College for all Texans

Technology Workforce Development Grants Program

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Texas Higher Education Coordinating Board

Texas Higher Education Coordinating Board

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Mission of the Coordinating Board

The Texas Higher Education Coordinating Board's mission is to work with the Legislature, Governor, governing boards, higher education institutions and other entities to help Texas meet the goals of the state's higher education plan, *Closing the Gaps by 2015*, and thereby provide the people of Texas the widest access to higher education of the highest quality in the most efficient manner.

Philosophy of the Coordinating Board

The Texas Higher Education Coordinating Board will promote access to quality higher education across the state with the conviction that access without quality is mediocrity and that quality without access is unacceptable. The Board will be open, ethical, responsive, and committed to public service. The Board will approach its work with a sense of purpose and responsibility to the people of Texas and is committed to the best use of public monies. The Coordinating Board will engage in actions that add value to Texas and to higher education. The agency will avoid efforts that do not add value or that are duplicated by other entities.

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Technology Workforce Development Grants Program

Summary of Grants Program

In response to requests by the high-tech industry to increase the number of electrical engineering and computer science graduates from higher education institutions in the state, the 77th Texas Legislature passed the Technology Workforce Development Act in 2001. This legislation, Senate Bill 353, created the Texas Engineering and Technical Consortium (TETC) and the Technology Workforce Development (TWD) Grants Program. The TETC is a not-for-profit organization composed of representatives from university engineering and computer science programs throughout the state, and representatives from Texas industry.

TWD grant projects support the recruitment, retention, and graduation of students in engineering and computer science. As a result of the grants, institutions implement and share recruitment and retention strategies that would not have been implemented or shared otherwise. University and industry leaders come together to collaborate and to replicate useful ideas, strategies, and curriculum. Students are provided support at critical junctures in their academic lives so that they make good choices regarding preparation, transfer, and career paths.

Examples of successful concepts developed through TWD grant projects include:

- Using work-study to keep students (especially first-generation students) involved on campus
- Achieving a higher rate of success using peer teachers instead of traditional teaching assistants with first- and second-year engineering and computer science students
- Developing more targeted transfer agreements between community colleges and universities so that students do not lose time or credit for courses already taken
- Undertaking course and laboratory re-design to make high-tech studies more relevant to students
- Using outreach in high schools to help students understand the value of studying engineering and computer science
- Creating more effective learning communities outside the traditional campus setting, for commuter students or for students used to communicating online

The Coordinating Board and TETC held Best Practices Conferences in 2006, 2007, and 2008 to disseminate information about effective practices to about 100 project leaders and industry representatives. In August, the Coordinating Board held a project leader conference to discuss high school “summer camp” strategies which have proven effective in recruiting students early on, and in helping students to make right choices for their college readiness preparation.

Also in 2008, TETC re-designed its “All Across Texas” program which enables students to connect with industry for internship opportunities and prepares them for interaction with industry culture. The program was funded through the Texas Workforce Commission,

and students representing 15 Texas colleges and universities attended and completed the first All Across Texas Leadership Development Week.

TWD projects have succeeded in recruiting and retaining students and in guiding them toward graduation. The projects will have a continuing positive effect on students and on the delivery of education in high-tech fields after the termination of the grants, but additional funding could further enhance and propagate advances achieved. Local industry could and has been involved to sustain the initiatives. Other projects secured federal follow-up grants.

The total amount of TWD funding since the program's creation in 2001 through 2008 is $19 million. A detailed description of the funding history for all grants is in the Coordinating Board's fifth annual report from October 2006 and posted on its website at <http://www.thecb.state.tx.us/reports/PDF/1261.PDF>.

