Abstract – A glaring problem in undergraduate computer science programs is the lack of females and members of certain ethnic minority groups. It has been shown that targeting incoming freshmen, and even high school students, is often too late to positively influence students towards studies and careers in computing. Another problem is that many faculty members and departments are unable to devote much time or many financial resources towards outreach efforts. This paper presents a model for a long-term outreach effort that is enabled by “adopting” a local K-8 School. This model enables a department to participate in effective outreach activities with a minimal time commitment. Additionally, this model provides tremendous educational and financial benefits to the partner school with little, if any, financial obligation on the part of the sponsoring department. While the scope of this project is relatively small compared to many outreach efforts, it is appropriate for departments that lack the time or financial means to launch a large-scale program.

Index Terms – STEM outreach, service learning, community building, computing education.

INTRODUCTION

A glaring problem in the computing field today is the lack of females and members of certain ethnic minority groups. While it is important to address this problem at an industry-level, academia must also do its part in encouraging students from these underrepresented groups to pursue computing degrees and careers.

The number of computer-related jobs is expected to continue to climb, and it is questionable if there are going to be a sufficient number of graduates to fill these positions in the years ahead. [ref?] This provides a fantastic opportunity and challenge to minimize the employment problem by addressing the diversity problem. According to the Bureau of Labor Statistics, the computer and mathematical occupation group is expected to grow 25 percent from 2006 to 2016, the fastest of all occupations. Occupational employment, Occupational Outlook Quarterly, Fall 2007, Vol 51, No 3.

We expect that a large population of computing science faculty members are in departments similar to ours, in that we want to contribute to solving the diversity problem, but lack the time to do so. In a research university, faculty members are typically assessed on their ability to produce technical research in a specific area. This leaves little time to contribute to outreach activities that ultimately may be ignored by a committee assessing the production of the faculty member. In a teaching university or college, the course load often leaves little time to pursue other activities.

An additional limitation on establishing an outreach program is the lack of financial support. Without budgetary statistics to backup our claim, we feel we can safely assume that most departments have more needs and wants than the resources to provide them. Thus, even if a department wanted to create a program, such as a summer computing camp for girls, it would probably be well below other items on the department’s priority list.

This paper presents our approach to outreach, taking into consideration the availability of these two important resources: time and money. We do not discuss the reasons for the diversity problem, but desire to contribute to the solution, despite limited resources.

RELATED WORK

The literature shows a number of studies that investigate the reasons behind the diversity problem (especially among females) in computing [1]-[3], as well as studies that assess programs designed to curtail the problem [4]-[5]. Studies such as these are invaluable resources in designing and establishing a departmental outreach effort.

Technology-related fields continue to expand, providing new and interesting career opportunities for our graduates. In fact, of the top ten fastest growing professions, five are computer related [6]. However, interest in CS fell by 80% between 1998 and 2004, and has dropped 93% since the 1982 peak of CS majors nationwide [7]. Unlike many fields where the representation of women has increased over time, computer science has experienced declines in the proportion of female graduates. In order to match future demands for information technology, we need to increase the participation of both men and women. Increasing diversity enhances the breadth of understanding in leadership positions, gives a different perspective in the marketplace, increases creativity, and improves problem solving, particularly in team situations [6].

Of particular interest to us is the issue of negative perceptions towards computing that are formed in the pre-High School years among females [8]-[10]. While outreach is important at all levels, this indicates that the pre-High School years are a critical time, where perhaps we can effect
the greatest fundamental change in how computing studies and careers are viewed.

MOTIVATION AND BARRIERS

The motivation for this endeavor can be considered both altruistic and greedy. Altruistic in the sense that we have the desire to provide educational opportunities to students by exposing them to experiences that may positively influence their educational and career decisions; and greedy as we hope to attract these students to our program to improve our department with new talent and diversity.

Increasing diversity in computing disciplines is a challenging, yet extremely worthwhile goal. Solving diversity issues at the university-level is an important step in reducing the problem in industry. As well, diversity in a university program is valuable as it enables students to develop communication skills through group projects that are not limited to a homogenous composition of stereotypical “computer geek” peers. [I’m not sure it follows that the diversity will get non-geeks. What is usually cited is: Increasing diversity enhances the breadth of understanding in leadership positions, gives a different perspective in the marketplace, increases creativity, and improves problem solving, particularly in team situations [6]. ] Thus, the benefit of diversity has a positive effect on all members of a department.

There are many approaches that can be taken to establish an outreach program. As well, there are a number of barriers and limitations that may be encountered, depending on the circumstances of the department. The following are issues that our outreach model is specifically designed to address.

