

The South Carolina Center for Advanced Technological
Education: Annual External Evaluation Report 1999-2000

Submitted to:

The South Carolina Center for Advanced Technological Education
The South Carolina State Board for Technical and Comprehensive
Education

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The South Carolina Advanced Technological Education Center of Excellence

Annual External Evaluation Report 1999-2000

1. The Problem: A Shortage of Engineering Technicians in South Carolina

The South Carolina State Board for Technical and Comprehensive Education undertook the SC ATE reform initiative in 1994 in order to close the gap between South Carolina industry's demand for skilled engineering technicians and the state technical colleges' supply of ET graduates. The reform initiative led to a National Science Foundation award in 1996 of a six-year \$4.1 million grant to the state system to establish a national Center of Excellence in Advanced Technological Education, called the SC ATE Center ("Center"), that would "increase the quantity, quality and diversity of engineering technology graduates from the State's technical colleges."

a. High Demand for ET Graduates

Unemployment in the state is at a 30-year low. According to the South Carolina Technology Alliance, South Carolina currently has 15,000 unfilled technology-intensive jobs. Manufacturers are creating new jobs in South Carolina faster than the state can supply engineering technicians. In 1999 for example, Michelin, Siemens Diesel Systems, Bell Atlantic Mobile, BMW, Robert Bosch, and Mack Trucks created 3,000 jobs.¹ And between 1996 and 2006, South Carolina industry will require an estimated 346 new

¹ *The State*. "1999 Great for S.C.'s Economy: Commerce Department Report Shows Companies Invested in Record Amounts." January 15, 2000.

² This figure includes the need for new employees resulting from any cause, including retirement, illness, and job creation.

engineering technicians per year, according to the state's Employment Security Commission and the US Bureau of Labor Statistics.²

b. Short Supply of ET Graduates

Over the past decade, however, the state's 16 technical colleges have been meeting only a portion of industry demand with engineering technology graduates. The Center is the state's strategy for addressing the shortage of engineering technicians in South Carolina. The Center is leading a statewide systemic reform to re-engineer the engineering technology programs and thereby boost the system's production of ET graduates to meet the state's growing needs for a skilled work force.

c. High First and Second-year Drop-out Rates

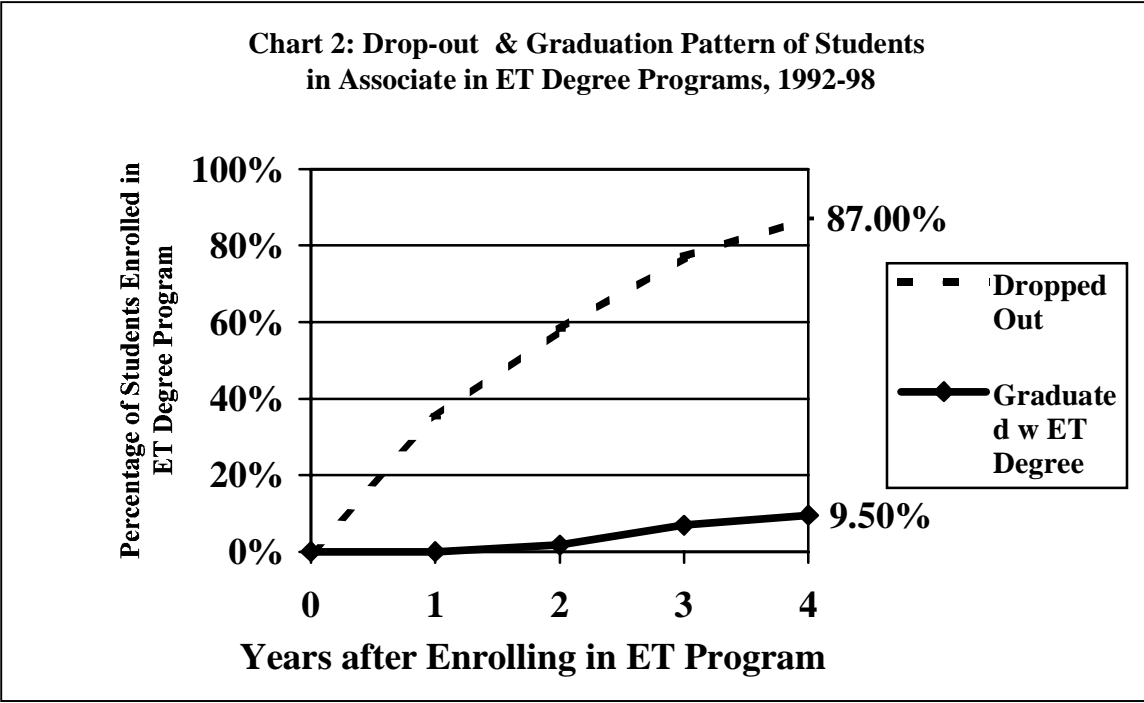
Historically, ET student attrition in the state college system has been high.³ Nearly 60% of students pursuing an associate degree in engineering technology drop out by the end of two years, and nearly 80% drop out by the end of three years. Only one out of every three students who began ET studies in 1995 or 1996 advanced to second-year ET courses, according to data from two colleges implementing the Advanced Technological Education program. (See Chart 1, below).

