

Maximizing Retention in Engineering/Engineering Technology

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Abstract

To maximize retention and learning, the disconnect students experience among key academic disciplines must be bridged. To minimize the dropout rate, this bridge must be built as soon as possible after a student chooses an engineering or engineering technology major.

The South Carolina Advanced Technological Education (SC ATE) Center of Excellence is dissolving discipline silos through a new problem-based, integrated curriculum for students just entering their study of engineering technology. The SC ATE curriculum integrates four traditional gatekeeper courses: communications, physics, mathematics and technology. SC ATE faculty from these different disciplines work together in teams to coordinate student learning. Students are held individually responsible for content mastery in the disciplines; from the first day of class, students work together in teams to solve industry-type problems. With the SC ATE curriculum, the common student question, "Why am I learning this?" is answered every day.

The SC ATE curriculum is now being taught in seven of South Carolina's technical colleges. Retention rates for SC ATE students have been 76-100 percent semester-to-semester at every implementation site, significantly higher than traditional retention rates of 50 percent in community colleges in general. Graduation rates for the first ATE graduating class was 50 percent, as compared with 10 percent in traditional engineering technology classes. In addition, industry has responded to the implementation of the SC ATE curriculum by providing more and better scholarships for engineering technology students than ever before. Industry leaders applaud the addition of workplace readiness skills (communications, teamwork and problem solving) to the list of traditional technical competencies expected of engineering technology graduates.

In this session, SC ATE resources available to engineering/engineering technology faculty and strategies that can be used in other colleges and universities will be discussed.

Introduction

A statewide systemic reform initiative has been initiated and implemented through the South Carolina Advanced Technological Education (SC ATE) Center of Excellence to maximize student learning and retention and stem the flow of students dropping out between the first and second year of challenging engineering/engineering technology programs. Beginning with an effort to develop a cadre of reform-ready faculty, SC ATE developed an integrated, problem-based approach to education. 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.

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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. Expanding career opportunities have created many new career opportunities.
- Declining graduation rates were occurring as new technologies and new or growing industries were creating a greater demand.
- Incremental reforms, such as adding more application into existing courses, were not having the needed impact on student retention.
- Discipline silos were not providing the connections that students needed to see to understand the relevance of what they were learning to other subjects or the world of work.

A multi-faceted retention strategy was adopted to meet the diverse challenges. Retention strategies to be discussed will include:

- Developing reform-ready faculty.
- Curriculum components that support retention.
- Industry support, SC ATE Scholars and workplace readiness.

In addition, results from these retention strategies and SC ATE resources will be reviewed.

Developing Reform-Ready Faculty

A cadre of interdisciplinary ATE faculty from across South Carolina 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, 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. 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.¹

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.² 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."³ 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.

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 methodologies, forms the cornerstone of the SC ATE reform effort. The SC ATE curriculum consists of two components: a one-semester Technology Gateway for students slightly under prepared to enter the engineering technology program and a first-year engineering technology core curriculum (ET Core). Mathematics, communications and physics/technology are taken concurrently in the one-semester Technology Gateway, and content and skills are taught in the context of solving six workplace-related problems. The ET Core curriculum for first-year students provides the major portion of the first year of study for any engineering technology major. Sixteen ET problem scenarios investigate physical systems (electrical, mechanical, fluids, thermal, optics and materials) relevant to engineering technology study. The four disciplines--mathematics, physics, communications and technology--are learned in the context of solving these industry-related problems. Through three Technology Gateway courses and 11 ET Core courses, students earn credits in English, physics and mathematics, in addition to engineering technology. Both SC ATE curriculum 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.

From the first day of class, students are introduced to a series of open-ended 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?"⁴
- Problem scenarios or modules provide a context and purpose for learning new skills.⁵
- 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.⁶
- 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.

Industry Support, SC ATE Scholars 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. 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 grow.

Corporate benefits of the SC ATE Scholars initiative include:

- Participating in the student screening and selection process.
- Offering an additional employee benefit that can help attract, motivate and retain employees in a competitive field.
- Having an expanded pool of workplace-ready engineering technicians.

College benefits include:

- Strengthening linkages with local industries.
- Improving student recruitment, retention and graduation rates in engineering technology programs.

Student benefits include:

- Gaining valuable work experience while in college.
- Getting relief from financial pressures.

Retention Results and SC ATE Resources

Implementation of the SC ATE curriculum has grown from four classes in four pilot sites to eight sites and 13 classes, including seven colleges and Technology Gateway classes offered for dual credit at a high school vocational center. 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 enrolled 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 SC ATE approach also supports the success of a diverse population of students, including students traditionally under-represented in engineering technology programs. The number of female students in ATE classes is up 15 percent (23 students) and number of African-American students has increased 29 percent (44 students).

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 was about 10 percent.

SC ATE provides an instructional approach and curricula that have been validated by industry. This validation has occurred through industry focus groups and endorsement of and involvement in the SC ATE Scholars initiative.

SC ATE provides support for colleges, administrators and faculty through expertise and resources. Many of these resources are available on the SC ATE web site (address below). SC ATE resources include:

- Videos on faculty development, the integrated curriculum and SC ATE Scholars.
- Workplace Research Model.
- Recruitment and retention monograph.
- Newsletters and special publications, including a SC ATE general information brochure, student recruitment brochure and posters, and a SC ATE Scholars brochure.
- Printed curriculum materials. Technology Gateway and ET Core curriculum materials currently are being published.

For further information on curriculum materials and other SC ATE resources, visit the SC ATE web site (<http://scate.org>).

Conclusion

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As the college population becomes increasingly diverse--in terms of age, previous work and life experiences, race and culture--and industry expectations for technicians evolve, engineering/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-faceted 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.
- Initial graduation rates are greatly improved.
- Strengthened partnerships with industry are enabling ATE classes to more accurately reflect the workplace and providing supportive, relevant work experiences for ATE Scholars.

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