A Pre–Engineering Program Using Robots to Attract Underrepresented High School and Community College Students

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Introduction

Robotics is a technology that is in high demand in the private, governmental, and military sectors. Many high-technology areas remain underrepresented, especially for African Americans. Engineering, like robotics, is another field where African American and other minorities (defined here as Hispanics and Native Americans) have been traditionally underrepresented (Lam, Doverspike, and Mawasha, 1997). National Science Foundation (NSF) data revealed that in 2000 only 7.5% of engineering and science technicians were African American (U.S. Census Bureau, 2005). This percentage is considerably lower than the 12.2% national population of African Americans (Conrad, 2006). To increase the number of African American technicians, more African Americans must be trained in emerging technologies such as robotics. In addition, the undergraduate engineering enrollment, retention, and success rate for African American students at community colleges and at four-year institutions must be significantly increased. Many underrepresented students have difficulties in taking technology courses because of limited math skills and limited knowledge in technology (Office of Institutional Research and Planning, 2006a).

Many colleges have responded to this problem by offering a variety of pre-engineering math and science programs in an effort to promote the pursuit of undergraduate STEM education. The objectives of these programs are to facilitate an increase in enrollment with concurrent retention of underrepresented students, defined here to include the following: (a) African American, (b) Hispanics, (c) Native American, and possibly (d) Asian-Pacific. In addition, those students who meet the federal income and/or first-generation college criteria (neither parent having earned a bachelor's degree) can participate in these pre-engineering math and science programs.

Other noteworthy goals for such projects include:

- Strengthen the self-confidence of under represented students
- Improve students' cognition via concrete hands-on labs
- Increase awareness of the student to pursue a career in STEM disciplines
- Provide pre-diagnostic testing in mathematics for potential college students so as to determine their deficiencies prior to their enrollment in college

Founded in 1947, Baltimore City Community College (BCCC) is currently celebrating its 60th anniversary. BCCC currently enrolls more than 12,000 credit and non-credit students in three main locations and in more than 80 off-campus learning sites at churches, community centers, schools, and businesses. BCCC currently enrolls 30% of the Baltimore City Public School System graduates (more than any other Maryland college or university). Ninety percent of BCCC's student body is African American (Office of Institutional Research and Planning, 2006b and Maryland Association of Community Colleges, 2007). In 2007, BCCC, Morgan State University (MSU), and Pace University were awarded an NSF grant to establish a 36-month Robotics Technician Curriculum (RTC). The RTC will be designed to do the following:

- Increase the technical proficiency of underrepresented and disadvantaged students from BCCC significantly
- Facilitate a 4-year career pathway option to MSU
- Involve an information technology and robotics employer relationship with Juxtopia, LLC

In addition, BCCC RTC graduates will be prepared for employment with both private and government employers (e.g., Lockheed Martin, Ft. Meade, Aberdeen Proving Grounds, and so forth).

The purpose of this paper is to describe this unique and innovative pre-college curriculum that uses robotics within its engineering courses to improve the STEM educational process for 9th- through 12th-grade students. This pa-

Abstract

This paper gives an overview of a new pre-engineering program—Robotics Technician Curriculum—that uses robots to solicit underrepresented students pursuing careers in science, technology, engineering, and mathematics (STEM). The curriculum uses a project-based learning environment, which consists of part lecture and part laboratory. This program at Baltimore City Community College is offered in collaboration with Pace University and Morgan State University. The effectiveness of the program over time will be measured from the survey responses from the students and by external evaluators, peer evaluation, evaluation of projects, and analysis of enrollment data. The assessment strategies are described and its implementation is discussed in this paper. This program serves as a model and a STEM approach is valuable in preparing students for STEM careers.

