The Evolution of a K – 12 Pre-College Program through Student Leadership Development

Myra W. Curtis, Clifton S. Martin, Carl White
Morgan State University

Abstract

This paper chronicles the evolution and development of the Morgan State University School of Engineering Saturday Academy. The Saturday Academy is coordinated and operated by the Engineering Student Organization Council (ESOC). ESOC was founded under the guidance of the Morgan ECSEL (Engineering Coalition of Schools for Excellence in Education and Leadership sponsored by NSF). ESOC is composed of executive board members from each of the student organizations in the School of Engineering. Through the operation of the Saturday Academy, the Morgan engineering students are able to develop their leadership skills while reaching out to mentor pre-college students. The objective of the Saturday Academy is to expose underrepresented pre-college students in the urban community of Baltimore City to a college campus, to student mentors with whom they can relate, and to learn how science, engineering and mathematics (SEM) relate to their everyday life. While these students participate in hands-on design projects, they learn how to work in teams. They attend classes that enhance their skills in mathematics as well as English, with a focus on critical thinking, writing and speaking skills. The paper describes the program, the leadership structure and the training/mentoring model that has resulted in the current program design and the expanded outreach effort.

Introduction

In the urban communities the underrepresented student is faced with roadblocks that can impede their educational development. These roadblocks include inadequate classroom environment, inadequate teacher preparation, inadequate educational tools, as well as any family economic and social barriers. Most of these students rarely break through these roadblocks successfully. Consequently, they do not reach their potential to achieve academically. This academic crisis for the underrepresented student is no more apparent than in the fields of SEM. According to the NSF, in 1993 only 6% of the science and engineering workforce in the United States were made up of African-Americans, Hispanics, and American Indians. African-Americans and Hispanics were each about 3% and American Indians were less than 1% of scientists and engineers. Yet, these three ethnic groups together, made up 23% of the total population in the United States.[1]

In a rush to expose the underrepresented student to SEM, many groups and organizations are ignoring the educational roadblocks when initiating SEM programs. Expectations of these groups and organizations assume that once the underrepresented student is exposed to SEM activities and projects, this will peak their interest to pursue higher education in SEM. This is true; but the underlying problem is not being addressed for these students. As Dr. Carl White stated at a Saturday Academy Partnership Workshop, "These groups are putting SEM careers in front of these students, yet they are not giving them the tools to actually participate in these

fields." The Morgan State University School of Engineering Saturday Academy, developed through the ECSEL Coalition, has evolved into a program that is trying to work through the roadblocks and make SEM undergraduate majors and careers viable alternatives for inner city youth.

ECSEL Coalition

ECSEL is a coalition of seven schools and colleges of engineering that entered into a cooperative agreement with the National Science Foundation, Engineering Education and Centers Division. Since its inception in October 1990, the ECSEL Coalition *(The City College of New York, Howard University, Massachusetts Institute of Technology, Morgan State University, The Pennsylvania State University, University of Maryland, and The University of Washington)* engaged in a ten-year effort to transform undergraduate engineering education and increase diversity of engineering graduates. The vision for achieving both of these goals has been the imaginative integration of design activities throughout the educational pathways of our students – including the K – 14 pipeline. Programmatic themes are "Learning by Design", "Our Role in the K – 14 Community", and "Student and Faculty Development."[2]

Morgan State University

Morgan State University is an historically black institution with the unique designation as Maryland's public urban university. Morgan's programs reflect the commitment of the university to have major impact on the underrepresentation of blacks and other minorities in the professional labor force within the city, state, and nation.[3] Morgan State University's various pre-college and outreach programs reinforce this commitment. Thus, the ECSEL "Learning by Design", "Our Role in the K – 14 Community" and "Student Development" programmatic themes were combined at Morgan to give focus to the urban community of pre-college students through the School of Engineering Saturday Academy. This ECSEL thrust supports the mission of the university and its commitment to community outreach.

