Engaging K–12 Students in the Engineering Classroom:

A Creative Use of Undergraduate Self-Directed Projects

Omolola Eniola-Adefeso, PhD
lolaa@umich.edu

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Abstract

A major contributing factor to the low number of students receiving degrees in engineering is the steady decline in student enrollment. Evidence in the literature suggests that this decline can be linked to K-12 students' lack of knowledge of engineering careers and their perception of engineering as “boring”. The two most common outreach tools used in presenting engineering to the public are (1) professional engineers/faculty spending time in the K-12 classroom to talk about the profession and (2) informal educational programs focused on improving students’ understanding of math and science[1]. However, visits from engineering professionals often leave students visual the level of success perceived in their visitors for themselves. Likewise, tutoring/mentoring outreach efforts often fail to connect K-12 students back to engineering. This paper presents an “each-one-teach-one” approach to introducing chemical engineering to K-12 students that involves chemical engineering undergraduates, their course project and a science fair style presentation to local high school students in an engineering classroom setting.

Methods

Students enrolled in the “Mass and Heat Transfer (ChE 230)” chemical engineering course in groups of four were asked to design and present one original experiment based on a heat/mass transfer concept of their choice suitable for a high school teacher to use to introduce this concept to his/her high school science class.

The goal is for the student designed experiments to be used as a tool to attract high school students to ChE.

Design constraints imposed on students: (i) experiment must be feasible; (ii) materials/setup cost must not exceed $25 and (iii) designed experiment must be easily set up in a high school classroom (i.e. no hazardous materials).

Project Presentation included an in class-demonstration and a written report. The in-class demo format allowed groups to either have one experimental setup that could be reused for multiple sets of judges or multiple disposable (inexpensive) setups.

A budget of $25 was provided for groups to obtain materials for their in-class demos. Groups had access to a senior engineer in the department to provide guidance on their design.

Grading. High school students (fifteen 10 – 11th graders) enrolled in the general chemistry class and their teachers from the Ypsilanti school district via (OE)^2 were recruited to view and grade the in-class presentations. Projects were graded on originality, feasibility for reproduction in a high school classroom, and the quality of the in-class demo via a survey.

Results

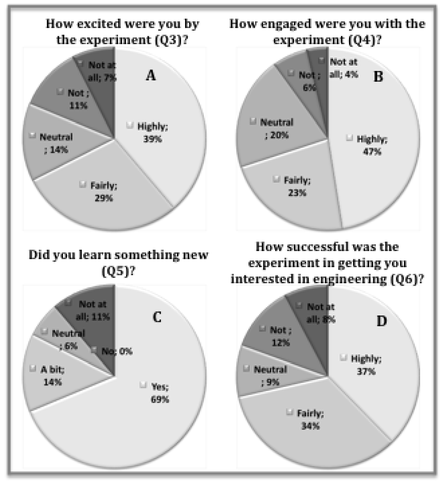

Fig. 1. Summary of high school student (HSS) survey on excitement and engagement rated on a scale of 1-10. High = 9-10; Fairly =7-8; Neutral = 5-6; Not = 3-4; Not at all = 1-2.

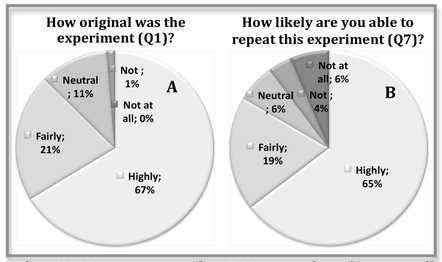

Fig. 2. Summary of HSS gauging how well ChE designs adhered to the project statement on a scale of 1-10.. High = 9-10; Fairly =7-8; Neutral = 5-6; Not = 3-4; Not at all = 1-2.

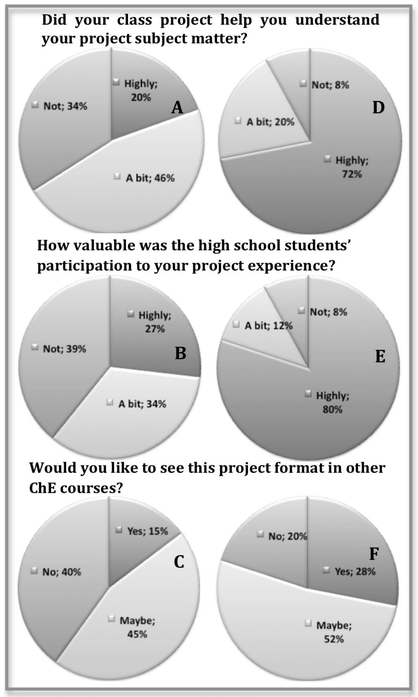

Fig. 3. Summary of ChE student end of course (A-C) and post-semester (D-F) survey. End-of-course survey was administered on last day of classes and the post-semester survey during the following winter semester.

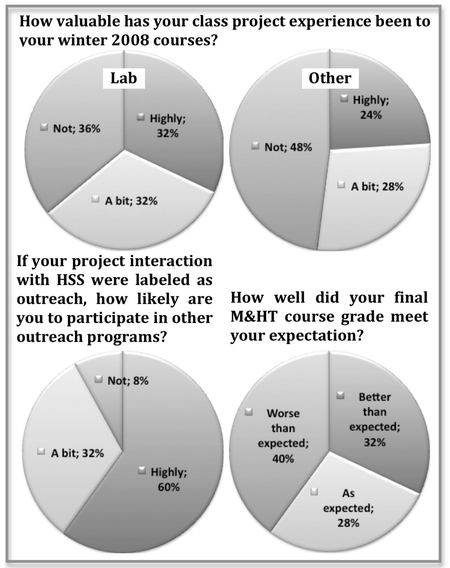

Fig. 4. Summary of ChE students’ response to questions unique to post-semester survey.

ChE students’ attitude towards the class project improved over time as observed in the post-survey. However, this improvement may not be representative of the entire class since only 44% of the class participated in post-survey compared to the 87% for the end-of-term survey. In spite of this, students appear to be more positive on the post-survey relative to the end-of-term survey, e.g. only 20 students on the end-of-term survey thought the project helped their understanding of their course material versus 36 students that felt the same way on the post-survey.

Conclusion

Both groups of students (HSS and ChE) that participated in this unique project indicated a better understanding of the demonstrated engineering principles. HSS indicated an overwhelming interest in chemical engineering as a result of their participation in the ChE course project. Overall, the incorporation of K-12 activities into the ChE classroom overcomes the time commitment barrier that often prevents college students and faculty from participating in outreach to K-12. Engineering is also likely presented to HSS in a less intimidating manner where these students themselves can get involved with demonstrations of engineering principles.

Acknowledgements

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