The South Carolina Advanced Technological Education Fall Semester 1998 Curriculum Pilot Project: Evaluation Report

Submitted to:
The South Carolina Center for Advanced Technological Education
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Submitted by:
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1.0 OVERVIEW

1.1 Introduction

The South Carolina Advanced Technological Education (SC ATE) Center's Vision and **Goal** for 2002 is to create and demonstrate a successful model for post-secondary systemic reform of science, mathematics, engineering, technology (SMET), and communications education. Combining faculty development, curriculum reform, and program improvement in engineering technician education, the **model** is designed to increase the quantity, quality and diversity of students graduating from South Carolina's Associate Degree engineering technology programs.

The first pilot test of the curriculum reform portion of the SC ATE Center was completed Fall of 1998. Between the four participating technical colleges – Florence-Darlington, Piedmont, Tri-County, and York – 44 students completed this first semester (out of 52 students enrolled at the beginning of the semester). Two of the schools, Florence-Darlington and Tri-County, implemented ET (Electrical) core curriculums, while the other two schools, Piedmont and York, implemented the Pre-ET curriculum.

In the Fall of 1999, Aiken and Spartanburg will join the schools in the "alpha" implementation of the new curriculum. By the 2001-2002 school year, the goal is to have all 16 South Carolina technical colleges implementing the curriculum reform.

1.2 Impetus for Project/Description of Reform

The curriculum reform pilot project tests an integrated approach to teaching engineering technology. Over the past few years, enrollment and retention of engineering technology students in South Carolina (and across the country) has declined. The curriculum reform, combined with the SC ATE faculty development and program improvement, is designed to increase the success rate and retention of students in engineering technology. By integrating the major engineering concepts around problem scenarios and projects, in theory, the new curriculum and pedagogy being pilot tested will, when fully implemented with supporting activities, increase student performance and achievement.

The Center's systemic reform model also entails student-centered, team- and project-based discovery learning, guided by the integrated curriculum described above. A highly trained interdisciplinary faculty team delivers the curriculum in a learning environment that simulates the high performance workplace.

2.0 EVALUATION DESIGN

This report addresses: student retention, needs, and performance; curriculum implementation, developments, and adjustments; and team-teaching and faculty collaboration. The main source of data was faculty responses, provided through faculty logs and informal interviews. Student data were also used. Data collection materials and methods are described below:

- **Institutional and Course level data –** "background" data. Each school participating in the pilot project was asked to provide student data from a set of pre-determined "comparison courses." The data from the comparison courses will be used to evaluate student retention and performance in the pilots.[1]
- **Faculty logs –** completed by faculty members following each project. The logs allow faculty to list their successes, failures, struggles, frustrations, and suggestions for the curriculum pilot project. For the Fall semester, the logs were completed individually by all team members.
- **Faculty interviews –** conducted in the middle of January 1999-March 1999, following the Fall semester. The interviews provided an opportunity for faculty to discuss specific experiences that may not be captured in the faculty logs.
- **Student surveys –** start-of-semester, mid-semester (given after project 3 of 7), and end-of-semester. The surveys were completed by enrolled students, and measure changes in student levels of interest and skill in the course materials.
- **ATE team visits –** on-site visits by ATE team

[1] The State Tech data set will also be used in the evaluation to provide an analysis of statewide trends in ET education. This data set contains information on all South Carolina community college students over the past seven years.

<u>3.0 RESULTS</u>

3.1 Student Retention:

The overall student retention rate for all four pilot schools was 85% (44 out of 52 students completed the semester).

Individual school breakdown:
<u>*Florence-Darlington*</u> – 100% (12 out of 12 students)
<u>*Piedmont*</u> – 67% (6 out of 9 students)
<u>*Tri-County*</u> – 89% (17 out of 19 students)
<u>*York*</u> – 75% (9 out of 12 students)

Program breakdown:
<u>*Pre-ET*</u> – 71% (15 out of 21 students)
<u>*ET*</u> – 94% (29 out of 31 students)

The background institutional data for all four schools are not yet available, so no comparisons have been made to previous cohorts.

