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Engineering Projects in Community Service (EPICS) High: Preliminary Findings Regarding Learning Outcomes for Underrepresented Students (Work in Progress, Diversity)

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In 2013, Velez joined the Ira A. Fulton Schools of Engineering as a Program Coordinator Senior with the K-12 Engineering Education and Outreach team. Since then, Velez has managed such programs as FIRST LEGO League Robotics, MESA, and the National Summer Transportation Institute. She currently coordinates EPICS High (Engineering Projects in Community Service) to engage high school and middle school students in human-centered engineering projects in their communities. Through this program, Velez works to build partnerships with school districts, industry, and non-profits to bring STEM programming to underserved communities across the state. Before joining ASU, Velez spent seven years as an elementary educator at a STEM focus school. She currently holds a Masters of Education in Curriculum and Instruction.

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Hope Parker is Associate Director for Ira A. Fulton Schools of Engineering PreK-14 Engineering Education and Outreach at Arizona State University. She and her team work to bring awareness, enthusiasm, interest, opportunity and understanding of engineering and social entrepreneurship to students. In 2017, the team served roughly 16,000 PreK through community college students in a variety of yearlong programs, events and teacher trainings. Hope serves on the PCEE board as Member at Large as well as assisted with the 2017 PCEE K12 conference. Hope has worked in education for more than 15 years including elementary and post-secondary settings. Prior to her current role, she served as Assistant Director of Graduate Business Student Services at the W. P. Carey School of Business where she oversaw the Full-time MBA program. Before relocating to Arizona she taught pre-K through sixth grade and also as a high school athletics coach.

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Engineering Projects in Community Service (EPICS) High: Preliminary Findings Regarding Learning Outcomes for Underrepresented Students in Arizona (Work in Progress, Diversity)

Abstract

Engineering Projects in Community Service (EPICS) High utilizes human-centered design processes to teach high school students how to develop solutions to real-world problems within their communities. The goals of EPICS High are to utilize both principles from engineering and social entrepreneurship to engage high and middle school students as problem-solvers and spark interest in STEM careers. Recently, the Cisco corporate advised fund at the Silicon Valley Community Foundation, granted Arizona State University funds to expand EPICS High to underrepresented students and study the student outcomes from participation in this innovative program. In this exploratory study we combined qualitative methods—in person observations and informal interviews—along with pre and post surveys with high school students, to answer the questions: What skills do students gain and how does their mindset about engineering entrepreneurship develop through participation in EPICS High?

Research took place in Title I schools (meaning they have a high number of students from low-income families) as well as non-Title I schools. Our preliminary results show that students made gains in the following areas: their attitudes toward engineering; ability to improve upon existing ideas; incorporating stakeholders; overcoming obstacles; social responsibility; and appreciation of multiple perspectives when solving engineering problems. While males have better baseline scores for most measures, females tend to have the most growth in many of these areas. We conclude that these initial measures show positive outcomes for students participating in EPICS High, and provide questions for further research.

Introduction

The ability to increase the K-12 pipeline of students choosing engineering careers, especially women and underrepresented groups, is paramount to meet the needs of the current and future generations[1]. Though the United States is in a demographic shift with an increasing population of ethnic minorities, they remain heavily underrepresented in the science and engineering fields[2]. In order to decrease this gap within the growing population, the country would need to increase the number of underrepresented students pursuing engineering by three-fold[1]. Researchers suggest that one way to meet this demand and increase the pipeline of women and minorities is to focus on K-12 Science, Technology, Engineering and Mathematics (STEM) preparatory programs[2]. In fact, Arizona, the setting for this research study, has a large Latinx population (30%) and offers an opportunity to increase STEM participation amongst the fastest growing population in the U.S.

