

**Texas Tech University's College of Engineering
Building Computers, Families, and Communities
After-School Program**

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Abstract

The Texas Tech University College of Engineering has developed an after-school program with local junior high schools to establish a practical means for getting seventh-through ninth-graders excited about science, engineering, and technology. The pilot offering suggests the program has significant potential to attract students from populations that traditionally have been underrepresented in science and engineering disciplines into educational and career paths in these fields. In addition, the program also directly addresses the problem of the growing "digital divide." This program puts computers in students' homes and teaches them meaningful ways to use the technology to relate to their schoolwork, family, and community. At-risk students work side-by-side with their parents and teachers to build their own computers and learn to use them by participating in community-oriented projects that incorporate essentials of science, mathematics, engineering, and technology (SMET) disciplines. They also develop communication and writing skills with curriculum components involving essay writing, business communication, and civic discourse. One of the most exciting aspects of this program is that students are equal participants in a community of learners that includes both their parents and their teachers. This article includes initial results of the pilot study for this program, conducted with 16 at-risk students from low-income families, their parents, and seven of their teachers during the Spring 2000 semester. Because the pilot demonstrated an extremely high degree of positive potential, a number of entities in the Lubbock community have formed a consortium to significantly extend the scope of the program. This article describes the plan for increasing the scale of the program to make it available to a much larger number of participants and to make the program sustainable over time.

Rationale for the Program

Problems related to keeping pace with the rapid development and adoption of technology and information tools such as the personal computer and the Internet are myriad and well documented. For example, the 1998 report to the Governor by the Texas Science and Technology Council concludes:

Industry requirements for skilled technology workers are clearly growing faster than our state's workforce pool. The Council believes that Texas currently has

between 26,000 and 34,000 technology-related job vacancies. Moreover, projections show that the state will need to fill over 130,000 new positions in the technology workforce by the year 2000.¹

While projections such as these have ominous implications for the rate of growth in the U.S. economy and demonstrate an obvious need for developing increased science and technical skills in the workforce, even more alarming is the growing “digital divide”—the current trend toward a stratified society, characterized by “haves” and “have-nots” with regard to science and technical skills, access to information, educational and career opportunities, and other vital affordances increasingly necessitated by our expanding use of information technology. A number of reports by the National Telecommunications and Information Administration conclude that income, ethnicity, and gender are primary factors determining upon which side of the digital divide a household is located. These findings demonstrate that low income, minority, and single-female-parent households are significantly more likely to be included among the “have-nots”^{2,3,4}. A study by the City of Lubbock substantiates these findings and demonstrates a wide disparity in the use of computers and information technology between predominately white, middle-to-upper income neighborhoods and neighborhoods in which the demographics reflect a high percentage of either low-income, Hispanic, or African-American families.

There is wide consensus among institutions and researchers that improving learning opportunities in SMET disciplines is a key approach for “ensuring a diverse, scientific and technical workforce, as well as a citizenry capable of mastering the scientific and technical concepts and skills needed by workplace, social, and home environments that are characterized by increasing technological sophistication”⁵. Over the past three decades, a significant amount of attention has been paid to improving formal SMET educational programs in K-12, two-year, and higher education institutions, resulting in improved educational opportunities for students⁶. However, formal educational programs continue to attract only a fraction of the number of students into SMET areas needed in the workforce. Moreover, women and minority students have remained disproportionately underrepresented in formal SMET programs^{7, 8, 9, 10, 11, 12}.

Community-based, informal SMET education programs have often been successfully established to increase involvement of these underrepresented populations in learning activities¹³. However, while a growing body of research tends to substantiate this claim [*See for example*,¹⁴], researchers recognize the need for developing more rigorous evaluation metrics to assess the effectiveness of informal programs^{13,14}. The pilot program for the Building Computers, Families, and Communities program has demonstrated a significant potential not only to attract students from underrepresented populations into educational and career paths in SMET fields, but also offers an effective means for addressing the problem of the digital divide. While the results of the pilot reported in the following sections are only preliminary, plans to increase the scale of the program include rigorous longitudinal research to measure the program’s effectiveness.