Saturday Academy: Goals

One of the two major goals of the Morgan State University School of Engineering Saturday Academy is to involve engineering students in the planning, development and implementation of pre-college programs through collaborative decision making with other students, faculty and staff. ESOC, the Engineering Student Organization Council, was founded in 1995 under the guidance of the Morgan ECSEL. This council is composed of representatives from each of the engineering student organizations at Morgan: IEEE *(Institute of Electrical and Electronic Engineers)*, IIE *(Institute of Industrial Engineers)*, SWE *(Society of Women Engineers)*, NSBE *(National Society of Black Engineers)*, ASCE *(American Society of Civil Engineers)*, SAME *(Society of American Military Engineers)*, SAE *(Society of Automotive Engineers)*, NSPE *(National Society of Professional Engineers)*, and Tau Beta Pi *(Honor Society)*. The purpose of ESOC is to maintain a collaborative relationship among the engineering student organizations and to combine resources to promote a successful outreach program to the urban community. Through the guidance of the Morgan ECSEL, ESOC developed and coordinated the Morgan State University School of Engineering Saturday Academy.

The other major goal of the Morgan State University School of Engineering Saturday Academy is to enrich the academic pre-college experiences of underrepresented students. The Saturday Academy exposes students to a college campus, to student mentors with whom they can relate, and to the application of science, engineering and mathematics (SEM) to everyday life. While students participate in hands-on design projects, they learn how to work responsibly in teams, develop leadership skills, and learn about time management. They attend classes that enhance their skills in mathematics as well as English, with a focus on critical thinking, writing and speaking skills. Prior to the commencement of the Saturday Academy, there are two workshops: ECSEL Workshop for K – 12 Administrators; Teachers; Parents; and Students, and the Saturday Academy Orientation Workshop. These workshops are followed by the ten-week Saturday Academy sessions.

Saturday Academy: Components

ECSEL Workshops for K-12 Administrators, Teachers, Parents, and Students

A workshop is held for school administrators, teachers, counselors, parents and students to discuss the collaboration of increasing SEM awareness in the schools. These workshops continue to establish and strengthen partnerships between the K – 12 schools in the Baltimore community and the School of Engineering. The workshop focuses on the two major goals of the Saturday Academy and is conducted by the principal investigator, professional staff director, and student coodinators.

The first ECSEL workshop was held in December 1995. The goals of this workshop was to formally introduce ECSEL and the School of Engineering student leaders to the Baltimore City Public School System (BCPSS) and to establish a working relationship with the administrators and teachers. Administrators and teachers from 17 elementary, middle and senior high schools were invited to this first workshop. Eleven schools were represented: 4 middle schools and 7 high schools. An open discussion was held on ECSEL's "Role in the K – 14 Community". Each school was given a survey to complete, indicating its needs in science, mathematics and technology. Ten surveys were completed: 4 middle schools and 6 high schools. The schools indicated a need for tutors/mentors, big sister/little sister programs, career motivation/student shadowing, and engineering projects/activities. As a result of the responses from the surveys, the ESOC Committee initiated the *Saturday Academy, The Little Sister Day, and The Engineering Awareness Day for the 1995 –1996* academic year.

The second ECSEL workshop was held in December 1996. The objective of this meeting was to evaluate the support that was given to the K-12 students, parents, administrators, and teachers by ECSEL and ESOC during the 1995 – 1996 academic year. Student leaders gave presentations on the goals, objectives, and outcomes of the Saturday Academy, Engineering Awareness Day, and Little Sister Day. An open discussion was led on ECSEL's "Role in the K - 14 Community" for the 1996 – 1997 academic year. Each participant from an ECSEL sponsored program was given a project assessment form to complete. Representatives from 14 elementary, middle, and senior high schools were invited to the workshop. Nine schools were represented: 1 elementary school,

3 middle school, and 5 high schools. Each school was given a survey to complete, indicating its needs in science, mathematics and technology for the 1996 – 1997 academic year.

In January 1998 and January 1999 the third and fourth ECSEL Workshops were held with the same objective to evaluate the support that was given the K – 12 students, parents, administrators, and teachers by ECSEL and ESOC during the 1996 – 1997 and 1997 – 1998 academic years, respectively. Each school completed surveys indicating their needs in SEM. The future ESOC leaders attended the workshops. They listened attentively to the academic needs of the pre-college students. The growing ESOC leadership learned about the roadblocks: inadequate classroom environment, inadequate teacher preparation, inadequate educational tools, family economic and social barriers. They heard the plight of the teachers needing assistance in preparing their students for taking standardized tests, especially in mathematics.