³ The analysis in this section is based on 1650 students who began their engineering technology studies in 1992, 1993, 1994 or 1995. These four cohorts were combined into one cohort whose progress was traced over four years. For example, year 1 refers to the students' year in ET studies, not to a calendar year. The dropout and graduation rates for that year are an aggregate of the dropout and graduation rates of all students in their first year of study, regardless of whether that year was 1992, 1993, 1994 or 1995.

| Chart 1: Historical Persistence of ET Students to 200-Level ET Courses | | | |
|---|--|---|---------------------|
| | Students Enrolled in ET Program (1995, 96 cohorts combined) | Students Persisting to 200-Level ET any time after 1st yr | % Persisting |
| College 1 | 105 | 32 | 30.8% |
| College 2 | 135 | 52 | 38.5% |
| Total | 240 | 84 | 35.0% |

d. Low ET graduation rates, especially for African Americans

Historically, only one in ten entering ET students earns an Associate in Engineering Technology degree within four years. See Chart 2 below.



Graduation rates are particularly low for African Americans. Between 1992 and 1995, only 6.1% of African American males enrolled for the first time as ET students at one of South Carolina's 16 state technical colleges graduated with an Associate ET degree within four years. By contrast, 10.8% of white males enrolled in the same degree programs during the same period graduated with the same degree within four years. A smaller disparity in graduation rates exists among women. Black female ET students enrolled during this period graduated at a rate of 7.1% while white females graduated at a rate of 9.4%.

2. Intervention: The SC ATE Center's curriculum development, faculty development, and program improvement activities in 1999

The Center targeted for reform the first year of the ET program because this was the major hurdle that, historical baselines on drop-out rates indicate, most ET students do not clear. Typically, most of those ET students that advance to the second year of the ET program eventually graduate. The redesigned first year, which incorporates the ET Core Curriculum, therefore was reformed *to increase ET student retention*, particularly in the first year of ET study. The redesign or "systemic reform" entailed a combination of new pedagogy, instructional design, technology-based learning environment and redefined teaching-learning roles and responsibilities that, research and local best practice showed, help similar students to persist and succeed.

In order to address the state's engineering technician shortage, then, in 1999 the Center intervened in the first year of the ET program with a comprehensive package of reforms. These reforms were developed and implemented by conducting three types of activities: curriculum development, faculty development, and program improvement. These activities, the Center leadership believes, will work to realize the improved student

outcomes intended (i.e., more, better skilled, and more diverse ET graduates) and eventually help solve the state's engineering technician problem. These activities are reviewed below.

a. Curriculum Development

The SC ATE Center engaged in several activities during 1999 to refine and expand implementation of the ATE curriculum. Implementation guidelines and faculty applications to join the project were sent to the chief instructional officers of South Carolina's technical colleges resulting in the addition of ten new faculty members to college ATE teams to teach the SC ATE curriculum. The Center also developed a video describing the SC ATE curriculum, a video incorporating workplace footage to introduce an industry problem used in the ET Core curriculum, and scope and sequence charts for mathematics and physics content in the SC ATE ET Core curriculum. The Center revised the Technology Gateway curriculum and the first semester ET Core projects and began to revise the second semester core projects and create core projects for the third semester. The ATE management team visited all colleges offering the SC ATE curriculum to observe ATE classes in progress, talk with faculty and students, and gather data.