Program Description and Initial Results

The Building Computers, Families, and Communities program was developed by Dr. John Chandler and Dr. Dean Fontenot of the TTU College of Engineering and successfully piloted by them at O.L. Slaton Jr. High School in Lubbock during the Spring, 2000 academic semester. This innovative after-school program establishes a practical means for addressing the digital divide by putting computers in the homes of students from low-income households and teaching them meaningful ways to use the technology to relate to their family, schoolwork, and community. In the pilot study, 16 at-risk, eighth-grade students from low-income households worked side-by-side with their parents and seven of their teachers to build their own computers and learned to use them by participating in community-oriented projects that incorporated essentials of SMET disciplines. In all, participants built a total of 21 computers, with the additional five built by the teachers and donated to the school. Participants also developed communication and writing skills with other curriculum components involving presentations, essay writing, business communication, and civic discourse. Researching the neighborhood in which their school is located and building a website for the neighborhood association was one of the projects the group completed as part of the program, and provides an example of a project that combines using technology and communication skills with community involvement.

Assembling the hardware, configuring the operating system, and learning the basics of industry-standard office and Internet software provided participants with a foundation in computing skills and other SMET knowledge areas, which they were able use immediately and can expand upon in the future. Preliminary research results from the pilot study indicate there are a number of significant benefits to teaching participants to build their own computers. One benefit is that it demystifies the technology, which not only empowered the students and their families to maintain and upgrade the hardware, but also makes them less afraid to interact with the interface for fear of breaking the machine. The initial study indicates that the pride and ownership in building their own computer motivated participants to gain proficiency with the computer quickly and to continue refining their computer skills after completing the program.

One of the most exciting aspects of this program is that students were equal participants in a community of learners that included both their parents and their teachers. In many cases students grasped concepts more quickly than the adults and were in a position to help instruct their parents and teachers. Significantly, working together to build and learn to use the computer opened new lines of communication between parent and child within a context that stresses the importance of learning about applications for science and technology in society. Chandler and Fontenot have found in their continuing research with the project that the pride and family ownership vested in the machine provides a common interest that continues past the life of the program, as family members have continued to support one another in learning meaningful ways to use their computers. Additionally, this program gave a segment of the population that often has limited access to information technology an opportunity to demonstrate the power and value of learning about technology to their extended families, friends, and neighbors.

The positive potentials for this program go well beyond the activities of the classroom, and should yield benefits for the community for years to come. In the long run, this program aims at effecting systemic change in the community, not only by making careers in technology fields a real possibility for these students, but also by building an appreciation for the value of life-long learning in their families and neighborhoods. One outcome of the pilot is that it attracted the attention of a wide-range of government, educational, and community entities that recognize the program's potential not only to interest students in SMET areas and address the problem of the digital divide, but also the potential for such collateral benefits as reducing juvenile crime, increasing community involvement, and providing workforce development. As a result of this attention, The City of Lubbock, Texas Tech University, Lubbock Independent School District, South Plains Community College, and a number of business and other community entities have formed a consortium to leverage their combined resources to make this program available on a community-wide basis.

Ultimately, these partners are committed to attracting more students to educational and career paths in SMET areas and developing support mechanisms to help ensure their success; to improving the technology skills-base in the existing workforce by providing new learning opportunities to all citizens in the Lubbock area for applying SMET concepts in their daily activities; and to developing a sustainable model for a "wired community," which makes egalitarian use of computers and information technology to encourage all demographic groups to actively participate in finding ways to improve the quality of life for the whole community. The following sections describe the plan for implementing the program on a large-scale basis.