Industry has contributed $3.37 million to the grants program and $1.07 million through in-kind donations such as hardware, software, and sponsored internships. The TETC secured two federal grants from the U.S. Department of Education for a combined total of $3.78 million for grants. Through 2005, the state provided $7.78 million in general revenue funds as matching for non-state contributions. In 2007, the program received, in two phases, a combined $3.0 million in U.S. Department of Labor funds from the Governor's Office through the Texas Workforce Commission for TWD 2006 or the "TETC Texas Youth in Technology (TYT) Demonstration Project" grants. Two-thirds of these funds were available for the second phase of these grants – between July 1, 2007 and August 31, 2008.

Outlook on Engineering Positions and Texas Graduation Numbers

There were about 1.5 million engineers employed in the United States in 2006 (National Bureau of Labor Statistics).[1] Of those, approximately 120,000 engineering positions were in Texas. The Texas Workforce Commission[2] (TWC) counted 111,400 positions for 2004, and a National Science Foundation (NSF) study[3] listed 123,990 Texas positions for 2006. While the National Bureau of Labor Statistics estimated the growth rate for engineering positions nationwide to be 11 percent for the next 10 years, TWC lists a growth rate for engineering in Texas at 20.7 percent.

The state needs new engineers to fill new positions, and also to replace workers who are coming to the end of their professional careers. The TWC estimates an average replacement need of 23 percent for the next 10 years. However, anecdotal estimates from industry, e.g., Lockheed Martin, put the replacement rate as high as 50 percent. According to the NSF report, more than half of all science and engineering degree holders in the labor force are above age 40, and more than one quarter of workers are age 50 and over.[4] These engineers will reach retirement age in the next 10 to 20 years.

Because of the uncertainties in the growth rate (11 to 21 percent), and in replacement need (23 to 50 percent), the calculation of new engineers needed in Texas over the next 10 years falls on average between 4,000 and 8,500 per year. Engineers will be needed to fill positions which require bachelor, master's, and doctoral degrees.

Table 1 lists Texas graduates, separated by degree-level, for computer scientists, electrical engineers, and for all engineering disciplines (including electrical) combined. Texas schools graduated 6,365 engineers in Academic Year 2006-07. This is an increase of 29 percent since Academic Year 2000-01, the benchmark for the state's *Closing the Gaps* initiative. However, engineering graduate numbers have declined since Academic Year 2004-05.

Degree production for electrical engineers experienced a lesser gain than that for all engineering fields together. Electrical engineers are graduating at a 16 percent higher level than in 2001.

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[1] United State Bureau of Labor Statistics, Occupational Outlook Handbook, 2008-09 Edition. <http://stats.bls.gov/oco/ocos027.htm#outlook>

[2] Texas Workforce Commission, Labor Market & Career Information Department Tracer data base. <http://www.tracer2.com/>

[3] National Science Board, Science and Engineering Indicators 2008. <http://www.nsf.gov/statistics/seind08/pdf/c08.pdf>

[4] National Science Board, Science and Engineering Indicators 2008. <http://www.nsf.gov/statistics/seind08/c3/c3h.htm>, and <http://www.nsf.gov/statistics/seind08/c3/c3s3.htm>

Table 1 Current and historic graduation data for engineers, electrical engineers, and computer scientists from Texas public institutions of higher education. Academic Year 2000-2001 is the benchmark for the state's *Closing the Gap* initiative.

Texas Public Higher Education Institution Graduates

		Academic Year						
		2006-2007	**2005-2006**	**2004-2005**	**2003-2004**	**2002-2003**	**2001-2002**	**2000-2001**
Computer Science Graduates	Bachelor's	937	1,222	1,430	1,614	1,708	1,640	1,531
	Master's	856	937	1,064	1,147	1,133	882	911
	Doctoral	131	89	57	44	44	37	57
	Total	**1,924**	**2,248**	**2,551**	**2,805**	**2,885**	**2,559**	**2,499**
Electrical Engineering Graduates	Bachelor's	1,175	1,262	1,266	1,337	1,266	1,151	1,075
	Master's	677	846	961	928	741	576	575
	Doctoral	188	172	133	129	106	98	110
	Total	**2,040**	**2,280**	**2,360**	**2,394**	**2,113**	**1,825**	**1,760**
All Engineering Graduates	Bachelor's	3,856	3,822	3,589	3,427	3,378	3,034	3,004
	Master's	1,963	2,283	2,621	2,504	2,131	1,634	1,574
	Doctoral	546	500	438	426	332	324	349
	Total	**6,365**	**6,605**	**6,648**	**6,357**	**5,841**	**4,992**	**4,927**

Data from the Texas Higher Education Coordinating Board's management information system database PREP-Online.