Finally, the Center began to develop models for alternative scheduling/delivery of the SC ATE Technology Gateway and ET Core curricula. It approved demonstration projects at two colleges to extend this effort. And, the Center worked to stimulate articulation agreements between South Carolina technical colleges and SC State University that will create pathways for ET graduates to continue their studies at four-year institutions and earn Bachelor of Science in Engineering Technology degrees.

Based on the results of a national peer review, the SC ATE Center is successfully developing quality ET curricula. A panel of 11 national experts conducted the review, which took place at Clemson University in September 1999. One member, Arnold Packer of Johns Hopkins University, said, "The SC ATE approach will, I hope, be the future of ET education." Reviewers indicated that the ET Core curriculum was based on complete and appropriate background information. They suggested that the curriculum be improved by providing an instructors' manual, presenting a model solution for projects, and making the curriculum more interdisciplinary.

The reviewers agreed that the Technology Gateway curriculum provided an excellent immersion in computers and communications, was based on accurate workplace scenarios, and prepared students well for study in the ET Core. They suggested that a more thorough listing of resources be made available and expressed concern that the curriculum covered a large body of material. Peer Review results are provided as an attachment to the Project's Annual Report.

b. Faculty Development

The SC ATE Center sponsored several workshops for ATE faculty members during the past year, including a graphing calculator workshop attended by 10 faculty members, and two workshops on Microsoft Excel attended by 29 faculty members. In February 2000, the Center sponsored the annual Instructional Leadership Institute where 58 faculty members participated in problem-based learning and student assessment workshops.

The Center also sponsored faculty and administrators to present ATE findings and attend national conferences. It supported 29 faculty and one administrator from six

