wait for the instructor or lab assistant to become available. Mentors are encouraged to be pro-active, ensuring that students have their e-mail or phone number, offering struggling students extra tutoring outside of class, and organizing study groups to help clarify issues and review for exams. In order to meet the needs of students who don't want to wait for the next lab or even e-mail reply, mentors are required to maintain known office hours so that students can seek assistance outside of class. Originally, students were required to come to an actual office to meet with mentors face-to-face, but the department has recently organized an independent computer room that can be used as a work area for the students; the mentor can then maintain a visible presence in an area where the students may choose to work, in any case.

In addition to their duty to support the beginning students, the mentors also assist us with recruitment efforts. Depending on their skills, they may assist us with the development or updating of recruitment videos, presentations, and tutorials. The presentations inform high school students, teachers, and counselors of the ways in which our major can help people achieve technology-related goals and inform them of related job opportunities. The tutorials are offered as part of a teacher workshop and provide teachers with tools that can encourage students to learn computational thinking and develop an interest in how technology can be used to accomplish goals. Mentors are also sent to high schools to make presentations for classes and at career fairs to let students know about the major and its opportunities.

By participating in these presentations and workshops, we hope that the mentors, themselves, will develop a better understanding of the major and the job opportunities to which it may lead. Ideally, mentors should be able to offer guidance and advice from their slightly greater experience that can impact students' college experience and awareness of career choices while helping them build a solid foundation for the major.

3. IMPACT OF MENTORS

Instructors of the beginning programming course often express their appreciation of the mentoring program. In order to evaluate the impact of the mentors on the students, themselves, we surveyed the students at the beginning and at the end of the semester. Then, we broke down the results into different groups to see if the mentors had a greater impact on

any particular group, such as underrepresented groups.

Methodology

In spring 2010, the enrollment was 115 from Introduction to Programming (87) and Introduction to Data Structures (28). The collected post-program survey sample was 56 which made a 48.7% of participation rate. The survey was constructed with a total of 14 questions divided into two parts (see Appendix A). The first part is constructed from seven demographic information questions with multiple-choice selection. The demographic questions included the age, ethnicity, gender, classification, transfer students, state financial aid support, and the methods of seeking help from a mentor. The second part included six Liker-scale questions and one open question regarding the students' expectation of the mentoring program (based on 5 scale system: 1 as being the least and 5 as being the most value). The Liker-scale questions allowed us to discover students' perception of the degree to which the mentor assisted their success in the course, impacted their college life, helped them select their future career path, participated in building a solid foundation in the major, and made them feel more a member of the department "family." The demographic questions allowed us to compare groups based on gender, ethnicity, and the degree to which they made use of a mentor either in the lab or outside class.

Analysis

The research hypotheses to be tested were as follows:

H1: The mentoring program has a profound impact on those who take full advantage of it.

H2: Students of underrepresented groups will find the mentoring program to be of higher value than others.

To test these hypotheses, the Statistical Package for the Social Sciences (SPSS) version 17.0 was utilized to determine if significant differences existed among the students' demographic information and their responses for each research question. Data was analyzed with independent t-test, cross tabulations, and analysis of variance (ANOVA).

Findings

Overall, students agreed that the mentoring program was valuable. Our impression that underrepresented groups might not be as confident and, thus, perceive a greater value in the program was not reflected by the results, largely because all groups valued the program, highly, at least with regard to its support of the course, itself.

Seventeen female (30.4%) and thirty-nine male (69.6%) samples were collected from this study. We found that there was not a statistically significant difference between genders in all of the post program survey items (see Table 1 in appendix 2). However, the females' mean scores were lower than the males' mean scores, except, specifically, for the question about the mentors' assistance in the course; female participants valued the mentors' assistance in the course more highly than male participants (see Table 2 in appendix 2).

Regarding the utilization of mentors by students, this study found that all of the female students used the mentoring program. 53% only used mentors during the lab time, and 47% took advantage of mentor support outside of lab, as well. For male students, 2 male students reported that they did not use mentors at all and 1 male student only approached mentors outside of lab. 41% of males stated that they only used mentors during the lab time; 51% used mentors both in and out of lab time (see Table 3). Since there were only one or two students who responded to the items of "Did not use mentors" and "only use mentors outside of lab", we will ignore these two items for the rest of the analysis.