Computer science graduates include Computer and Information Systems, Computer Programming, Information Sciences, Computer System Analyst, Computer Science, Software Engineer, and Computer Software Engineering. Electrical engineering graduates include Computer Engineering, Computer Networks, Electrical Engineering, and Systems Engineering. The category "All Engineering Graduates" includes electrical engineers.

The decline in computer science degrees began earlier with Academic Year 2002-03, at which time it was 15 percent over the benchmark. Currently it is 23 percent below the benchmark. This decline is well known and commonly correlated with the "dot-com demise" at the onset of the decade. The decline is a nationwide phenomenon.

Table 2 lists students enrolled in Texas, separated by degree level, who declared a major in computer science, electrical engineering, and any type of engineering combined. The decline in computer science enrollments may have leveled off just above 60 percent compared to the Academic Year 2000-01 benchmark. Electrical engineering did not change more than a few percentage points. Engineering overall saw a 22 percent increase in Texas over the last half decade.

Table 2 Current and historic enrollment data of declared majors for engineers, electrical engineers, and computer scientists from Texas public institutions of higher education. Academic Year 2000-2001 is the benchmark for the state's *Closing the Gap* initiative.

Texas Public Higher Education Institution Declared Majors

		Academic Year						
		2006-2007	**2005-2006**	**2004-2005**	**2003-2004**	**2002-2003**	**2001-2002**	**2000-2001**
Computer Science Majors	Bachelor's	5,941	6,074	6,495	7,537	8,911	10,182	11,070
	Master's	2,652	2,408	2,362	2,675	3,124	3,277	3,208
	Doctoral	641	691	732	671	634	589	484
	Total	**9,234**	**9,173**	**9,589**	**10,883**	**12,669**	**14,048**	**14,762**
Electrical Engineering Majors	Bachelor's	6,701	6,728	7,001	7,501	7,980	8,344	7,666
	Master's	2,133	1,899	1,794	2,082	2,331	2,236	1,741
	Doctoral	1,011	1,078	1,092	1,107	1,066	930	786
	Total	**9,845**	**9,705**	**9,887**	**10,690**	**11,377**	**11,510**	**10,193**
All Engineering Majors	Bachelor's	26,281	25,473	24,540	24,403	24,124	23,395	21,911
	Master's	5,929	5,154	5,101	5,740	6,233	5,770	4,725
	Doctoral	3,024	3,141	3,084	3,117	2,938	2,491	2,212
	Total	**35,234**		**32,725**		**33,295**		**28,848**
			33,768		**33,260**		**31,656**	

Data from the Texas Higher Education Coordinating Board's management information system database PREP-Online.

Computer science majors include Computer and Information Systems, Computer Programming, Information Sciences, Computer System Analyst, Computer Science, Software Engineer, and Computer Software Engineering. Electrical engineering majors include Computer Engineering, Computer Networks, Electrical Engineering, and Systems Engineering. The category "All Engineering Majors" includes electrical engineers.

TETC Best Practices Meeting 2008

The Texas Engineering and Technical Consortium (TETC) held its third annual Best Practices Conference at Southern Methodist University on February 28-29, 2008. The school's Engineering Dean, Dr. Geoffrey C. Orsak, gave a passionate keynote address challenging Texas engineering faculty and educators to take risks and fundamentally change the way engineering is presented and taught.

