Successful Interventions for Engineering Student Retention

Aliecia R. McClain and Sandra J. DeLoatch
College of Science, Engineering, and Technology, Norfolk State University

Abstract

As it is in many STEM disciplines, retention is a serious problem for engineering students. Some of the factors that impact retention include the following: (1) mathematics preparation; (2) advising and mentoring; and (3) student support systems.[1] Retention issues tend to be more acute in populations of minorities and other underrepresented groups. Norfolk State University, Virginia's largest Historically Black College and University (HBCU), introduced interventions in 2004 to improve the retention of engineering and other STEM students enrolled in a special honors program. The interventions include: a four-week mathematics-intensive summer bridge program; extensive academic advising and mentoring; peer-tutoring; and evening collaborative group learning sessions. These initiatives address retention risk factors and have helped to improve the academic performance of students.

Introduction

The Dozoretz National Institute for Mathematics and Applied Sciences (DNIMAS) Program at Norfolk State University (NSU) is an honors program for students who major in biology, chemistry, computer science, engineering, mathematics, or physics. It was created to reduce the shortage of minority scientists by producing highly trained graduates capable of earning the Doctor of Philosophy (Ph.D.) Degree. The key features of the DNIMAS Program are a four-week summer bridge program (pre-freshman), four-year academic scholarship which includes tuition, fees, room, board, and textbook allowance; specialized curricula in biology, chemistry, computer science, engineering, applied mathematics, and physics; internships and/or research experiences; career counseling; and seminars. DNIMAS scholars participate in internships and/or research programs at the nation's premier government and corporate laboratories and prestigious universities. Placement sites have included NASA, Jefferson Lab, Lucent Technologies, Harvard, M.I.T., Georgia Tech, Virginia Institute of Marine Science, General Mills, Fermi Laboratories, and many more.

To improve the retention of engineering and other STEM students enrolled in the DNIMAS Program, Norfolk State University introduced some structured interventions in 2004 that included a more math-intensive summer bridge program, advising and mentoring, and strong student support programs. The goal was to produce a significant increase in graduates from historically underserved groups that are prepared to attend graduate schools and/or be more effective employees in the highly technological environment of the 21st century. The objective of interventions is to provide the required structured academic support to effectively meet needs of students and increase the graduation rate to 100%.

[1] National Science Board-Sponsored Workshop on Moving Forward to Improve Engineering Education, p. 28

Student Profile

Ninety (90) students were enrolled in the DNIMAS Program in Fall 2007. As depicted in Figure 1, females comprised 64% of the student population, while 36% of the students were male. Engineering students represent the third largest group of DNIMAS students (see Figure 2).

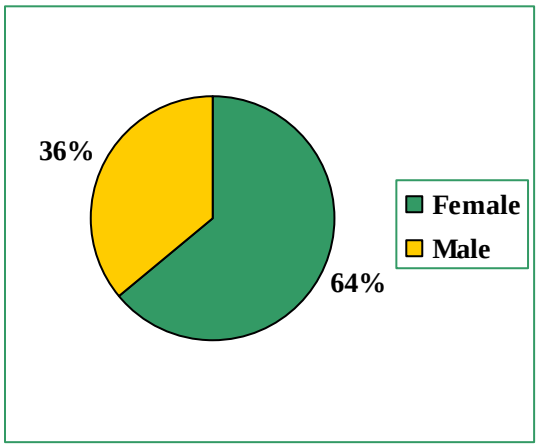

Figure 1. Enrollment by Gender

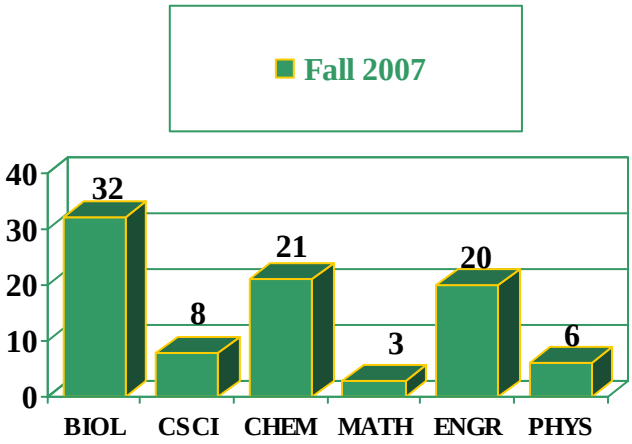

Figure 2. Enrollment by Major

Interventions

Summer Bridge Program

The summer bridge program for DNIMAS students provides intensive academic preparation in mathematics, chemistry, and college acclimation with the goal of improving retention. The schedule for the 2007 program is presented in Table 1. Students are housed in a campus dormitory and upper classmen serve as peer mentors and tutors. Peer mentors live in the dormitory, attend classes, and are involved in activities with the students. They also have evening 'Rap' sessions about college life and other topics.

