AC 2009-2505: CSTEP: TRANSFERRING COMPUTER SCIENCE COMMUNITY COLLEGE STUDENTS TO FOUR-YEAR UNIVERSITIES

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CSTEP: Transferring Computer Science Community College Students to Four-year Universities

Abstract

Computer Science Transfer Programs (CSTEP) is a series of coordinated programs and activities specifically designed to successfully bridge computer science students from community colleges to four-year universities and beyond. In this paper we describe the program and its main objectives, present some evaluation results, and include the lessons that we learned. We found that the personalized advising service is crucial for the success of the program and identified specific adjustments that community college instructor and students need to make when they come to a four-year university.

1. Introduction

In recent years, alarming national statistics and trends have shown declining graduate and undergraduate enrollment, graduation rates, and participation of minority groups in Science and Engineering (S&E) fields, and in Computer Science in particular. According to NSF’s Science and Engineering indicators 2006, underrepresented minorities did not enroll in or complete college at the same rate as Caucasians. In 2003, the percentage of African-Americans and Hispanics who completed a bachelor’s or higher degree were 18% and 10% respectively, compared with 34% of Caucasians\(^3\). In addition, the graduation rate for African-Americans and Hispanics in Engineering has remained at 11% over the last ten years\(^1\). Underrepresented minority students are also less likely than other ethnic groups to be enrolled in research institutions and instead, a high percentage of them (47%) enroll in two-year institutions. The intentions of first-year undergraduate students to major in S&E\(^3\) are equally alarming. Although 9% of these students planned to major in engineering in 2004, only 2%-5% had plans to major in Computer Science. At the graduate level, enrollment in S&E has declined since 2003 mainly as a consequence of the decline observed in foreign students attending US universities, which declined 12% in Engineering and 23% in Computer Science.

Motivated by these statistics and trends showing a dramatic decrease in undergraduate and graduate enrollment in Computer Science, the University of South Florida (USF) together with Hillsborough Community College (HCC) has implemented a series of coordinated programs designed to broaden the participation of Hispanics as well as other underrepresented minority students in Computer Science. The proposed programs, called CSTEP (Computer Science Transfer Programs), establish an educational pathway and provide the support that students need to make successful transitions at critical points in their educational journey from community college to the baccalaureate level and from the baccalaureate level to the graduate level. As enrollment in computer science decreases and the State University System of Florida puts more demanding admission restrictions on community college students, it is crucial for these transfer students to have programs such as CSTEP to prepare and support them in this transfer process.
The primary goals of this paper are to describe the CSTEP model, its objectives and individual programs, which are included in Sections 2 and 3; present the program evaluation results, which are included in Section 4; and describe the lessons learned after CSTEP has been in place for one year, included in Section 5.

2. Program Description and Objectives

CSTEP consists of personalized advising and tutoring services, two summer programs combining research and academic courses, and research activities to recruit, retain, and prepare community college students on their path toward four-year universities and beyond.

The model, shown in Figure 1, illustrates how personalized advising and tutoring activities are implemented throughout the entire educational pathway. The advising service tracks students very closely during the school year to make sure they take the required coursework and continue on their chosen educational path, which has been agreed upon by each student and the advisor, and formally written into a Personalized Transition Plan.

In addition to the two-year course of study at HCC, two summer programs are incorporated into the curriculum to help prepare students to transfer from HCC to USF. The summer programs are designed and implemented by USF and HCC faculty, creating a new learning community that will extend to HCC classrooms on a permanent basis. Upon the completion of the two summer programs, HCC students enrolled in CSTEP are expected to graduate and transfer directly to the Department of Computer Science and Engineering at USF. During Summer Program I, students are enrolled in the Programming Concepts course at USF, are exposed to basic research activities, and participate in various educational and social activities. Summer Program II is similar in structure but students take Computer Organization and Program Design courses at USF.

Figure 1. CSTEP model.

These academic courses, with an important programming and math component, will allow the transfer students to meet the academic requirements which will enable them to be directly admitted to the Department of Computer Science and Engineering at USF, while the research component will pave the way for them to participate in the Research Experiences for Undergraduates (REU) programs at USF later on. It is worth mentioning that by taking these courses over the summers, CSTEP students not only transfer directly to the Department, but also
transfer with 3 courses more than regular transfer students, allowing them to possibly graduate in less than 4 years.