On January 24, 2000 the fifth ECSEL Workshop was held. The previous ESOC leaders had graduated. The next ESOC leadership prepared a presentation on an infrastructure enhancement for the Saturday Academy and the new organization structure. This enhancement was well received by the teachers and parents and the student participants of the 1999 – 2000 Saturday Academy. The ECSEL Workshop for 1999 - 2000 was even renamed Saturday Academy Partnership Workshop. This workshop led the Saturday Academy from *linear program design model* to the *4-tier program design model*. These two models are described in the section on Parallel Development of Saturday Academy Program and Student Leadership Development

O*rientation Workshop/Student Assessment*

Through the cooperation of school administrators, teachers, counselors and parents, pre-college students are selected to attend the Saturday Academy program. On the first day of the academy a mandatory Orientation Workshop is held for the teachers, parents, and students that are participating in the academy. The workshop describes the overall program, the daily schedule, logistics, and policies and procedures. The workshop is conducted by the principal investigator, professional staff director, and student coodinators. After orientation, all participants take a pre-test in mathematics. The purpose of this test is to place each student in the appropriate mathematics class.

Engineering Awareness Day

ESOC held the Engineering Awareness Day on April 25, 1996. This program was implemented to expose youth between the ages of eleven and fourteen years of age, to the SEM fields. Sixty students from five Baltimore area middle schools were in attendance. The day's activities consisted of an engineering information session featuring Dr. Eugene DeLoatch, Dean of the School of Engineering, Dr. Carl White, and other members of the engineering faculty. During this session, the students were also informed about having leadership roles and the importance of following through with your responsibilities. Following the information session, the students were given a tour of the School of Engineering Laboratories, which included hands on demonstrations. At this time, the students were shown how the field of engineering impacts their everyday lives.

Little Sister Day

The goal of Little Sister Day was to introduce young women of all ages to a world with no boundaries, which includes the fields of SEM. On May 4, 1996, 75 female students between the ages of 10 and 14 from 4 local middle schools participated in Little Sister Day at the School of Engineering. Members of NSBE and SWE organized this special day for the middle school students. Representatives from Big Brothers - Big Sisters, Planned Parenthood, U.S. Naval Academy, MSU Career Development and the engineering faculty conducted workshops that included the following topics: *Soul Searching*, *Interviewing Techniques*, *Business Etiquette*, and *Women in Industry*. As a special treat, a drill team from the U.S. Naval Academy entertained the students.

Middle Passage Program

For the 1996 – 1997 and 1997 – 1998 academic years, ESOC eliminated the *Engineering Awareness Day* and the *Little Sister Day*. The Middle Passage program, a six-week program, developed by the Morgan NSBE Chapter, was implemented to provide a pathway for students in grades 6 and 7 to transition into pre-college programs while promoting SEM awareness. Fifteen students from Chinquapin Middle School were selected to participate in this program. The students were exposed to SEM careers through a variety of techniques. One such technique was to allow the students to interact with students from the SEM disciplines. The middle school students met with students from MSU School of Engineering and had an on site visitation with the students at the United States Naval Academy. Another technique was to expose the students to various design based competitions (i.e. air penny contest, egg drop competition, etc…). The students were also allowed the opportunity to interact with the Saturday Academy students, which fostered a relationship between the students of the two programs. Since both programs ran simultaneously, this gave the middle school students the opportunity to experience what they could be a part of in the future.

Saturday Academy: Curriculum

The Morgan State University School of Engineering Saturday Academy is divided into three major academic academies: elementary, middle, and high school. Each academic academy has its own curriculum.

