GC 2008-221: INCREASING AWARENESS OF ENGINEERING DISCIPLINES IN HIGH-SCHOOL STUDENTS THROUGH A PRE-COLLEGE PROGRAM

Anoop Ramakrishna, Wright State University
Anoop H. Ramakrishna received his Bachelors Degree in Electronics and communication from Visveswaraih Technological University, India in 2007. He is currently pursuing his Masters Degree in the Department of Computer Engineering at Wright State University, Dayton, Ohio. His research interests include Embedded Systems, VLSI Systems and Applications of Radio Frequency Identification Devices.

Kumar Yelamarthi, Central Michigan University
Kumar Yelamarthi received his Ph.D. degree from Wright State University in 2008, in electrical engineering. He is currently an Assistant Professor of Electrical Engineering at Central Michigan University. His research interest is in the area of timing optimization, computer-aided design, semiconductor process variations, multi-disciplinary VLSI design, and engineering education. He has served as a technical reviewer for several IEEE/ASME/ASEE international conferences and journals, and has written over 35 publications in both technical and educational fields. He is a member of Tau Beta Pi engineering honor society, and Omicron Delta Kappa national leadership honor society.

Ruby Mawasha, Wright State University
Ruby Mawasha is the Assistant Dean in the College of Engineering and Computer Science at Wright State University. He received a B.E. degree in mechanical engineering from the City College of New York in 1990 and an M.S. and Ph.D., from the University of Akron in 1993 and 1998, respectively. His areas of specialization include engineering education and thermo-fluids. He has co-authored over 15 journal articles and over 50 conference proceedings. He is a registered professional engineer in the state of Ohio; and a member of the American Society of Mechanical Engineers and American Society for Engineering Education.

P. Ruby Mawasha, Wright State University
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Increasing Awareness of Engineering Disciplines in High-School Students through a Pre-College Program

Abstract

In the present generation, the life of every individual is interleaved with science and technology. May it be a 16 year old listening to music on an iPod or a professional sending email from his/her Blackberry, science, engineering and technology are fueling the needs of everyone around the world, and have become an integral part of their lives. So, it is essential to expose high school students to engineering concepts through hands-on design activities at an early stage, in an effort to better prepare them for a college education. This paper presents a pre-college program that exposes students to engineering workforce through academic instruction and laboratory setting. Also presented are the program implementation, results, and candid feedback obtained from the participating students.

Introduction

With a major emphasis on increasing the awareness of pre-college students in science, technology, engineering and mathematics (STEM), it is essential for the engineering educators develop a framework that prepares students for a smooth transition into college. One such program that runs in line with this ideology is the Wright Science Technology Engineering Preparatory Program (Wright STEPP) initiated at Wright State University in 1988. The program was initiated to increase the number of high school graduates from the Dayton public schools and help them pursue college education in STEM disciplines. The three-week long program takes place every year, comprises of students from 7th up to 10th grade, and focuses on developing the skill set of the students. The program covers both academic and non-academic components such as career awareness, academic motivation and enrichment, etc.

The major goals of Wright STEPP are: 1) to demonstrate students, the importance of graduating from STEM fields; 2) to enhance the students’ math skills as a preparation to college; 3) to increase minority enrollment in STEM programs; 4) to increase the graduation rates; and 5) to help students have a smooth transition to college.

The scientific, mathematical and technical content of the sessions were designed very similar in fashion to the courses freshman students will be taking during their first year of college. These sessions provide students with a foundation necessary for succeeding in college. Oral and written communication skills are some of the other topics taught. These training sessions play a very important role in the overall development of an individual, also demonstrating some of the requirements in a workspace environment.

The 10th grade students undertake several training sessions which help them prepare for the mathematics proficiency test (MPT) that all the freshman students are required to take up during their first year of college. The MPT helps the college evaluate the mathematical knowledge of an individual so as to customize their program of study.
Through all these mentoring sessions, Wright STEPP is catering to the interests of students in bringing engineering, technology principles and its application to the pre-college classrooms. To date, Wright STEPP has been one of the leading pre-college programs that focus on enhancing the development and knowledge base of underrepresented students in STEM disciplines in the Dayton vicinity.