Plan for Expanding the Scope of the Program

Based on our experience with the pilot of the Building Computers, Families, and Communities program, we have developed a viable plan for scaling-up the program not only to significantly increase the number of families directly participating in the program, but also to leverage the resources of the partnering entities to increase public awareness of the role of SMET in the community and to provide additional learning opportunities for all area citizens. The key elements of the plan are as follows:

- We propose offering the program to 100 low-income families each year during the course of the spring semester, with additional activities continuing into the summer and fall. Lubbock Independent School District (LISD) comprises 10 Jr. High Schools, and we will select 10 families of eighth grade students from each school. Selection will be based on need (using mechanisms such as participation in free-lunch programs to identify candidates, and then surveying this population to establish need, interest in the program, and willingness to commit the after-school time the program requires).
- Initially, we will bring all the participants together in a facility provided by LISD to build the computers, instruct participants in concepts regarding computer

hardware and software, and provide an overview of the curriculum and program requirements. In our experience with the pilot program, participants tended to bring other family members to meetings, so we estimate this group will number somewhere between 250 and 400 people each time we run the program. We will use volunteers from student chapters of engineering and science professional societies, technicians from local businesses, and other volunteers to act as facilitators to help participants build their computers.

- After the computers are built, the participants will take their computers home and be provided Internet access. They will then begin twice-weekly meetings at the school the student attends for curriculum components that include software training, SMET projects, communication and presentation skills, and community oriented projects. These meetings will be facilitated and taught by TTU graduate students from SMET disciplines and two to three teachers from each local school. We anticipate hiring a total of five graduate students, and they each will work with groups from two of the schools. The teachers and graduate students will be paid a stipend for directing the program at the local schools and for participating in curriculum training and development.
- The project will incorporate other resources to support SMET learning experiences, such as the Projects Advisory Board, which is composed of academic and professional experts in SMET areas. For example, if one of the SMET projects involves making observations about some variable in growing conditions in one of the city's community gardens, a professor of biology might act as consultant for the project to direct the participants to reference materials and to help design a credible research plan.
- In turn, participants will use the computer and information skills they gain in the program to benefit the community by teaching others. For example, community oriented projects will include such activities as helping patrons in the public libraries learn to use the available computer resources and public Internet access, or teaching patrons in the public community centers and senior centers to use Internet browsers or email.

The preceding list describes key elements of the strategy for implementing the program on a large-scale basis. The following sections describe elements of the plan such as educational goals and research associated with the program in more specific detail.

Project Goals

The project is specifically designed to provide all participants with an increased understanding of SMET concepts and practical technology skills. The previously stated goals of the program include attracting more students from underrepresented demographic groups into educational paths in SMET disciplines and increasing the technology skills-base in the local workforce. In addition to these overarching goals, more specific goals are to improve student grades; to encourage students to enroll in more demanding coursework, such as advance placement courses in SMET areas; and to

increase student participation in other SMET activities already in place, such as SMET college preparatory programs offered by TTU, technology workforce development programs at South Plains Community College, or the use of Gates Foundation interactive educational software in the public libraries.

Because parents and teachers were actively engaged in the learning along with the students in the pilot study, it is important to establish goals for their participation as well. Certainly, chief among these goals is to get parents more actively engaged in their children's education and in the public school system. Similarly, the program is designed to encourage participation in community activities and improvement, which is a goal applicable to student, parent, and teacher participants. In surveys conducted in the pilot study, both parents and teachers overwhelmingly indicated that they felt the program curriculum and the technology skills they acquired contributed to their professional development and increased the number of career choices available to them. Ultimately, perhaps this is the most important goal of the program—to provide the resources and skills that allow all participants to use technology in ways that are meaningful to each individual.

Level and Depth of Instruction

The curriculum for the pilot program stressed elements of the Texas Essential Knowledge and Skills (TEKS) criteria for the targeted student population. The curriculum also addressed technology skill criteria established by LISD for teachers in the district. These elements will remain in the curriculum, and the recently published Standards for Technological Literacy also will be built into the curriculum¹⁵. In our experience with the pilot program, these kinds of standards provided a base level of technical skill needed to complete the various elements of the curriculum; however, because of the level of engagement with using computer and information technology skills to develop meaningful projects, we found that the majority of the participants far exceeded the level of technical expertise reflected by these standards.