Index Terms
CADD, computer information systems, collaboration skills, education, electronics, programming, LEGO Mindstorms, robot, robotics, technical programs, Tetrix, training

per provides an overview of this program that will help to attract underrepresented students to the STEM field of study in college. The assessment of the program will be evaluated by using the following information:

- Average high school grade-point average both before and after participating in the RTC program
- High school math and science achievements
- Retention rate for students returning from the previous year
- Percentage of students committed to STEM upon graduation

Problem Solving Using LEGOs at Pace University

Problem Solving Using LEGOs is an introductory robot-based design course that not only extends efforts in the field of computing and robotics but also serves the community by establishing robotics clubs in middle schools and high schools located in New York City and Westchester County. The courses objectives are as follows:

- The course exposes college students to the excitement, spirit, and intellectual substance of the physical sciences and engineering through hands-on robotic design projects.
- The course encourages explorations spanning a wide range of disciplines including physics, computer science, mathematics, biology, engineering, and art. The course is accessible to all college students with only the university-wide course Introduction to Computing as a prerequisite.
- The course has a civic engagement component that uses the pedagogy of community-based learning to connect students to their local community and to sensitize them to the challenges of problem solving.
- Students are expected to demonstrate abstract robotic concepts acquired through concrete hands-on robotic manipulation by mentoring in middle school or high school LEGO clubs.
- Students of the course will provide individual instructor training for those teachers who want to become coaches and to create a LEGO club at their middle school or high school. In addition, students will prepare educational DVDs to complement their instruction.

The Seidenberg School of Computer Science and Information Systems (CSIS) offered the course as a pilot for the first time in fall 2005. (Mosley and Doswell, 2006) Almost all of the assignments and activities in the course, both in Pace University classrooms and in middle schools or high schools, are team-based. This structure challenges groups to work together to attain the common goal of each individual project, while respecting individual contributions and differences of opinion. Participants of this course develop stronger skills in logical thinking, critical analysis, working effectively in teams, and oral presentation. In addition, students gain an understanding of the value of community service, and they gain general interest in science and technology.

The course content was based on the LEGO Mindstorms robotics technology product, which was designed for individuals age 9 and up. This equipment lets young students learn concepts of robotics technology and computer programming in a fun and engaging environment. For college-age students targeted by the course, the robotics set design lets Pace University students of any major learn the basics of using the material quickly. Middle schools and high schools that participate in the course are given assistance in forming LEGO clubs and information on entering the first LEGO League tournament. This tournament is an international competition whose regional tournament is hosted each year by Pace University. RobotC developed by Carnegie Mellon University Robotics Academy is being used in K-12/community college/university curriculums. RobotC is an ideal application to introduce basic programming skills to students at various levels. RobotC is currently used in Computer Science 1 and RBT 101 Introduction to Robotics at Baltimore City Community College. Significant improvement on the grasp of functions, loops, and other basic programming skills has been discovered.

Pedagogy and Practice

Introducing students to robotics for the first time is extremely challenging. This initial stage exposes students to basic engineering concepts, mechanical designs, and introductory programming skills (Mosley and Doswell, 2008). Because students are pliable at this initial stage, they need to be immersed in a learning environment that addresses all these skills. To reinforce the material, it is necessary to complement classroom lectures with hands-on laboratory exercises. However, providing robot hardware to a large group of students may be cost prohibitive. It is also time intensive because of the time needed to learn programming
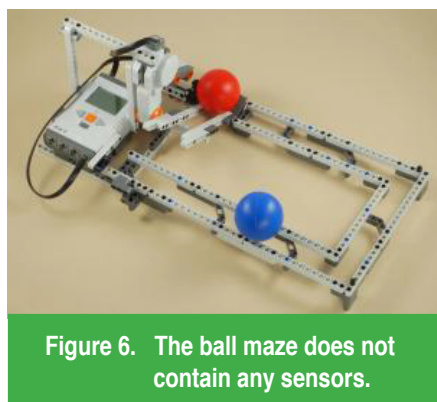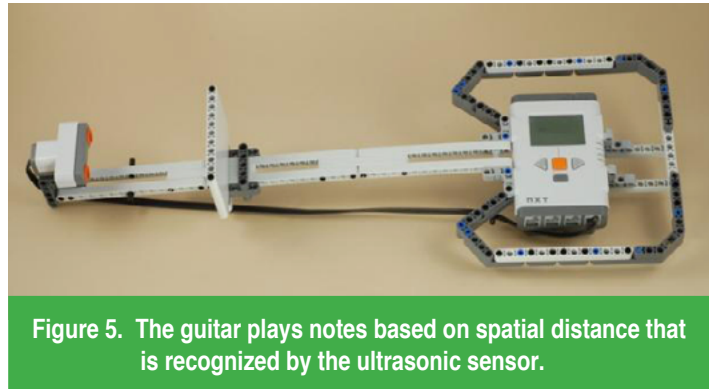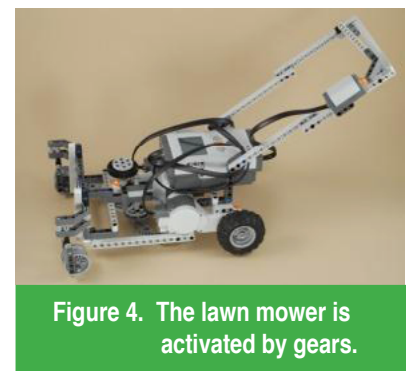
and design techniques.