Dean Orsak pointed out that 50 percent of post-World War II United States' economic growth was due to technology and emphasized that the importance of engineering needed to be recognized. He noted that recently successful countries such as Malaysia and Korea began with a narrow and single-minded focus on engineering education.

However, in the United States, only one out of 100 ninth graders attains an engineering undergraduate degree.

Dean Orsak quoted Tom Engibous, chairman of Texas Instruments, statement that we "can't even comprehend the competition that is coming" and a 2006 National Academies study that found that the next generation may be the first to be economically worse off than its parents' generation. Dean Orsak made it clear that the solution to the engineering education crisis must come from the educators in the field. He said, "in this country the role of public policy is to give incentives to do the right thing, but it will not provide the answers to solving the crisis."

Round-table Discussions

The Best Practices meeting included round-table discussions by the participants. TETC summarized their input:

1. Consistent with Dean Orsak's message, TETC needs to continue to encourage engineering/computer science college educators to implement change.

2. The Technology Workforce Development program needs continuing funding. Funding allows projects otherwise not done and the exploration of ideas. Involve local industry to sustain the initiatives.

3. TETC should make resources/programs to increase interest in STEM careers available to educators: make the connection between engineering and quality of life.

4. High school outreach efforts are needed to increase awareness and involvement of parents, to help prepare counselors and career centers, and to make use of college student groups and college student outreach programs.

5. One of the greatest values of the Best Practices Conference is the opportunity to network and share information; participation should be mandatory for grant recipients.

Best Practices

The summaries for each of the presented Best Practices projects below show again that increasing graduation numbers overall depends on the attention given to each student by individual educators and advisors. It also shows increasingly, however, that engineering and computer science students thrive on opportunities to lead and participate. These students respond to opportunities to mentor or peer teach, to get involved with secondary school students or industry leaders, to build campus communities, or to take up educational experiences outside the classroom. When engineering education provides opportunities during the time of study, it motivates by

convincing students that their engineering education will also open doors after graduation.

Sustaining successful outreach, recruitment, and retention programs

A joint recruitment and peer mentoring program between the **University of Houston Clear Lake** and **San Jacinto College** was expanded through a STAR program (Success Through Academic Recognition) with heavy faculty involvement that seeks to identify and inspire individual students. The close collaboration between the institutions forms the backbone of the program's success.

Texas Tech University operates an interlocking program of outreach from elementary to high school through robotics. The institution recognizes the value of sustained and repeated involvement to build students' interest in technology. While secondary education as a profession is not attractive economically to newly graduated engineers, the program found an ideal, synergistic relationship between teachers and undergraduate students that requires both directing a class of pupils and handling the robotics and computer technology.

Prairie View A&M University used the Infinity curriculum and laboratory hardware to jump-start its new degree program in computer engineering. Student enrollment increased from 15 students in the first year (2003) to 81 in fall 2007. Retention of freshmen students taking the Infinity Project course is above 80 percent, and the engineering school now is adopting the Infinity curriculum in its other disciplines.

Advancing successful articulation and transfer agreements with community colleges

Texas State University-San Marcos (TX State) and **Austin Community College** (ACC) have an agreement that allows 74 transferable hours from the community college for the completion of the computer science degree at the Round Rock Higher Education Center (RRHEC). The program specifically targets working professionals and uses a web-based tutoring system with tutoring stations at ACC, TX State, RRHEC, and, in the future, the Austin and Round Rock Independent School Districts. It also offers a web-based mentoring system whose mentors are volunteer industry professionals.

Richland College and **Collin College** worked out specific articulation agreements with **The University of Texas at Dallas**' (UTD) Erik Jonsson School of Engineering that allows community college students to earn an Associate in Sciences degree that replicates the first two years at UTD. The agreement bridges the gap of what a student can potentially transfer from the Field of Study Curriculum in Engineering and what is applicable in actuality. The agreement requires twice-yearly meetings to assure alignment of every aspect, from textbook selection to syllabi and laboratory facilities.