We found that there are no statistically significant differences among ethnic groups in all of the post program survey items (see Table 4). However, certain trends were observed in the mean scores; due to the small sample size, particularly among underrepresented groups, further data should be collected to confirm these trends. This study found that the mean score from the Hispanic group is higher than the rest of the ethnic groups' mean scores on almost every item (see Table 5). Moreover, we found that the African American group joined the Hispanic group as the top two groups who value the mentor program and stated that the mentors did indeed assist with their success in the course.

To verify the validity of the feedback, we also added the one-sample t-test to compare with a value of 2.75 (above average from 5 point scale) to determine to what degree the students evaluate each survey item. We found that each survey item showed statistically significant

difference (see Table 6), except the items that asked if mentors were of assistance to the students in their college life, in general, and their future career path. We were not surprised to see those two items show a minor lower score than the rest of the survey items, because the beginning programming course is used to introduce programming to other majors who often question why they must take it. One of the students provided the following statement: "I am an MIS minor so the mentor didn't really need to help with my success in college life or my future career path, but he was very helpful with my [course] work."

Based on the feedback and the statistical analysis, we confirmed Hypothesis 1, the mentoring program has a profound impact on those who take full advantage of it. The breakdown by student participation with mentors proved unnecessary as even those who did not utilize the mentors recognized their value. Hypothesis 2, students of underrepresented groups will find the mentoring program to be of higher value than others, was not significantly confirmed because all groups found the mentoring program helpful and the number of members in underrepresented groups was too small for firm conclusions in this case. However, the numbers do suggest that underrepresented groups do value the program slightly more in helping them get through the first major courses.

Students' Thoughts about the Mentoring Program

At the end of the survey, we asked the participants to provide some feedback about the mentoring program they experienced. There were 20 responses provided, all of which constituted positive feedback. To reach the goals of our mentoring program, we are glad to hear that there were significant and positive impacts in the mentees' learning and future plans. The following are some common statements we found:

For Mentors:

"Always ready to help."

"I appreciate the help they have given me."

"Mentors were very friendly, understanding, and helpful."

"The mentors helped a ton!"

"Very kind and patient."

"Very patient and helpful. Also very nice."

"They were all very great and helpful."

For Mentoring Program:

"I think the mentor program is excellent."

Impacts in their Learning:

"I felt that the mentors in my lab greatly helped me in developing in Java programming."

"I would like to help people when they need it."

"They helped me understand the basic concepts behind the subjects in the class and helped me be successful in the lab and class."

Contrary to expectations that students who refused to take advantage of the program might not appreciate it, one of the students who did not use the mentor stated that "I never really used the CS mentors. They rocked though!"

4. FUTURE POSSIBILITIES

We were awarded a grant that allows us to pay our mentors. We have been forced to handle a small number of situations where students were just looking for any job and were not mature enough to handle flexible hours and remain sufficiently pro-active about helping students. Many of our mentors, however, have truly risen to the challenge and exceeded our expectations. It may be that a system of rewards for volunteer mentors might address that issue. If students are only paid in experience and opportunities, then only motivated students would apply. At some point, we may want to try motivating participation with something other than money.

Our students, some of whom have little support from parents, tend to feel pressure to take a job while in college, so we were concerned that volunteer mentors would not spend enough time working with students between the requirements of their job and their own classes. However, some of our better mentors actually push themselves to maintain a second part-time job while continuing to maintain high involvement with their students, so this reasoning may be flawed. Consistently well-motivated students would have an even stronger impact on new majors.

Mentors report learning valuable leadership and communication skills while also improving their own understanding of the field as they try to determine how to explain aspects of it to their students (Miller & Kay, 2002). If these advantages are, by themselves, insufficient to motivate participation in the mentoring program, other rewards that would appeal to better

students might be used, such as the opportunity to take classes for honors credit or the opportunity to work on professors' research with the option to gain credit in an independent study course.