**Wright STEPP Program and Engineering**

The challenge for academic institutions into educators to train highly qualified employees skilled in mathematics, science and technological innovation is critical and has drawn national attention. The Wright STEPP program can be seen as an outcome of an intricate relation between the corporate world in and around the Dayton vicinity. These corporate industries not only provide monetary support, but also help mentor high school students through their employees. Through these interactions, students are educated about the requirements of an organization during the hiring process, and skills necessary to succeed in the STEM workforce. Delivering presentations, developing effective communication skills are some of the topics that students are trained in.

Engineering plays a major role in shaping the world today. Engineers strive hard to implement new designs leading to inventions that help technology evolve. It is very important for the next generation of engineers to keep up this pace of development. With this in mind, educating pre-college students about engineering disciplines would give them an idea of the career path they could pursue in the future. It can be seen as an opportunity being provided to students to decide what their interests lie in and accordingly take decisions with emphasis being laid on technical education.

The session on electronic circuits was included in order to introduce the students to hands on design activities. It was structured into two parts; the preliminary being an interactive session in which the students were educated about engineering education and the basics of electronic circuits. It also included a power point presentation giving the students an introduction to all the different branches of engineering. This gave them a purview of pursuing a degree in engineering and the career path they could follow by enrolling in a STEM based program. The students were also briefed about the basics of electronic circuits, the different characteristics (current, voltage, resistance) and components used in a circuit (resistor, capacitor, inductor, power source). This was followed by an activity where in they worked on “Elenco Snap Circuits” kits, designed different electronic circuits and tested them. This provided the participating students with an exposure to the process involved in an engineering design.

The second session held involved the pre-college students participating in a survey followed by an activity of soldering different components on a printed circuit board (PCB). The survey encompassed questions to provide an insight into the student’s mindset and their perceptions about pursuing a degree in a STEM discipline.
Fig 1: Coin decision maker

**Question 1.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>1</td>
</tr>
<tr>
<td>Slightly disagree</td>
<td>8</td>
</tr>
<tr>
<td>No opinion</td>
<td>14</td>
</tr>
<tr>
<td>Agree</td>
<td>8</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>2</td>
</tr>
</tbody>
</table>

**Question 2.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>35</td>
</tr>
<tr>
<td>Slightly disagree</td>
<td>26</td>
</tr>
<tr>
<td>No opinion</td>
<td>10</td>
</tr>
<tr>
<td>Agree</td>
<td>5</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>3</td>
</tr>
</tbody>
</table>
Student Perception

The survey was conducted for a group consisting of 34 high school students. The questions primarily focused on student perceptions towards a program in STEM disciplines. Valuable insights were obtained from this data collected. Table.1 presents some of the questions used in the survey. The questions were designed to see how students relate to education in a STEM based program. From the graphs presented, we can observe that a majority agree with mathematics and science being a requirement for every student, and a college degree will help them in securing a job as shown in Questions 2 and 3. College not only imparts education but also allows students to socialize. Student organizations, personality development programs and various other student activities help in the overall development of an individual. The students perception towards college agrees with the reasoning that college helps in the overall development of individuals as seen in Question 4.

When asked whether the program offered enough to help them take a decision as to what major they would pursue in college (Question 1.), we notice that the feedback was spread out with the majority opting for “No opinion”. The Wright Stepp program primarily focusses on preparing the students to enter college. The program helps as a medium of guidance to the students but the decision as to which major to choose solely lies on the student.
Table 1: Sample questions from the survey used for Assessment

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1.</td>
<td>Did the program help you in deciding what major you want to pursue in college?</td>
</tr>
<tr>
<td>Question 2.</td>
<td>College education will get you a job</td>
</tr>
<tr>
<td>Question 3.</td>
<td>Is knowledge of mathematics and science a requirement for every student?</td>
</tr>
<tr>
<td>Question 4.</td>
<td>College education helps in the overall development of an individual?</td>
</tr>
<tr>
<td>Question 5.</td>
<td>Will frequent interaction with college students help you in deciding what you want to be studying in college?</td>
</tr>
<tr>
<td>Question 6.</td>
<td>Is the electronic circuit’s project lab and effective method to introduce students to engineering?</td>
</tr>
<tr>
<td>Question 7.</td>
<td>Is designing electronic circuits an effective method to help you understand the basic components of electrical engineering?</td>
</tr>
<tr>
<td>Question 8.</td>
<td>Did you have fun working with electronic circuits?</td>
</tr>
</tbody>
</table>