Once at USF, USF’s REU programs for juniors and seniors can help transfer students graduate and prepare themselves for graduate school and the work force. These research programs are also meant to create a learning community among these students, the graduate students, and professors at USF.

CSTEP provides scholarships for 10 students each summer to attend the summer programs at USF. The summer programs run for 12 weeks, usually from the end of May through July. CSTEP provides students with an $800 stipend to offset any costs they may have and help with some of the students’ financial responsibilities, pays for an annual membership in the IEEE Computer Society, as well as pays for books, tuition, fees, and a parking permit.

During the summer programs students are also required to attend several educational and research-related workshops, research presentations, and social activities. All of this information is available on the program’s website at http://www.csee.usf.edu/BPC/. In summary, CSTEP pursues the following objectives:

- **Increase the enrollment of minority students in Computer Science programs.** CSTEP generates interest in Computer Science through the use of informational materials, personalized identification, advising, and tracking activities. Marketing for CSTEP includes information on why Computer Science is an attractive and viable career. CSTEP especially targets Hispanic students as they constitute a high percentage of the student population at HCC.

- **Retain students in Computer Science programs.** CSTEP offers summer program scholarships, personalized advising service, mentoring at USF and HCC, paid research experiences for undergraduates, a peer tutoring program, and professional development opportunities. All of these programs are used to recruit, retain, and prepare community college students to continue on their educational path toward a four-year university experience.

- **Bridge students from community colleges to four-year universities and graduate school.** CSTEP offers two summer programs with strong math, programming, and research components. These components are taught in formal courses that allow the students to be admitted directly to the Department of Computer Science and Engineering, bridging the students from HCC to USF.

- **Increase graduation rates.** CSTEP is meant to enhance the students’ curricular and academic activities to keep them more engaged in their field of interest and thus increase graduation rates.

- **Create an exportable and expandable model.** CSTEP creates a clear educational path that could be replicated at other community colleges and universities.

### 3. CSTEP Main Components

Although creating a program like CSTEP may seem like a straightforward academic endeavor, in reality it requires more time, preparation, and organization than most realize. A successful
program requires careful design and implementation of all of its components. In this section, we present specific core components, which are critical to the success of the program. These core components are described in the following subsections and will map out the educational path that will help students enroll, graduate, and continue their educational path or join the work force successfully.

A. Recruitment Plan

Recruitment is a very important program component. A good recruitment plan is necessary in order to guarantee that the program will benefit those for whom it was designed. There are many strategies that can be utilized in the recruitment of students, and CSTEP makes use of several methods and mediums.

Promotional marketing materials were created to market CSTEP and convince students to choose Computer Science as a career. This material presented students with all the areas encompassing Computer Science, the potential for its contributions to and advancement of science, the significant opportunities for societal impact, and the opportunities for a successful career in academia, government, or industry. Marketing materials included postcards, brochures, flyers, posters, and in-class power point presentations for students and professors. Furthermore, a project website was developed which advertised CSTEP, included all marketing materials, and explained the application process.

In addition, the marketing materials along with a letter explaining CSTEP were distributed to each HCC campus via inter-office mail while the applications were distributed via email as an attachment. The following departments, offices, and individuals received the marketing materials: Academic Advisors, Enrollment Development Coordinators, Academic Deans, Deans of Student Services, Computer Science Program Managers, the Honors College, African-American Student Union, Computer Connections Club, Engineering Club, and the Latin American Student Association. A campus visit was also scheduled with each Student Services Department during which the program was explained in depth and posters were displayed to help recruit students.

Finally, reports were also requested from HCC’s Office of Management Information Systems in order to target students for whom the program was designed. From these reports, the prospective eligible students were emailed a letter explaining CSTEP and the benefits that a program like this could offer them. The application for the summer scholarship was also sent as an attachment. An advisor dedicated to the CSTEP program at HCC also spent a considerable amount of time talking to prospective students about the program via phone, email, and one-on-one personal information sessions.

