

# Work-in-Progress - A Program for Improving Student Preparedness for College

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**Abstract** - The shortage of STEM graduates in the United States has been the focus of numerous recent reports and various studies have been undertaken to determine ways to address this issue. A major concern is that engineering graduation rates in U.S. colleges and universities are low. Data compiled by the American College Testing demonstrates that the mean for the National 5-year graduation rate of 4-year public institutions is 37.9%, while the overall four-year engineering graduation rate is 22% in public schools and 45% in private schools. The rate varies greatly from one institution to another. At the University of Texas at Austin for example, the rate was 31% in 2012, while it was 51.5% at Texas A&M University and 66% at Santa Clara University in 2010. While there are many causes that result in low graduation rates, it is more likely that rates could be improved if students are well-prepared for college and have clear goals. This paper describes a two-week summer enrichment program that focuses on improving student preparedness for college, while promoting active learning through hands-on experiences and activities. Students will be introduced to various science and engineering disciplines through hands-on activities that include topics in chemistry, biology, physics, mathematics, computer science, electrical engineering, civil engineering, and mechanical engineering. The program also includes two field-trips where students tour local laboratories and manufacturing plants. This paper presents planning details and progress to date.

*Index Terms* – High school students, Enrichment program, Preparing for college, Engineering retention.

## INTRODUCTION

To improve retention and graduation rates, many universities are implementing programs that employ several high impact retention approaches, including advising, mentoring, active learning, student engagement, and support services [1-9]. Any of these activities help to retain women in engineering. This is important as it is well-known that female students disproportionately switch majors out of engineering [10, 11].

The summer enrichment program described in this paper offers high school students the opportunity to participate in hands-on science, technology, engineering, and mathematics activities delivered by university faculty and laboratory personnel. It is believed that exposing young students to engineering concepts, opportunities, and career prospects, would enhance their interest in engineering education, and influence them to choose programs in engineering after graduation from high school [12].

Engagement in STEM subjects during high school can be sparked by lessons that include concepts from the real world and fantasy. In this program, robots and multi-dimensional worlds bring science and math to life. This is not only more likely to encourage student interest in STEM subjects but research shows [11, 13] that female students connect to educational subject matter that is relevant to their lives rather than abstract concepts that seem untouchable. During the two-week program students will work with the laboratory instruments and equipment while planning a final presentation to implicitly teach the importance of writing and presentation skills. Engineering laboratory experience plays an important role in determining the future of engineers. This role is emphasized greatly in the discipline and activities embedded in the program.

## PROGRAM DETAILS

The program consists of a two-week workshop that will be held on the Campus of Penn State Harrisburg from June 13 to June 24, 2016. A program website [14], program flier, application materials, and conducting visits to high schools in the area were used to recruit students. The application form requires basic contact and school information and a 300-500 word essay explaining why the student is interested in the program.

Program sessions are scheduled from 9:00 am to 4:00 pm on Monday thru Friday. Student presentations and the awarding of certificates of completion are on the last day, Friday, June 24, 2016.

The workshop is open to 10<sup>th</sup> and 11<sup>th</sup> graders and designed to improve students' knowledge through hands-on activities in a variety of STEM areas, including:

## Session T2A

- mathematics
- computer science
- chemistry
- biology
- civil engineering
- mechanical engineering
- electrical engineering
- physics

There is no cost to the students for this day program.

### Activities and benefits to participants:

- Two field trips, a tour of several university facilities, demonstrations, hands-on experimentation, and learning how to do prepare effective scientific oral presentations.
- Workshop sessions will be conducted by discipline-specific instructors with emphasis on critical thinking and problem-solving skills. Students will see for themselves in hands-on laboratory exercises that demonstrate how science and engineering devices work.
- Students who complete the summer workshops will receive a certificate of accomplishment and an invitation to the School of Science, Engineering, and Technology Capstone Design Conference which is held in May of each year.
- Students will receive supplies and training material.
- Free lunch and snack breaks.
- Transportation for field trips is provided, but note that transportation to/from STEM-SEP each day is the responsibility of the student.