3.2 Faculty Logs:

<u>Meeting Student Needs</u> and <u>Faculty Opinions about Curriculum</u> – Faculty found that students responded well to the "real-world" aspect of the curriculum, and would benefit from that exposure. Faculty also found that many students (especially in Pre-ET) were lacking basic math and grammar skills.

- Students had simulated "real-world" work through: completion of team projects and memo writing.
- Oral presentations provided realistic assessment of workplace expectations. Students used Microsoft Word and Excel, and CAD to do presentations. (Piedmont)
- Students were exposed to problem-based learning (PBL). Very few students had any previous exposure to this approach.
- The "real-world" nature of the projects forced students to make decisions about whether or not to include information in a final report. (Piedmont)
- Students used "technology" to do work, while still learning "conventional" methods.
- Students sought out-of-class remediation in math and science. (Piedmont)
- Students grasped the physics concepts well. (Tri-County)
- Faculty observed that some critical student knowledge was missing, for example: basic computer experience. A need for re-mediation of these skills was identified – providing students with computer applications to use at home was a suggested solution. There was little room within the curriculum for remedial work. (Tri-County)

<u>Teaching Methods</u> – Many of the projects took more time than expected to complete; faculty worked together.

- Faculty felt overloaded by the demands on their time and energy from the pilot. (Florence-Darlington)

- In-class group work took more time than anticipated.
- Faculty had to "teach on the fly," abandoning work plans to accommodate unanticipated student needs/some project timeframes were extended, others shortened, some activities cut altogether.
- Faculty met with students individually outside of class to discuss performance and attendance. (Florence-Darlington)
- Faculty implemented student progress checks. (York)
- Each project was modified based on input from industrial leaders. (Piedmont)
- Faculty hope to include industry tours for students in relate their learning to the workplace. (Piedmont)
- Faculty planned and sponsored a cookout for ATE students. (Florence-Darlington)
- The curriculum required closer coordination among the faculty. (Tri-County)
- With the entire faculty team in class at the same time, assignments could be linked. (Piedmont)
- Faculty used weekly meetings to plan common agenda.
- Faculty graded projects together. (Tri-County)
- Working together with other faculty allowed teachers to better coordinate their efforts; it created a true "team effort" where the faculty started "to think as one." (York)
- Faculty met before classes *everyday*, identifying problems and developing strategies to address them. (York)

<u>*Implementation of ATE concepts*</u>

- Technician from local industry came and spoke to students on teamwork and ethics. (Florence-Darlington)
- Students submitted assignments early through e-mail to receive feedback before actually due date. (Piedmont)
- Students were assigned to teams based upon multiple intelligence analysis. (Tri-County)
- Use of group work extended learning for students outside of the classroom; this was especially useful for students who work well in teams.

3.3 Faculty Interviews:

<u>Student Retention</u> – No students dropped out because of academic concerns.

- In the Fall semester, the average student was "medium-to-weak," and at least one or two of the students would not have been able to stay beyond two or three weeks in a conventional course. There was a "human continuity," and students had a "home" in the courses. All the students shared the same courses and instructors. As a result, they were more inclined to stay and succeed. (Florence-Darlington)
- Faculty have worked hard to retain students. Student retention has benefited from the individual attention students have received. The students feel "ownership" of the courses early on in the semester because they see the same teachers (who are obviously working together and collaborating) and the same students in all of their classes. (Florence-Darlington)
- Classroom environment has improved, but what has been most spectacular is the increased student retention. Eleven out of twelve students stayed in the course in the Fall semester, whereas previous retention rates were approximately 67%. (Florence-Darlington)

- There has been little change, according to anecdotal sources, in the number of students who drop out. However, when students were asked why they decided to drop out, they all cited personal reasons. None of them dropped out because of the curriculum – they dropped out because of reasons beyond the control of any school. In the absence of personal problems, students would be less likely to drop out or miss class since all work is team-based, and they are held accountable by their teammates, who would need to bring them up to speed if they do not show up for class or lab sessions. (York)

<u>Meeting Student Needs</u> – Students have gained more than just knowledge from the curriculum pilot.