Table 1. Daily Schedule for the 2007 Summer Bridge Program

Time	Activity
8:30-9:30	Group A Mathematics Group B Chemistry
9:45-10:45	Group A Chemistry Group B Mathematics
11:00-12:00	Survival Skills Workshop
12:00-1:15	Lunch (Scott-Dozier Hall)
1:30-2:30	Group A Mathematics Group B Mathematics Lab
2:45-3:45	Group A Mathematics Lab Group B Mathematics
4:00-5:00	Writing Skills/Mathematics Activities

Sixteen engineering scholarship students participated in the 2007 Summer Bridge Program. The intensive four-week program included classes on mathematics, chemistry, scientific ethics, and study skills. Students also participated in an intensive 2-day math drill workshop based on their performance on a mathematics placement test. Possible placements included Elementary Algebra (101), Intermediate Algebra (105), College Algebra (151), College Algebra and Trigonometry, and Calculus (184). As illustrated in Figure 4, none of the 16 engineering students initially placed in calculus. In fact, more than 50% placed in courses below pre-calculus.

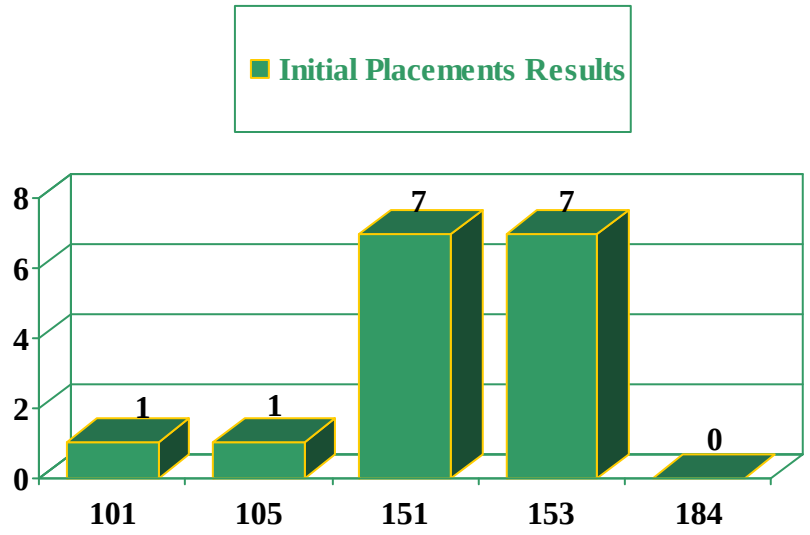

Figure 4. Initial Placement Test Results for 2007 Engineering Students

As indicated previously, math has been identified as one of the key factors for student success in STEM disciplines. Accordingly, math was the key focus of the summer bridge program and students were divided into two groups based on the placement test results. The first group (group A) extensively reviewed topics selected from intermediate algebra and pre-calculus I. The second group (group B) covered topics in pre-calculus I as well as pre-calculus II.

Thirty-five online tutorial labs, corresponding to the 35 questions on the placement test, were available for students. All students were required to complete mathematics labs corresponding to their incorrect items on the placement test. Some students had as many as 29 incorrect items. In addition to the final placement test and online labs, participants were required to take two in-class exams. The final placement test was administered at the end of the program.

The summer bridge program has helped all STEM participants to improve their math course placements substantially and as a result students are better prepared for calculus and other courses. Final mathematics course placement data for the 16 engineering students who participated in the 2007 summer bridge program is presented in Figure 5. The data reflects the fact that the number of students who qualified for calculus rose from 0% to 88%. Two students placed in the pre-calculus course (153).

