AC 2007-2955: ENGINEERING STUDENT DEVELOPMENT AND RETENTION STRATEGIES AT A HISTORICALLY BLACK UNIVERSITY

Morrison Obeng, Bethune-Cookman College

Xiaohe Wu, Bethune-Cookman College

Engineering Student Development and Retention Strategies at A Historically Black University

Abstract

Student retention and completion of degrees in the STEM areas are issues that higher education institutions have been dealing with for quite sometime. Historically Black Colleges and Universities (HBCUs) also have their share of issues with STEM-student development, retention and completion of degrees. Various approaches have been adopted by educators and researches to alleviate the STEM-student development, retention and graduation problems. Unfortunately, the retention rates and graduation rates are still lower than desired. There is a need to continue to re-asses and re-evaluate previous efforts and to investigate and research alternative or additional methods and techniques to enhance student development, retention and graduation rates in the STEM disciplines at HBCUs.

In this paper, the engineering student development and retention strategies at Bethune-Cookman University, a Historically Black University are discussed and compared with strategies at other institutions of higher education.

Introduction

Many students who enter college to study engineering go with the notion that scientific knowledge is certain. The teacher lectures it to them; they memorize it and reproduce it on tests and exams. Educational Research points to the Models of Intellectual Development, the levels of which indicate whether a student is at a blind acceptance of authority/knowledge level (Perry's Level 1) or anywhere in-between up to the level where they accept knowledge conditionally until the evidence that supports it changes (Perry's Level 9). Research further shows that as students move from the lower levels of the Intellectual Development Models to higher levels, the students become more open to alternative ideas and accept responsibility for their own learning[1,2]. Engineering Programs strive to move their students up the ladder of the Models of Intellectual Development.

This paper describes the development and retention strategies in the engineering program at Bethune-Cookman University (BCU) an HBCU. The strategies are meant to help the engineering students to become more active and self-directed learners who are motivated and retained in the field of engineering. It is our hope that these strategies will move the BCU engineering student up the ladder of the Intellectual Development Models. BCU offers a four year Bachelor of Science degree in computer engineering and a " 3 + 2 " dual-degree program in engineering with partner engineering schools. The portion of the dual-degree program taken at BCU is referred to as pre-engineering.

Student Intellectual Development Strategies

Hands-on team-based projects in the curriculum have been reported in the literature to enhance engineering student intellectual development and retention[1,2]. At BCU, a project of the type described below are assigned in the microprocessor and embedded systems course.
The project, assigned to a group of 2 to 3 students may be stated as follows: "design, develop and implement a microcontroller-based system on a Printed Circuit Board (PCB) to measure the temperature of a specified location and transmit the measurement by wireless means to a given server". In this assignment, the students will have to obtain on their own all the information needed to do the project. The instructor provides the resources requested by the students. These resources must not be readily available in the laboratory. This type of project may also be assigned in the "Senior Thesis Projects" capstone course. A project such as the one described, may involve a multi-disciplinary team of engineering, computer science and physics majors. Knowing that the completion of a project will help them with their performance in industry and in graduate schools, the students are motivated to do what it takes to complete the project successfully[3]. The functional, finished products are put on display in the engineering laboratories to be used as demonstration tools for other students to encourage and motivate their interest in Science, Engineering and Mathematics. Middle School and High School students who visit the BCU School of Science, Engineering and Mathematics are given live demos of the functional projects designed by the BCU students. This approach is beneficial in the recruitment of students in the STEM disciplines at BCU. The approach described is currently implemented on a limited basis in the Computer Engineering Program at BCU. The impact of the approach on the "Intellectual Development" and "Retention" of the students has not been fully quantified. The next step is to quantify the impact of such project-based courses and compare the outcomes with those in other minority and non-minority institutions.

In the senior seminar/thesis course, students work individually or in interdisciplinary groups to complete a significant project. The results of the project: hardware, software and documentation are presented to the faculty in the form of a senior thesis. In completing their senior thesis projects, the students get to interact with each other, with vendors and manufacturers of software and hardware components and spend a great deal of time on the internet searching for information on manufacturer specifications and the best components and vendors. For the capstone project, the computer engineering students use the science, engineering and general education backgrounds acquired over the four year period in the design and implementation. This experience enhances the ability of the students to work on teams. It is hoped that the assessment data when collected and analyzed for the BCU engineering program will confirm the research results on the student communication skills and interest in engineering reported in the literature[4].