### PROGRAM ACTIVITIES

Activities of the two-week workshop are listed in Table 1.

TABLE I  
PROGRAM ACTIVITIES

#### (a) WEEK 1 ACTIVITIES

Day	Morning Session	Afternoon Session
1	Registration/Welcome Pre-test/Tour of facilities	Math applications 1
2	Math applications 2	Physics applications
3	Chemistry applications	Field trip 1
4	Biology 1	Biology 2
5	Computer science 1	Computer science 2

#### (b) WEEK 2 ACTIVITIES

Day	Morning Session	Afternoon Session
1	Civil engineering 1	Civil engineering 2
2	Electrical engineering 1	Electrical engineering 2
3	Mechanical engineering 1	Mechanical engineering 2
4	Field trip 2	College admission process
5	Finalize presentation	Presentations/Awards

### Session Descriptions

#### Biology

- CSI (Crime Scene Investigation): Participate in an exciting laboratory-based scientific investigation including state-of-the-art DNA profiling as done in real-world forensic science labs.
- Explore Nature's Pharmacy through a Taste, Touch, and Feel experience.

#### Chemistry

- What are Polymers? Where can we find them? Synthesize gloop, extract DNA, breakdown carbohydrates and study Styrofoam.

#### Civil Engineering

- The Past, Present, and Future of Construction Materials: learn how materials have changed and test them yourself. Think the General Motor's commercial "It's not your father's Oldsmobile."
- Build-A-Bridge: a friendly competition to design and build a bridge.

#### Computer Science

- Create bots in a video game while learning the basics of Java programming. Your creation will compete against the other students' bots in a Bot!Battle! tournament.

#### Electrical Engineering

- Learn to solder and build a light-seeking robot.
- Once it is working, you are free to modify your robot for better performance.
- You get to keep the robot at the end of the session.

#### Mathematics

- Cryptography: Learn how experts send messages and information securely, even when they know people are listening.
- Explore a hyperspace world with four spatial dimensions and build your own hypercube.

#### Mechanical Engineering

- Create your own airplane and see how far it can fly. Compete against other teams of students to determine who can create the best airplane design.
- Dive into 3D printing! Turn your engineering designs into real objects with just the click of a button.

### Physics

- Investigate energy! Start by studying the physics of light, heat, and flight through experiment. End by designing a solar-cell powered model car.

During the sessions the students will be assisted by undergraduate STEM students, male and female, that will circulate to make ensure a positive collegial atmosphere and to teach as needed.

Results to date: Recruitment resulted in a group of 29 students (10 female and 19 male). While the laboratories can accommodate up to 32, we are satisfied with this first-year group of high motivated individuals as indicated by the 300-500 word essay submitted in the application.

### CONCLUSION

This summer enrichment program has been designed to use active learning to promote interest in STEM subjects and demonstrate to the students how these fields intersect with future careers they could pursue and even their current daily lives. It has also brought together a group of educators that can work together across disciplines to improve the math and science basics that many students struggle with in the first year of engineering classes in college.

### ACKNOWLEDGMENT

This program is partially funded by a grant from ArcelorMittal. The authors would like to thank all instructors and professionals who contributed to the delivery of the sessions and activities, including Dr. Justin Keller (mathematics), Dr. Peggy Ankney (physics), Mr. Thomas Kell (chemistry), Dr. Sairam Rudrabhatla (biology), Dr. Jeremy Blum (computer science), Dr. Shashi Marikunte (civil engineering), Dr. Seth Wolpert (electrical engineering), Drs. Brian Maicke and Ola Rashwan (mechanical engineering), Ms. Barbara Thompson (Office of Multicultural Recruitment and Community Affairs), Dave Wirick (Arcelor Mittal), and Dr. Deep Tewari (The Pennsylvania Veterinary Laboratory). The authors also extend their thanks to Ms. Lori Ricard and Ms. Alison Smolinski (school of science, engineering, and technology), Dr. Catherine Rios (school of humanities), and Ms. Marissa Hoover (development and alumni relations) for their support and invaluable contributions.

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