After only two months of recruitment efforts, a total of 36 applications were received for 10 available places. Out of all the marketing methods described above, we found that the presentations and personal interactions were the most successful ones.
B. Personalized Advising Service

This aspect of CSTEP is based on the services provided by a personal advisor, who hereafter will be called the Personal Transition Services Specialist (PTSS). It is our experience that minority students need a permanent and close advisor to help them solve their academic and personal problems. We have learned that the personal component of transitional services is crucial to the success of these students.

The PTSS develops and implements a Personalized Transition Plan (PTP) identifying challenges the students face, short-term and long-term personal and career goals; and course mapping for upcoming semesters to ensure that appropriate courses are taken so that all the credits earned will be accepted at USF. In addition to the PTP, a student questionnaire was developed to identify career and employment goals, financial aid status and need, time management skills, family support, and personal educational goals.

The PTSS is also a major resource in connecting students to well-established academic support services. We have found that many Hispanic students are reluctant to admit that they may be having academic difficulties. In an effort to resolve this situation, we have successfully used the PTSS and the students’ instructors as an early academic warning system. For example, early in the semester, the PTSS meets with individual course instructors and works out a mechanism whereby the instructor informs the PTSS when a student is beginning to experience academic difficulties. At that time, the PTSS meets with the student and refers him or her directly to our academic support service unit, where tutoring and other support services are provided.

The PTSS has additional responsibilities as well. For example, she is also the PTSS at USF. This makes the transfer of students easier and more effective. The PTSS arranges campus visits, coordinates career development activities, identifies scholarships, informs students about curricula and changes in procedures, and links students with student organizations and mentors at HCC and USF. The PTSS has complete knowledge of and information about the students, their problems, programs, etc., and, therefore, will facilitate the transfer process. The PTSS meets with the students twice a semester or more often, if necessary.

C. Social and Educational Components

A number of social and educational activities are scheduled year round. During the first summer semester, research presentations were given to the students by several faculty members from the Department of Computer Science and Engineering at USF. Lunch-n-Learn career exploration presentations about Computer and Network Security, Data Mining and Fuzzy Clustering, Wireless Sensor Networks, and Data Bases, and other areas of faculty expertise, were given. The students also had the opportunity to interact with the participants of the REU Site in Computer Science and Engineering by attending their research presentations and poster competition. The students also attended presentations on how to write a research paper and how to design and present a poster. In addition, students were invited to workshops about financial assessment and how to write a statement of purpose. Regarding the social aspect of the summer semester, students participated in USF’s Riverfront Park Challenge Course.
During the school year students continue to be invited to several professional development workshops and presentations as well as to take field trips to different local industrial companies that employ computer science professionals.

D. Summer Programs at USF

Besides the social and educational components during the summer mentioned above, students also have an academic component. During their first summer program at USF, students enroll in Programming Concepts. This Java-based course covers problem-solving techniques, program design, implementation, and testing, as well as graphical user interface and object-oriented concepts.

During their second summer program at USF, students enroll in two courses. Computer Organization and Program Design are USF’s “gate” courses which are mandatory for admittance into the Department of Computer Science. Students are required to take and pass these courses with a C or better. The Computer Organization course allows the students to understand Boolean algebra, master the operation of basic logic elements and learn how to design simple combinatorial circuits, understand the basic structure of a central processing unit (CPU), and the basic concepts of input, output, and memory technologies. The Program Design course utilizes the C programming language and teaches the students how to write programs of moderate size; compile, test, and debug programs; use pointers correctly as well as basic data structures; write short programs that make use of arrays, linked lists and recursion, and use dynamic memory allocation.

E. REU Program at USF

As shown in Figure 1, once transferred and enrolled at USF, students are able to participate in the College of Engineering REU Program during the academic year, and are encouraged to participate in the USF REU Site and other REU sites around the country during the summer semester. The REU Site at USF is a very good fit for CSTEP students since it provides them with a broad range of research project options in Computer Science and Engineering. The program runs for 10 weeks during the summer semester, usually from the end of May to early August. The program provides each student with a stipend, travel and housing support, and an allowance for meals. During the 10-week period, students are assigned to faculty mentors to work on the research projects of their choice. In addition, several workshops, presentations, and social activities are included in the program. REU Sites are meant to reduce high dropout rates, low graduation rates, and low enrollment in graduate programs involving undergraduates in research activities -- all goals well in line with CSTEP’s objectives. Additional information about the REU program has been previously published.