Minimum/Maximum Length of Instruction/Student Involvement

Participants will meet after school twice weekly during the course of the spring academic semester for approximately 16 weeks of intensive inquiry-based learning. They will continue to participate on a monthly basis during the following summer and fall working with neighborhood associations and patrons of the public libraries, community centers, and senior centers to teach technology skills to others. In addition, participants that successfully complete the curriculum will be offered opportunities and scholarships to take additional technology courses at South Plains College, TTU, and other area educational institutions.

The SMET projects are ongoing during the length of the course. The role of the Projects Advisory Board is to help participants understand science and mathematical concepts that contribute to the phenomenon under investigation (examples of these could be something to do with astronomy, biology, or an engineering problem). Additionally, the Projects Advisory Board is in place to help participants understand why a rigorous research design is necessary in scientific inquiry.

The software training and communication skills components are also ongoing during the whole 16-week curriculum and are aimed at developing workplace skills that are useful to all three populations engaged in the programs. Surveys conducted in the pilot demonstrate that students, parents, and teachers all applied the technology skills they were acquiring in their work environments to improve the quality of their work. For example, one of the fathers was a mechanic, and reported that information he gathered from the Internet significantly improved his work performance. Teachers all reported that the program contributed to their professional development by not only giving them computer and information technology skills, but also by increasing their understanding of SMET concepts and putting them in touch with resources available at TTU.

Recruitment

Using existing mechanisms, such as participation in free lunch programs to identify candidates for the program helped ensure that underrepresented populations were able to take advantage of the program. Of the 16 families participating in the pilot study, 13 were of Hispanic origin, two were Afro-American, and one was Anglo. The demographics of the scaled-up program will be influenced by the demographics of the particular neighborhood a school is located in; however, based on the pilot and available demographics, we are confident that using income-level as a criterion for identifying candidates will result in predominate participation by underrepresented groups. In the pilot, five of the 16 students were female, but because in nearly every case the mothers participated in the program, a significant female population participated.

Parental Involvement

Our experience with the pilot indicated that the involvement of the parents is one of the most gratifying aspects of the program. Survey results clearly demonstrate that the parents not only felt that they were gaining important technology skills that increased the number of career options available to them, but also that the program was allowing them to make a real connection with their child. In the pilot, because the program required at least six hours each week in after-school meetings, we were concerned that we would not get an adequate level of parental involvement, so we required the parents to sign contracts promising to attend at least one meeting each week. Our attendance rolls indicate that in virtually every case, both parents (all of the households except two were two parent households) came to both meetings every week. We found that the program also offered a unique platform for informing the parents about educational opportunities for their children and community programs that could be advantageous for their families.

Research and Evaluation

The program will employ both formative and summative evaluation methods to guide and evaluate the activities of the center. The pilot made use of survey instruments at various points in the program to evaluate the success of certain activities. This practice will continue, and will provide data to help shape the curriculum. In addition, Meetings among the principal investigators, the center's advisory board, the public school teachers and administrators, and other stakeholders in the program will be used to gather data useful in developing metrics for both formative and summative assessment^{13,14}.

One of the most exciting opportunities the program offers, however, is the potential to conduct a large-scale, longitudinal study designed to track a variety of outcomes of the program over time, such as the program's impact on student grades and educational choices in comparison to the rest of the student population in LISD. Such a study would allow gathering significant data on the impact of technology and the program in the lives of the participating families. The data and conclusions of a longitudinal study of this nature would provide a wealth of information useful to researchers and managers involved in workforce development, the design of educational and community programs, and understanding the impact of computer and information technology in the social milieu.

Conclusion

While this plan is extremely ambitious, we are encouraged by the results of the pilot and the willingness of such a wide range of institutions and entities in the community to participate in implementing the program. Changes engendered by computers and information technology in our culture make it increasingly evident that many of the old models for education, community involvement, workforce training, and other basic ways in which we organize our society, work, and share knowledge are becoming less effective, or even relevant. It is our hope that this program will provide the catalyst for change in Lubbock. If nothing else, bringing together decision makers, administrators, and citizens from across the community will increase the opportunities for the free exchange of ideas and articulation of issues. In this context, the Building Computers, Families, and Communities program creates the framework for an extremely powerful forum to initiate positive change in the community.

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