One-half of **The University of Texas at Arlington's** (UTA) undergraduate students are transfer students. UTA has had a working informal agreement with **Tarrant County College District** for more than seven years. Maintenance requires yearly

reviews and meetings. The agreement includes dual enrollment opportunities and transfer of hours back to the community college level. This allows students to take advantage of college advising and to manage their grade point averages, and allows the community college to reach its performance goals for completed associate degrees.

Recruiting and retaining women in engineering and computer science programs

Overall retention in electrical engineering for minority, first generation, and female students is very low at **The University of Texas at San Antonio** (UTSA). The institution is redesigning curricula from the high school to its senior design course levels. This includes a "Just in Time Math" course based on the Wright State Model of introducing engineering mathematics. It includes structured problem solving and conceptual learning in its engineering design courses and visual pedagogy for its statistics course. The latter course is a gate-keeper course for students that lack the language skills to work through word problems dominating the subject.

The University of Texas at Austin targets female high school students from across the state with its First Bytes Outreach Programs. The programs include summer camps for students and workshops for teachers and counselors. Enrollment in these programs is highly selective, but the university achieves a 50 percent enrollment of female camp participants in its science and technology degree programs.

The **University of Houston** recognized that today's students, the "Millenials," use the worldwide web, including "wiki" pages, "blogs," and social networking sites such as "Facebook" and "MySpace" to communicate and build relationships. These tools blur the boundaries between leisure and learning, socializing, and professional interaction. They also give the faculty an opportunity to support its student community by incorporating these tools into special recruitment and retention programs such as WELCOME (Women in Engineering Learning Community for Maximizing Excellence), PROMES (Program for the Mastery of Engineering Studies), and G.R.A.D.E. (Girls Reaching and Demonstrating Excellence) camps.

The **Southern Methodist University** (SMU) School of Engineering has achieved a 32 percent overall participation of female students, while the national average has dropped to 17.5 percent. SMU finds that its female students are drawn to the subject because they recognize that a degree in engineering or computer science will be a foundational degree. The institution gives support by emphasizing a holistic educational approach, including participation in professional organizations, opportunities for work experience, opportunities to pursue multiple interests, and experiences outside the classroom.

Appendix A: Summary Reports for TWD 2006 Phase II Projects

Project summaries are condensed from project leaders' quarterly reports to the Coordinating Board.

Prairie View A&M University:

Recruitment and Retention Programs for the Department of Electrical and Computer Engineering

During the summers, Prairie View A&M University (PVAMU) held camps for high school students from the Houston area. The two-week camps were intended to increase awareness and enthusiasm for math and sciences, prepare students for matriculation at a four-year college, and to build self-confidence and self-esteem. Fifty-five percent of the participants were female, 85 percent African American, and 15 percent Hispanic. The curriculum covered math, physics, English, electrical engineering with laboratory, plant visits, and engineering ethics.

For the school year, the institution created an Academic Enhancement and Enrichment (AEE) program with "enrichment advisors" (tutors) for students of 10 sophomore and junior-level courses. Advisors had weekly meetings with the class professors, held twice weekly tutorial sessions, and had to report on the problems discussed. Those students participating in the AEE program sessions had significantly higher percentages for grades "A" and "B" and significantly lower failure rates.

Texas Tech University:

Curricular Development, Multidisciplinary Team Internship, and Undergraduate Peer-mentors for West Texas Students

During the summers, Texas Tech University (TTU) conducted multidisciplinary summer campus internships for community college and high school students, with teams under the leadership of TTU students. The teams conducted socially valuable projects, such as smart house measurement devices, a fall detector for the elderly, and a special-needs bicycle for a disabled school girl. The projects concluded with working prototypes.

TTU also started an undergraduate peer-mentor system for assistance with discussion sections, Q&A sessions, and one-on-one tutoring. Fourteen mentors supported three courses with multiple sections. The pass-fail-drop ratio improved for these courses.