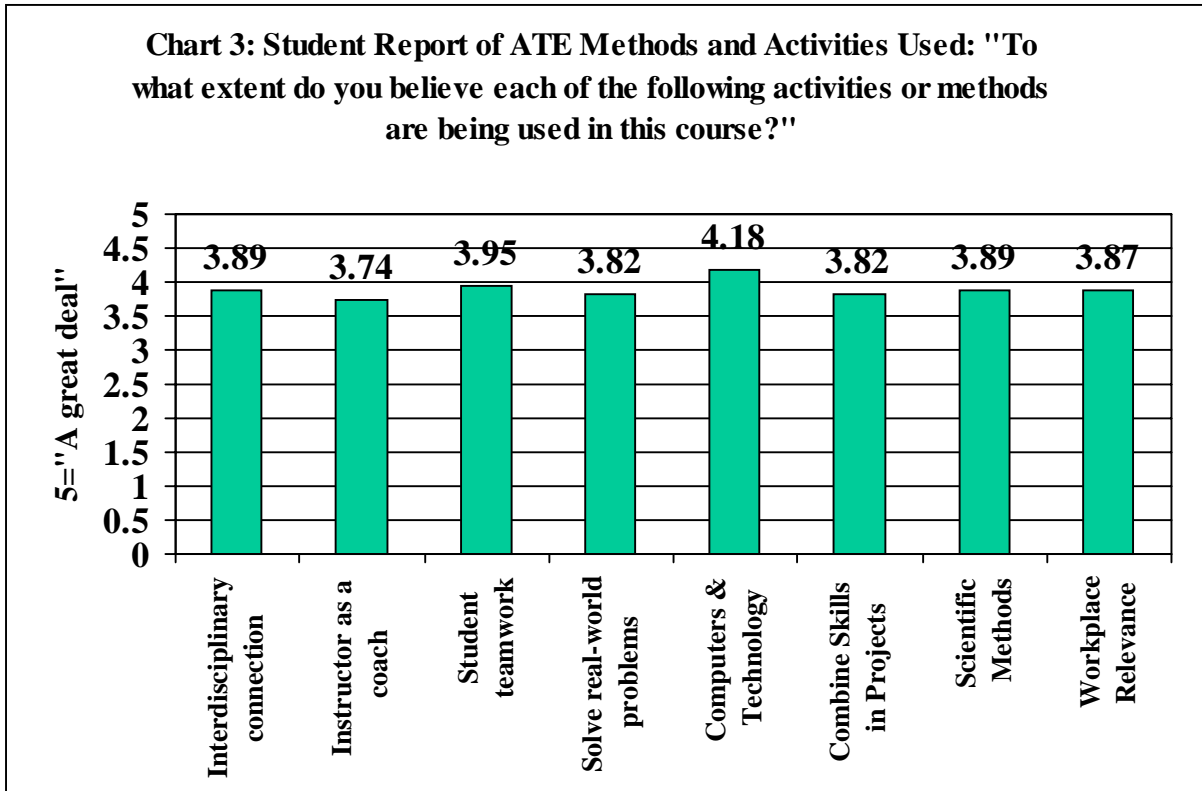
colleges to make presentations, publish papers, and exhibit project outcomes. Four faculty members and the two ATE principal investigators attended the "Problem-Based Learning Workshop" sponsored by the Illinois Math and Science Academy Center for Problem-Based Learning. In addition, the SC ATE Center of Excellence and the Trident Area Consortium for the Technologies (Tech Prep) co-sponsored five ATE faculty to participate in a five-day curriculum writing institute focusing on development of integrated curricula.

Finally, faculty engaged in a variety of activities that both developed them professionally and promoted the work of ATE. Six faculty members applied the SC ATE Workplace Research model as they visited local manufacturers to identify ways of integrating aspects of the manufacturing workplace into ATE classroom instruction. Faculty teams revised curriculum projects for the first and second semesters of the ET Core and created projects for the third semester.

Nearly all ATE faculty members said in individual interviews that the Center's faculty development opportunities are excellent. One said, "[The ATE faculty development is] as good of a professional development program as there has ever been. I will always be a better teacher." Another stated that pedagogical training makes ATE faculty "head and shoulders above the rest." "I don't know of any other technique that could rival ATE," said a third.

Faculty are applying what they learned at the development workshops in their own classrooms. ATE students indicated in surveys that ATE faculty members frequently use the eight major instructional methods taught by the SC ATE Center at workshops. According to these student surveys, ATE faculty members used each of eight

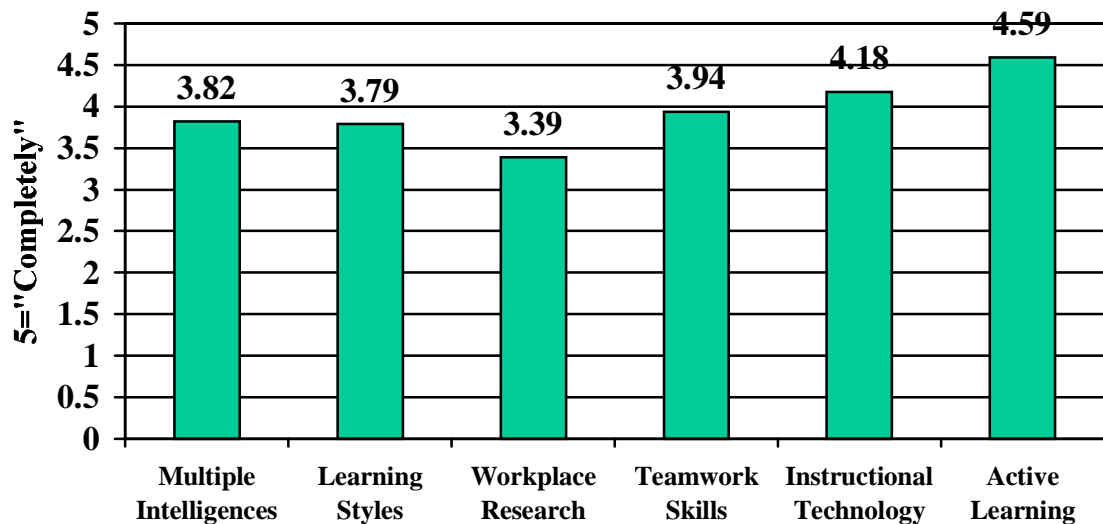
major instructional innovations in their classroom with a frequency of between three (“somewhat”) and four (“very much”) on a scale of one to five. See the Chart 3, below, for a student report of ATE activities and methods used.



