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In this issue:

Peer Tutoring in Programming: Lessons Learned

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Peer Tutoring in Programming: Lessons Learned

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This article describes our experience with peer tutoring in introductory programming courses. This tutoring concept was one of the integral support services out of five student services, which were part of a National Science Foundation Grant, designed to improve education, increase retention, improve professional development and employability, and increase placement in graduate schools for Computer Science and Information Systems or Mathematics majors. In addition, an emphasis was placed on strategies that could make the support services female- and minority-friendly. In the review of the literature, reasons are delineated as to why tutoring can be particularly valuable for females and minorities. After the peer tutoring program was initiated, data was collected. This paper includes results from a questionnaire administered to students in programming classes over a two-year period in which the free peer tutoring was available. The make-up of the students, frequency of tutoring, evaluation of tutors and services, and tutor comments are included. Suggestions concerning how to improve the peer tutoring service are provided. Subjective data of the tutoring program indicates that it was a success. Objective data on the students exposed to the five support services demonstrates success of the program as a whole.

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1. INTRODUCTION

The Richard Stockton College of New Jersey (Stockton) was awarded a National Science Foundation (NSF) Computer Science, Engineering, and Mathematics Scholarships (CSEMS) Grant in the Fall of 2003. The purpose of the grant was to provide scholarship money to talented, but financially disadvantaged students (Gerhardt, 2004).

Stockton used this grant to provide funds for 30 student scholarships to encourage and enable the achievement of bachelors degrees in Computer Science and Information Systems (CSIS) or Mathematics within four years.

In addition to the financial support provided by the NSF Grant, Stockton was to provide the students with academic and non-academic support in order to improve education, increase retention, improve professional development and employment, and increase higher education placement in graduate school.

A team of six Stockton faculty members (four CSIS and two Math) developed the following Integral Support Services for the scholarship recipients:

- a new one-credit Bridges Connecting Computer Science and Calculus course

- an already tested Women in Computing course
- **a tutoring service for introductory programming courses**
- a research seminar
- a mentoring program

The National Science Foundation encourages strategies that broaden the participation of underrepresented groups. Therefore, for each of our integral support services we looked for ways to make them female- and minority-friendly. Previous articles have been written on the "Bridges" course (Gerhardt, 2005; Gerhardt, 2006) and the "Women in Computing" course (Mathis, 2008). This article will concentrate on the peer tutoring service for introductory programming courses. We will share the lessons learned.

2. RELATED LITERATURE

The enrollment and participation of female and minority students in computer fields is of great concern, and creating a female- and minority-friendly class environment is considered highly desirable. In 1985 women earned 37% of the computing degrees (NSF 2007). From that high point the trend has been downward. In 1993/1994, women earned 18% of the computing degrees in the United States and in 2006-2007 they earned 12% (Vegso, 2008).

As of 2006, women represented only 26% of the IT workforce, and are responsible for less than five percent of new IT companies. (NJWIT, 2007; Bureau of Labor Statistics, 2008). When it comes to professional employment, women are better represented than men; however, only 9% of the female professionals are employed in the higher-paying computing fields compared to 45% of the male professionals who are employed in those fields (TED: The Editor's Desk, 2009).

As the number of female computing majors is going down, the need for computing professionals is going up. The U.S. Bureau of Labor Statistics (2008) released its latest projections of the fastest growing jobs. It predicts the following growth by 2016: Database Administrators- 29%, Computer Systems Software Engineers- 28%, Network Administrators- 27%, Computer Applications Engineers- 45% and Network Systems Analysts- 53%. At the same time, girls represent less than 15% of all of the students who take AP computer science exams (NJWIT, 2007). Therefore, it appears that the low representation of females in computing majors will continue.

If women can be attracted to a computing major and retained in the program, they can help supply the expected demand for computing jobs. Stockton College has 137 CSIS (Computer Science and Information Systems) majors and only 12% are female. Since computer programming is an integral course for the computer major, and one that has been historically difficult for students, it is important to make it female- and minority-friendly. One technique that can be used to make the environment friendlier is to provide assessable and free tutoring in programming to our students. Research has confirmed that giving students positive experiences in computing may encourage them to take more computer courses in their future (Campbell, 1992). Further, when freshmen have a good first experience with Computer Science, they might even change their major (Carter, 2006). An important aspect of capturing students' interest in programming is helping them to feel confident and capable in that subject. This is important because programming and problem solving is often considered as the "heart and soul of computing" (Denning and McGettrick, pg.16, 2005).

Programming in JAVA is a challenging course for many of our students, particularly female, who generally have less programming courses in high school. According to a study by Carter, 40% of men had taken a computer course in high school and only 27% of the women (2006). Therefore, female students enter college computing classes with less confidence than male students. Treu and Skinner (2002) recommend spending time on the basics of programming in order to decrease the anxiety of females. Consequently, peer tutoring in programming can contribute to filling in the gaps for females and ensuring increased self-perceptions of proficiency in programming.

Research demonstrates that student-student interaction contributes to students remaining in the major (Barker, 2009). Peer tutoring is a student-student interaction with someone else in the major. This can help to develop an academic community which will support the student throughout her college career.