During the spring semester, the institution held four weekend outreach activities for about 50 high school students, during "Super Saturdays." The grant allowed the fabrication of a number of student-built kits that included a leaf-blower hovercraft, windmills, magnetic levitation, a fuel cell for cars, and equipment for data collection through the Global Positioning System (GPS).

Texas Tech University:

Integrated Outreach, Mentoring, and Placement of Texas Youth in Engineering Careers

Summer activities provided one-week camps for students from grades four through seven; and from grades eight through 11; a four-day girls-only camp for grades seven through 11; and 10-hour classes at a community center for grades three to five. The camps utilized the LEGO NXT robotics kits, used support from TTU students, and

involved, for the lower grades, elementary school teachers to teach the content. Teachers previously trained for the LEGO NXT system taught summer classes at their schools at three different school districts. These teachers used traveling LEGO NXT laboratories on loan from TTU and received support from TTU mentors and through visiting demonstrations. The classes benefitted about 60 students each summer.

TTU organized summer on-campus internships for secondary schools students, either involving them with design challenges for robotics competitions or having them conduct a complete test procedure for a local medical appliance development company. Three exceptional high school students continued to work 10 to 15 hours a week on their internship throughout the school year. The grant allowed a high school teacher internship for the adaptation of the LEGO NXT processor to topics of biological sciences and the adaptation of the National Instrument ELVIS (Educational Laboratory Virtual Instrumentation Suite) system to high school projects.

The school used eight mentors for a week-long pre-semester BRIDGE program for about 100 freshmen students and two diversity mentors for its underrepresented students. The mentors stayed in touch with their peers throughout the year. The grant also allowed nine peer mentors for freshmen and sophomores throughout the year that turned out to be very beneficial for the mentors as well, in terms of self-esteem and improved grades.

During the fall semester, the institution provided student mentors and coaches to 23 teams of the West Texas BEST (Boosting Engineering, Science, and Technology) middle and high school competition and trained 23 teachers for a new microprocessor-based controller. During the spring semester, the grant involved 39 undergraduate and two graduate students who mentored and led workshops for high school students involved in the FIRST Robotics competition, and 15 elementary school teams (about 300 students) involved in the GEAR competition.

The project leaders have secured follow-up funding from industry for both the high school robotics competition as well as for the summer BRIDGE program.

Texas Engineering Experiment Station:

Assessment of Computer Science at Texas A&M University Peer Teachers Program

Texas A&M University Department of Computer Science developed the peer teacher system for its courses. Peer teachers are an alternative source of help because they are not involved in the grading process as are graduate teaching assistants. Therefore, peer teachers have a more direct communication opportunity with the target students. The institution implemented the peer teaching system for all its computer science courses at the freshman, sophomore, junior, and senior levels. The evaluation through this grant involved 1,100 students for the fall and 910 students for the spring semesters. About two-dozen peer teachers were employed for each semester through the grant.

Students taking freshman-level courses were most comfortable asking peer teachers for help (94 percent) rather than asking the instructor (73 percent) or the teaching assistant (79 percent). For the sophomore-level courses, students preferred asking peer teachers and teaching assistants over the instructor. In upper-level classes, the comfort level was reversed, with students being most comfortable asking the instructor (95 percent), followed by peer teachers (88 percent), and lastly the teaching assistants (84 percent).

Throughout the semester, peer teachers recorded which students asked or did not ask questions. About 900 students asked questions, while about 1,100 did not. Students who asked questions of peer teachers obtained a higher course grade than did students who did not. The difference was most pronounced at the freshmen-level, with about a 0.6 difference in grade point average (GPA). It was least relevant for the upper-levels, with less than 0.2 GPA difference.

The University of Texas at Austin:

Increasing the Applicant Pool and Retention in Computer Engineering

The University of Texas at Austin (UT) Electrical and Computer Engineering department started an undergraduate tutor program based on the TWD best practice of peer mentor support. The program now reaches over 500 students per semester and is so successful that the department seeks to expand the effort with follow-up funding.