Source: ATE student surveys.

Faculty teams also were asked the extent to which they and their team members implemented various teaching methods. They replied that they had used all eight of the methods listed at least "somewhat." The method used most often was “enabling students to be active learners” while the least used was “us[ing] workplace research finding.” See the Chart 4, below, for a faculty report of ATE concepts and methods used.

Chart 4: Faculty Report of ATE Concepts and Methods Used: "To what extent did faculty implement ATE concepts and methods inside the classroom?"



Source: ATE faculty teaching team logs, fall 1999.

c. Program Improvement

In addition to developing curricula and training faculty members to improve retention, the SC ATE Center worked to increase the number of students enrolling in ET courses and to expand ATE offerings.

The Center continued to publicize its work in 1999, primarily to recruit ATE students. The Center's writer/editor publicizes the success of ATE through the "ATE Briefs" quarterly newsletter and recruitment brochures and posters. The Center provided articles for South Carolina publications, including *South Carolina Commerce* magazine and the South Carolina Technology Alliance newsletter, and presented material at the SC Education and Business Summit, the South Carolina Science Council, the South Carolina

Council of Teachers of Mathematics, and the Governor's Math and Science Advisory Board. Finally, the Center revised its website in 1999 to include an ET careers page for students, and developed an ATE Scholars video for statewide dissemination.

In 1999, the Center reached out to government, industry, and education leaders to expand ATE offerings and increase enrollment. The Center met with chief instructional officers of the South Carolina's 16 technical colleges to integrate ATE goals into colleges academic planning. Center staff collaborated with one technical college and high school to offer dual credit for the Technology Gateway with the goal of establishing a model for others to follow. Principal Investigators and project staff met with SC State University officials to pave the way for 2-year to 4-year institution articulation agreements to be developed between individual technical college programs and the University's Bachelor of Science in Engineering Technology degree program. Center personnel also spearheaded development of an ATE Scholars Industry Consortia for each of three colleges over the past year and formed a partnership with the SC Departments of Commerce and the SC Technology Alliance to further boost recruitment.

Perhaps the best evidence of the success of the Center's efforts to market the benefits of the SC ATE Technology Gateway and ET Core curricula to industry was the launching of the ATE Scholars program. The ATE Scholars Initiative has already resulted in the creation of 20 new scholarships, which are coupled with relevant paid work experience, for students enrolled in SC ATE classes. ATE Scholars work as technicians in local industry while enrolled in SC ATE classes. Nearly all faculty mentioned in interviews that the ATE Scholars program boosted the caliber of ATE students and motivated the scholars themselves to take special pride in their studies.

Managers of manufacturing plants also indicated the program is successful. “The ATE program . . . is right in line with what industry needs today,” said Jeffrey Helton, Honda manager of administration. Eugene Grant of Bosch said the ATE program “is our answer [to employee training].”

3. Preliminary Outcomes and Conclusion: Increases in Course Retention and Potential Increases in Enrollment and Graduation

a. Pilot Tests

From fall 1998 through fall 1999, a total of five colleges piloted the ATE curricula. Two colleges piloted the Engineering Technology Core, and four colleges, the Technology Gateway. The two colleges piloting the ET Core taught the first semester of the curriculum to a total of 30 students in the fall of 1998 and 34 in the fall in 1999. In the spring of 1999, these same colleges taught the second semester of the curriculum to 24 students, all of whom advanced from the first semester the previous fall. The Technology Gateway was offered to 20 students in the fall of 1998 and 62 in the fall of 1999.