In spite of these hurdles, using robotics is proving to be well worth the investment. Through series of research and educational practices, robotics provides students with the opportunity to test the results of abstract design concepts through concrete, hands-on robotic manipulation (Druin and Hendler, 2000). Using robotics requires a conceptual shift away from learning from technology toward learning with the technology that is consistent with the "Mindtools" approach to problem-solving advocated by Jonassen (2000). In this learning environment, students often discover they need to learn new knowledge and to continuously revise existing knowledge before they can begin solving problems.

Dr. Mosley, developer of the Problem Solving Using LEGO course at Pace University will assist BCCC and MSU in the development of their robotic courses for the RTC program. All robotic courses will consist of two parallel instructional components, lecture, and open laboratory. The lecture portion of the course will meet once a week. Lectures are typically 30 to 40 minutes long and include an in-class activity. The laboratory portion of the class will meet once a week for 30 to 40 minutes also. Students are placed into groups of three or four students depending on class size, and each group is given a LEGO kit. Several of the robotic courses use the Mindstorms NXT kit (refer to Figure 1a), and the other robotic courses use the LEGO Tetrix kit (refer to Figure 1b).

Two members of the group are responsible for constructing the robot and the other two members are responsible for programming the robot. Roles are rotated among the group members such that all parties have the opportunity to learn each phrase of robotic construction and assembly. This informal environment provides students with hands-on experience with building and programming robots.

The laboratory sessions will enable students to explore robotics concepts and apply what is presented in the lectures. Students are expected to build new robots from scratch for each assignment and to produce a new mechanical design to complement the software they will write. Thus, students will acquire hands-on experience with building and programming robots in an informal environment. Many of the courses consist of five to six laboratory exercises. The number of sessions needed to complete each lab will vary based on the skill sets of the students and the complexity of the labs.

The RBT 101 Fundamentals of Robotics

(a) Mindstorms NXT Kit   (b) Tetrix Robot Kit

Figure 1. Two kits used in robotics courses.

Figure 3. The puppy walks and barks.

Figure 4. The lawn mower is activated by gears.

Figure 5. The guitar plays notes based on spatial distance that is recognized by the ultrasonic sensor.

Figure 6.   The ball maze does not contain any sensors.

Figure 7. The Alpha Rex is the most complex project because it uses all the sensors.

class has five lab exercises designed to be fun while challenging the students to think as a team and to develop solutions. Table 1 depicts all of the labs covered in this course. Figure 3 through Figure 7 depict a sampling of sensors projects students may want to construct.

RTC at Baltimore City Community College

The pre-engineering program entitled The Robotics Technician Curriculum enables students to have the opportunity to experience a real-world project. All robotics courses are designed to expose BCCC students to real-world practices with emphases on four critical components: Component Design, Simulation, Fabrica-

tion/Assembly, and Field Test.