The department supported its transfer students from the Austin Community College with scholarships.

The grant allowed UT to conduct its fourth Edison Lecture Series for high school students. Each lecture series focuses on one high-interest topic, such as renewable energy sources or television and surveillance. The lectures include information about career options and demonstrate diversity through inclusion of women presenters. The effort started with the Austin Independent School District but is now ported to the San Antonio area. The Edison Lecture Series has reached over 15,000 middle and high school students. UT students are involved in marketing the lectures through broadcasts for the school districts' television networks.

The University of Texas at Dallas:

Jonsson School Undergraduate Scholars Program

The University of Texas at Dallas (UTD) used several small camps during the first summer as pilot projects for two week-long camps during the second summer. It now conducts the camps in conjunction with the Dallas Museum of Nature and Science. The camps benefit about 60 high school students.

Also during the first semester, a pilot head-start program was used for 40 entering students to develop a new freshman experience course that employs the Lego Mindstorm system in team projects. The newly designed class proved effective and attractive; it was designed to be applicable to all electrical and computer engineering programs. The school made the course part of the degree requirement for its new mechanical engineering program which will begin in fall 2008.

The grant allowed the school to create a mentoring office that is staffed by teaching assistants and has organized mentoring sessions. The goal of the mentoring office is to provide students with help right from the beginning, and to promote study groups among students.

The grant also supports undergraduate research involvement; two TETC-TYT supported students were part of a three-person team award from Texas Instruments for a wireless sensor design project.

The University of Texas at El Paso:

Reaching out Across Disciplines: Learning from Each Other to Produce More Graduates in Computer Science.

During the summer, the College of Engineering and the College of Education jointly held a one-week computer science summer camp for eighth-graders on graphic design topics. The camp was led by graduate students previously trained through a three-week professional science academy for the integration of science and math content. Guest speakers, e.g., from the Army Research Laboratory at the White Sands Missile Range, helped the students put their projects into a real-world context.

In summer 2008, the school employed 18 undergraduate researchers in five projects with four faculty advisors. The research groups were mixed groups with upper and lower division undergraduates and graduate students.

During the school year, the grant allowed the training of 12 undergraduate peer leaders per semester. These leaders facilitated peer-led, team-learning in workshops for the introductory course sequence of the Department of Computer Science and its computer architecture course with about 180 lower-division students. New training materials were developed. Peer-led, team-learning provided timely assistance to students in learning the course concepts that the students and instructors have identified as problem topics. Assessments at The University of Texas at El Paso (UTEP) showed that peer-led, team-learning leads to higher grades, faster time to graduation, and improved retention of undergraduate students.

Eight to 12 undergraduate students per semester were able to work on research projects with their research advisors, with applications in astronomy, biology, and computer systems analysis.

The University of Texas-Pan American:

Increasing Engineering and Computer Science Retention through Mentoring and Learning Communities.

The University of Texas-Pan American established a Mentoring and Learning Communities program with the intent of providing entering students at a large commuter campus the opportunities for establishing relationships with faculty and peers that are more readily encountered at a traditional campus. The program supplements existing programs that ease the often difficult transition to university life. The program's academically focused elements supplement, coordinate, and refine existing university structures.

A key element of the project was that it was designed for sustainability. It made use of student effort through student clubs and professional societies and integrated program activities with introductory courses to gain broad faculty involvement.

Student mentors led small groups of students to give tutorial support and allowed a personalized introduction to the university's culture and processes. Opportunities were provided for one-on-one interactions with faculty and successful upper-division students. Student mentors established a well-executed mentor group website and mailing list server to address the electronic communication expectations of the entering college students.

The program initiated a speaker series for the larger computer science and engineering community and, together with the universities career placement staff, informed students about career paths and professional opportunities.

The University of Texas at San Antonio:

An Engineering Pipeline for High School to Undergraduate Through a Structured Research & Mentoring Experience.

