

2004-1552

ASPIRE – The Academic Summer Program Introducing Resources for Engineers

Tremayne O. Waller, Dr. Bevlee A. Watford

**Center for the Enhancement of Engineering Diversity
Virginia Tech**

In 1995 as part of the NSF SUCCEED (The Southern Universities and Colleges Consortium for Engineering Education) Engineering Coalition Professional Development activities, Virginia Tech's Center for the Enhancement of Engineering Diversity (CEED) implemented a summer pre-freshman year program for under-represented engineering students. ASPIRE (Academic Summer Program Introducing Resources for Engineers) is designed to help 'bridge' the transition between high school and college. It is well documented that a student's first semester academic performance is often an excellent predictor of their future success as an engineering student. It was believed that, by providing this opportunity for students, their first semester and continuing performance would be enhanced, resulting in improved retention and graduation rates.

Of particular interest in 1995 was the disproportionately high numbers of under-represented students that Virginia Tech identified as being unprepared to take first semester calculus. It was believed that, by providing intensive math preparation, these students could become ready for calculus at the start of the academic year. It was also observed that the courses that appeared to be the most difficult for the incoming students were math, chemistry and introduction to engineering. These therefore formed the core academic areas addressed during the five (5) week program. Additionally the summer program was used to enable under-represented students to become familiar with the campus environment, forming a supportive community within the engineering college.

Over 275 students have participated in ASPIRE since 1995, and the program has undergone several revisions, primarily due to changes in the freshman year academic program and the academic preparedness of the students. CEED has maintained data on the academic performance of the ASPIRE participants and generated comparisons with a cohort control group. The data indicates that ASPIRE participants exhibit better academic performance overall than their comparison cohort group. ASPIRE participants earned higher grades in specifically targeted freshman courses, and have higher retention and graduation percentages.

This paper will describe the ASPIRE summer bridge program and discuss how continuous improvement practices have resulted in the present day program format. Furthermore, data is

presented detailing the academic performance of the student participants in comparison to the control groups. Given the current financial situation at Virginia Tech (and most other institutions of higher education), this data provides a substantial measure of justification for program continuation and expansion.

Overview of the program

The College of Engineering at Virginia Tech sponsors a five week orientation program called ASPIRE for students entering the college. The program is five (5) weeks long, beginning the last week of June. Students submit an application in order to participate in the intensive academic program the summer prior to their freshman year at Virginia Tech. The essential goal for ASPIRE is help ease the student’s transition from high school to Virginia Tech. The program provides the following:

- the opportunity to become familiar with the university community
- academic enrichment in selected subjects (i.e., mathematic, chemistry and engineering fundamentals)
- the opportunity to participate in seminar sessions to enhance personal and professional development.

Courses

The students receive instruction in chemistry, mathematics, and engineering fundamentals. Students participate in a chemistry laboratory as part of the program. These classes are taught by instructors from each department. The five week summer classes are similar to those classes taught in the fall semester. Both, mathematics and engineering fundamentals introduces students to Matlab (a software program). All instructors give tests each week. Also, the incoming freshmen participate in orientation seminars emphasizing study skills, time management, and collaborative learning. The courses and seminars are intended to teach the students how different college is from high school. Below is the weekly class schedule.

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 AM	Chemistry	Chemistry	Chemistry Lab	Chemistry	Chemistry
9:45 AM	Math	Math		Math	Math
11:30 AM	Academic Analysis		Academic Analysis	Academic Analysis	Seminar
12:30 PM	Lunch	Lunch	Lunch	Lunch	Lunch
2:00 PM	Engineering. Problem Solving (Group A)	Engineering. Problem Solving (Group B)	Engineering. Problem Solving (Group A)	Engineering. Problem Solving (Group B)	Engineering. Problem Solving (A) & (B)
4:00 PM					
7:00 PM		Orientation			

Course Details

Chemistry

The instructor of this class emphasizes problem solving. The topics covered in this class deal with chemical fundamentals, bonding, and thermodynamics. The students are assigned multiple problems sets and homework assignments. The problems sets are given to measure the student's grasp of the material covered each week in the class. There are three exams given outside the class time. Students have the opportunity to participate in evening help sessions prior to each test. Also, there is a post-test given the last week of classes to view how much the students comprehended.