I. Time Limitations

The typical distribution of workload for tenure-track assistant professors in our department is 50% research, 40% teaching, and 10% service. For tenured professors, service increases slightly at the expense of research. Research production is the most valued aspect of a portfolio during tenure and promotion assessments. That research is expected to follow the technical expertise that the faculty member brings to the department.

What this means is that any time spent on outreach activities is done at the expense of the core responsibility of the faculty member. Typically outreach activities are counted as service, a very minor part of the overall charge and something that most portfolios already have in abundance. Especially for tenure-track faculty members, engaging in outreach can, unfortunately, be implicitly viewed as a negative in terms of the pursuit of tenure.

The solution is to create an efficient model where participating faculty can contribute time that is effective, but minimal. Effective, in this case, means time that is spent actually interacting with students, rather than planning or recruiting students to participate.

II. Financial Limitations

Without the benefit of a grant or other source of funding, options are limited as to what type of outreach program can be instituted. A summer computing camp program may sound appealing, but is probably infeasible for many departments to fund. Sponsors and other donations can be sought, but this is not a simple task, potentially requiring a significant amount of time and effort to procure.

Promoting outreach activities to recruit students to the program may incur some cost without guaranteeing that a set of target students will be obtained. The end result of a promotional campaign may potentially be a set of students who are already interested in computing. While that is not completely negative, as retaining and increasing the level of interest is important, it fails to include students who have not considered computing already.

III. Gaining Participants

An effective outreach program must obviously target students who would otherwise not be interested in computing due to lack of awareness or knowledge of the subject. As stated previously, a program may only serve to attract students already interested in computing.

Taking into consideration the time and financial limitations, gaining participants may appear to be an overly difficult obstacle. Even disregarding financial constraints, it is undesirable to spend a large amount of the limited time available on “overhead” activities rather than face-to-face interactions.

The location of activities play an important part in the ability to recruit students to the program. This is particularly true when targeting pre-High School students where parents are needed to transport young students to activities. Our campus provides ample space and computing resources, but travel requirements would limit participation.

ADOPT-A-SCHOOL MODEL

In accordance with the limitations and barriers presented, the model outreach program is essentially one that takes little time, little or no money, and already has students ready to participate. Despite this seemingly ludicrous description of an outreach program, these are not impossible characteristics to achieve without sacrificing effectiveness and impact.

The adopt-a-school model is centered on establishing a relationship with a local primary or secondary school. This approach provides a number of benefits including overcoming the limitations placed on the program.

More formally, the model is a long-term partnership between a university department and pre-college school at an administrative and a classroom level. The administrative support is important to foster a mutually beneficial program.

An outreach program founded on a relationship with a single school might be considered to have too narrow a scope. We certainly agree with the assessment of the narrow view, but contend that the positive impact we can make on a personal level warrants the continued pursuit of this program. Additionally, this effort will potentially directly benefit our department in years to come.
[I worry about suggesting criticism. Perhaps you could say: While the relationship is necessarily limited in scope, this relationship provides a working model for others in the business community. Often people are willing to provide some level of support, but do not have the time to organize the effort.]

The following is a general overview of the outreach program model: [donating computers is not part of it?]

- Partner with a local school, preferably pre-High School
- Present periodic outreach activities as part of the regular computer class curriculum
- Recruit undergraduate and graduate students to volunteer as helpers for activities
- Invite campus computer club groups to organize special outreach events
- Encourage majors looking for course/senior/M.S. projects to develop tools that can be used for outreach efforts
- Keep track of students so for future assessment and recruiting purposes

As the program matures, we expect to add additional components such as an extracurricular Alice programming contest, annual parent-student presentation, and after-school events. This will be made possible as more faculty members and students participate in various activities. This will be discussed more in a later section of the paper.

I. The Partner School

Partnering with a school in the K-8 range provides additional opportunities as compared with traditional 9-12 grade High Schools. First, as stated previously, various studies indicate that perceptions of the computing disciplines are often molded before the High School years. Thus, a High School partnership may limit the effectiveness of the outreach effort

Second, in the High School curriculum, the computer course is often a CS1, or introductory programming course. This type of computer class is not ideal for an outreach partnership as the target student population may already have eliminated themselves from participation.

In contrast, computer classes in the elementary and middle school curriculum are typically general computer courses that teach basic user skills (typing, word processing, spreadsheets, email, web browsing, other application skills ). These are skills that are applicable to a broad range of students, therefore, there is a smaller chance of students being eliminated from participation due to their lack of knowledge or interest in the technical aspects of computing. In many cases, depending on the grade and school, the computer class may be a required part of the core curriculum.