Elementary School Academy Curriculum

Mathematics: Basic Mathematics / MSPAP Mathematics
Addition, Subtraction, Multiplication, Division, Fractions, Decimals
Language Arts: Basic Language Arts / MSPAP Reading, Writing, Language Usage
Spelling, Sentence Structure, Reading Comprehension, Public Speaking

Middle School Academy Curriculum

Mathematics: Review Basic Mathematics / MSPAP Mathematics
Maryland Functional Mathematics Test (MFMT)
Multiplication, Division, Fractions, Decimals, Pre-Algebra
Language Arts: Language Arts / MSPAP Reading, Writing, Language Usage

Maryland Functional Reading Test (MFRT)
Maryland Functional Writing Test (MFWT)
Writing Skills (Sentence Structure, Paragraph Structure, Short Story or Essay Structure), Reading Comprehension, Public Speaking

High School Academy Curriculum

Mathematics: Review Basic Mathematics
Maryland Functional Mathematics Test (MFMT)
SAT Prep
Pre-Algebra, Algebra, Geometry

Language Arts: Intermediate Language Arts
Maryland Functional Reading Test (MFRT)
Maryland Functional Writing Test (MFWT)
SAT Prep
Writing Skills (Sentence Structure, Paragraph Structure, Long Story or Essay Structure), Reading Comprehension, Public Speaking

All students have classes in computer science and a challenging hands-on engineering project.

Saturday Academy Schedule

09:30am – 10:00am General Assembly
10:00am – 11:00am Computer Science
11:00am – 12:00am Mathematics
12:00pm – 01:00pm Lunch
01:00pm – 02:00pm English
02:00pm – 03:00pm "Learning by Design" Activities / Projects

Parallel Development of Saturday Academy Program and Student Leadership Development

The Saturday Academy is coordinated and operated by the students of the School of Engineering. The current Saturday Academy program is a result of changes recommended by the student leaders as they assessed program outcomes through their integral involvement. By operating the Saturday Academy, the Morgan engineering students are able to develop their leadership skills while reaching out to mentor and tutor their younger peers. To develop student leadership skills, a structural model was developed for planning, design, and implementation of the Saturday Academy. This model was based on the principle of collaborative decision making between faculty, staff, and students. Table 1 describes the organizational structure, the target population and the program focus from 1995 – 2001 as it evolved as a result of student leadership.

	1995 - 1999	1999 - 2000	2000 – 2001
Organization Structure	_ Principal Investigator _ Professional staff director _ One student director (also a teacher) _ One student coordinator (also a teacher) _ Student teachers, tutors, mentors	_ Principal Investigator _ Professional staff director _ One evaluator (Graduate student) _ Three student coordinators for elementary, middle, and high school (also a teachers) _ Student teachers, tutors, mentors _ Volunteer school teachers	_ Principal Investigator _ Professional staff director _ One student director _ One evaluator (Graduate student) _ Three student coordinators for elementary, middle, and high school _ Three student co-coordinators (transition team) _ Student teachers, tutors, mentors _ Volunteer school teachers
Target Population	_ High school students _ Some middle school students added in 1997 _ Some elementary school students added in 1998	_ High school students _ Middle school students _ Elementary school students _ Parents	_ High school students _ Middle school students _ Elementary school students _ Parents
Program Focus	_ Engineering projects/activities for enrichment	_ Academic skill building _ Engineering projects/activities for enrichment	_ Academic skill building _ Engineering projects/activities for enrichment

Table 1. Evolution of Program Structure/Student Leadership Development

Saturday Academy Program Design, 1995 – 1999: Linear Model

From 1995 – 1999, the organizational structure of the Saturday Academy was a linear model. The student leaders administered and taught in the program with very little supervision from the principal investigator and the professional staff director. Initially the target population was high school students; but by 1997 some middle school students were included. The program focused on team-based engineering projects and activities.

The first Saturday Academy began on February 17, 1996 and ended on May 4, 1996 with the closing ceremony. Twenty-nine students from nine different high schools participated in the 4-hour 8-week program: one 9^{th} grader, fifteen 10^{th} graders, twelve 11^{th} graders and one 12^{th} grader. The students were not required to attend every Saturday. The ESOC students took into consideration time off for the BCPSS spring break and the Morgan State University spring break. The major "Learning by Design" project for the Saturday Academy participants was to design and build a functioning drawbridge to scale for competition. The students were divided into six groups, each consisting of representatives from each high school. In building the bridges, the

students were required to take force, momentum, landscape, automobile dimensions and other physical factors into consideration. To assist the students in understanding the required parameters, a civil engineering professor and his students were solicited. The participants were given six Saturdays, three hours per, to complete their projects. Several of the students were assigned an additional task. They were assigned the task of developing individual and academy web pages. These students were given electronic mail accounts, and trained on the internet. The training was provided by the MSU system administration team. This assignment gave students who would otherwise not have the opportunity to explore the World Wide Web, the opportunity to not only explore this environment, but also be a part of it.