Chemistry Lab

The chemistry lab meets once a week. The students are exposed to a variety of topics selected by the instructor. Some of the topics covered by the lab instructor are measurement, determination of a chemical formula, stoichiometry, properties of gases and line spectra.

The class is geared to expose students to similar laboratory experiments in which they will experience in the fall semester. The instructor spends the first class meeting discussing the laboratory environment. This is important for the student to understand to be on time for each class. If late for the lab, the student may be dismissed from the lab because they missed a safety briefing.

The second class session is when the students are given the opportunity to participate in lab. The instructor goes into great detail about writing techniques for lab reports. The third class session is when the instructor divides the class into small groups in order to analyze each group member's lab reports. Students are encouraged to rewrite their lab reports to meet the expectation set by the department. It is during these last two class sessions, the professor will schedule one-on-one meetings with the students to discuss their progress in the class.

Math

Initially, the math course was designed to assist students who were not calculus ready to pass the Mathematics Department's Mathematics Readiness Test (MRT). The MRT exam was designed by the math department. So, the exam can be difficult to take if the students have not used or seen some of the formulas in while.

Some of the information covered in the math class includes geometry, trigonometry, and algebra. The math class meets four times a week. In the first meeting, the instructor gives the students expectations for the class and a diagnostic exam. While the majority of the ASPIRE students are calculus ready, they have not had to use the basic skills reviewed for the class in while. They tend not perform well on the diagnostic exam. However, they have another opportunity to retake the exam at the end of the program. The students that pass the MRT with a 70% or higher could enroll in calculus.

Each student in the math course must complete 4 Matlab projects. These Matlab projects are to be done on the students own time. (There is a computer lab reserved for the ASPIRE program in order for the students to complete the tasks). The students are assign homework each night and the homework problems are randomly collected and graded. Quizzes are given and based on the understanding of the material covered for each class session. Students are given 3 in class tests.

Engineering Problem-Solving

The instructor of this course exposes the students to the skills of how to solve pencil and paper engineering problems. Also, assignments cover email, internet, Microsoft Word, Excel, PowerPoint, AutoCAD, and Matlab. These computer sessions are to ensure that students are somewhat efficient with the computer.

The ASPIRE students are divided in two small groups (A and B). This is an opportunity for the instructor to work with the students in a small group setting and assign group work. On Monday and Wednesday, Group A meets with the instructor while Group B meets with the instructor on Tuesday and Thursday. Each Friday, the entire group meets to take a test or group presentation.

Skill Development

Personal and professional development is critical to the student's success at Virginia Tech. The ASPIRE program provides the students with weekly seminars to learn about the resources available at Virginia Tech. Students have the opportunity to become familiar with these resources such as career services and the cooperative education program, the Center for Academic Enrichment and Excellence, academic advising and course registration and student organizations. Additionally, guest speakers from the local area discuss their leadership skills and what company's expect from college graduates.

The students meet weekly with academic advisors. In these weekly meetings, students discuss their performance in ASPIRE. In this manner, students are pro-actively learning self-discipline with respect to accomplishing the requirements of the program. This particular activity was implemented following the first year of ASPIRE. It was determined then that unless students were forced to discuss their academic performance, they tended to ignore poor performance.