Studies have shown that students gain a greater understanding of the possibilities of their area of study and its appropriateness for them through greater professor-student interactions (Crenshaw et al., 2008) and are more likely to stay in a major with healthy peer networks (Barker et al., 2009). Rather than consider these concerns in an isolated fashion, departments should make an effort to integrate professor and peer mentoring throughout their program. The computer science department at Appalachian State University seeks to make mentoring a priority by establishing it as the natural behavior for interactions between professors and students (Tashakkori, Wilkes & Pekarek, 2005). Professors write prescriptions for students in need of help and occasionally participate in peer mentor sessions to offer guidance to the mentors at least as much as the mentees, helping both to learn from the experience. In addition, more advanced students are selected to work directly with professor and graduate student mentors on more advanced material related to research.

Many mentoring programs referenced here rely on volunteer participation. Rather than paid tutors, the goal is to create "communities of scholars" (D'Souza et al., 2008). Although paying for basic assistance during labs might still make sense, utilizing every student with a willingness to serve could conceivably meet students' needs more effectively. Advanced mentors could help new mentors as well as students in sophomore or junior level courses. Mentors enrolled in sophomore and junior level courses would help new majors in the freshman level courses. The instructors would meet with mentors helping their students, and the advanced mentors would work directly with professors who would share their research and teaching experience. Mentoring would become an accepted part of the learning experience instead of a part-time job.

4. CONCLUSIONS

Healthy IT salaries in the United States make it easy for countries with growing technological expertise to compete. Failure to inspire students to prepare for technology-related careers will logically require that industry look elsewhere for their technological needs. When technology-related jobs and technological innovation are primarily overseas, how will this affect the U.S. economy and our own ability to keep IT and CS departments active?

No doubt a media campaign and K-12 education reform are necessary components of any long-term plan to improve the strength of U.S. technology, but the truth remains that many students are getting frustrated and considering a change of major before they truly see what is possible in the major. Making the mentoring of students a priority is one step we can take toward meeting the needs of industry and our economy. Recruiting mentors from underrepresented groups will also provide role models to other members of those groups; however, mentoring benefits everyone.

5. REFERENCES

Asmar, C., Brew, A., McCulloch, M., Peseta, T., & Barrie, S. (2000). *The First Year Experience Project: Report May 2000*. Institute for Teaching and Learning, University of Sydney.

Barker, L., McDowell, C., & Kalahar, K. (2009). Exploring factors that influence computer science introductory course students to persist in the major, *SIGCSE '09: Proceedings of the 40th SIGCSE Technical Symposium on Computer Science Education.*

Bureau of Labor Statistics, U.S. Department of Labor (2010a). Computer and Information Systems Managers. *Occupational Outlook Handbook, 2010-11 Edition*. Retrieved June 14, 2010, from http://www.bls.gov/oco/ocos258.htm

Bureau of Labor Statistics, U.S. Department of Labor (2010b). Computer Software Engineers and Computer Programmers. *Occupational Outlook Handbook, 2010-11 Edition.* Retrieved June 14, 2010, from http://www.bls.gov/oco/ocos303.htm

Crenshaw, T., Chambers, E., & Metcalf, H. (2008). A case study of retention practices at the University of Illinois at Urbana-Champaign, *SIGCSE '08: Proceedings of the 39th SIGCSE Technical Symposium on Computer Science Education*.

D'Souza, D., Hamilton, M., Harland, J., Muir, P., Thevathayan, C., & Walker, C. (2008). Tranforming learning of programming: A mentoring project, *Proceedings of the 10th Australasian Computing Education Conference (ACE2008)*.

Field, A. (2000). *Discovering statistics using SPSS for Windows.* Thousand Oaks, CA: Sage Publications.

Miller, A., & Kay, J. (2002). A mentor program in CS1, *ITiCSE '02: Proceedings of the 7th Annual Conference on Innovation and Technology in Computer Science Education*.

Tashakkori, R., Wilkes, J., & Pekarek, E. (2005). A systemic mentoring model in computer science, *Proceedings of the 43rd Annual ACM Southeast Regional Conference* 1, 371-375.

Zweber, S. (2009). Upward trend in undergraduate CS enrollment; doctoral production continues at peak levels. *Computing Research News*, May 2009. Retrieved June 14, 2010, from http://archive.cra.org/statistics/survey/0708.pdf

Appendix 1

Mentee Survey: Post-Program Survey

Name: _____ Date: _____

Demographic information: Please circle the proper status.