Engineering-based instruction is increasingly implemented at the high school level to help increase the STEM pipeline. Instituting engineering-related programs can help introduce the field to students and build their skills as design-thinkers, with the hope of sparking interests in pursuing undergraduate degrees in sciences and engineering. One research study found that classes that focused on engineering design within a middle school reduced gaps in performance for specific ethnic groups, along with increasing students' knowledge of science and their ability to analyze and synthesize information[3]. In another study, engineering and design courses impacted end of year mathematics standardized test scores by showing student gains[4]. Although these results appear to provide positive outcomes, the study of the efficacy of such programs is sparse and more research is needed to fully understand what gains specific programs have on student participants[5,6]. Moreover, programs that seek to incorporate students' backgrounds and cultural knowledge in order to solve problems in their communities through engineering design practices may spark more interests among underrepresented groups in pursuing engineering careers[7,8]. One such program is EPICS High, the focus of this research study, which seeks to connect students to their communities through applied engineering projects.

What is EPICS High?

Originally founded in 1995 and currently housed out of Purdue University, the Engineering Projects in Community Service (EPICS) program aims to connect students interested in engineering and computing design with people in the local community in order to solve problems. It was originally intended for college students and is implemented in colleges across the country. In 2006, however, the program developed a high school curriculum and is now deployed in high schools throughout the country. The goal of EPICS High is to utilize both principles from engineering and social entrepreneurship to engage high and middle school students as problem-solvers and spark interest in STEM careers. Arizona State University (ASU) began delivering the EPICS college program in 2009 and then expanded to EPICS High in 2012. The ASU program currently serves 800 high school students within 32 schools in the Phoenix Metro area.

The EPICS High model is integrated into existing classroom frameworks. Teachers are trained on the EPICS high curriculum that is then incorporated into their STEM or CTE classes or in afterschool clubs. The curriculum is grounded in design education and service learning and promotes engineering for social good (social entrepreneurship), see figure 1.

EPICS Design Process

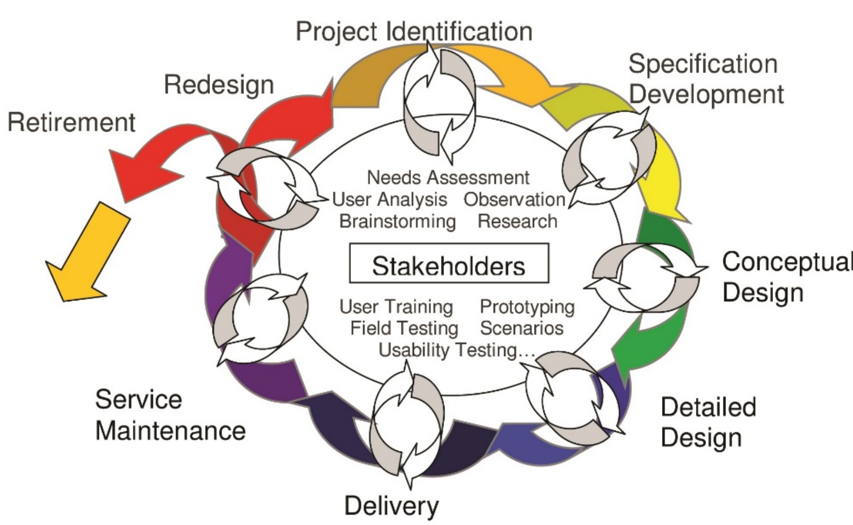

Figure 1

By pairing meaningful community service with engineering instruction, EPICS High provides a conduit for students to engage in project-based learning to master course content while fostering greater civic responsibility and community engagement. Moreover, the curriculum incorporates human-centered design and key engineering processes to foster engineering habits of mind such as systems thinking, optimism, and ethical consideration in engineering as well as entrepreneurial mindsets such as the three C's (creativity, collaboration, communication). Throughout EPICS High, students continually explore potential problems in the community that can be solved by the skills they are learning in the classroom. Ultimately, students learn to work with members of the community to create engineering solutions that are designed to address real-world problems. Preliminary research shows that EPICS High promotes positive outcomes among high school students[9,10].