During the course of the program the students were given tours and exposure to other colleges and universities including the University of Maryland at College Park, and the United States Naval Academy. Several of the students attended the National Society of Black Engineers Conference in Nashville, Tennessee. At this conference the students were exposed to over 100 engineering colleges and universities from throughout the country, 175 corporate representatives, in excess of 6000 college and high school students from across the United States. The participating students also attended the United States Black Engineer Conference (USBE) Pre-College Day. At this conference the students attended workshops, spoke to various corporate representatives, and college recruiters. They obtained valuable information on a range of subjects from financial aid, to preparing for college engineering programs, to what they could do as high school students to prepare for a career in engineering.

Results came almost instantaneously. At the onset of the program, approximately 15% of the students knew about the engineering profession, and had even considered engineering as a possible career option. At the end of the program the students were knowledgeable on at least one or two engineering disciplines, and about 70% of them had begun to consider the field of engineering as a viable option.

From 1995 –1999, an average of 30 – 50 pre-college students completed the program each year. Some students from previous years returned as participants. ESOC's goal in 1996 was to expose inner city high school sophomores and juniors to the field of engineering. By 1998, ESOC began accepting elementary, middle and high school freshmen, exposing them to SEM. Students who had no knowledge of engineering began to consider engineering as a possible career option. Several students entered Morgan and other higher education institutes to study engineering. Several of the middle school students enrolled into a high school whose primary focus is engineering. For the first four years of the Saturday Academy, ESOC exposed the participants to SEM through "Learning by Design" activities and projects.

Saturday Academy Program Design, 1999 – 2000: Four Tier Model

The current leadership structure of the Saturday Academy is composed of four tiers: 1) Principal Investigator, Program Director, Program Evaluator; 2) Elementary, Middle, and High School Coordinators; 3) English, Mathematics, Computer, SAT Prep Teachers; 4) WEB Page Developer and "Learning by Design" Project Coordinators. This staff includes one faculty, one administrative staff, twenty-one engineering students, and three public school teachers. The entire staff meets monthly and the first and second tiers meet weekly to exchange information on the effectiveness of

the program implementation, student progress and staff needs. This model of interaction among the tiers resulted in a cohesive team effort, constant evaluation of program strengths and weaknesses, and shared knowledge of participant needs. Moreover, this model was a result of the redesign of the Saturday Academy from the *Linear Model* to the *4-Tier Model.* Table 1 indicates the evolution of the Saturday Academy through student leadership development.

At the recommendation of the student leaders, an infrastructure enhancement for the Saturday Academy model was implemented in January 2000 to include an academic curriculum for high, middle, and elementary school students. The length of the program was increased. In addition, a coordinator was added for each school level and there was increased supervision and direction from the principal investigator and the professional staff director. Thus, the Saturday Academy became a ten-week program for elementary, middle, and high school students held for five hours on Saturdays during the second semester of the academic school year. The goals for this new Saturday Academy infrastructure is to increase student motivation and performance in SEM; increase parent participation and involvement in the development of SEM students; increase student performance in the classroom as well as on state performance tests such as the Maryland State Performance Assessment Program (MSPAP) and the Maryland Functional Test (MFT) in the areas of science, mathematics, reading and writing; and to prepare students with test-taking strategies for taking national normalized tests, i.e. the SAT.

For year 2000, 99 pre-college students completed the Saturday Academy: 49 elementary, 31 middle and 19 high school students. Another enhancement to this year's Saturday Academy was the involvement of parents learning about computer technology and making a commitment to keep their child enrolled in the Saturday Academy through the completion of high school, maintaining the pipeline to higher education. Twenty-five parents volunteered their services and learned a bit about computer technology. Three elementary school teachers also volunteered to teach and mentor.