Student Retention Strategies

Some of the students seeking to enter BCU's engineering programs enter BCU at the level of college algebra in mathematics. They are therefore required to take pre-calculus and trigonometry. While taking the pre-calculus and trigonometry courses, they also take the required general education courses in the Humanities and in the Social Sciences.

At BCU all freshmen in engineering (computer engineering and pre-engineering) are required to take the Engineering Drawing Class using Computer-Aided Software provided in the engineering laboratory. Students work on a CAD/CAM project and present their finished projects at the end of the semester to the class. This is the first exposure of the freshmen to an engineering class at BCU. Even-though the freshmen at this point are not very advanced in math, the project-based nature of the assignments are meant to enhance their conceptual development[5]. It is envisaged to add an additional course such as "Foundations in Engineering" course to the freshman list of courses to allow for more Project-Based Learning (PBL) at the freshman level since research shows that PBL in the first year enhances student's active learning and increased student retention[6,7]. The second, third and fourth year engineering classes have PBL infused in them to enhance student comprehension of the subject matter and the ability to successfully relate and apply the knowledge gained to different situations and environments and also to become Self-directed Learners as reported by other researchers in the literature[5,8]. Some of the assigned projects are group-based while the others are done completely by the individual students. Project-Based Learning has been introduced in the BCU engineering curriculum but needs to be enhanced to boost student intellectual development and student retention. The impact of the PBL on the modest gain in student enrollment in the computer engineering program shown in figure 1., has not yet been quantified.

It has been reported in the literature that similar measures at the University of Colorado at Boulder produced retention gains between 3 percent to 54 percent[6]. Carnegie Melon University reports significant retention of students in first-year courses with project-based design components from about 80 percent to 97 percent[4]. It is anticipated to compare the retention rates at bigger engineering HBCU institutions such as Howard University, Florida A&M University, Tuskegee University with the retention data at BCU after data has been collected for a few more years on the BCU program.

Student organizations such as the National Society of Black Engineers (NSBE), the Florida Georgia Louis-Stoke Alliance for Minority Participation (FGLSAMP) through their social and technical activities have helped in the retention of students in the engineering program. The BCU faculty and Administration are very supportive of these student organizations. It is planned to form the IEEE student chapter at BCU in the spring of 2007. Figure 1, and Figure 2 show the engineering student enrollment at BCU from fall 1999 to fall 2006.

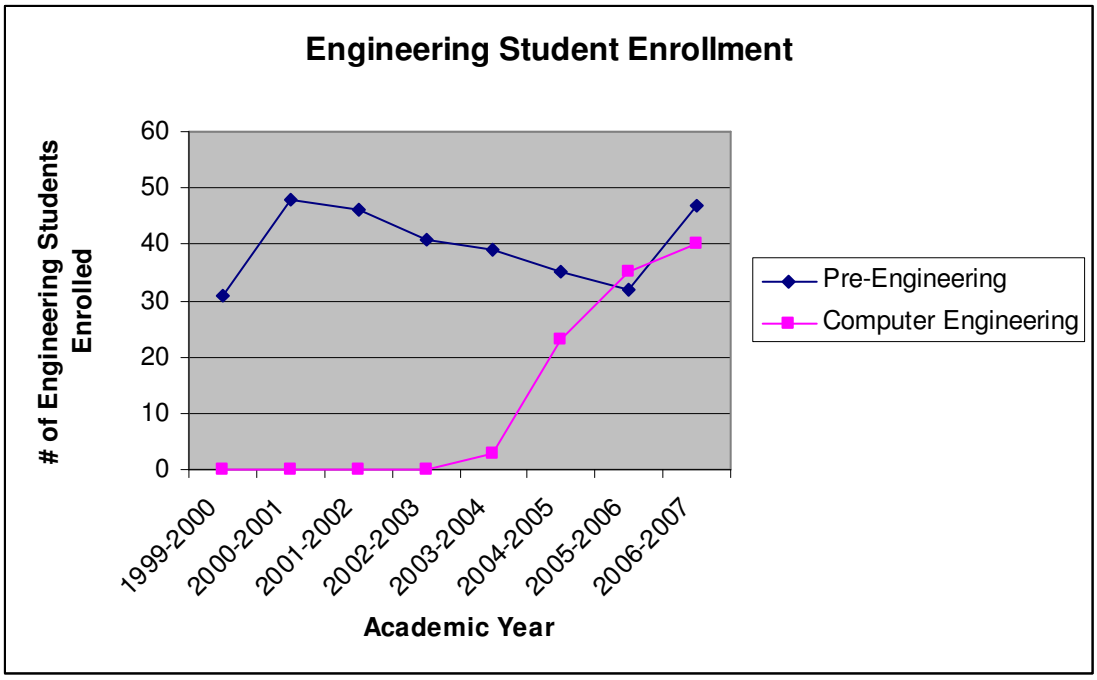

Figure 1. Engineering Student Enrollment at Bethune-Cookman University.