The goal of this curriculum is to build a rewarding career in the high-tech field of robotics with the expertise in all aspects of robotics. The emphasis of the curriculum is on the basic technology used in robotics including but not limited to programmable logic controllers (PLC), hydraulics, pneumatics, electronics, programming, and actuation. Students will learn about robot construction and several LEGO Mindstorms robots will be designed, simulated, fabricated, and tested.

The RTC is a 2-year program in which graduates will be awarded an Associate Degree in Applied Science (AAS).

Lab	Title	Objectives
1	Skyscraper	• To become familiarized with the LEGO pieces and its functionality. • To learn the names of the assorted building elements. • To investigate the various ways in which the elements can be combined.
2	Car Racing	• To construct a chassis using plates, beams, and connectors. • To become familiarized with gears and gear ratios. • To understand the relationship between gears and motors in regards to acceleration.
3	Sensor Projects	• To become acquainted with the light and touch sensors. • To learn the advantages of sensors.
4	Leaky Pipes	• To develop a solution using all the skill sets covered in class. • To learn untaught skills and troubleshoot issues as they arise
5	Building Inspection	• To develop a solution using all the skill sets covered in class. • To learn untaught skills and troubleshoot issues as they arise

Table 1. Lab Exercises for RBT 101 Fundamentals of Robots

Courses will provide students with a thorough understanding of theory together with hands-on laboratory experience. This curriculum will let a student graduate either as a robotics technician after 2 years at BCCC or to continue at MSU for additional studies and a bachelor's degree. The proposed RTC will be supported academically by BCCC's Engineering Transfer Program, Electronics Program, CIS Program, and CADD Program.

The curriculum design is detailed in Table 2

Semester	Course Code	Course Name	Credits
Semester 1	ELC 190	Electric Circuits	4
	EGN 101	Engineering Graphics	3
	MAT 107	Technical Mathematics	4
	PRE-100	Preparation for Academic Achievement	1
	SOC 101	Social and Behavioral Science Requirement	3
Semester 2	ELC 191	Semiconductors	3
	ELC 192	Digital Electronics	3
	RBT 101	Fundamentals of Robotics	3
	RBT 110	Fluid Power and Components (New Course)	3
	PHY 101	College Physics I (New Course)	4
Semester 3	RBT 201	Robotics Applications (New Course)	4
	RBT 205	Robotics Simulation (New Course)	3
	SP 101	Fundamentals of Speech	3
	ELC 290	Electromechanical Devices	3
	ENG 101	English Composition	3
Semester 4	RBT 202	Robotics Work Cell (New Course)	3
	RBT 204	Programmable Logic Controllers (New Course)	3
	RBT 203		3
	ELC 291	Computer-Assisted Manufacturing (CAM) (New Course)	4
	HLF 205	CET Preparatory 4	3
		Interdisciplinary and Emerging Issues Elective	

Table 2   Robotics Technician Curriculum Design

Note. Total 63 credits.

If students want to transfer to MSU to pursue BS degree, they will take Math 128 (Pre-Calculus I) instead of MAT 107,. Then, they will take Math 129 (Pre-Calculus II) in the following semester or summer.]

and the course descriptions are given in Table 3. Five robotics-related courses will be developed specially for BCCC RTC graduates. By finishing all other required math and engineering courses plus these five courses at MSU, BCCC RTC graduates can earn a MSU bach-