Expansion of Saturday Academy to Community Based Organizations

On August 10, 2000, the School of Engineering Saturday Academy faculty, staff, and student leaders met with the Executive Director and staff of Payne Memorial Outreach, Inc. (PMO). The purpose of this meeting was to discuss the possibility of partnering with the MSU School of Engineering to establish a Saturday Academy model at the PMO facility. PMO, which was formed in 1993 to "educate, develop and strengthen" the church's community, is a nonprofit affiliate of Payne Memorial AME Church of Baltimore, MD. As a result of this meeting and subsequent meetings, PMO in partnership with the MSU School of Engineering had its Saturday Academy Opening Ceremony on October 20, 2000 and the Saturday Academy classes began on October 21, 2000 with 60 participants. Morgan State University School of Engineering provided the Saturday Academy model, the technology and the engineering students to serve as program coordinator and teachers (English, mathematics, and computer). Because of the success of the Morgan State University School of Engineering Saturday Academy and its expansion program at PMO, there are plans to further expand the Saturday Academy model.

Conclusion

Morgan State University's mission as an urban university coupled with the programmatic themes of the ECSEL Coalition, "Learning by Design", "Our Role in the K – 14 Community", and "Student and Faculty Development" was the catalyst for the development of the Saturday Academy through ESOC. The involvement of the students in the administration and implementation of the program resulted in increased leadership skills and an improved program for the participants. The present model has a training/mentoring component (co-coordinators) to ensure the continuation of the program. In addition the Saturday Academy has been adopted by community-based organizations.

Acknowledgements

We would like to thank the ECSEL Coalition and the National Science Foundation, Engineering Education and Centers Division for funding. We also would like to thank the ECSEL and ESOC students who worked so diligently in developing and coordinating the Saturday Academy, especially Quardre' Washington, Helen Ambrose Washingtion, Christopher Giusto and Ammyanna Williams.

Bibliography

1. Women, Minorities, and Persons with Disabilities in Science and Engineering: 1996, NSF 96-311, September 1996.

2. ECSEL Third-Year Progress Report, April 1, 1998.

3. Abridged version of Mission Statement as approved by the Maryland Higher Education Commission, June 27, 1990.

Biographical Information

MYRA W. CURTIS
Myra W. Curtis is the ECSEL Local Program Director at Morgan State University. Ms. Curtis received her B.S. degree in Mathematics from Morgan State University in 1970. Before joining the staff at Morgan, she spent twenty years in industry in designing, programming, and testing software systems on various platforms for the Department of Defense, National Aeronautics and Space Administration (NASA), and the Department of Transportation. She has taught mathematics and computer science in the public and private sector. Ms. Curtis works closely with the ECSEL student leaders in developing and coordinating the school of engineering pre-college and college programs.

CLIFTON S. MARTIN
Clifton S. Martin is a senior electrical engineering student at Morgan State University. Since 1998 he has been the current ECSEL student leader. As the ECSEL student leader he has been instrumental in the development and transformation of the school of engineering pre-college and college programs, i.e. the Saturday Academy and the PACE Program. He has received the 2001 U.S. Black Engineer of the Year Student Leadership Award and a citation from the Baltimore City Council for his student leadership with the Saturday Academy.

CARL WHITE

Carl White is Associate Professor of Electrical Engineering at Morgan State University. He received his B.S.E.E. in 1981 and M.S.E.E. in 1983 from Howard University. In 1988, he received his Ph.D. in Engineering from Cornell University. He is the Local Principal Investigator at Morgan for the ECSEL Coalition (Engineering Coalition of Schools for Excellence in Education and Leadership) and the Principal Investigator for the Pre-Freshman Accelerated Curriculum in Engineering (PACE) Program. It is his concept to develop the undergraduate student leadership skills through the development and coordination of the school of engineering pre-college and college programs. Dr. White is also the Director of the Morgan State University School of Engineering COMSARE (Center of Microwave, Satellite and RF Engineering) Laboratory.