Finally, the High School curriculum may provide less flexibility in terms of the ability to incorporating activities that may not necessarily flow with the overall course topic and structure. At an earlier stage, where the curriculum is broad and perhaps less strict, it may be easier to add topics that, while important and interesting, do not fit in the defined course curriculum.

II. In-Class Activities

It is assumed that the partnering school has a computer class, or is at least interested in having a class, and has a teacher for the class. Space for a computer lab is, of course, essential, but, as will be discussed, the state of the equipment (or the existence, for that matter) may not be important.

The computer teacher plays a critical role in the ability of the outreach program to function successfully. While it is not required for him/her to spend extra time or effort outside of his/her normal teaching duties, s/he must support the activities that will take place during the scheduled class time.

The ability to execute outreach activities during regular class time eliminates the problem with generating participants in the program. A captive audience is there for each activity without any effort. Additionally, all students are participants, eliminating the problem of potentially targeting only those students who already have an interest in learning about computing.

The relationship with the computer teacher is essential to facilitate easy scheduling and coordination. It is this relationship which enables outreach efforts to focus on face-to-face time, significantly limiting overhead activities of scheduling and promoting activities. Thus, fostering this relationship is invaluable.

Aside from relieving the teacher from their duties periodically, the teacher should be able to expect other benefits as part of the partnership. The most important benefit is simply to act as a resource. The teacher is a trained professional and thus probably does not need to rely on our help, but having this available, we believe, has helped make our relationship a good one. For example, we have offered advice and feedback on grant proposals, something that is often difficult to obtain at a middle school where most faculty members may not have experience.

III. Involving Others

It is possible to have an effective outreach activity with a single faculty member being the only participant. However, by involving others, including students, the effectiveness and ease with which the activity can be executed will increase tremendously.

Having undergraduate and graduate student volunteers participate enables a more personal experience for the students at the partner school. The volunteer students can be used in many ways. However, from our observations the young students have a better experience when they are split into small groups with a volunteer student assigned as the team leader. These small groups encourage interaction by all, not only by those who typically make comments and speak in class. Additionally, this makes the outreach activities more unique as it is not possible for a single teacher to function as a team leader for many small groups during a typical class period.
By involving students and student groups, we hope it will ultimately be possible to have outreach activities that do not require the time or attendance of faculty members. While faculty members will, of course, continue to be involved, this enables the program to expand to other schools without increasing the burden on participating faculty members.

A unique way to involve students is to encourage senior and M.S. projects that focus on developing a software tool that can be used as part of the outreach effort. While various tools and educational activities do exist, this presents the opportunity to create tools for specific needs that are customized for a particular class. We are just beginning this phase of the project, but have a student who will be beginning soon on a Plan B M.S. project that includes developing custom Alice applications for use in the outreach program.

IV. Tracking Students

As we are targeting students in pre-High School years, there is potentially a gap between when we are able to interact directly with the students and when they begin the college enrollment process. While we hope to expand to the point where we do have some type of relationship with the local High Schools, for the foreseeable future, this may not be a possibility. In order to quantify our results, it is important to track students who have participated in our outreach activities.

In our community, we are the only public 4-year institution within an hour drive. Thus, despite being a residential campus, we have a large number of students that are from the surrounding area. By tracking students, we can send targeted recruiting materials as they prepare to make college decisions. As well, we can send email invitations to visit our booths during local university recruiting events. Many departments already participate in these types of events and activities, so this is not an added financial obligation. At the very least, emails can be sent to the target students as they prepare for college to remind them of our existence. Many of our outreach activities are free to students, as well as much younger students. This is also beneficial as we have the opportunity to work with students over a long period of time, rather than only during the few years prior to entering High School.

GETTING STARTED

This section discusses our process for establishing our outreach laboratory. Included are some issues that may be unique to our university and our community, but we feel the insight is valuable for others seeking to establish a similar type of laboratory.

I. Finding a Partner

The first step in setting up an outreach laboratory is to identify a partnering school that fits the profile of the target groups. While identifying a school with a large percentage of females is not a problem in any part of the country, it may be difficult to find a school with a significant ethnic minority population in some areas.

Utah State University is located in an area with a relatively small population of ethnic minorities. However, the Hispanic population continues to grow and it is concentrated in a specific part of the county. Thus, while the number of minorities is small, we expect to see a significant increase over time. Again, in many parts of the country with a significantly diverse population, this will not be an issue that must be considered.