Course Title	Credits	Course Description
RBT 101Fundamentals of Robotics	3	The topics covered in this course will include: motion of rigid body, mechanical system of robots, electromechanical system of robots, control system of robots, information system of robots, visual sensory system of robots, visual perception system of robots, and decision-making system of robots. Prerequisites: ELC190 and EGN 101, and the course is to be taken concurrently with ELC191 and ELC192.
RBT 110 Fluid Power and components	3	This course provides, through lecture and laboratory experiences, knowledge about fluid power industrial components and systems. The course covers: the fundamentals of fluid power operation, properties and types of five fluids, conductors, contamination control, function and construction, and operation of pumps, motors, cylinders, valves, and system accessories. Prerequisite: MAT 107.
RBT 205 Robotics Simulation	3	This course will be conducted with lectures and laboratory experiences. The course will cover the following topics: importance of robotics simulation, simulation and reality, drawbacks of simulation, and advantages of simulation. The software used in the lab will be Microsoft Robotics Studio Simulation. Prerequisite: RBT 101.
RBT 201 Robot Applications	4	The student will be instructed through the use of industrial quality laboratory equipment, computer software, videos, written text and laboratory activities on the basics of robotic applications. These applications include the operation and programming of robots, material transfer, machine tending, quality control, and the interfacing of supporting equipment. Prerequisite: RBT 101.
RBT 204 Programmable Logic Controllers	3	This course will provide students with knowledge of general PLC issues and teach students to write simple ladder logic programs. The topics will include: PLC history, ladder logic and relays, PLC programming, PLC operation, and PLC practices. Prerequisites: ELC 190, 191, and 290.
RBT 203 Computer-Assisted Manufacturing	3	This course will be conducted at both BCCC's Robotics Laboratory and at MSU's Industrial Manufacturing Center. The topics covered will be: early use of CAM, historical shorting comings, current CAM solutions, machining process, and CAM software. Prerequisite: None.
RBT 202 Robotics Work Cells	3	The student will learn how to set up work cells through the use of industrial quality laboratory equipment, computer software, written text, and laboratory activities. The student will also learn how to program a robotic work cell to maintain production control, and how to program offline using Robot Simulation Software. Further, the student will learn the fundamentals of motors and motor controls including DC, split phase, and three-phase motors as well as motor controls including reversing circuitry. Prerequisites: RBT 205 and ELC 290.

Table 3.   Robotics Technician Course Descriptions

elor's degree in industrial, manufacturing, and information engineering. The proposed five courses are listed as follows:

- IEGR 299 - Robotics Fundamentals (3 credits)
- IEGR 298 - General Robotics (3 credits)
- IEGR 297 - Robotics Programming (3 credits)
- IEGR 488 - Robotics Senior Project I (3 credits
- IEGR 499 - Robotics Senior Project II (3 credits)

The above courses are the core courses of technicians' programs at BCCC. Currently, only 75% of the students pass these key courses. To increase students' success rate in these courses, robots will be considered as a virtual instructor enabled, mixed reality learning intervention. Researchers believe that this approach will revolutionize the way STEM skills are taught (Office of Institutional Research and Planning, 2006a). In each of the above classes, either developed construction robots or LEGO Mindstorm robots will be used as an assistant or tool to teach students. Each student will be assigned a class robot project related to one or more following subjects: experimentation, problem solving, principles of programming, mechanical design, microcontroller, electronics communication between chips and actuators, and feedback systems. The head mounted displays provided by Juxtopia and Pace University can also be used for students in electronics, CIS, and CADD programs. Students can use speech commands to request instruction on various concepts in certain subjects that need to be addressed or repeated. This instructional design can measure, in real time, the learning performance of each individual learner while they are in class.

Participants

The pre-engineering target groups are students from the 11th and 12th grades participating in Academic Achievement Programs. A profile of the participating Baltimore City Public Schools is provided in Table 4. Approximately, 70 students are selected for the program at the beginning of September 2009. To be accepted in to the Pre-Engineering Program, prospective students are:

- Required to have a 2.5 grade point average or higher
- Attend a robotic seminar with their parents
- Interview with the program director

Students will be encouraged to work hard in all their courses and to maintain a minimum 2.5 GPA. Failure to maintain the minimum GPA results in the student being removed from the program. Any student removed from the program will be replaced by another student chosen through the high school teacher's recommendation.

The participants for this curriculum will follow a 2+3+3 model. This model has a career ladder with 2 years (11th and 12th grades) at Baltimore City Public School System (BCPSS) high schools, 2 years at BCCC, and 3 years at MSU School of Engineering, leading to a bachelor's degree.