During the summers, the school held Summer Bridge programs for 20 female high school juniors with five undergraduate mentors.

Recruitment of diverse students into the electrical engineering program at The University of Texas at San Antonio (UTSA) was predicated on relationships with high school math and science teachers and counselors, established through activities from a prior Technology Workforce Development program grant. Of the current recruits, about 46 percent are from underrepresented groups, and about 50 percent are female. Retention of the 20 students in the program into the spring semester was 100 percent. Retention of 20 students from *Phase I* of the grant also was 100 percent.

The grant allowed 20 entering and progressing students to be integrated into externally funded research programs. These students received clearly delineated tasks and expectations, as well as complementary workshops. A formal and structured year-long pyramid-type mentoring program emphasized formal study groups and ensured the progress and success of the participants.

The institution leveraged the TETC-TYT grant through a Department of Education grant targeting Hispanic high school students and was able to double the number of student participants to 40.

University of Houston:

Step Forward: Preparing Low-Income High School Students for Academic Success in Electrical and Computer Engineering at the University of Houston.

The University of Houston (UH) Step Forward program trained 90 undergraduate students through professionally conducted learning and teaching seminars to become mentors to low-income students of Houston-area high schools. Mentors spent a minimum of three classroom contact hours with students of Houston's Phillis Wheatley and Cesar E. Chavez high schools. They assisted with project-based learning in circuitry, computer programming, robotics, math, and problem solving. The schools adopted lessons prepared and sponsored by Step Forward staff. Grant funding provided laboratory equipment for this collaboration.

The student mentors also worked for several large-scale events, each addressing hundreds of students, such as the Mexican American Engineers and Scientists student chapter's on-campus fall Science Extravaganza; the Engineering Career Day at Houston Independent School District schools sponsored by the Texas Alliance for Minorities in Engineering, Shell, and ConocoPhillips; the SECME (Science, Engineering, Communication, Mathematics Enhancement Program) and Gulf Coast Texas Alliance for Minorities in Engineering's Houston-wide Math and Science Mousetrap Car competitions; the UH spring semester Math Olympiad; and the high school First Robotics competition.

The program provided scholarship funding for Step Forward freshmen scholars for which retention into the spring semester was 100 percent.

During the summers the program allowed two weeks of summer camps for the partner high schools in cooperation with Houston's East End Chamber of Commerce.

University of Houston-Clear Lake:

Computer Science Scholars: Recruiting, Retention, and Mentoring.

This program allows cooperation between San Jacinto College-Central, San Jacinto College-South, and the University of Houston-Clear Lake with the purpose of joint recruitment and mentoring of new students and to assure their success.

At the community colleges, the mentors help the students with hardware and software issues, join lectures and help students with the material, and serve as liaisons between students and faculty to provide feedback about what topics need further explanations. Mentors help distance education students. They also prepare promotional materials such as career information, PowerPoint presentations, and promotional software that they place on memory sticks or DVD medium for distribution at high schools during recruitment visits. High school students are invited for campus visits. At San Jacinto College-South, mentors tutored sixth-grade students in a middle school computer class and reviewed the class curriculum. These activities enhanced the mentors' confidence.

The University of Houston-Clear Lake (UHCL) created a mentoring office which serves an average of about 100 student visits per month with about six mentors. The office provides support in programming, peer advising/networking, homework problems, and tutoring. In addition to one-on-one support, the office arranges a schedule for group tutoring sessions which promote the formation of student study groups. Several of the mentors have come from the partner community colleges and are motivated and able to help their peers transition successfully to the university.

The program conducted a high school Skills USA contest at San Jacinto College-South, as well as the first annual UHCL Programming Challenge for undergraduate and area community college students that featured video game, theme-base programming. The competition tested analytical thinking skills, problem solving, and also teamwork between the students of the different colleges. Mentors of the three partner colleges helped prepare the event. The institution received follow-up funding for this event from local industry.

Appendix B: Technology Workforce Development Grants Program Advisory Committee

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