F. Administration Time

There are a large number of administrative tasks required to run a year-round project like CSTEP. The organization of the workshops, presentations, catering, social activities, payroll and reimbursements, recruitment activities, program evaluation, use of university facilities and services, receiving and reviewing applications, selecting students and sending official acceptance
and rejection letters, etc., are only some of the tasks that need to be accomplished. In addition, there will always be questions about policies, procedures, projects, and behavioral problems to deal with. In most cases, the amount of time needed to run these programs is underestimated.

However, the wonderful groups of students participating in CSTEP make the entire effort fun, rewarding, and worthwhile. The best strategy is to start early and make a weekly (in the summer) and monthly (for the school year) plan of activities. Another strategy is to create a schedule for all of the activities planned for the first year, and then reuse and build upon that schedule during the subsequent years of the program.

4. Program Evaluation

This section presents the evaluation that has been and will be performed every year. The program effectiveness in terms of transfer and graduation rates will be also continuously measured as soon as this information becomes available. CSTEP completed its first year in the summer of 2008. CSTEP students took Programming Concepts at USF along with other USF students. The evaluation is based on the students’ performance in class and their perceptions of CSTEP. Performance of CSTEP students was compared with USF students. As shown in Table I, although some CSTEP students were included in the group with the lowest grade in the class, half of them got the highest grade.

Table I. Programming Concepts class performance.

<table>
<thead>
<tr>
<th>Grade</th>
<th>All</th>
<th>USF</th>
<th>CSTEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>58%</td>
<td>62%</td>
<td>50%</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>26%</td>
<td>29%</td>
<td>20%</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td>9%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Students in the program were asked whether they had previous experience in computer programming (previous course or work experience). Table II shows that there is a correlation between having previous experience and obtaining good grades. In the case of the CSTEP students, 3 out of the 4 students with previous programming experience obtained an “A”. Further investigations revealed that these students had taken a Programming Logic course at HCC that uses Alice as the programming tool. The second observation is that the 3 CSTEP students who received a “C” did not have any programming experience and two of these students worked more than 20 hours per week during the summer. Table II also shows that programming experience is not necessary to get good grades.

The students’ feedback about CSTEP was gathered via online surveys in three different time periods. First, a pre-program survey was distributed to establish factors that influenced students’ enrollment decisions and to identify students’ expectations and concerns. This survey showed that 60% of the students consider that the most effective factor in enrollment decisions was CSTEP’s personalized advising. Interestingly, family advising did not impact the students’ enrollment decision at all. Academic and economical support provided by the program were the more relevant factors with 80% impact each. The survey also showed that 80% of the students think that the application procedures were very clear.
Second, surveys every other week were used to track the evolution of the program to be able to make corrections as necessary. These surveys revealed that some of the students were encountering academic difficulties and scheduling issues to attend additional CSTEP activities. These scheduling issues are mainly because most of the students have part-time jobs or work during weekends. In response, evening Java tutoring sessions were implemented and positively evaluated by the students.

Table II. Students' programming experience and grades.

<table>
<thead>
<tr>
<th>Students who didn't have programming experience</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>USF</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>CSTEP</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Students who didn't have programming experience</td>
<td>USF</td>
<td>CSTEP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had taken previous programming course</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Had programming experience (work)</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>USF</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>CSTEP</td>
<td>75%</td>
<td>0%</td>
<td>25%</td>
<td>4</td>
</tr>
</tbody>
</table>

Finally, a post-program survey was administered indicating overall student satisfaction. As shown in Table III, in all of the surveys administered, the students expressed their great satisfaction with the benefits of an advising staff that tailors each educational plan according the student’s needs.

Table III. Students' programming experience and grades.