- Students have been taught to have a new "attitude" towards learning. Previously, there was a passive learning attitude, where the students sat back and expected to be fed the material. Students have responded well and like the new methods of learning that emphasize teamwork and interaction. (Florence-Darlington)
- Students are more "employable" because they have matured socially. There are no students "hiding in the corner." The students show a maturity that would be expected of second-year students. "Employers always say that the technical skills can be taught, and that the 'social skills' are more important initially." (Florence-Darlington)
- "We didn't know how well they were prepared to go back to a traditional classroom. Perhaps we did not challenge them enough. The problem is that they are unable to write long, sustained reports. They were turning in short memos and lab reports. Still, the one-on-one contact improved their skills. They gained confidence and were enthusiastic. Their math and technology skills advanced more than their writing skills." (York)

<u>Student Interest/Achievement</u> – Overall student achievement improved.

- Students have not sought out the faculty outside of class as much as they should – but they are freshman, and the students in the curriculum pilot visit faculty more than other freshman in the past. (Florence-Darlington)
- "Did they learn more? Actually, they probably learned less. And there was no 'singular excellence,' where one or two students really excelled. In place of that individual achievement was an 'overall class achievement,' where a class of medium-to-weak students achieved better than average results overall. There were no students clearly at the 'head-of-the-class,' but there were no 'laggers' either." (Florence-Darlington)
- Historically, application of knowledge to real-world situations has been poor. Curriculum pilot achieved "positive" progress in this area – but results will be seen in the long term. (Florence-Darlington)
- Attendance has not changed much, but students are more focused. They ask more questions, and they ask better questions. In the first and second weeks of class, some students said that they did not want to speak in class. However, after those two weeks, they realized that the environment was different from that of a regular classroom and they "turned around." (York)
- Students go to the lab when class is not in session to work on projects without direct supervision. They are more likely to work with one another in groups and have improved their interpersonal skills. (York)

- Students understand the material better. They ask better questions and engage in more thoughtful discussions. Students benefit from the more integrated curriculum by bringing knowledge from other classes into the classroom and the group projects. (York)

<u>Teaching Methods</u> – *The flexibility of the curriculum pilot and the collaboration between faculty have been beneficial for both the students and the faculty.*

- Students work more outside of class. Faculty are pushing hard to encourage that, but are coming up against old habits and expectations. One specific method is holding students accountable for deadlines. (Florence-Darlington)
- The curriculum pilot has changed the learning environment into an active one. There is more discussion, and students participate in figuring out how to solve a problem. In a regular classroom, students are shown step-by-step how to solve a problem. Now, students figuring out those steps on their own. (York)
- The curriculum allows for greater flexibility in teaching. For example, the training talked about multiple intelligence and that has come into use. (York)
- The curriculum better incorporates the instructor's interests and talents into the classroom because collaborating with other instructors in the sciences allows teachers to "do more than just teach math." In a regular classroom, it is apparent that instructors are not working with faculty in the other sciences. Now, faculty work together to create a better learning environment for their students. Moreover, the integration of different subjects means that all available technologies are presented to students and utilized. (York)
- "I really think that having the three of us in a classroom was a very good idea. I know that it is not feasible economically, but it was a very, very beneficial experience. Because there were fewer students, there was a great deal more one-on-one contact. However, we were asked to cover too much material. There were just too many things to do. If we were given more freedom, we would take the first half of the semester and retrench it."