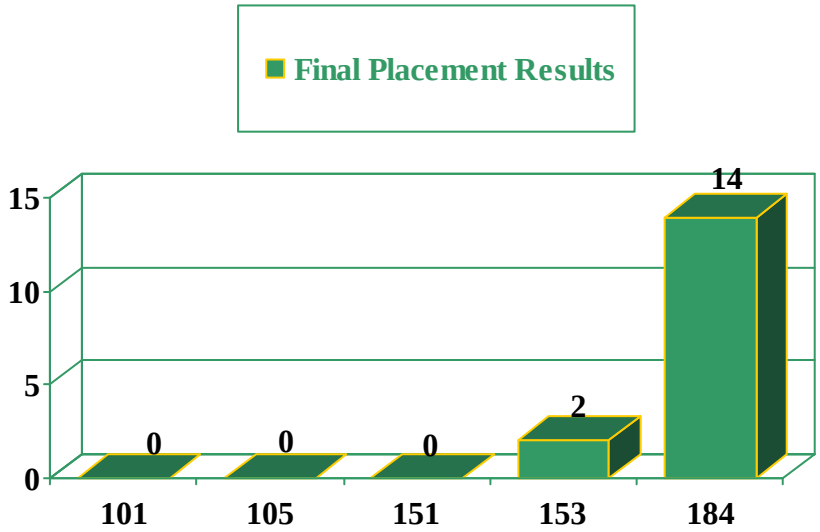

Figure 5. Final Placement Test Results for 2007 Engineering Students

Advising and Mentoring

As a part of the DNIMAS efforts to assist first year students in making a smooth transition, a student tracking/monitoring process called Shadow Mentoring has been implemented. The objectives of this intervention are to help first year students manage their academic schedules, provide proactive mentor support, and monitor academic progress. Mentors meet with the students at least one hour per week to ascertain information and to assist with their issues and/or concerns. A major meeting takes place with freshmen students before the last day to drop a class to offer advice and counseling. Both the mentor and mentee also meet together with the DNIMAS Director, at least once during the semester, to discuss academic performance and to share successful strategies for the remainder of the semester.

Student Support Programs

Two academically based student support initiatives have been introduced that are also designed to help improve academic performance and increase retention. These initiatives included peer-tutoring and evening collaborative group learning sessions. They are prototypes of models that exist at Auburn University[2]. Specific student time requirements include two hours per week for peer-tutoring and two hours per week for evening collaborative group learning.

The peer tutoring activity requires participation in one-on-one or group tutoring led by a team of volunteer DNIMAS upperclassmen who are proficient in a given course. The tutorial format fostered peer group learning as well as one-on-one learning. The peer tutoring initiative operates in collaboration with the STARS Tutoring Center that is housed in the College of Science, Engineering, and Technology.

[2] Dennis Weatherby. Bell South Minority Engineering Program, Auburn University, August, 1996

The evening collaborative group learning intervention organizes participants into study groups based on a common STEM course. Each group consists of 4 to 6 participants. With the assistance of 2 or 3 facilitators, participants solve homework problems and prepare for exams as a cooperative group using open discussions. The facilitator provides structure for the session and ensures that problem-solving progresses at a reasonable pace. The evening collaborative group learning sessions integrate a variety of tutorial formats to foster learning through group and peer-to-peer interactions. Students openly exchange problem solving ideas and methods. The aim is to create a forum where students in need of academic assistance were comfortable asking questions and to promote an environment conducive to camaraderie and studying. The study sessions are organized by classification and attendance is taken at each session. Groups meet on Wednesday and Thursday as indicated below:

Wednesday Night Two Hour Study Session

Time: 6:00 – 8:00 pm in the Woods Science Building (WSB)
Freshman and Sophomore Classes
Study rooms are located on the 2nd and 3rd Floors of WSB Bldg and the 1st Floor STARS Tutoring Center

Thursday Night 2 Hour Study Session:

Time: 6:00 – 8:00 pm in the Woods Science Building (WSB)
Junior and Senior Classes
Study rooms are located on the 2nd and 3rd Floors of WSB Bldg and the 1st Floor STARS Tutoring Center

Results

Tables 2 provide fall semester[3] grade point averages for engineering students. This data provides some insight on the impact of the interventions.

Table 2. DNIMAS Engineering Students with Fall Semester GPA of 3.5 or Above

Semester	Number of Students with GPA ≥ 3.5	Percent of Students with GPA ≥ 3.5
Fall 2005	**5**	**45%**
Fall 2006	**9**	**50%**
Fall 2007	**17**	**85%**

[3] Retention and performance results typically use data from the fall semester

The majority of the students in each classification earned a semester GPA of 3.0 or higher. Significant, however, is the percent that earned a GPA of 3.5 or above. Although there are some minor variations, this number is increasing. Students earning the higher grade point averages had 100% participation in the intervention activities. Our challenge is to increase the participation rate for all students.

Conclusion

Norfolk State University has introduced some structured intervention programs to improve the academic performance of STEM scholarship students and increase their retention rates. Academic performance data suggests that these initiatives have proven successful in improving academic performance and are "best practices" that are being expanded to include all engineering and other STEM majors. Our findings include the following:

- The four-week summer bridge program continues to be an outstanding success as evidenced by placement test gains. Specifically, 14 out of 16 (88%) of Summer 2007 engineering students placed in Calculus I after the summer enrichment activities. The initial test placed no students in Calculus I.
- The Summer Bridge Program reached its goals of providing students with academic enrichment and positive university experiences.
- Peer tutoring, evening collaborative group learning, and advising and mentoring interventions have proven to be "best practices" that provide valuable assistance to students.
- An indicator of the success of these "best practices" has been the improved performance of scholarship students as measured by their grade point averages (i.e., number above 3.5) at the end of the fall semester.
- This number has steadily increased during the last three years from 45% in Fall 2005 to 88% in Fall 2007.

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