The main purpose of including electronic circuits in the program was to help the students gain hands on design experience and to introduce them to the complexities involved in an engineering design. Hence this makes it an effective way of introducing students to engineering. The presentation on engineering education and the basic components of an electrical design was followed by an activity involving use of these components to develop an electrical circuit. This is a structured approach to introduce students towards a particular field of engineering. Allowing the students to experience technology hands on would not only help them in retaining that knowledge but may also help in stimulating their interests towards an engineering field. The majority of the students too felt that the electronic circuit’s lab was an effective way to introduce them to electrical engineering and the presentations and hands on activity helped them in understanding the basic components of that particular field as shown in Question 7. A student can imbibe most from an activity only when he or she enjoyed being a part of it. This is a very important aspect of any activity organized and the student’s feedback for Question 8 clearly shows that they found it a fun filled learning experience.

Conclusion

With the demand for engineers increasing on a daily basis, it is imperative that emphasis be given to engineering education. It is through such outreach programs that we can educate the youth in pursuing their education in a STEM based program. It is essential that the pre-college students obtain the right advice from knowledgeable individuals so that they get an idea of what they will have to endure in the future in order to become successful. Hands on design activities not only help the students in understanding the difficulty associated with implementing a design but also allow them to experience technology first hand. All graduating school students should be made to go through programs which will help them in making the transition from school to college with ease. If such programs can be standardized it would not only better prepare the student to enter college but will also allow them to pin point what their weaknesses are and work towards overcoming them.
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Appendix

Electronic Circuits Survey - 2008


Circle the choices that you think are right for the questions posted below.

1. Please fill the circle below
   o Male
   o Female

2. Is knowledge of mathematics and science a requirement for every student?
   1  2  3  4  5

3. Did the program help you decide what major you want to pursue in college?
   1  2  3  4  5

4. College education will help you get a job.
   1  2  3  4  5

5. College education helps in the overall development of an individual.
   1  2  3  4  5
6. Do you have any siblings that are attending college?

   Yes                       No

7. Have either of your parents received college education?

   Yes                       No

8. Will frequent interaction with college students help you in deciding what you want to be studying in college?

   Yes                       No

9. What is the best way for you to retain information?

   Reading books   listening to lectures   writing reports

10. Have you had any exposure to electronic circuits before you attended this class?

    Yes                       No

11. Are electric circuits difficult to understand?

    1  2  3  4  5

12. What best defines an electric current in a circuit?

    1. Electric current is the flow of electric charge/electrons.
    2. It is the electric potential energy between two points.
    3. Energy that flows from one point to another point.

    1  2  3

13. What best defines electric voltage?

    1. Voltage is the difference of electrical potential between two points of an electrical or electronic circuit.
    2. It is the measure of the flow of electrons from one point of a circuit to another point.
    3. Energy that flows from one point to another point.

    1  2  3

14. Which statement best defines the function of a resistor?

    1. Opposes the current flow in a circuit.
    2. Stores energy between a pair of conductors.
    3. Stores energy in the form of electromagnetic energy.

    1  2  3

15. Which statement best defines the function of a capacitor?

    1. Reduces the current flowing in a circuit.
2. Stores energy between a pair of conductors.
3. Stores energy in the form of electromagnetic energy.

16. Which statement best defines the function of an inductor?

1. Reduces the current flowing in a circuit.
2. Stores energy between a pair of conductors.
3. Stores energy in the form of electromagnetic energy.

17. Is designing electronic circuits an effective method to help you understand the basic components of electrical engineering?

1 2 3 4 5

18. On a scale of 1 to 5, what would your rate yourself based on your knowledge about electronic circuits (1= outstanding and 5=poor)?

1 2 3 4 5

19. Does your knowledge in math and science affect the way you approach a problem (electronic circuits in this case)?

Yes No

20. Is the electronic circuits project lab an effective way to introduce students to Engineering?

Yes No

21. Did you have fun working with electronic circuits?

Yes No

22. Compared to the other learning sessions you had in the program, rate this program on a scale of 1 to 5 (1= high, 5= low) based on how much you learnt and how much you understood?

1 2 3 4 5

23. Would you recommend this project to incoming freshman students?

Yes No

24. Coming into the electronic circuit’s lab, did you have any expectations from the session? If ‘YES’ did the session meet your expectations? If ‘NO’, why do you feel so?