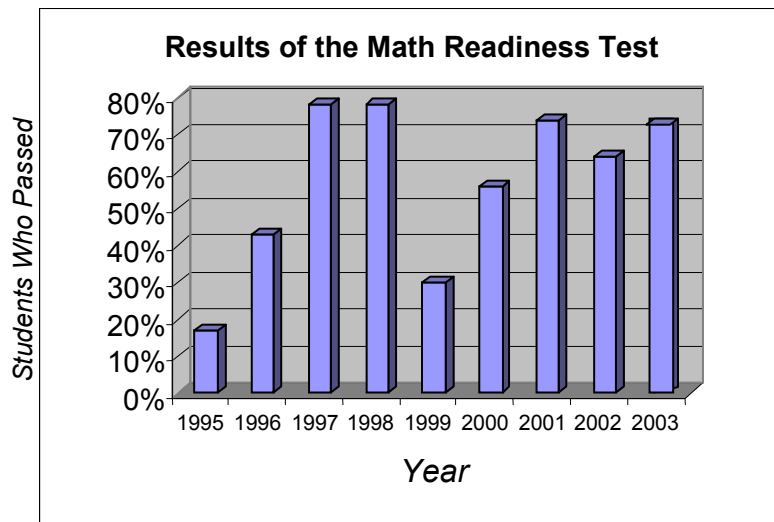
The students participate in numerous activities during their free time. Students take part in a campus tour, ropes course, dining etiquette seminar, 4th of July cookout/pool party, and the University's Summer Orientation Program. The Virginia Tech Cummins Engine team conducts a team building and leadership skills workshop. The students visit the General Electric plant in Salem, VA, participating in a leadership workshop.

Math Readiness

One of the program's goals is to prepare students for the engineering calculus class (Math 1205), especially those students who may not have had calculus in high school. In 1998 Virginia Tech implemented a math placement evaluation for all incoming freshman. A score is assigned to each student based on if they took calculus in high school, what grades they earned in high

school math and their math SAT score. Students with low scores reflecting weak mathematics backgrounds are required to enroll in College Algebra (Math 1015). However a student may take a math readiness test (MRT), which if passed will allow them to enroll in first semester calculus. For College of Engineering students, this is extremely important as they cannot begin introductory engineering classes unless they are enrolled in calculus.

ASPIRE participants are given a pre and post test of the MRT. The pre-testing is conducted with an old, extremely difficult version of the test. The initial result which generally is a low score, serves as a strong motivator for the students to work hard on their basic mathematics skills. Of the 27 students in ASPIRE 2000, 56% passed the MRT. In 2001, 74% of the 31 students passed the MRT. Of the 24 students in ASPIRE 2002, 64% passed the MRT. The results from the MRT test is from 1995-2003 is provided in the chart below.



In recent years, the number of students who are considered not-calculus ready has declined. However, the results of the MRT pre-test are typically abysmal, with two or less students earning a passing grade. Additionally, computer science became a department in the College of Engineering in June 2003. A relatively high number of computer science freshman are not ready for calculus. A third population we consider are students who are admitted as undeclared students, even though they originally requested admittance to the College of Engineering. Frequently these students could not be admitted directly into engineering due to weak math ability.

First Semester Academic Performance

A student's first semester academic performance is critical to their continued success in engineering. When comparing the grades of the under-represented engineering students, it was determined that their academic performance in certain classes was significantly below that of majority students. Therefore ASPIRE had a goal of better preparing these students for their first semester. It was believed that if these students experienced what engineering undergraduate studies was like, they would be better prepared to do well academically. ASPIRE served two