This collaborative curriculum will provide robotics technology case studies and hands-on laboratory experience to students in Baltimore City. The curriculum will train students to use, manufacture, test, evaluate, and repair robots. The basics of robotics will be introduced systematically in BCPSS high schools. Those concepts will then be re-introduced and reinforced in successive courses at BCCC and MSU. In addition, the program includes a robotics career pathway to MSU, Department of Industrial,

Participating High School	Total Students	Male	Female	African American	Asian	Hispanics	White
Patterson High School	10	5	5	10	0	0	0
Merganthaler Vocational High School	10	5	5	10	0	0	0

Table 4. High School Student Profile

Manufacturing, and Information Engineering. Students upon successful completion of the 2-year Robotics Technician Program are eligible to apply to MSU and to pursue a bachelor's degree.

Robotics Seminars for 11th- And 12th-Graders at BCPSS and College Prep

Robotics seminars targeted to 11th- and 12th-graders will be held at two BCPSS high schools in the fall semester. The high schools will be selected with the input of the area high school administrators of the BCPSS. The seminars will focus on what robotics is, how much a robotics technician or engineer can expect to earn, and the educational requirements to become a robotics technician or robotics engineer. These seminars will market robotics as a profession to underrepresented students. During the spring and summer semester (after the seminars are conducted), a minimum of 20 underrepresented 11th- and 12th-graders with interests in robotics (per information provided to high school guidance counselors) will be selected from the five targeted high schools.

These students will take an Algebra Review and Accuplacer1 Placement Test Preparation course taught by BCCC mathematics faculty. This course will be designed with the consideration of the following aspects: high school environment, high school student learning style, and continuation of the mathematics courses taken in 11th grade. This course will smooth the transition for underrepresented students from the BCPSS to BCCC by improving their Accuplacer Placement test scores by at least 30%. This improvement will eliminate the need for remedial or development courses (that will lengthen the time to complete the robotics technician program).

Proposed Assessment Plan

Traditionally, assessment is used for measuring learner success rather than to bring about that success. Instructors instruct, give an exam, assess and grade the papers, and then disseminate the results to students. The students may compare their results with other students and those who did well are motivated and those who did not do well are usually unhappy. Assessment under this methodology has very little to do with learning. Instead, it is more of measuring tool for the instructor rather than for the student. Another problem with this method is that it is part of top-down, teacher-centered process that does not serve to help students become problem solvers, nor does it allow stu-

dents to use their programming skills as learning tools. Students don't really learn what they did wrong nor does the instructor really know where the cognitive learning gaps exist for each student.

We have incorporated the assessment of student learning in every robotic course. Assessment methods used for this program will be: student's surveys, external evaluators, peer evaluation, evaluation of projects, and analysis of enrollment data.

Students are responsible for their learning from the first day of class. The syllabi list specific learning activities, its purpose, and the due dates. Empowering students with this information early on in the semester enables them to schedule their personal lives around their lives as members of the class. Each session is structured so that students must prepare themselves for each class session, participate in that session, and evaluate their overall performance or risk being left behind. Starting in the fall semester of 2009, all RTC students will have completed an attitude survey (shown in the Appendix). The objective of this questionnaire will be to collect measures such as background information, the student's current experience with engineering, and their overall attitude towards engineering as a profession.

External evaluators from the NSF grant will conduct several group meeting with the students enrolled in the RTC program. In these meetings, the evaluator will interview the students to generate feedback about the course and their learning experience. The evaluator will also audit a lecture and provide feedback on the instructor's strengths and weaknesses.

Another key component to assessment is peer evaluation and assessment of student robotic assembly after the robot operates through one cycle. Students will be taught how to evaluate. They must know that they are not troubleshooters. Instead, they are measuring each other's work based on the criteria they have selected as appropriate. Students have to be convinced that they are knowledgeable enough to evaluate. Often, students know when they have not done what has been asked of them. They understand how their work did or did not measure up to the criteria they set for themselves. Requiring students to go a step beyond helps them make the necessary connections to the activity and the learning objectives. This approach sheds light on what they did wrong and how to correct it.

