Multi-Pronged Retention Strategy Successful In Retaining Engineering Technology Students

James C. Wood, Elaine L. Craft
Tri-County Technical College/SC Advanced Technological Education Center of Excellence

Abstract

A retention strategy that incorporates a new integrated, problem-based curriculum, collaborative, student-centered teaching methodologies, faculty and student teams, and the involvement of industry partners is demonstrating success in retaining students in engineering technology programs in South Carolina.

The South Carolina Advanced Technological Education (SC ATE) Center of Excellence is focused on increasing the quality, quantity, and diversity of engineering technology graduates. The SC ATE Center has developed two curriculum components for beginning engineering technology students that integrate the core disciplines for engineering technicians -- mathematics, physics, communications and technology. SC ATE industry-based problems are providing a mechanism for integrating these subjects and an important new context for learning. SC ATE classrooms model the workplace from the physical set up of the classrooms to the use of student teams to solve problem scenarios. By modeling the classroom and instructional approach after the workplace, students are seeing the connections between subjects traditionally taught in isolation and between their study and engineering technology careers.

The SC ATE curriculum is being taught in seven South Carolina technical colleges and one high school career center. Engineering technology retention rates have increased 50-100 percent. In addition, industry has responded to the implementation of the SC ATE curriculum by providing more and better scholarships and meaningful work experiences for engineering technology students through the SC ATE Scholars initiative. Through the ATE Scholars partnerships, industries and colleges work together to recruit and select students as ATE Scholars. The financial support of local industries (tuition, books and paid work experience) and relevant real-world industry exposure is providing additional motivation and incentive for students to complete their program of study.

In this session, SC ATE retention strategies and results will be shared.

I. Introduction

Adopting a multi-pronged approach to retaining students in two-year engineering technology programs until graduation has been a successful strategy for the South Carolina Technical College System. A statewide systemic reform initiative, created and implemented through the SC

Advanced Technological Education (SC ATE) Center of Excellence, is focused on increasing the quantity, quality, and diversity of engineering technology graduates to support economic development. The SC ATE Center is funded by the National Science Foundation and the SC State Board for Technical and Comprehensive Education. The SC Technical College System consists of 16 two-year technical colleges.

The SC ATE project was begun to address a number of key concerns:

- Limited number of technicians available.
- Need to tap in to an increasingly diverse population of students. The expanding career opportunities in engineering technology have created additional opportunities for the technical college student population.
- Declining graduation rates were occurring as new technologies and new or growing industries were creating a greater demand for technicians.
- Incremental reforms, such as adding more application into existing courses, were not having the needed impact on student retention.

A multi-pronged retention strategy was adopted to meet the diverse challenges confronting colleges, and specifically engineering technology programs, throughout the SC Technical College System. Retention strategies to be discussed will include:

- A research-based approach to reform.
- Curriculum components that support retention.
- Industry support and workplace readiness.

In addition, results from these retention strategies will be reviewed.

II. Research-based approach to reform

SC ATE started at the grassroots roots level, with faculty, to initiate reform. A cadre of interdisciplinary ATE faculty from across the state conducted research and participated in extensive faculty development to prepare to better meet the needs of students and solve the chronic problem of poor retention and low graduation rates. Research efforts conducted by the SC ATE Center included commissioning a research report on enrollment and retention in the state's engineering technology programs, presenting results of a second research study, and hosting focus group and panel discussions at a 1998 Retention Forum. The Center's commissioned report and results from the Retention Forum have been published in a recruitment and retention monograph.[1] Research findings included:

- Many students are more successful in learning environments that emphasize applied and problem-based instructional methods.
- Student support services, including tutoring, counseling, career advising and other assistance is important for all students, but especially for minority students.
- Employer encouragement for engineering technology students is a factor in taking and completing engineering technology coursework.
- Strengthening associations with K-12 and industry are important for recruitment and retention efforts.[2]