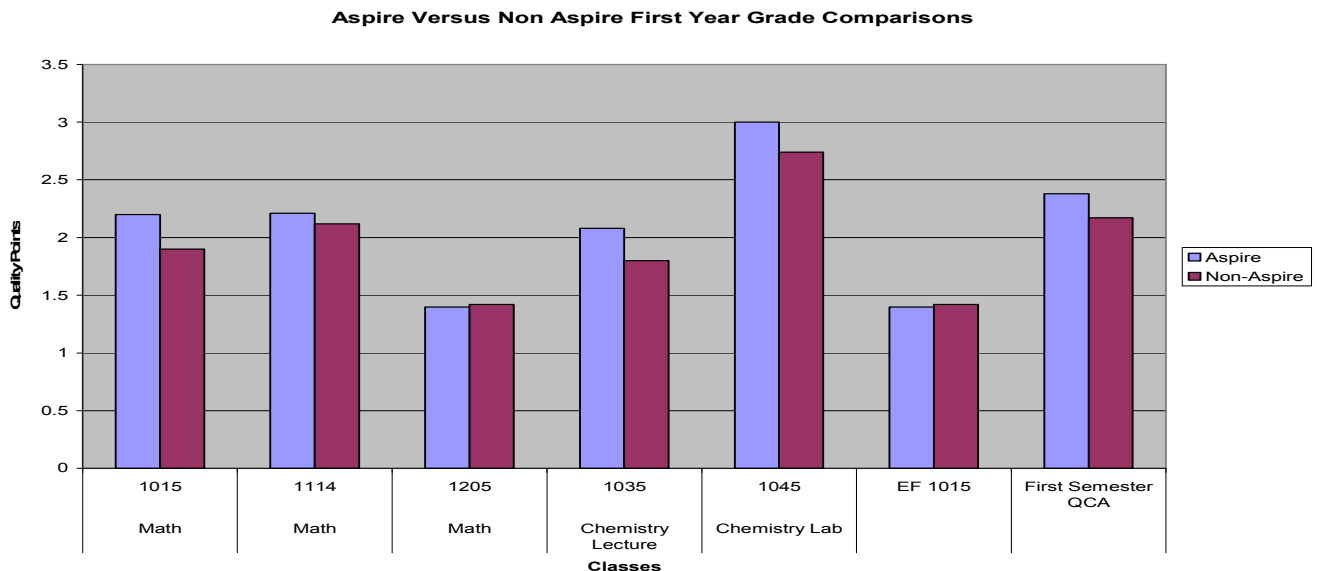
functions; to help the students become acclimated to Virginia Tech and other students, and to let them experience engineering studies.

The expectation was that students participating ASPIRE would be comfortable in the Virginia Tech community. Therefore, when students began in the fall, they should have been accustomed to the academic and social expectations. Given knowledge of the expectations, their first semester grade point averages (GPA) would be higher than that of their cohorts who did not participate in ASPIRE.

In fall 1997, a more rigorous academic eligibility policy for the university went into effect. Previously a student was required to earn a 1.5 overall GPA by the end of their freshman year; a 1.75 overall GPA by the end of their sophomore year; and a 2.0 GPA following the end of their junior year. With a 2.0 graduation requirement, this policy often resulted in student digging an extremely deep academic hole. The current policy requires that a student continually earn a 2.0 overall GPA or face academic sanctions. In 1999 ASPIRE participants had an increase with 61% maintaining an overall 2.0 QCA. Following fall 2003, 85% of the students earned above a 2.0 GPA during their first semester. Using data for all ASPIRE cohorts, the fall semester GPA for ASPIRE participants is 2.41, compared to non participants who have averaged 2.17.

Data Collection

It is critical to collect data. The CEED office tracks all minority students from year to year retention, graduation rates, and transfer into major. The following grades have been collected for the 1995-2003 cohort classes: Math 1015 (college algebra), Math 1114 (linear algebra), Math 1205 (calculus), Chemistry 1035 (chemistry lecture), Chemistry 1045 (chemistry laboratory), and EF 1015 (introduction to engineering) and first semester QCA (see chart below).



The ASPIRE students on average earn higher grades than the non-ASPIRE students for each class with the exception of EF 1015. Significantly higher average grades were earned by the 1997, 2000, and 2003 ASPIRE participants in math, chemistry, chemistry laboratory, and the overall first semester QCA when compared to their peers.