The final assessment tool that will be used to measure the performance of this model will

be the success rate. The success rate will be defined as the ratio of students receiving a C or better grade to the total number of students enrolled (A+B+C/Total). The drop-out rate is defined as the number of students who dropped the course sometime during the semester divided by the total number of students enrolled. From an engineering viewpoint, the success rate is a measure of the quality of the product (the students), and the dropout-out rate is a measure of the robustness of the process (the course).

This assessment plan supports a more responsive role of formative assessment. Using liberatory pedagogy as a supporting theory, this assessment strategy fosters dialogue between the student and instructor and lets the student retain an active role in his or her learning process.

Conclusion

The goal of establishing and implementing the RTC pre-college program is to improve the learning opportunities for high school students and to motivate them to seek STEM careers and majors. The authors hope that the pre-visit robotic activities will help the students obtain a basic knowledge of robots and to generate excitement in these talented students such that they will enroll in math and science classes. The ultimate goal is to increase the numbers and proportion of underrepresented students in STEM majors and careers.

Acknowledgments

References

Conrad, C. A. (2006). Final report, African Americans and high-tech jobs: Trends and disparities in 25 cities. Joint Center Board of Governors.

Doswell, J. (1999). Internet-based virtual reality for math instruction. Paper presented at The Society of Applied Learning and Technology (SALT) conference in Arlington, VA.

Doswell, J., Mosley, P. (2007, June). A virtual instructor service-oriented architecture for teaching robotics in mixed reality. *Journal of Computers*, 2 (4), 17–22.

Druin, A., Hendler, J. (2000). Robots for kids: Exploring new technologies for learning. San Diego, CA: Academic Press.

Lam, P., Doverspike, D., and Mawasha, P.R. (1997). Increasing diversity in engineering academies (IDEAs): Development of a program for improving African American representation. *Journal of Career Development,* 24, 55–79.

Jonassen, D. H. (2000). Computers as mindtools for schools: Engaging critical things (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Office of Institutional Research and Planning, Baltimore City Community College (2006a, October). Graduation and Employment Rate of BCCC Students. *BCCC Institutional Report 2006.*

Office of Institutional Research and Planning, Baltimore City Community College (2006b, October). Preliminary opening fall headcount by program. *BCCC Institutional Report 2006.*

Maryland Association of Community Colleges (2007). Enrollment Data Book. Retrieved, 2007, from http://www.mdacc.org/publications/Databook07/Enrollment%20FY%20 2007.pdf.

Mosley, P., and Jayfus T. Doswell. The Virtual Instructor Intervention: A Case in LEGO Robotics. *The International Journal of Virtual Reality, 2008*, 7(1):15-20

Mosley, P., and Richard Kline. Engaging Students: A Framework Using LEGO Robotics to Teach Problem Solving. Information Technology, Learning and Performance Journal, 2006, 39-45.

U.S. Census Bureau (2005). Percent of the total population who are Black or African American alone. *Race and Ethnicity*, M0202. Retrieved from http://www.census.gov.

Appendix

Pre-Survey of Student Perceptions

Name: _____

Major: _____

Age: _____

Use the Likert scale for all the questions below (1-Low, 5-High)

1. Do you feel that your high school math courses prepared you well for the undergraduate engineering program?
2. On a scale of 1 to 5, compared to other college-bound students in your high school's math and science courses, rate yourself on each of the following traits:

_____ Mathematical abilities

_____ Oral skills

_____ Competitiveness

_____ Leadership abilities

_____ Problem-solving skills

_____ Computer skills

_____ Self-esteem

_____ The ability to work in a group or team

_____ The ability to work alone

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Yun Liu is currently an Associate Professor in Mathematics and Engineering at Baltimore City Community College (BCCC). He holds a Doctor of Engineering degree from Morgan State University and two Master Degrees in Engineering and Computer Science from Morgan State University and University of Northern Virginia respectively. He holds a Bachelor of Science Degree in Mechanical Engineering from Huazhong University of Science and Technology in Wuhan, China. He has extensive experiences in teaching mathematics, engineering and robotics. Before his teaching assignment at BCCC, he worked as a researcher and an engineer in power generation, energy and environmental protection fields.

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