The early results from these pilots are summarized below.

b. High Course Pass Rates

A high percentage of ATE students passed all courses in both the Technology Gateway and the ET Core pilot tests. These early results suggest that ATE could boost substantially student enrollment, retention, and ultimately graduation rates in ET programs. The overall pass rate was 81% for the ET Core first semester, 92% for the ET Core second semester, and 67% for the Technology Gateway. If these pass rates should continue, 74.5% percent of ATE students would pass all courses of the first two

semesters of the ET Core.⁴ Chart 5, below, shows aggregate enrollment and pass rate statistics for the ATE pilots.

| Chart 5: Course Pass Rates in ATE Pilot Tests | | | |
|--|--|---|---|
| | ET Core 1 st Semester (Fall 98 & Fall 99) | ET Core 2 nd Semester (Fall 99 only) | Technology Gateway (Pre-ET) (Fall 98 & Fall 99) |
| Students Enrolled | 64 | 24 | 82 |
| Number of Colleges | 2 | 2 | 6 (2 in Fall 98 and 4 in Fall 99) |
| Students Passing all Courses | 52 | 22 | 55 |
| % Passing all Courses | 81% | 92% | 67% |

Source: ATE faculty teaching team logs fall 1999.

c. Increase of ET-Prepared Students, Particularly Minorities

Since the Technology Gateway Program has increased the number of ET-prepared students, it will likely increase the number of ET Core students. As the project tracks students after completing the Technology Gateway program, evaluators will determine whether the program contributes to increased enrollments of ET students.⁵

The pass rate of Technology Gateway students increased substantially as the number of piloting colleges increased and program refinements derived from the initial pilot were made. The pass rate of Technology Gateway students increased from 52% in the fall

¹ The 74.5% estimate is derived by multiplying the percentage of students passing the first semester of the ET Core in both Fall semester 1998 and Fall semester 1999 (81%) by the percentage of students passing the second semester of the ET Core in Spring 1999 (92%).

⁵ Exit competencies for the Technology Gateway have been designed to match entrance qualifications for ET programs.

1998, to 71% in the fall 1999 pilot. In fall 1998, 20 enrolled students enrolled in the Technology Gateway pilot at two colleges and 11 (52%) passed. The next fall, 62 students enrolled in the Technology Gateway program at four colleges and 44 (71%) passed. In the second phase of the pilot tests, as a result of the improvement of the program and expansion from two to four piloting colleges, the Technology Gateway enrollment per piloting college increased from six to 11 students on average. Therefore, between the first and second years of pilot testing, the Technology Gateway increased the number of students prepared for ET majors. Numbers rose from six per piloting college to 11 per college on average, and from a total of 11 ET-Prepared students to a total of 44 ET-Prepared students.

To date, there is no significant difference between the proportion of women enrolled in the ATE program – including both the Technology Gateway and the ET Core -- and the proportion of women historically enrolled in ET programs. In each year between 1995 and 1997, between 17% and 19% of ET students in the five colleges now piloting the ATE curriculum were women. By contrast, of the 82 students enrolled in the Technology Gateway in fall 1998 and fall 1999, 16% were women. Since this rate increased substantially from 1998 to 1999, from 5% to 19%, the Technology Gateway may be increasing in its appeal to women. In any case, however, the Technology Gateway's highest percentage of female students does not exceed the historical range. In the ET Core, the percentage of women remains unchanged from historical levels. Of the 68 students enrolled in the ET Core in fall 1998 and fall 1999 at the two colleges piloting the first semester, 12% were women. At the same two colleges, the same percentage of women were enrolled full-time in the traditional ET program

d. Potential Increase in Minority Enrollment

The number of African Americans enrolled in the ET Core is low in comparison to the traditional ET program while the number of African Americans enrolled in the Technology Gateway is high. Of the 68 students enrolled in the ET Core in fall 1998 and fall 1999 at the two colleges pilot-testing the first semester, 15% were black. At the same two colleges, historical enrollments of blacks were higher. In 1997, a total of 161 full-time students were enrolled as engineering technology majors. Of those students, 19% were black.