3. PEER TUTORING IN PROGRAMMING

This article describes the tutoring service that was introduced as part of the support services for the CSEMS scholars. Stockton already had a successful tutoring program in writing and basic math and many of our computing and math students benefit from these services. However, tutoring in computer programming was nonexistent. One of the goals of the CSEMS grant was to provide tutoring in computer programming to fill this void and to improve retention in the CSEMS areas.

Dr. Michael Olan, a member of the Computer Science Program recruited and trained the tutors. Tutors worked in the campus Math Center, along with Math and Science tutors. The director of the Math Center was involved with hiring, scheduling and supervising the tutors. The tutors were students who had successfully completed the programming courses. Wages for tutors were paid with CSEMS grant funds. Tutors were paid at the same rate as other student workers. They tutored in the introductory programming and problem solving courses (CSIS 2101/2102) for the first time in Spring 2004. The programming language was Java. Tutoring services were available 20 hours per week during the Fall and Spring semesters (CSIS 2101/2102 are not offered during the Summer).

4. METHODOLOGY

At the end of each semester, a survey was administered to the students in the CSIS 2101/2102 courses. This study reflects data that was collected over four semesters beginning Spring 2004 and ending Fall 2005. The questionnaire (See Appendix) was distributed to students in CSIS 2101/2102 at the end of the semester for four semesters. A total of 182 questionnaires were completed, 113 from CSIS 2101 students and 69 from CSIS 2102 students (See Table 1). Unfortunately, gender and minority status were not indicated on the questionnaire. That information will be included next time.

5. MAKE-UP OF THE STUDENTS

Of the students completing the survey, 63.0% were CSIS majors, 34.0% were Math majors (several were double majors), 0.5% were Business majors, and 5 % were Other (i.e. Physics, Visual Arts, Political Science, and Hospitality) (See Table 2). In CSIS 2101, 41.0% of the respondents were CSIS majors, and 96.0% of the CSIS 2102 respondents were CSIS majors (See Table 2). It should be noted that MATH and several other majors require or encourage their students to take CSIS 2101 but no other majors require CSIS 2102. Students repeating the courses included 7.1% of those taking CSIS 2101 and 4.3% of the CSIS 2102 students (See Table 3).

Table 1: Response distribution by course

Responses	N
CSIS 2101	113
CSIS 2102	69
Total	182

Table 2: Response distribution by major

	CSIS	MATH	BSNS	Other
CSIS 2101	47	60	0	9
CSIS 2102	66	2	1	0
Total	113	62	1	9
	63%	34%	0.5%	5%

Table 3: Times course was previously repeated

	0	1	2	
CSIS 2101	105	6	2	7.1%
CSIS 2102	66	3	0	4.3%

Table 4: Distribution of students who used tutoring services

	Used tutoring	
CSIS 2101	24	21%
CSIS 2102	18	26%

6. FREQUENCY OF TUTORING

Twenty-one per cent of the CSIS 2101 respondents and 26% of the CSIS 2102 respondents used the tutoring service (See Table 4). About half of the CSIS 2101 students who used the tutoring service were CSIS majors. On average, CSIS 2101 students who used the tutoring service did so 2.3 times and CSIS 2102 students 2.6 times (See Table 5).

Table 5: Frequency of using tutoring service

	Average use
CSIS 2101	2.3
CSIS 2102	2.6

Table 6: Reasons for not using tutoring service

	NN	NK	TC	Other
CSIS 2101	69	13	6	4
CSIS 2102	30	15	17	1
NN: Did not need help NK: Did not know about tutoring service TC: Time conflicts				

Table 7: Reasons for using tutoring service (average rank)

	UC	CH	EP
CSIS 2101	1.9	1.1	1.7
CSIS 2102	1.25	1.4	2.9
UC: Help understanding course concepts CH: Help completing homework / programming projects EP: Exam preparation			

Initially, respondents cited not knowing a tutoring service was available as the most common reason for not using the tutoring service. As information about the tutoring service became more widespread, students' reasons for not using it have shifted to time scheduling conflicts and not needing help (See Table 6).

When ranking their reasons for using the tutoring service, both CSIS 2101 and CSIS 2102 students ranked "Needed help with homework / programming projects" as their highest priority. In CSIS 2101, this was followed by "Needed help preparing for exams" and finally "Needed help in understanding course concepts". In CSIS 2102 the second and third reasons were reversed with understanding course concepts ranked over exams (See Table 7). These rankings suggest that students tend seek tutoring help primarily when encountering difficulty with assignments or exams. This trend may shift towards understanding concepts as students gain experience.