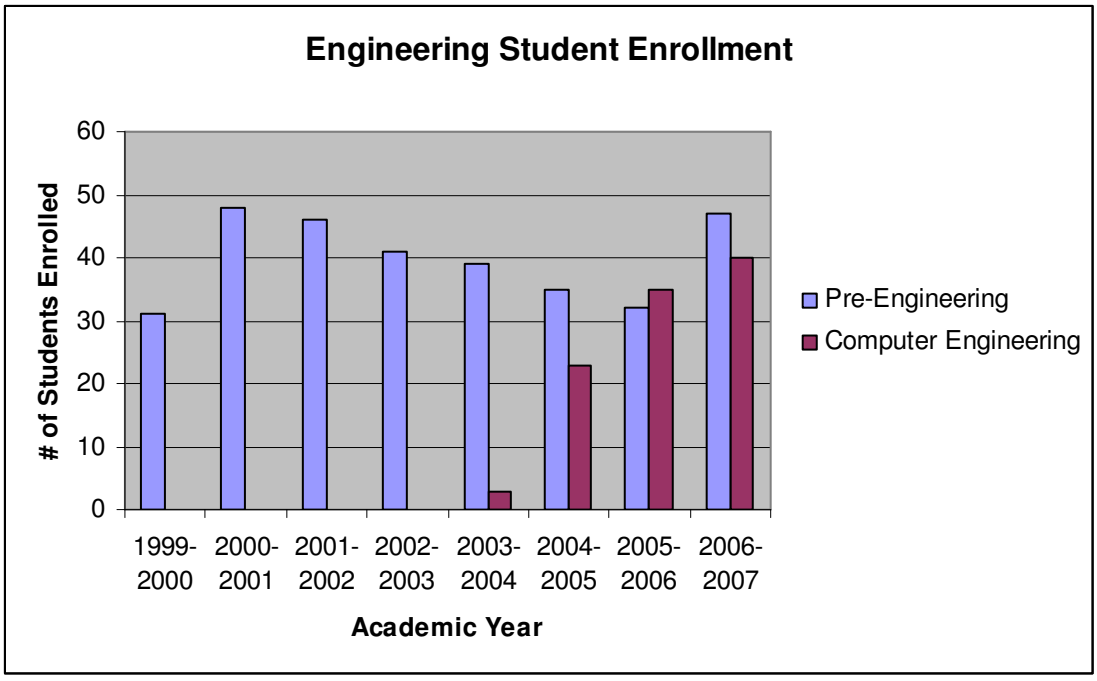

Figure 2. Histogram of Engineering Student Enrollment at Bethune-Cookman University.

Figure 3 shows the retention trend of the computer engineering students. The computer engineering program is four years old. We are hoping that the data collected in the next few years will indicate the impact of the project-based approach in the retention of the students.

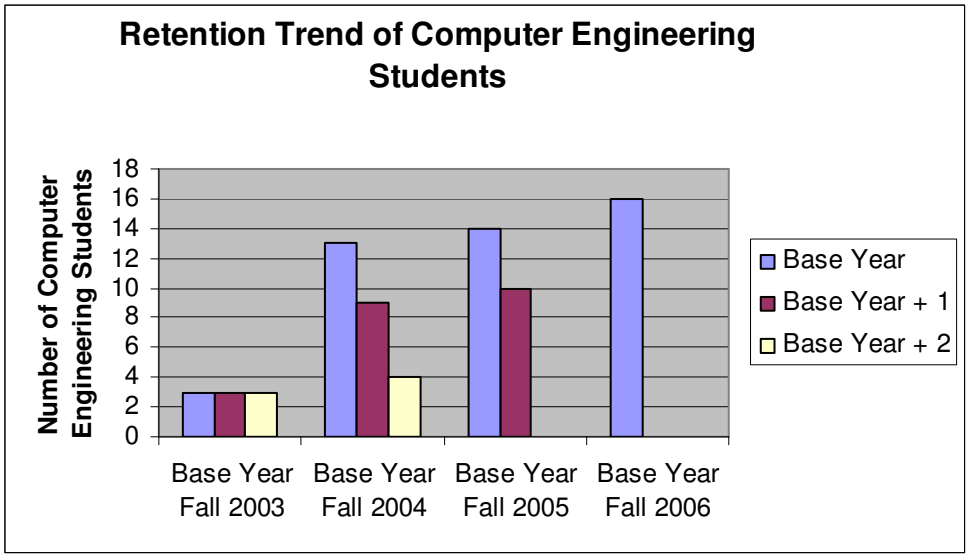

Figure 3. Retention Trend of Students in the Computer Engineering Program.