In a small study on an EPICS High pilot program, students responded that they gained the ability to work as a team, understanding of the design process, awareness of the role of the customer, as well increased their ability to be resourceful[9]. In another study, EPICS High students became solution-driven problems solvers, developed a cooperative, team-based working environment and were able to employee multiple cognitive strategies for solving problems[10]. While these studies point to positive outcomes for high school students, a more robust assessment can help assess the gains made by a variety of students. The research questions presented in this paper are: What skills do students gain and how does their mindset about engineering entrepreneurship develop through participation in EPICS High?

In 2016, the Cisco corporate advised fund at the Silicon Valley Community Foundation, granted Arizona State University funds to expand EPICS High to underrepresented students. With the funds, the program expanded to 12 Title I schools in Year 1. The Title I designation signifies that they serve low-income students, and these schools typically have a large number of ethnic minority students. For example, in Arizona, 41.5% of students in Title I schools are White and Latinos represent 43% of the school population[11]. The research presented here comes from the first year of data collection.

Methods

We collected the data presented here during the 2016-17 school year after receiving Human subjects' approval for this study through the ASU Institutional Review Board (#STUDY00004523) and gaining permission from each school to conduct the research. The purpose of this study is to assess the gains in engineering habits of mind and the three C's from beginning to the end of the program. In order to do so, we developed an online survey – deployed at the beginning and the end of the school year – that included both qualitative and quantitative data about their perceptions of engineering and the design process. The quantitative scale contains 23 items that assesses growth in the following domains: attitudes towards engineering (learning about engineering, considering studying engineering, understanding importance of engineering); improving ideas (inventing new ways to do things); importance of feedback (identifying needs of stakeholders, seeking input, incorporating feedback into designs); growth mindset (seeing obstacles as opportunities, not giving up on difficult tasks, seeing failure as a chance to improve); social responsibility (contributing to the good of society, seeking opportunities to improve lives of others); and importance of multi-perspectives (putting self in other's shoes, incorporating different expertise/ideas). The item responses were on 5-point Likert scale ranging from strongly agree (5) to strongly disagree (1). Despite the small sample size, these scales demonstrated a high reliability across both the pre- and post-test. (see Appendix A for questions and scale construction).

Another important design element of this study is including both Title I and non-Title I schools in the study to allow for comparisons. A total of thirteen schools completed the pre-test (n=416 student responses), while only eight schools took the post-test (n=179 student responses). However, issues with the unique identifiers (in order to protect student identities) between pre and post-tests caused a reduction in matched samples (n=95). The data presented within this paper is based upon both the scores at baseline and post-tests, as well as the matched samples. Of the eight matched schools, 5 were Title I (n=27 student responses from Title I schools vs n=68 from the remaining non-Title I schools). Within the match samples, 28% (n=27) identified as female, 64% (n=61) as male, and the remaining 7 participants chose “prefer not to respond” or left the question blank. Regarding ethnic/racial self-identification, 32% identified as Latino (n=30), 37% identified as white/Caucasian (n=35), 13% chose Asian (n=12), 5% selected Black/African American (n=5), 3% chose American Indian or Alaska Native (n=3), one student identified as Native Hawaiian or Pacific Islander, 6% (n=6) chose “other”, and one student chose not to respond. Statistical analyses of the survey responses were conducted using SPSS 24.0, with alpha set at 0.05, using non-parametric, independent, and paired-sample t-tests to compare means between groups.

Qualitative data collection includes open-ended questions in the survey (not included in the data presented here) as well as classroom observations. The research coordinator accompanied the EPICS High coordinator during site visits in order to observe how students engage with the curriculum and learn more about students’ EPICS experiences and community projects. Moreover, site visits served as an opportunity to talk with students and to take field notes on the following: their motivations for joining EPICS; their motivations for enrolling in engineering; students’ experiences working and designing for a stakeholder; student team dynamics; among other topics. She attended a total of 13 schools in Year 1 (6 Title I and 7 non-Title I). A preliminary analysis of the quantitative and qualitative data are presented below.