The high enrollment and pass rates of African Americans from the Technology Gateway program, however, indicate that the ATE program is preparing more minorities for ET majors. Fifty-two percent of the 82 Technology Gateway students enrolled in the Fall 1998 and Fall 1999 pilots were African American. Since there is not a course in the traditional program comparable to the Technology Gateway, there is not a perfect baseline against which to measure this rate of black enrollment. This rate is very high, however, in comparison to the historical enrollments of blacks in the ET program. Between 1995 and 1997, at the five colleges currently piloting the ATE curriculum, no more than 23% of the students enrolled as ET majors were black. The high enrollment and pass rate (67%) among Technology Gateway students indicate that student enrollment in the ET Core will become more diverse and that more minority students might graduate with Associate degrees in Engineering Technology.

e. Shift in Drop-Out Trajectory

As mentioned earlier, one of the biggest reasons that so few students graduate with ET degrees is that so many drop out, especially in the first two years. By increasing

student retention during this crucial period, SC ATE could substantially boost graduation rates. If 74.5% of ATE students persist through the first year of ET study, as opposed to 52% of students in the traditional program, 44% more students would be enrolled in their second year of ET studies, leaving more to persist finally to graduation. In the graph below, Chart 6, the first-year dropout rate of ATE students is juxtaposed with the four-year dropout pattern of traditional ET students.⁶ Notice that the large difference in the first year ET dropout rates sets a different trajectory for ATE students: many more are likely to graduate.