Figure 4 shows the trend in retention of the pre-engineering students at BCU. The pre-engineering student spends three years in the engineering program at BCU and completes additional two years at BCU's partner Engineering School to finish the BS engineering degree. This agreement enables the BCU engineering student to complete the bachelor's degree in fields such as mechanical, electrical, civil and environmental engineering that are not offered at BCU. In addition, the pre-engineering student obtains a bachelor's degree in Mathematics from BCU after completing specified requirements. The fluctuation in the retention data in Figure 4 is because some of the pre-engineering students change majors in the middle of the program to become mathematics majors since the two programs have a lot of courses in common.

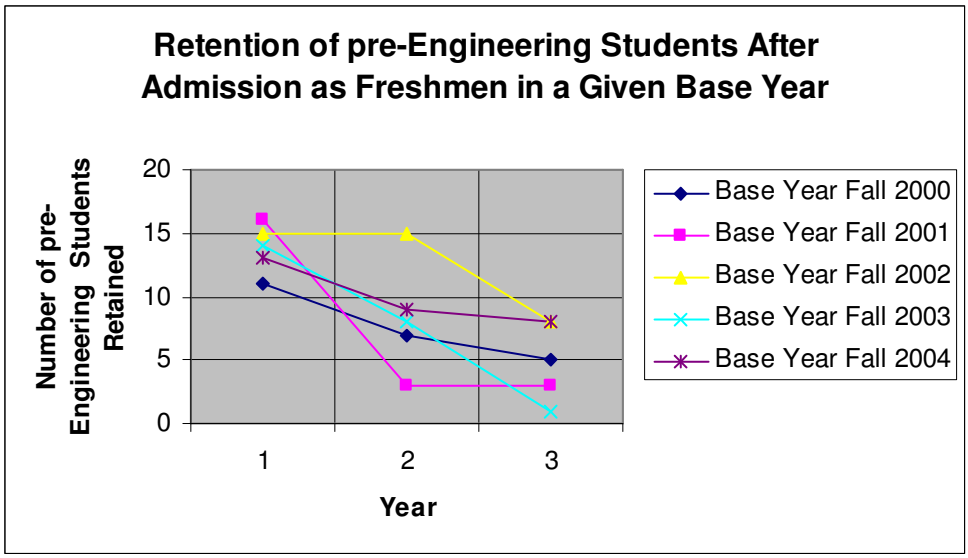

Figure 4. Retention Trend of Students in the pre-Engineering Program.

A list of the activities of the Engineering Program at BCU for enhancing the Intellectual Development and Retention of its students is as follows:

- Infuse every engineering course with hands-on group-based projects, since research shows the benefits of PBL[9,10] .
- Evaluate student performance on group-based projects.
- Survey students on perceived impact of group-based projects.
- Survey faculty on their perception of the impact of the group-based projects in the curriculum.
- Use statistical analysis techniques to analyze survey responses on expected outcomes.
- Compare outcomes with those reported in the literature and feedback results to improve the engineering program.
- Continue to work with the mathematics, physics, chemistry, biology departments and the other supporting areas in enhancing student competence in those areas.

Conclusion

Project-Based Learning (PBL) as applied in the engineering curriculum at BCU has been described in this paper. Owing to the reported student gains in PBL approaches described in the literature, the BCU engineering program is experimenting with PBL approaches at all levels in the engineering curriculum to see their impact on student intellectual development and retention. Enough data (quantitative and qualitative) has not yet been collected to yield conclusive comparison with similar data reported in the literature. Due to the small number of students in the BCU engineering program, it is planned to collect data on the BCU engineering program for the next several years to determine the trend of the impact of PBL-based curriculum on student intellectual development and retention in the environment of a small HBCU. The total student population of BCU is about 3000. Since the student profile of BCU is different from that of many other Universities, it would be interesting to compare the extent to which a PBL–based

curriculum impacts the students at BCU versus those at other institutions (minority and non-minority institutions) and what lessons can be learned for improving engineering programs.

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