3.4 Student Achievement (from Student Surveys):

Figure 1: Pre-ET students (Piedmont/York) – *see Appendix A for complete tables*

How capable do you feel to… *Note: Percentage of students answering "Very capable" or "Extremely capable."*	***Start***	***End***		***Percentage Change from Start to End***
Work with other students in a team to complete class projects	*69.23%*	*92.31%*		*33.33%*
Solve real-world problems as part of class projects	*53.85%*	*84.62%*		*57.14%*
Use your mathematical knowledge to solve a science problem you are investigating	*30.77%*	*61.54%*		*100.00%*
Make oral presentations to an audience with a team of other students on class projects	*53.85%*	*84.62%*		*57.14%*
Write about the results of science or engineering projects	*38.46%*	*69.23%*		*80.00%*
Solve problems your instructor gives you	*53.85%*	*76.92%*		*42.86%*
Investigate problems using scientific method	*30.77%*	*69.23%*		*125.00%*

Use computers and similar technology	*61.54%*	*76.92%*		*25.00%*
Learn science, math, and communications are related	*23.08%*	*76.92%*		*233.33%*
Communicate with others orally and in writing	*53.85%*	*76.92%*		*42.86%*
Relate what you are learning in ET to the workplace	*53.85%*	*76.92%*		*42.86%*

The student surveys provide a sense of how well students have responded to the curriculum pilot, based upon their own self-reported abilities. As Figure 1 above shows, students in the Pre-ET curriculum have shown improvement in many areas from "Start" (beginning of the semester) to "End" (end of the semester). Especially notable are students' expressed confidence in "solving real-world problems," and their understanding of the relationships between the concepts they are learning ("learn science, math, communications are related").

Figure 2: ET students (Florence-Darlington/Tri-County) – *see Appendix B for complete tables*

How capable do you feel to…	***Start***	***End***		***Percentage Change from Start to End***
Note: Percentage of students answering "Very capable" or "Extremely capable."				
Work with other students in a team to complete class projects	*64.71%*	*88.24%*		*36.36%*
Solve real-world problems as part of class projects	*64.71%*	*76.47%*		*18.18%*
Use your mathematical knowledge to solve a science problem you are investigating	*41.18%*	*76.47%*		*85.72%*
Write about the results of science or engineering projects	*23.53%*	*58.82%*		*150.01%*
Use computers and similar technology to do class projects	*35.29%*	*70.59%*		*100.00%*
Work with electrical systems in a classroom	*31.25%*	*58.82%*		*88.24%*
Learn about electrical concepts such as current, voltage, impedance & power	*47.06%*	*70.59%*		*50.00%*
Solve problems your instructor gives you	*52.94%*	*70.59%*		*33.33%*
Investigate problems using scientific method	*29.41%*	*82.35%*		*180.00%*
Use computers and similar technology	*23.53%*	*76.47%*		*225.01%*
Learn science, math, and communications are related	*50.00%*	*76.47%*		*52.94%*
Communicate with others orally and in writing	*47.06%*	*70.59%*		*50.00%*
Relate what you are learning in ET to the workplace	*47.06%*	*64.71%*		*37.50%*

Figure 2 above summarizes the responses of ET students to the student surveys. Similar to the Pre-ET students, they experienced improvements over the course of the semester in several important academic areas, including: their oral and written communications skills, their ability to use technology, and problem solving abilities.

3.5 ATE Team Observations from Visits:

Florence-Darlington – ET Core

- All 12 students (including one female) who started the pilot program were still enrolled and were present the day we visited. They worked in three teams of four students. Posted on the wall were reminders of the PBL process: "What do we know?" and "What do we need to know?" Also posted were team "rules of conduct" created by the individual teams. Students were making a good impression by not wearing ball caps when we arrived (faculty were working on "acceptable workplace behavior"). The class was beginning Project #5.
- A hands-on math lesson (sine curves), with students using protractors and calculators, prepared students for a lab workshop using technical lab equipment. Students worked well in teams and seemed quite capable of conducting the lab experiments.
- When asked, students said they liked this program better than other classes they have taken. They commented particularly on how much the faculty cared about them and helped them. The only female (17 years old) seemed at ease in class; she participated well in the teamwork.

Piedmont – Pre-ET

- Students were working in teams of 3 with obvious comfort and rapport (6 students-all male). All three instructors were in the room at the same time with students. Students discussed their feelings about class freely with instructors and praised the team modeling of the faculty. Good-quality written products were produced with Word using graphics. References were made by teachers to content learned in math, physics, and communications illustrating good integration of content and good tieback to the problem scenario.