Results

Quantitative

The quantitative analysis consisted of non-parametric (Mann-Whitney U-test) independent sample t-test to assess differences in scale scores across gender, ethnicity, Title I status, and across students with college-educated parents. To assess changes in pre-and post-test scores, we used a non-parametric paired samples t-test, assessing within-group growth. Results are presented in Tables 1 through 4.

Scale items were similar for males and females at baseline with the exception of attitudes towards engineering where females’ scores were lower. At post, scores on all scale items were similar for both males and females. Despite no significant differences at either baseline or post, females saw significantly larger increases in scores on attitudes towards engineering, the importance of feedback and the importance of multiple perspectives than males. This puzzling finding is a result of small differences between males and females at both baseline and post. Females had slightly lower scores at baseline and slightly higher scores at post than males (See Table 1). While neither of these were statistically significant, they reflect that females had greater overall gains in scores than males. Assessing the change in scores within gender showed that, at post, females saw significant improvements in attitudes towards engineering, importance of feedback, growth mindset, and the importance of multiple perspectives when compared to their pretest scores.

At baseline, we observed no significant differences by ethnicity in scale scores across all six domains. Similarly, post-test scores were statistically similar. However, we did observe significant growth in white/Asian students in the importance of growth mindset and attitudes towards improving ideas.

Analysis of the differences between Title I and non-Title I schools revealed two interesting findings. First, in the matched sample, those students whose data were captured at both pre-and post-test, Title I schools had higher scores on all scale measures. However, only differences in the growth mindset scale were statistically significant. At post-test we found no statistical differences between Title I and non-Title I schools in any of the scale items. Second, upon analyzing the full pre-test sample, not just the matched samples, we find that Title I schools had lower scores on all scale items than non-Title I schools, with lower scores in attitudes toward engineering, importance of feedback, and the importance of multiple perspectives statistically significant. We need a bigger sample of matched students at pre-and post-test in order to understand these conflicting findings.

Finally, students with a parent who has graduated college had significantly higher scores on the importance of feedback and the importance of multiple perspectives than students whose parents did not attend college. These differences remained at post. Furthermore, students whose parents have a college degree also saw greater gains in improving ideas and growth mindset.

Qualitative

Site visits served as an opportunity to learn the variety of skills students gain in EPICS High and how students' mindsets towards engineering entrepreneurship and community engagement change over time. Throughout site visits, we noted that EPICS projects fell on a continuum and that there were variations in program implementation, variations in project relationships to stakeholders and community partners, and variations in student project sophistication. Despite these variations, salient themes emerged that highlight how EPICS High enables students to explore the ways in which engineering may be relevant to their academic, professional and personal lives. Below are three salient themes that emerged from field notes:

<u>Theme 1: Increase in Engineering Self-Efficacy</u>

Throughout site visits, students spoke of how the class enabled them to gain real-world experience and witness how engineering can be used beyond the classroom. Students cited how EPICS serves as an opportunity for them to learn to "think like engineers," as project experiences helped foster some of the 21st century skills needed of today's engineers. Throughout our discussions with students, they often spoke of how they had to learn to construct a project budget and plan, utilize Gantt charts to track task assignments, increase their technology literacy to learn new software for their projects, and more. Additionally, students expressed that working on their EPICS projects helped increase their teamwork, communication, and critical thinking skills to ensure their solutions aligned to stakeholder and community needs. Furthermore, students spoke of how they liked that the class was hands on, and that they not only are learning, but are *applying* what they are learning as they engage in the EPICS design process. Ultimately, this theme highlights that EPICS High provides a space for students to increase their STEM knowledge as "some students don't even realize their using math because they're having fun," (EPICS teacher, central Phoenix, AZ).