<table>
<thead>
<tr>
<th>Item</th>
<th>Not Satisfied</th>
<th>Somewhat Satisfied</th>
<th>Very Satisfied</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking at USF</td>
<td>25.0%</td>
<td>50.0%</td>
<td>12.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>USF Library</td>
<td>0.0%</td>
<td>25.0%</td>
<td>50.0%</td>
<td>35.0%</td>
</tr>
<tr>
<td>Labs</td>
<td>0.0%</td>
<td>37.5%</td>
<td>62.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Lectures</td>
<td>0.0%</td>
<td>12.5%</td>
<td>87.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Program Information</td>
<td>12.5%</td>
<td>0.0%</td>
<td>87.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>USF registration</td>
<td>12.5%</td>
<td>37.5%</td>
<td>50.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>CSTEP staff</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Stipend</td>
<td>0.0%</td>
<td>0.0%</td>
<td>87.5%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>
5. Conclusions

In this section, we summarize the lessons that we learned during this first year as well those solutions that we implemented or will be implemented in the coming years.

1. The role of the Personal Transition Services Specialist is essential for CSTEP or any other program trying to implement a bridge program like this one. The PTSS does first-hand recruiting and advising; champions the program at HCC and at other institutions with which HCC associates; understands students’ problems, both academic and personal, and finds solutions to them; and builds the HCC-USF transition plan and monitors its progress. This is a full-time position with responsibilities that would have been very difficult to fulfill remotely from someone at USF.

2. The Personalized Transition Plan is also a key part of the program which serves several important functions. First, it forces students to understand the curriculums at both institutions and to design the necessary course mapping they need to graduate and transfer successfully. Second, it makes the PTSS understand course pre-requisites, so they can be enforced at the appropriate time. It is important to mention that some flexibility on the part of the four-year institution might be necessary to allow community college students to register for its summer courses. In our case, USF agreed to allow students to take Computer Organization without Physics II. Finally, the PTP is an agreement between the student and the program, a perfect instrument for follow-up discussions.

3. It appears that the CSTEP students who took Programming Logic at HCC before taking Programming Concepts at USF as part of the CSTEP program have been able to obtain better grades than those who had not taken the course. Similarly, it seems like there is a correlation between C grades and students working more than 20 hrs per week. As a result, we are requiring future students to take Programming Logic at HCC before taking Summer Program I, and are asking them to limit the number of hours they work.

4. CSTEP students suffered some difficulties adjusting to the university environment in terms of time and quality of attention and support, larger and more demanding classes, and a faster teaching pace. We addressed some of these issues by having an HCC instructor teach the lab part of the course at USF and by having extra tutoring sessions for CSTEP students.

5. The HCC instructor in charge of teaching the lab sessions at USF also had some difficulties adjusting to a new style of teaching and grading which required a faster pace and grading of a larger number of students. The HCC instructor had to limit the level of detail at which he graded the program assignments as well as the amount of time he spent providing one-on-one help to students.

6. The idea of having an HCC instructor teach the lab sessions at USF has been very beneficial to CSTEP students and USF students too. CSTEP students found that not everything was new and unknown. USF students receive more feedback and attention than normal.

7. We found that the stipends provided by the program are very important. Many students support their families, and can't afford to quit their jobs and commit exclusively to the program.

8. Interactions among the CSTEP students and the summer REU program participants seemed to be very important. CSTEP students saw themselves as future REU students and have a good notion of the types of future activities they will be performing.
In addition, we plan to implement the following programs for the next school year:

1. We will create a tutoring network that will support the students all the way through their program. Specifically we will train several CSTEP participants from this first year to become tutors for next year's participants. At the same time, we will recruit and train several USF students to be the tutors for this year's students when they enroll in next year's Summer Program II.

2. We will change the advertising strategy to recruit more students into the program. Although we accepted one self-funded student into the program during the first year, we feel that we did not emphasize that possibility enough. Even if students do not obtain a CSTEP scholarship, they could participate in the program and still receive many benefits at no cost, such as advising, mentoring, and tutoring as well as the program infrastructure that facilitates their registration at USF, transferring services, and participation in REU activities.

3. There will also be a change in the student recruitment timeline. We will move up recruitment to the Fall Semester so we can make sure students take Programming Logic prior to Summer Program I. We also need to advise students as early as possible so that they take the pre-requisites courses needed for the summer course at USF.

4. Finally, due to the increased interest on this program we plan attempt to raise more funds so we can financially support additional students. We plan to expand the program to include other community colleges and areas of computing, such as Information Technology and Information Systems, as well as other departments within our College of Engineering, since Engineering as a discipline is facing similar issues.

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Bibliography