We feel fortunate that a K-8 public charter school, Thomas Edison Charter School (TECS), provides the best opportunity for ethnic diversity in our area. The charter school’s enrollment is determined by a lottery system with priority enrollment for siblings of children already enrolled in the school. (The lottery typically pertains to Kindergarten only as once a student is accepted they do not need to reapply).

One drawback of partnering with a charter school is that being in an ethnically diverse area does not guarantee that the same level of diversity exists in the school. Parents must choose to have their children attend, as it is not the default school for a geographic area. Based on our observations, it appears that the rate of enrollment of ethnic minorities is less than the overall rate of the area. However, we are pleased with the ethnic diversity level and expect it to improve in the future as the school focuses on promoting itself to these communities. [So if a charter school limits diversity, why not choose a non-charter school? Are there other advantages – like funding or parent participation? I think it might be better to leave out the discussion that says diversity is less there.]

A major benefit of TECS is that it ranges from Kindergarten through 8th grade. This enables us to interact with our core target group, middle school/junior high students, as well as much younger students. This is also beneficial as we have the opportunity to work with students over a long period of time, rather than only during the few years prior to entering High School.

II. Partner Incentives and Benefits

Our experience in establishing and operating an outreach laboratory has been a very positive one. The principal at TECS has been enthusiastic about the potential of our partnership from our initial talks. Additionally, the computer teacher is a wonderful contributor, as she too understands the need to create a positive experience in order to encourage young students to pursue computing disciplines.

It is understood that this may not always be the case. While it would probably be a waste of time to partner with a school that has no interest in being an active partner, there...
may be schools that are interested, but are hesitant to commit. Thus, it may be requisite to not only sell the long-term benefits, but provide an immediate incentive for a school as well.

Computer laboratories are often a huge expense for schools with extremely tight budgets. Updating or perhaps even establishing a relatively up-to-date computer laboratory can be quite a drain on the school budget. In our situation, TECS was a relatively new charter school with many needs associated with a newly established school. They did have a computer laboratory that consisted of an interesting hodge-podge of outdated systems purchased from our university’s surplus. Outfitting a new laboratory was in the near-term plans for the school.

As a department, we were able to provide an immediate incentive to establish the lab by outfitting an entire computer laboratory. Our CS department operates multiple computer laboratories and replaces systems in at least one lab approximately two out of every three years. These systems are either taken by other departments in the university or are sent to university surplus. The outgoing systems do not generate any revenues for the department; therefore, from financial and utility standpoints the department gains nothing from these systems.

As part of establishing our outreach laboratory we maintained ownership of these systems and used them to outfit the computer lab at TECS. In using the systems to outfit the TECS computer lab, we had to ensure we were in compliance with all university policies. In the end, the policies actually led us to establish the lab in a way that is the most beneficial for our department. In essence, the lab is a distance laboratory where the equipment is still owned by the department. We expect to incorporate this lab periodically as part of our normal update of departmental computer lab systems. While these systems are a few years old and may not be completely adequate for the needs of our students, they are more than sufficient for the needs of the outreach laboratory.

By outfitting the laboratory our partner school was able to save a large amount of money, enabling them to focus on other needs of the school. [It would be nice if they were able to focus on other COMPUTING needs – such as scanner, printer, software, etc.] While this incentive was not a critical component of establishing our laboratory, we expect that this incentive would be more than sufficient to gain the commitment of a school to establish an outreach partnership. Best of all, we were able to provide this incentive without any financial output from our department.

Outfitting the laboratory with our systems is a benefit from our perspective as well. While TECS was planning on updating systems, we did not know when this would actually be possible. By updating the systems we do not need to be concerned with the ability (i.e. performance) of the lab to support the applications we need for outreach activities (Alice, web services, custom applications, etc.).

**Activity Goal**

The purpose of our outreach program is not necessarily to prepare and train young students to pursue studies in computing, but to create and foster an interest in computing. With this purpose in mind, we select activities that focus on being fun, enjoyable, and exciting while at the same time have an element of computing attached. It is in our best interest to pique their interest and curiosity, not to ensure that they understand the marvel of a while-loop. Additionally, we select activities that are gender neutral or that are biased towards female interests.

I. Our First Activity

Our first attempt at an in-class activity was fraught with the typical stresses of entering a new school for the first time. (Are the kids going to bored? Will anyone relate to me? Etc.) However, we were very pleased with the interest and respect that the students showed us.

The activity was quite simple. One faculty member and two volunteer graduate students participated. We brought an old PC desktop and gave a presentation about the different parts of the computer. First we passed out computer components to the students in the class. Then, over the course of about 45 minutes, we asked students about things they do on the computer. They would have to figure out what component enables that activity and then determine who had the component. For example, if a student stated they listened to music, we would talk about the sound card. Then we would ask what kind of things the students thought would be on a sound card (headphone jack, picture of a speaker, etc.). The student with the sound card would then come to the front and would “install” the card in the computer.