Faculty development activities revolved around creating classrooms that model the workplace. To enhance student retention, an emphasis was placed on creating a connection between the skills needed in the workplace and the skills taught in the classroom.[3] Research also showed that students were more successful learners if information was taught in context; integration of skills in the context of solving workplace problems is how technicians learn and work in the "real world."[4] Retention research supported development and implementation of collaborative, student-centered teaching methodologies in the classroom. Professional development activities helped interdisciplinary faculty from science, mathematics, communications, and technology develop new instructional pedagogical frameworks and "teaching and delivery" values that supported: creating and facilitating an active learning environment; and, integrating content knowledge in a problem-based learning approach. Faculty activities included creating interdisciplinary, industry-modeled faculty teams and continuing education in key concepts and learning theory, including multiple intelligences, gender differences, team teaching, active/collaborative learning, problem-based learning, and using instructional technology. The SC ATE Center also sponsored workplace research to bring industry knowledge and experiences into ATE engineering technology classrooms and make industry-education connections even more crucial to everyday learning. Interdisciplinary ATE faculty teams have visited 45 companies ranging in size from 10 to 45,000 employees nationwide and have interviewed and observed more than 80 technicians with a range of years of experience. ATE faculty members report that their research allows them to appropriately prioritize content coverage, make instruction more reality-based, and bring industry techniques, problems and solutions into the classroom, better equipping students for the workplace.

III. Curriculum components that support retention

The SC ATE curriculum is itself designed as a retention strategy. An integrated, problem-based curriculum approach, matched with student-centered teaching strategies, form the cornerstone of the SC ATE goal to retain and graduate more engineering technology students. The SC ATE curriculum consists of two components. Both components provide an integrated, problem-based course of study that models the workplace through the use of industrial-type problems and student and faculty teams. Physics, mathematics, communications and technology are taught concurrently in the context of solving workplace-related problems.

The pre-engineering technology program, referred to as the Technology Gateway, addresses the needs of students who are slightly under-prepared to enter engineering technology programs. Mathematics, communications, and physics/technology are taken concurrently in the one-semester Technology Gateway. Content and skills are taught in the context of solving six workplace-related problems. The second curriculum component, the engineering technology core curriculum for first-year students, provides the major portion of the general education requirements for the first year of study for any engineering technology major. Sixteen engineering technology problem scenarios or modules investigate physical systems (electrical, mechanical, fluids, thermal, optics, and materials) relevant to engineering technology study. The four disciplines--physics, mathematics, communications, and technology--are learned in the context of solving these industry-related problems.

From the first day of class, students are introduced to a series of loosely structured problems and must determine what they know and what information and skills they need to know to solve each problem. Instructor-led workshops assist students in gaining the necessary knowledge and skills. Student teams present their recommendations for resolving problems in written form or oral presentations. Through the "just-in-time" delivery of instruction and integration of content, students see the connections and relevance of what they are learning to solving workplace problems. By working in team-centered workspaces, complete with computer stations, tables for meetings, and tools such as white boards, the workplace environment is reinforced.

Retention aspects of the SC ATE curriculum include:

- Students clearly see the connections between subject areas and between subjects and the world of work.
- Integration of disciplines answers the fundamental question of students, "Why do I need to know this?"[5]
- Problem scenarios or modules provide a context and purpose for learning new skills.[6]
- The SC ATE teaching approach supports the success of a diverse population of learners, including those under-represented populations in traditional engineering technology programs. Incorporating hands-on experiences, small group or team projects, and problem situations that are not limited to one right answer have been found to support diversity.[7]
- Additional faculty support is made possible by interdisciplinary teaching teams. Team members are taking greater "ownership" of the success of their ATE students.
- The use of student teams creates an additional support system for learning and encourages student retention.

IV. Industry support and workplace readiness

Industry involvement in the SC ATE project has been expressed in a number of ways. Industry representatives were involved in focus groups used to ensure workplace relevance of the new curriculum components. Industry partners also have provided valuable assistance by allowing faculty teams to conduct workplace research in their facilities. Additionally, industry leaders have supported the SC ATE approach by participation in the SC ATE Scholars initiative.

The SC ATE Scholars initiative is an innovative technical college/economic development partnership that has been endorsed and supported by the SC Department of Commerce and SC Technology Alliance. Through the initiative, industries and colleges work together to recruit and select students as ATE Scholars. Through local ATE Scholars consortia, identified students are offered competitive technical college scholarships (for tuition and books) and related, paid experience with sponsoring companies. Student benefits include gaining valuable work experience while in college and getting relief from financial pressures. Students have commented that the skills learned in the workplace reinforce those learned in college and vice versa. At one college, 100 percent of ATE engineering technology students have been offered an ATE Scholars scholarship and paid internship. The number of industries involved in the ATE Scholars initiative continues to multiply.

V. Retention results

The number of students directly involved in ATE classes has grown from 50 in 1998-99 pilot classes to 151 in fall of 2000. The number of students enrolling in ATE engineering technology classes has increased 51 percent over the past year (year 2000 enrollment data is based on faculty reported data as of 10/10/00). The number of female students is up 15 percent (23 students) and number of African-American students is up 29 percent (44 students). Implementation of the curriculum has grown from four classes in four pilot sites to eight sites and 13 classes, including a Technology Gateway class offered for dual credit at a high school career education center.