Table 8: Perceived usefulness of tutoring service

	Not at all	Some what	Very	Extremely
CSIS 2101	0	7	9	13
CSIS 2102	0	7	12	4

Table 9: Perceived knowledge level of tutors

	Not at all	Some what	Very	Extremely
CSIS 2101	0	5	9	15
CSIS 2102	0	5	13	5

Table 10: Satisfaction with tutoring service

	Not at all	Some what	Very	Extremely
CSIS 2101	0	5	12	12
CSIS 2102	1	7	11	4

Table 11: Tutoring mode

	One-on-one	Group	Both
CSIS 2101	17	7	5
CSIS 2102	14	7	6

Table 12: Tutoring improved understanding of course material

	Yes	No
CSIS 2101	28	1
CSIS 2102	21	2

Table 13: Tutoring improved grade in course

	Yes	No
CSIS 2101	23	6
CSIS 2102	17	4

7. EVALUATION OF TUTORS AND SERVICE

On average, respondents who used the tutoring service said that it was very useful, that the tutors were very knowledgeable, and overall they were very satisfied with the service (See Tables 8, 9 and 10). Fifty-five per cent of the respondents who used the

service did so in a one-on-one basis (See Table 11). Ninety-seven per cent of the respondents who used the tutoring service said that it helped in their understanding of course material, and 91% thought that it improved their grade in the course (See Tables 12 and 13). A significant majority of the respondents said that the tutoring service was very valuable (See Table 10), and that the tutors were very competent and helpful (See Table 9).

8. TUTORS' COMMENTS

Each of the tutors has commented that it is not unusual to have times when no one comes for help in the introductory programming courses. During these times, they have provided assistance in basic computing skills (e.g. using Microsoft Excel) or have helped with math tutoring. The tutors enjoyed their role and received satisfaction in helping students increase their programming skills.

9. OBJECTIVE FINDINGS

Although we do not have objective findings that are solely linked to the peer tutoring in programming, we do have findings which resulted from the total package of the Integral Support Services for the scholarship recipients. The five services, mentioned earlier included:

- a new one-credit Bridges Connecting Computer Science and Calculus course
- an already tested Women in Computing course
- **a tutoring service for introductory programming courses**
- a research seminar
- a mentoring program

All of the scholarship recipients were exposed to all of those support services. In order to estimate the retention rate over a 4-year period, the following numbers were used: on average there were 30 scholarship recipients per year and over a 4-year period the program only lost six students. That resulted in an 80% CSEMS retention rate based on a four year period which exceeds the College average. One hundred percent of the graduates remained in the CSEMS fields.

The average GPA for the Stockton CSEMS graduates was 3.33. In contrast the overall Stockton GPA for Computer Science and Information Systems (CSIS) students is 2.94 and for math 3.01. Given these retention rates and the GPAs, the CSEMS support services demonstrate success.

10. SUGGESTIONS FOR IMPROVEMENT

The main drawback of the tutoring project was that more students did not take advantage of it. We recommend that the tutor visits each programming classroom and introduces him or herself and professors add information about tutoring services to syllabus or course container (e.g. Blackboard and WebCT). The professor could also announce it in class and occasionally remind students. Also students should be asked what are the best times to provide the tutoring service and the tutor should try to match those times as much as possible.

It might be helpful if the professor gives some type of extra credit for attending tutoring sessions. Also, just as programming tutors also tutored in math, it would be valuable, when possible, if math tutors would also tutor in programming. Finally, the services should be well publicized throughout the school and in the tutoring center.

11. CONCLUSION

According to the students, the tutoring in programming was a success. They said that the tutoring was very useful, the tutors were very knowledgeable, and they were very satisfied with the tutoring. The vast majority of them said that the tutoring helped them to understand the material and even improve their grade.

In the bigger picture, the results of the tutoring should improve self-perception of skill proficiency which has been shown to be a predictor of enrollment in computer courses for first and second-year students. And this improved self-perception is an important part of attracting and retaining female and minority Computer Science majors.

When the tutoring in programming is viewed as part of the total package of the five integral support services, the collective success of the program is demonstrated. Students having the benefit of these five services had higher retention rates and higher

GPAs. Also, one hundred percent of the graduates remained in the CSEMS fields.

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Appendix: Tutoring Survey Questionnaire

MAJOR: CSIS MATH BUSINESS OTHER

1. Which course are you taking? CSIS 2101 CSIS 2102
2. How many times have you taken this course before, and either dropped it or received a D, F, W or I?

   None 1 2 3 or more
3. If you did ***not*** use the CSIS tutoring service this semester, was it because

   did not need any outside help in this course

   did not know that there was a tutoring service

   available tutoring times did not fit my schedule

   other

(Only answer the remaining questions if you *did* use the CSIS tutoring service this semester)

4. How many times did you use the CSIS tutoring service this semester?

5. Why did you use the tutoring service (write 1 next to the most important reason, 2 next to the second most important reason, etc. -- write 0 next to any that do not apply)

   _____ Needed help in understanding the course concepts.

   _____ Needed help completing homework assignments or programming projects.

   _____ Needed help preparing for exams.

   _____ Other (please specify)
6. How useful was the tutoring service.

   Not at all Some what Very Extremely
7. Was the tutor knowledgeable about the subject?

   Not at all Some what Very Extremely
8. Did the tutor address your problem to your satisfaction?

   Not at all Some what Very Extremely
9. Was the tutoring you received usually:

   One-on-one With a group Both
10. Do you think the tutoring service helped you better understand the course material?

    Yes No
11. Do you think the tutoring service improved your grade in this course?

    Yes No

Please give any comments about how to improve the CSIS tutoring service.