<u>Theme 2: Community Embeddedness</u>

Throughout the program, EPICS High asks its students to continually explore problems in the community that can be solved by the skills they are learning in the classroom, and identify those in their community that would benefit from an EPICS project. During the site visits, students stated that they liked that their EPICS projects connected them to a community or issue, and cited how liked that their projects provided value to their community partners and project stakeholders. Moreover, students expressed that by working with, and designing solutions for members of their local community, they were able to identify and connect the ways in which their skills and passions can be used to creatively solve problems. Additionally, students expressed that their projects provided value to themselves as many students cited that their projects were "more than just grade" for them and that "for other projects you do for other classes aren't personal – you're just following instructions to get things done; with this class, it's more personal." Furthermore, students often expressed that the opportunity to positively impact their communities kept them motivated to persist on their projects, especially when they encountered setbacks or design difficulties. Lastly, many students cited that knowing their projects were going to help someone as a major takeaway from participating in the program.

Theme 3: Increase in Resiliency and Positive Relationship with Failure

In EPICS High, students are encouraged to approach the design process with a mindset that is open to failure, ambiguity and feedback. While working on their projects, students expressed that they often had to pivot, redesign, iterate or restart a project to ensure the solutions they designed were both feasible and of value to their stakeholders. Many students expressed that EPICS High provided a space for them to comfortably fail in a safe environment and gain confidence in their mistakes. Students expressed that "in other classes, failure is a big deal, and you only get one chance and it's more punishing to make those mistakes. It feels like you can't make mistakes in other spaces whereas in engineering failure is seen as progress." Ultimately, this theme highlights how the program provides opportunities for students learn to embrace their mistakes, evolve when necessary, and foster resiliency to increase their learning potential.

Next Steps

We are currently collecting Year 2 data in order to increase the overall sample and confirm or reject our initial findings. This will also allow us to run further analyses on other factors such as ethnic background and parental level of education. The inability to match samples between the pre and post-tests was due to the open-ended nature of the unique identifiers (e.g. we asked for students to input the first three letters of their mother/maternal guardian's first name and the last three digits of their phone number). In order to address the issues with matching samples between pre and post-tests, we consulted the IRB and updated the survey to include a more structured response system. For instance, we updated the unique identifier question to now ask students to provide their two-digit birth day, two-digit birth month and the first 4 letters of students' last names to create a unique identifier that is easy to remember and will maintain participant anonymity. Moreover, in order to increase student participation, we are offering five dollars cash for students who complete the pre and post-tests. Therefore, we expect to have a high post-test response rate as well as have a higher number of matched samples to provide power to the analysis. A larger sample size, particularly across different ethnic groups and in Title I schools will help to assess program effectiveness across student and school characteristics. With our limited sample size, we were unable to explore possible interactions. For example, it is possible that the effects of gender may vary across different ethnic groups or across Title I or non-Title I schools.

The survey also presented open-ended narrative responses to questions that are suited to systematic qualitative analysis and still need to be analyzed. These questions include reasons for joining EPICS High, their goals after high school, their knowledge of EPICS (pre and post), their views of engineering, expectations of the program (pre) and what they believed they gained (post). Furthermore, we are continuing site visits as well as collecting in person interviews with EPICS High teachers to assess the various outcomes of the program. In order to analyze the data, we will utilize deductive coding techniques in order to identity theme repetition based upon the previous outlined literature on the benefits of K-12 STEM based curriculum[12]. Once the core themes are identified, we will systematically apply the thematic codes to the qualitative data. After we finish coding the data, we will be able to identify the most salient themes, identify exemplar quotes and generalize our findings in order to help provide context to students' close-ended responses. Thus, with further data we will have a more robust assessment of student gains from participation in EPICS High.