		1 st Semester GPAs
1995	ASPIRE	1.98
	Non-ASPIRE	1.90
1996	ASPIRE	2.32
	Non-ASPIRE	1.83
1997	ASPIRE	2.56
	Non-ASPIRE	2.05
1998	ASPIRE	2.42
	Non-ASPIRE	2.15
1999	ASPIRE	2.42
	Non-ASPIRE	2.15
2000	ASPIRE	2.78
	Non-ASPIRE	2.30
2001	ASPIRE	2.29
	Non-ASPIRE	2.57
2002	ASPIRE	2.30
	Non-ASPIRE	2.17
2003	ASPIRE	2.65
	Non-ASPIRE	2.32

Retention

Retention rates are summarized in the chart below. Participation in ASPIRE does not appear to greatly affect the retention of students. However, this can be interpreted as students are making decisions to stay in engineering or transfer to another major or school. As of now, 71% of 2002 ASPIRE students are still enrolled in the college of engineering. The 1997 ASPIRE cohort was the largest graduating group thus far.

Cohort	Number of Participants	Graduated in Engineering from VT	Graduated from VT	Still enrolled in Engineering at VT	Still enrolled at VT	No longer enrolled at VT
1995	26	13 (50%)	8	0	0	5
1996	26	12 (46%)	6	0	0	8
1997	31	16 (52%)	2	0	0	13
1998	33	14 (42%)	6	7 (21%)	2	4
1999	26	4 (15%)	3	9 (35%)	2	8
2000	17	-	-	10 (67%)	0	5
2001	27	-	-	14 (52%)	7	6
2002	24	-	-	17 (71%)	6	1
2003	28	-	-	17 (61%)	11	0

Improvements in the program

The first year of ASPIRE was not very successful, although much was learned. In particular, we continually survey the students, faculty and staff associated with the program to determine what works and what does not work. The following are some of the changes we have implemented in the program since the start in 1995.

- Students must meet weekly with an academic advisor in the CEED office.

One key to ASPIRE's success is that students are treated as if they were enrolled freshman. They are not told when or what to study, there is no curfew, nor any wake up call. However it is a requirement to be in class on time – no exceptions. The students typically have a test on the first Friday. It was found that if the students were not forced to evaluate their performance on these tests with an academic advisor, they were quick to discount poor performance as a fluke. However all students must not have 20 minute weekly advising sessions where their grades are discussed and future actions planned. The academic performance of the students markedly improved with this addition.

- Weekly staff meetings were implemented and included all program staff.

This may straightforward, but this was an overlooked event for the first 2 years of ASPIRE. The result was that each program staff had information on various students, but it was never shared. Therefore weekly faculty meetings were held. After another year it was determined that all program staff, including residence hall advisors, tutors and door monitors needed to be included in these meetings. As a result problems with students are more quickly identified and addressed.

- Tutors are now part of the ASPIRE program staff.

While the College of Engineering provides free tutoring it is not available during the summer months. Some students were seriously challenged by the work, and had no assistance once the instructor's office hours were over. Two years ago, we began hiring tutors to be available 3 evenings per week in the residence hall. This has served two purposes. The students have access to the assistance they may need. Additionally they learn early the benefits of seeking tutor assistance. As a result, the numbers of ASPIRE participants that seek help from the College's Student Assistance Center has increased.

- Fall programming

ASPIRE student performance continued to improve through 1999. However in 2000 the fall academic performance was not as expected. As a result, plans were developed for a fall semester component for ASPIRE. In fall 2003 the program was initially implemented with noticeable results. In 1999 30% of ASPIRE participants earned above a 2.5 GPS during the fall semester. This past fall 2003 semester 74% of ASPIRE participants earned above a 2.5 GPA.