In speaking with the computer teacher after the activity, we were excited to learn that a few students who were very active in participating and making comments were, in fact, very shy and quiet in class normally. In addition, we heard through a parent that their child and her friends thought the class was very fun and interesting. Our experiences with subsequent activities have netted similar positive observations.

In these early stages, we do not have formalized survey results or another way to assess the effectiveness of the activities, but we are encouraged by the anecdotal evidence we observed. It may be that students simply enjoy doing something new or having someone besides their regular teacher instruct them, but whatever the cause may be, it appears that the activities have had an overall positive impact on the students.

II. Sources of Activities

Creating activities is not a difficult endeavor, but can be costly in terms of time. Many sources for activities exist, but we have drawn on two specifically. The *Computer Science Unplugged* website [11] contains a number of activities and other information about introducing computer science to middle school students. As the name infers, these activities do not involve using a computer. They are,
However, very interactive and fun and can be followed up with a computer activity.

The second resource we use is the NetSmartz series of websites [12]. These websites have resources for teaching Internet safety to students. Included are activities for the classroom, home, and individual student use. The activities are age-appropriate, meaning it is easy to select applicable activities without worrying about being too simplistic or too mature. The activities present invaluable material, but do so in a fun and interactive way.

As our graduate and undergraduate students develop tools that can be used as part of our outreach effort, we will make them available to others. The future work section discusses this in more detail.

III. Extracurricular Activities

As the outreach program expands, we plan to introduce extracurricular activities sponsored by student clubs and organizations. These activities include events such as: Alice programming contest, Girl Computing Power Night, and Internet safety presentations for parents and children. Again, while these activities will have an important computing component, they will be designed from the perspective of making a fun and enjoyable event for the students. Over time, we envision that we will have a small number of annual events, each sponsored by a different group. Thus, we will be able to provide a breadth of activities, without undue burden being placed on a small number of individuals.

ASSESSMENT

Other than anecdotal evidence, we do not have any early assessment statistics to report. However, this is an essential component of the future of our program. Assessment will be addressed from both a short-term and long-term perspective.

The short-term perspective will focus on specific activities. Student surveys will be solicited periodically in order to gather the opinions of the students involved in the activities. Additionally, the teacher’s input will be sought frequently. Finally, faculty and student volunteers will discuss the success/failure following each activity. These short-term assessments will answer questions such as: Did the students enjoy the activity? Was there effective interaction? How can this activity be improved? What valuable information did the students learn?

The long-term perspective centers on tracking the students, as was discussed earlier. In addition to identifying the major selected by students, we will perform a survey of these students in order to gain better insight into the impact our efforts have had over the years.

SUMMARY

This paper presented our computer science outreach laboratory that was established despite significant limitations in time and money. By creating a partnership with a local public school, we are not burdened with promoting the outreach program in order to draw participants. Additionally, we are able to target all students as part of their required computer course, whereas optional activities may only serve to promote computing to students who already have a strong interest.

As part of establishing this project, we were able to outfit an entire computer laboratory at no cost to our department, while saving tens of thousands of dollars for our partner school. This benefits us as well as we are not limited in the types of computer-based activities. With an outdated and heterogeneous set of computers, this could potentially be a significant problem.

As our outreach laboratory evolves, we hope to expand by including more faculty members, students, and student groups. However, we do not seek to increase the time commitment of any current participants in the effort. Our efforts will be assessed from both a short and long-term perspective with the hope that the program influences underrepresented student populations to pursue studies and careers in computing disciplines.

FUTURE WORK AND AN INITIATION

The future work of the project centers on expanding and assessing the program. This will be done, however, through expanding involvement, not by expanding time commitments. Even at a small-scale we are pleased with the opportunities it provides our department and students to engage in activities to promote computing to young people.

One vision for expansion involves cooperating with similar outreach laboratories. We view the cooperation as a method by which we can improve effectiveness and efficiency even further. A collaborative bank of easy to prepare and implement activities will be beneficial to all participants. In addition, it would enable new opportunities for activities such as virtual-team projects where students at remote locations can work together to complete a web-based activity. We foresee a number of opportunities for exciting outreach activities resulting from a cooperative environment.

If you are interested in creating a similar type of outreach laboratory, or if you are interested in being part of a cooperative group of educators that don’t have the time, but do have the desire to perform outreach, please contact the authors of this paper.

REFERENCES