Age	Younger than 18	18	19	20	21 and older
Ethnicity	African American	Asian American	Hispanic American	Caucasian American	Other
Gender	Female	Male			
Classification	Freshman	Sophomore	Junior	Senior	
Transfer Student	Yes	No			
State Financial Aid Support	Yes	No			
Sought help from mentor	Never	In Lab	Outside class		Both

Please answer the following questions based on a 5 scale-system: 1 as being the least and 5 as being the most value.

To what degree have you benefited from your participation in the mentoring program in the Computer Science Department?

1 2 3 4 5

To what degree do you believe the mentor assisted your success in ***your course***?

1 2 3 4 5

To what degree do you believe the mentor assisted your success in ***your college life***?

1 2 3 4 5

To what degree do you believe the mentor assisted your success ***in selecting your future career path***?

1 2 3 4 5

To what degree do you believe the mentor assisted you with ***building a solid foundation in the major***?

1 2 3 4 5

To what degree do you feel the mentoring program helped you feel ***more a member of this community***?

1 2 3 4 5

Please share your thoughts on other ways that the mentoring program has assisted you:

Appendix 2

Analysis

Table 1. Gender Independent Samples Test

Survey Item	*t*	*df*	*Sig. (2-tailed)*
Benefitted from Mentor Program	-1.570	52	.122
Assisted with success in this course	.624	54	.535
Assisted with success in college life	-.051	54	.960
Assisted in selecting future career path	-1.622	54	.111
Assisted in building a solid foundation in the major	-.519	54	.606
Helped you feel more a part of this community	-1.687	54	.097

Table 2. Gender Group Statistics

Survey Item	*Mean*		*Std. Deviation*	
	Female (*N*=17)	Male (*N*=37)	Female (*N*=17)	Male (*N*=37)
Benefitted from Mentor Program	3.823	4.243	.951	.895
Assisted with success in this course	4.471	4.333	.717	.772
Assisted with success in college life	3.059	3.077	1.197	1.244
Assisted in selecting future career path	2.647	3.231	1.367	1.180
Assisted in building a solid foundation in the major	3.882	4.026	.857	.986
Helped you feel more a part of this community	3.412	3.974	1.372	1.038

Table 3. Gender related seeking help from the mentors

Participation	*Female (N=17)*	*Male (N=37)*
Did not use mentors at all	0 (0%)	2 (5%)
Only use mentors during lab	9 (53%)	16 (41%)
Only use mentors outside lab	0 (0%)	1 (3%)
Use mentors both during and outside of lab	8 (47%)	20 (51%)

Table 4. Ethnicity ANOVA Test

Survey Item	*Mean Square*	*F* (*df*=4)	*Sig.*
Benefitted from Mentor Program	1.027	1.220	.314
Assisted with success in this course	.597	1.059	.386
Assisted with success in college life	.759	.492	.741
Assisted in selecting future career path	.429	.257	.904
Assisted in building a solid foundation in the major	.951	1.073	.380
Helped you feel more a part of this community	1.073	.910	.465

Table 5. Ethnicity Descriptive

Survey Item	*Mean of Ethnicity Groups*				
	Africa American *N*= 8	Asian *N*= 4	Hispanic *N*= 6	Caucasian *N*= 33	Other *N*= 3
Benefitted from Mentor Program	4.250	3.500	4.667	4.091	3.667
Assisted with success in this course	4.500	4.000	4.500	4.429	3.667
Assisted with success in college life	2.625	3.250	3.500	3.057	3.333
Assisted in selecting future career path	2.875	3.250	3.500	3.000	3.000
Assisted in building a solid foundation in the major	3.875	4.000	4.333	4.029	3.000
Helped you feel more a part of this community	3.875	4.500	4.167	3.714	3.000

Table 6. One-Sample Test

Survey Item	*Mean*	*t*	*df*	*Sig. (2-tailed)*
Benefitted from Mentor Program	4.111	10.815	53	.001 **
Assisted with success in this course	4.378	16.165	55	.001 **
Assisted with success in college life	3.071	1.973	55	.053
Assisted in selecting future career path	3.054	1.808	55	.076
Assisted in building a solid foundation in the major	3.982	9.771	55	.001 **
Helped you feel more a part of this community	3.804	6.759	55	.001 **

Note. **P* value < .05; ** *P* value <.001