References

1. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2007. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11463.
2. National Academy of Sciences (US), National Academy of Engineering (US), and Institute of Medicine (US) Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline. Expanding Underrepresented Minority Participation. Washington (DC): National Academies Press (US); 2011. 1, A Strong Science and Engineering Workforce.
3. Cantrell, P., Pekcan, G., Itani, A., & Velasquez-Bryant, N. (2006). The effects of engineering modules on student learning in middle school science classrooms. *Journal of Engineering Education*, *95*(4), 301-309.
4. Dyer, R. R., Reed, P. A., & Berry, R. Q. (2006). Investigating the relationship between high school technology education and test scores for algebra 1 and geometry. *History*, *54*(69.7), 71-7.
5. Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classrooms. *Journal of Engineering Education*, *97*(3), 369-387.
6. Sheppard, S. D., Pellegrino, J. W., & Olds, B. M. (2008). On becoming a 21st century engineer. *Journal of Engineering Education*, *97*(3), 231-234.
7. National Academy of Engineering. (2008). *Changing the Conversation: Messages for Improving Public Understanding of Engineering*. Washington, DC: The National Academies Press. https://doi.org/10.17226/12187.
8. Wilson-Lopez, A., Mejia, J. A., Hasbún, I. M., & Kasun, G. S. (2016). Latina/o Adolescents' Funds of Knowledge Related to Engineering. *Journal of Engineering Education*, *105*(2), 278-311.
9. Nation, S., Oakes, W., Bailey, L., & Heinzen, J. (2005, October). Conversion of Collegiate EPICS to a K-12 Program. In *Frontiers in Education, 2005. FIE'05. Proceedings 35th Annual Conference* (pp. S1F-S1F). IEEE.
10. Kelley, T., Brenner, D. C., & Pieper, J. T. (2010). PLTW and Epics-High: Curriculum Comparisons to Support Problem Solving in the Context of Engineering Design. Research in Engineering and Technology Education. *National Center for Engineering and Technology Education*.
11. United States Department of Education, National Center for Education Statistics (2013). Common Core of Data (CCD), State Nonfiscal Public Elementary/Secondary Education Survey, 2012-2013. https://nces.ed.gov/ccd/stnfis.asp
12. Bernard, H. R., Wutich, A., & Ryan, G. W. (2016). *Analyzing qualitative data: Systematic approaches*. SAGE publications.

Table 1. Scale scores by Gender

	PRETEST			POSTEST			PAIRED SAMPLE	
	Males (N=65)	Females (N=30)		Males (N=65)	Females (N=30)		Males (N=65)	Females (N=30)
	Mean	Mean	Diff.	Mean	Mean	Diff.	Mean	Mean
Attitudes towards engineering	4.2	3.5	**0.7**	4.1	3.9	0.2	0.1	**-0.4**
Improving Ideas	4.0	3.8	0.2	4.1	4.1	-0.1	0.0	-0.3
Importance of feedback	4.2	4.2	0.0	4.2	4.5	-0.3	0.1	**-0.3**
Growth mindset	3.9	3.7	0.2	3.9	4.1	-0.2	0.0	**-0.4**
Social Responsibility	4.0	4.0	0.0	4.0	4.3	-0.2	0.0	-0.2
Importance of multiple perspectives	4.4	4.4	0.0	4.3	4.6	-0.2	0.1	**-0.2**

1-Strongly Disagree to 5 - Strongly Agree. **Bold = p<0.05**, *Italic=p<0.1*

Table 2. Scale scores by Ethnicity

	PRETEST			POSTEST			PAIRED SAMPLE	
	WHITE / ASIAN (N=49)	NON-WHITE / NON ASIAN (N=46)		WHITE / ASIAN (N=49)	NON-WHITE / NON ASIAN (N=46)		WHITE / ASIAN (N=49)	NON-WHITE / NON ASIAN (N=46)
	Mean	Mean	Diff.	Mean	Mean	Diff.	Mean	Mean
Attitudes towards engineering	3.9	4.0	-0.2	4.0	4.1	-0.1	-0.1	0.0
Improving Ideas	3.9	4.0	-0.1	4.1	4.1	0.0	**-0.2**	0.0
Importance of feedback	4.3	4.2	0.0	4.3	4.2	0.1	0.0	0.0
Growth mindset	3.7	4.0	-0.2	4.0	4.0	0.0	**-0.3**	0.0
Social Responsibility	3.9	4.1	-0.2	4.1	4.0	0.1	-0.2	0.1
Importance of multiple perspectives	4.4	4.4	0.0	4.5	4.3	0.2	-0.1	0.1