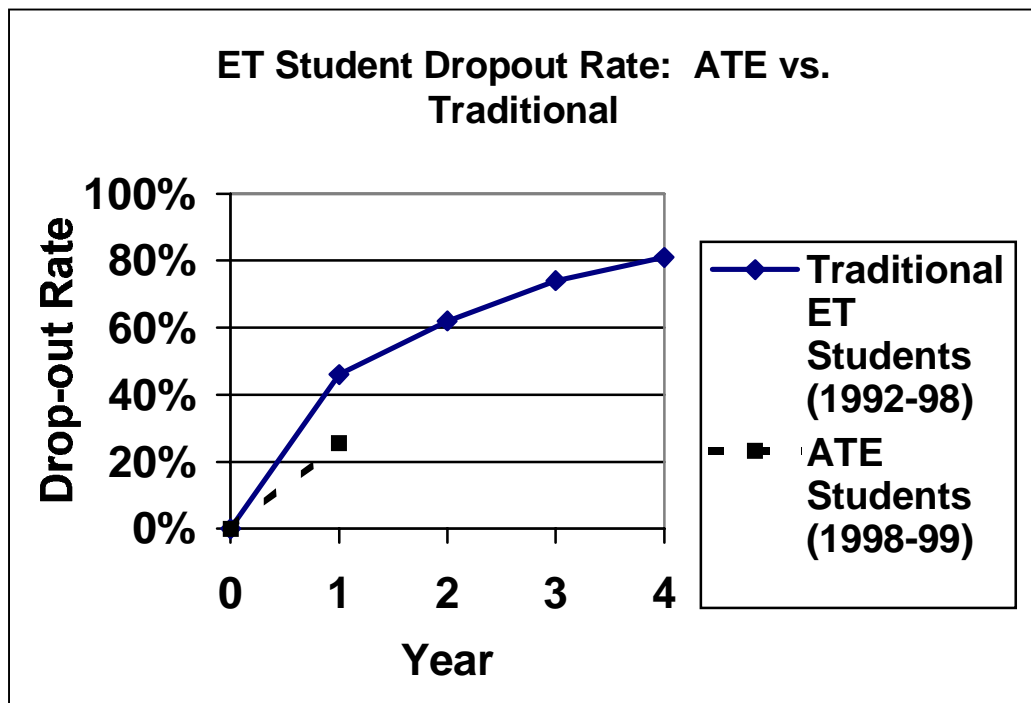


Chart 6: ET Student Dropout Rate: ATE vs. Traditional

⁶ This graph is identical to that in Chart 1, except that the comparison group comprises all full-time students enrolled in traditional mechanical, civil, graphics, and general engineering technology programs in the SC technical college system. Only full-time students were selected because 97% of ATE ET core students are enrolled full-time, even before their enrollment in ATE. Only students in those particular ET programs were selected because those are the only degree programs offered by the two colleges piloting the ATE ET core.

Further, not only do far fewer than 74.5% of students make it through the first year of a traditional ET curriculum, but students who do make it through have not necessarily passed through the rigor and met the skill standards required in the first year of ATE study. As a result of the integrated SC ATE curriculum, students acquire all prerequisite skills for entering the second year of ET study. Students in traditional ET programs, by contrast, often do not complete prerequisite courses in the best sequence. Thus, when compared to the number of students who met the academic competencies required of first-year ATE students, the difference between the success of the ATE program and traditional programs might be even greater.⁷

f. Success factors identified by ATE faculty

ATE faculty members mentioned in interviews that more ATE students than traditional ET students are motivated to attend, complete and pass courses. According to the faculty, ATE students see their coursework as directly applicable to their careers: “They never have to worry about relevance of the program.” Further, the perceived value of the classes and the costs of missing class seemed higher than in traditional classes. Several faculty members also mentioned another reason for greater student retention and success in ATE. As one of them put it, the “key to retention” is SC ATE’s *interdisciplinary, applied approach to instruction*. “No one gets paid to find ‘x’,” said another, referring to the way in which the ATE program motivates students to learn by presenting not academic exercises but technical problems in a learning environment that simulates the high performance workplace. Further, several faculty members posited that ATE’s emphasis on teamwork, where students depend upon each other to complete

⁷ Unfortunately, exact comparison data were not available.

assignments, and its use of an integrated block of courses are factors motivating students to complete the semester. One faculty member cited the case of a student who dropped out mid-term yet returned to complete his team's final project so that the grades of his teammates would not suffer. Another said that a student ran to campus to submit a portion of her group's assignment, even though her child was in the hospital, because she was afraid of "letting down" her teammates. Both faculty members mentioned that they did not see this level of commitment among traditional ET students.

g. Improved "Soft Skills"

Although few faculty stated in interviews that ATE students learned more material than traditional students, virtually all indicated that ATE students could better apply their knowledge and were more professional than traditional ET students. Since ATE students are responsible for finding out the answers to questions, they mature more quickly and become more independent. The problem-based approach to learning teaches them how to apply their skills and to learn on their own. Students may not necessarily perform better on a standardized test, said one faculty member, but they are much better at demonstrating their knowledge by building a circuit, for example. "They understand [course material] better but not necessarily broader," summarized one faculty member.

h. Conclusion

The goal of the SC ATE Center is to increase the quantity, quality and diversity of ET graduates. It is on track to increase the quantity. Pass rates for the first two semesters of the ET Core have been so high that 44% fewer ATE students drop out of college after their first year compared to traditional ET students. This success puts many more students on course to graduate with an Associate degree in ET. Success in the

Technology Gateway indicates that the ATE program has potential to increase the number of students enrolling in ET majors, further boosting graduation rates. High enrollment of minorities in Technology Gateway – 52% of Technology Gateway Students are African American – indicate that the ATE program might increase the number of minority ET graduates, assuming these students advance to the ET Core. ATE faculty attribute these successes to the program’s emphasis on applied work skills and indicate that ATE students develop more “soft skills” and professionalism than traditional ET students.

APPENDIX
Data Collection Instruments

Interview Protocol for ATE Curriculum Faculty, Fall 1999

Survey of Students Enrolled in Pre-Engineering Technology Courses:
Start-of-Semester Fall 1999

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