Tri-County – ET Core

- The English instructor presented with PowerPoint and led a class discussion on speaking skills. Students worked in teams (18 students-one female). One male student (recorded on videotape) told us about a "company meeting" the students ("employees") had arranged with faculty ("management"). Students initiated the meeting, setting the agenda and arranging time and place (they sent a memo to instructors). The purpose of the meeting was to clarify some process and evaluation concerns of students. According to the student (and also the faculty) the meeting went extremely well, with students modeling professional workplace behavior. Additional meetings will be planned as the need arises.
- The female student was asked her opinion on why she was the only woman in class. She said, "Women think this work is too hard, and it is not. They (women) think this work is dirty, and it is really clean work." This student is one of the Bosch apprentices and has work experience from which to speak. She feels comfortable in class and at work and appears to be succeeding in both places.
- Students worked in teams on a hands-on active learning discovery lesson, using technical equipment and devices. There was considerable interaction among the students and

between the instructor and teams. Ron Talley spoke to us (recorded on videotape) about how the ATE experience has changed faculty. He spoke of how enlightening it is for teachers to be on the "other side" of the desk during ATE staff development activities. He also spoke of the benefits of teaming, PBL, and integrated curricula for students.

- Two other faculty team members came into the pilot class and stayed awhile, helping and encouraging students. Two faculty team members had a private conversation about a student assessment situation, collaborating and coming to consensus on a "math vs. science" approach to the solution of a test item.

York – Pre-ET

- All three instructors and the pilot coordinator were in class with 11 students (one female). One could not tell if the class was math, science, or communications, demonstrating a really good integration of content. Students made oral team presentations of solutions to the third project (electrical), using some visuals and handouts for support. Students were reasonably comfortable working in teams and making team presentations.
- Products from the first two projects (career planning brochure and simple machines) were impressive. Students created job informational brochures using text and graphics. Models of simple machines (inclined plane, block and tackle, etc.) demonstrating solutions to a workplace problem were on display.
- Project #4 was introduced to the class. Students knew how to get started and easily began the PBL process. Each instructor led a student discussion on what content students "needed to know" to approach the problem.
- When asked, students reported that this class was better than their other classes in that they had the help of their teammates and a faculty team. They said they liked the methods used in class and the methods "were working" for them. The woman in class commented that she had had a great deal of difficulty with math and science in the past. She declared she would not be able to succeed if it were not for this integrated, problem-based class.

4.0 FUTURE EVALUATION

Future evaluation (years 4-6) will determine whether the curriculum promotes better student outcomes, including improved recruitment, retention and persistence of engineering technology students (with an emphasis on female and minority students). Outcome indicators include:

Quantity Measures:
- Program enrollment rates;
- Student success rates in Pre-ET and ET courses;
- Program retention rates;
- Persistence rates (i.e., rate at which students continue on to other ET courses);
- Degree completion rates.

Quality Measures:
- Consistent with National Science Education standards;
- Skills acquisition;
- Allows multiple exit and entry points to increase access;
- Responds to business and industry needs;
- Incorporates industry reactions and inputs to curriculum;
- Integrates core and technical content;
- Integrates school-to-work principles;
- Uses problem-based and hands-on approaches;
- Uses teamwork project approaches; and
- Integrates technology into curriculum.

To answer this question, AED will assemble institutional research, State Tech system data, and other information (analyzed by year, college, major, race and gender), including institutional pre/post and national normative comparison data, on:

- Enrollments in pre-ET and first-year ET core programs, to determine recruitment success;

- Course completion rates each semester in pre-ET and first-year ET core programs, to determine persistence success (i.e., the rate at which students continue on to other ET courses) and semester-to-semester retention success; and,

- Graduation/degree completion and transfer rates, and numbers of graduates available for ET employment.

These student and institutional outcomes are expected to increase over time upon wider implementation of the model compared to the performance of the South Carolina technical colleges' traditional ET programs prior to the Center, as well as to national norms established for similar programs by two-year colleges.