The fall semester ASPIRE program centered on goal setting for both individual participants and teams of participants. This gave the student the opportunity to set both individual and group

goals. Regular meetings with the students addressed such topics as setting goals, a time management challenge, developing strategies for saying no to friends who were not academically inclined and others. The final event held was to celebrate their accomplishments with holiday dinner, providing students with the opportunity to share their goals and discuss their challenges during the semester. Several students were able to offer helpful suggestions on how to resolve the different issues that hindered them from reaching their goals

- The type and number of seminars has varied greatly over the years.

Initially the students had a fifty minute seminar three days per week. Specifically, it was desired to introduce them to the various engineering degree programs within the college. Virginia Tech's students enter as general engineering students, selecting a major following their freshman year. In addition to these department sessions, there were seminars on time management, leadership development, career services and a whole host of other extremely important topics. Eventually, it was determined that this was too great a load for the student. The department presentations became instead a two hour department fair, with table top displays and representatives from each department. In addition to allowing the student to choose among the departments, this was used by other summer pre-college camps. Both students and faculty indicated greater satisfaction with this change.

Student Survey

As part of the effort to obtain feedback, students are provided with pre- and post-surveys about the material presented, the academic rigor and other aspects of the program. A survey is administered approximately three weeks into the fall semester. In this survey, the students evaluate both the program and their current status. The table below contains a summary of the top five most helpful things about ASPIRE; the items in column one were ranked the most helpful, the items in column two the second most helpful, etc.

	1	2	3	4	5
1995	Friends	Learn VA Tech	Chemistry	Time Management	Study Skills
1996	Friends	Chemistry	Chemistry Lab	Instructors	Time Management
1997	Friends	Learn VA Tech	Chemistry	Instructors	Math
1998	Chemistry	Friends	Math	Leadership Workshop	Registration for Fall Classes
1999	Friends	Chemistry	Chemistry Lab	Instructors	Time Management
2000	Learn VA Tech	Friends	Instructors	Chemistry	Math
2001	Math	Friends	Learn VA Tech	Chemistry	Leadership Workshop
2002	Chemistry Lab	Engineering	Friends	Math	Chemistry
2003	Friends	Learn VA Tech	Chemistry	Tutors	Math

Being able to make friends has always been one of the top five most helpful experiences in ASPIRE. One interesting point is that it appears the skill set of the students has changed. In 1995 and 1996, skills regarding study skills and time management were rated as important. The participants in the other cohorts were focused more on the academic side.

Conclusions

The successful thing about ASPIRE is building a routine for the students. The data collected on the program demonstrates that student's benefit from the classes, leadership, and team building workshops. This feedback is essential to continual improvement of ASPIRE. For example feedback received from the students resulted in the addition of the engineering problem solving course during the summer component. This need was evidenced by poor performance in Engineering Fundamentals 1015 (Introduction to Engineering) by both ASPIRE and non-ASPIRE students.

As another example, survey data revealed that the students felt under-prepared to handle the Matlab assignments in the introduction to engineering and calculus classes. The next year Matlab programming was added to the summer program. Feedback from participants, faculty and staff is essential to keep pace with an ever changing undergraduate engineering curriculum. The activities for the ASPIRE participants must be consistently viewed through different lenses, those of the various constituencies during both the summer component and the freshman academic year.

Biography

DR. BEVLEE A. WATFORD, P.E. is Associate Dean for Academic Affairs in the College of Engineering at Virginia Tech. She is also the founding Director of the Center for the Enhancement of Engineering Diversity, established in 1992. Watford was the recipient of the ASEE 2003 Minorities in Engineering award due to her efforts to increase the recruitment, retention and graduation rates of under-represented students in engineering.

TREMAYNE WALLER received a B.S. degree in Liberal Arts Education from Averett University in 1996 and M.S. degree in Counseling from Radford University in 1999. Currently, he is working on a PhD. degree in Educational Leadership and Policy Studies Virginia Polytechnic Institute and State University. He works for the Center for the Enhancement of Engineering Diversity at Virginia Tech as the graduate assistant overseeing ASPIRE and THE Pre-College Initiative Program.