Retention rates have been 76-100 percent in each term since pilot implementation began two years ago, significantly higher than traditional retention rate of 50 percent for all open enrollment, associate degree colleges nationwide. The graduation rate of the first "pilot class" students to have been engaged in the SC ATE engineering technology first-year program is an exciting 50 percent, with additional students expected to graduate within the academic year. When the ATE effort was started, the graduation rate for engineering technology rested at about 10 percent.

The number of SC ATE faculty (full time and adjunct) continues to grow, with 128 faculty members involved (as of 9/13/00). Industry interest in and support for the program also continues to broaden, as reflected through the development of the SC ATE Scholars initiative.

VI. Conclusion

As the technical/community college population becomes increasingly diverse--in terms of age, previous work and life experiences, race and culture--and industry expectations for technicians evolves, two-year engineering technology programs must change in response. Systemic change initiatives destined for success are those that garner the enthusiastic endorsement of industry, merit the willingness and dedication of college faculty members and administrators to make it happen, and capture the interest of the typical technical college student focused on career opportunities. SC ATE's multi-pronged strategies are reaping benefits for those colleges and students involved in implementation:

- ATE faculty members are experiencing a new synergy and momentum gained from implementing current educational instructional methods research in their classrooms and strategies learned through workplace research.
- ATE teaching teams are assuming more responsibility and accountability for their teaching and their students.
- The use of interdisciplinary teaching teams is overcoming traditional faculty discipline barriers, which ultimately benefits students and student learning.
- The number of students in ATE classes is growing.
- The number of under-represented students (women and minorities) in ATE engineering technology class is increasing.
- Students are seeing the connections between subjects previously taught in isolation and between their study and engineering technology careers.
- SC ATE's integrated, problem-based learning approach is having a positive impact on student success and student retention.

- Strengthened partnerships with industry are enabling ATE classes to more accurately reflect the workplace and providing supportive, relevant work experiences for ATE Scholars.
- Initial graduation rates are greatly improved.

Bibliography

1. *Monograph: Recruitment & Retention of Engineering Technology Students*, South Carolina Advanced Technological Education Center of Excellence, South Carolina Technical College System (2000).
2. *Monograph: Recruitment & Retention of Engineering Technology Students*, South Carolina Advanced Technological Education Center of Excellence, South Carolina Technical College System (2000).
3. Collins, Timothy, W., Don K. Gentry and Vernon O. Crawley, report co-chairs, "Gaining the Competitive Edge: Critical Issues in Science and Engineering Technician Education," a report from a workshop sponsored by the National Science Foundation and the Federal Coordinating Council for Science, Engineering and Technology, Division of Undergraduate Education, National Science Foundation (July 1993).
4. Bottoms, Gene and Deede Sharpe, *Teaching for Understanding through Integration of Academic and Technical Education*, Southern Regional Education Board, Atlanta, Ga. (96V11), p. 41.
5. Bottoms, Gene and Deede Sharpe, *Teaching for Understanding through Integration of Academic and Technical Education*, Southern Regional Education Board, Atlanta, Ga. (96V11), p. 44.
6. *Crossroads in Mathematics, Standards for Introductory College Mathematics before Calculus*, Prepared by the Writing Team and Task Force of the Standards for Introductory College Mathematics Project, Don Cohen, Editor, American Mathematical Association of Two Year Colleges, September 1995, p. 4.
7. Gardner, April L., Cheryl L. Mason and Marsha Lakes Matyas, "Equity, Excellence & Just Plain Good Teaching," *American Biology Teacher*, 51, February 1989.

ELAINE L. CRAFT
Elaine L. Craft is principal investigator and director of the South Carolina Advanced Technological (SC ATE) Center of Excellence, with previous experience as a technical college instructor and administrator and chemical engineer. She is the recipient of numerous awards, including the 2000 South Carolina Governor's Award for Excellence in Science and the National Institute for Leadership and Institutional Effectiveness David Pierce Leadership Award. She holds a B.S. degree in chemical engineering, a M.B.A. from the University of South Carolina and has conducted post-graduate study in mathematics.

JAMES C. WOOD, PH.D.
James C. "Jim" Wood has been co-principal investigator of the SC ATE Center of Excellence since 1995. He was principal investigator of the SC ATE planning grant and co-principal investigator of the SC ATE Exemplary Faculty project. Since 1973, Dr. Wood has been chair of the Industrial and Engineering Technology Division at Tri-County Technical College in Pendleton, SC.