1-Strongly Disagree to 5 - Strongly Agree. **Bold = p<0.05**, *Italic=p<0.1*

Table 3. Scale scores by Title 1 Status								
	PRETEST			POSTEST			PAIRED SAMPLE	
	NON TITLE ONE (N=68)	TITLE ONE (N=27)		NON TITLE ONE (N=68)	TITLE ONE (N=27)		NON TITLE ONE (N=68)	TITLE ONE (N=27)
	Mean	Mean	Diff.	Mean	Mean	Diff.	Mean	Mean
Attitudes towards engineering	3.8	4.2	*-0.4*	3.9	4.2	-0.3	-0.1	0.0
Improving Ideas	3.9	4.2	*-0.3*	4.0	4.2	-0.1	*-0.2*	0.0
Importance of feedback	4.2	4.4	-0.3	4.2	4.4	-0.2	0.0	0.0
Growth mindset	3.7	4.2	**-0.5**	3.9	4.1	-0.2	**-0.2**	0.1
Social Responsibility	3.9	4.2	-0.3	4.0	4.2	-0.2	-0.1	0.0
Importance of multiple perspectives	4.4	4.4	0.0	4.4	4.4	0.0	0.0	0.0

1-Strongly Disagree to 5 - Strongly Agree. **Bold = p<0.05**, *Italic=p<0.1*

Table 4. Scale scores by Parents College Degree								
	PRETEST			POSTEST			PAIRED SAMPLE	
	COLLEGE GRADUATE (N=55)	NON GRADUATE (N=40)		COLLEGE GRADUATE (N=55)	NON GRADUATE (N=40)		COLLEGE GRADUATE (N=55)	NON GRADUATE (N=40)
	Mean	Mean	Diff.	Mean	Mean	Diff.	Mean	Mean
Attitudes towards engineering	4.0	3.9	0.2	4.1	3.9	0.2	-0.1	-0.1
Improving Ideas	4.0	3.9	0.1	4.2	3.9	*0.2*	**-0.2**	0.0
Importance of feedback	4.4	4.0	**0.4**	4.4	4.0	**0.4**	0.0	0.0
Growth mindset	3.8	3.9	-0.1	4.1	3.8	*0.2*	**-0.3**	0.1
Social Responsibility	4.1	3.9	0.2	4.2	3.9	*0.3*	-0.1	0.0
Importance of multiple perspectives	4.5	4.3	**0.3**	4.6	4.2	**0.4**	-0.1	0.1

1-Strongly Disagree to 5 - Strongly Agree. **Bold = p<0.05**, *Italic=p<0.1*

APPENDIX A

EPICS High Assessment Items

Open ended questions:

Why did you join EPICS High?
What do you want to do when you finish high school?
What do you know about EPICS High?
What do you expect to learn or gain from EPICS High?
What are your views of engineers?

Likert Scale:

Strongly Agree (5) Agree (4) Neutral (3) Disagree (2) Strongly Disagree (1)

I learned about one or more engineering fields.
I will consider choosing an engineering major for college.
I understand the importance of engineering in my daily life.
I think about ways to improve accepted solutions.
I invent new ways of doing things.
I look for ways to make things better.
I reimagine existing ideas.
It is important to identify the needs of stakeholders.
I incorporate stakeholder feedback into my designs.
I seek input from stakeholders throughout the design process.
I value feedback.
I see obstacles as opportunities.
I give up when a task becomes too difficult.
I see my ideas through even if there are setbacks.
I see failure as a chance to improve.
I contribute to the good of society.
I seek opportunities to improve the lives of others.
I feel a sense of responsibility to address society's major problems.
It is important that I do things to fix problems in the world.
Knowledge from different subject areas should be brought to a project.
It is important to put myself in somebody else's shoes to understand their perspective.
I appreciate the importance of different people's expertise.
The best solutions are informed by multiple perspectives.