AC 2009-1116: IMPROVING EARLY INTEREST AND CONFIDENCE IN ENGINEERING: CREATING PARTNERSHIPS BETWEEN UNIVERSITIES, K-12 TEACHERS, THEIR STUDENTS, AND ENGINEERS

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Improving Early Interest and Confidence in Engineering: Creating Partnerships between Universities, K-12 Teachers, their Students and Engineers

Abstract

The Design Your Future (DYF) project is part of a California State University (CSU) multi-campus Engineering Academies initiative with the goal of increasing the number of students that enroll in engineering programs. In 2008, Humboldt State University launched a multi-faceted project with three main components. The first component included a hands-on, one week summer DYF Teaching Institute offered to 15 secondary teachers. Secondary teachers participated in a hands-on, problem solving engineering curriculum where they learned and used the design process to complete a service learning project for a local client. The second component focused on building community between local practicing engineers and K-12 educators. Participants attended social events and were later linked through web tools that enable teachers to find engineers who are available to assist in delivering engineering content. The third component was a Fall 2008 "Introduction to Design" class. This college credit class was co-taught by high school and university faculty and offered in a mixed online format for 11th and 12th grade students at the only California public high school on an Indian reservation. Assessment results from the summer teacher workshop show that institute participation improved teacher understanding of engineering and the design process. In addition, confidence in teaching engineering concepts improved. Participants reported that they could on average add 39 more teaching days of engineering-related curriculum into their teaching and were very likely to make changes to increase engineering curriculum. Follow up teacher workshops will assess how much engineering content has been added to the teachers' classes. No assessment of the community building component has been completed. This fall sixteen high school students started the Introduction to Design course and thirteen finished. This spring the students are implementing their design project as part of a high school credit course. Assessment results from the pilot course indicate that students' confidence in their ability to succeed in college increased. However, students were not more likely to choose engineering as a major by the end of the first term. Another assessment will occur in May 2009, after the high school students have implemented their design project on their campus.

Keywords: high school outreach, dual-enrollment, co-curricular, introduction to design, underrepresented, Native American, service learning and community partnerships.

California State University (CSU) Engineering Academies

The CSU Engineering Academies project supports 14 of the 23 CSU campuses to use multiple outreach models to increase engineering enrollment by reaching out and attracting diverse underrepresented student populations. The purpose of the academies is to "expand and diversify the pool of incoming students who are *well prepared* and *eager* to enter as engineering majors" [1]. This expanded diverse pool of engineering students should help meet the governor's request for

20,000 more engineers, as a baseline requirement for California's economy[2], into the state's workforce in the next 10 years.

Three main outreach models had shown success at different CSU campuses: 1) The Math, Engineering and Science Achievement (MESA) program[3], 2) Project Lead the Way (PLTW) [4], and 3) the Accelerated College Entrance (ACE) program at CSU Sacramento. The ACE model was chosen for Humboldt State University as it seemed the best fit for this small rural community in Northern California that does not have a MESA program, nor the financial resources to start a PLTW program.

North Coast Engineering Academies – Design Your Future at Humboldt State University

The North Coast Engineering Academies – Design Your Future (DYF) program at Humboldt State University's goal is *to facilitate more engineering concepts be presented in K-12 classrooms* in order to "expand and diversify the pool of incoming students who are *well prepared* and *eager* to enter as engineering majors" [1]. The DYF program had three components. The first component was a hands-on, one week summer DYF Teaching Institute offered to 15 secondary teachers, where teachers learned and used the design process to complete a service learning project for a local client. The second component focused on building community between local practicing engineers and K-12 educators. Participants attended social events and were later linked through web tools that enable teachers to find engineers available to assist with engineering content. The third component was a university class "ENGR 215: Introduction to Design" offered to high schools students. This college credit class was co-taught by high school and university faculty members in a mixed online format for 11th and 12th grade students at a regional high school. Each of these three components is described in more detail below.

Approach

DYF Teacher Institute

The 2008 Design Your Future (DYF) Teacher Institute offered at Humboldt State University (HSU) had the following objectives for secondary science and math teachers as stated in the Invitation to Participate (Appendix A):

- Provide opportunities to experience the engineering design process first hand; teacher teams will complete a hands-on engineering design project at the institute.
- Provide opportunities for reflection and curriculum planning during the institute. Participants will leave with tangible products to use during the school year.
- Develop awareness of existing engineering secondary school curriculum, K-12 engineering education research (see www.teachengineering.com).
- Develop a community of teachers interested in pursuing engineering approaches to teaching math and science.
- Identify teaching partners for teaching ENGR 215 Introduction to Design to high school students for 3 units of college credit in Spring 2009 or later. High school students will

take ENGR 215 at their high school campus. Instruction would be available online from Humboldt State. Teacher partners will facilitate student projects and assignments.

The institute was developed in partnership with the HSU Redwood Science Project. The Redwood Science Project (RSP) offers K-12 educators professional development opportunities and support with teaching science. RSP provided teacher stipends for attending the summer week long institute. The institute was also offered for credit via HSU Extended Education.

K-12 educators play an important role in introducing students to the fields of engineering and supporting interest in engineering education and careers. Yet according to the Extraordinary Women Engineers Project (EWEP) most teachers are unfamiliar with the practice of engineering and engineering pathways[7]. Educators in the EWEP study were unsure how to guide students into engineering careers. They noted engineering as a challenging profession requiring superior math and science abilities, but this was not the message that girls (and many boys) needed to hear. The girls reported that they wanted to hear the benefits and rewards of a profession. And other research suggests these same messages would be effective in attracting more boys into engineering[8,9,10].

One EWEP Coalition recommendation was to provide training opportunities and resources for teachers to promote engineering education and careers to girls and their parents. The DYF Teacher Institute was designed to directly address this link in the engineering pipeline: targeting K-12 educators and introducing them to the engineering design process and teaching strategies.

Educators were recruited for participation in the engineering institute through existing Redwood Science Project channels. The Redwood Science Project maintains a web site announcing institutes and relies also on a network of educators in Humboldt County who are familiar with their program.

The 15 workshop participants met for a week from 7:30 a.m. to 5 p.m. They convened outside their classroom for continental breakfast and later lunch was served on site. Instruction took place in an engineering classroom equipped with tables for collaborative work and 13 computers that circled the classroom including an instructor station and overhead projector. They also worked in the engineering technician's workshop (Figures 1 - 3). Each teacher received a copy of *Engineering the Future*[11] and *Engineering Design: An Introduction (Project Lead the Way)*[12] as well as a notebook containing all class notes. Instruction was supported by on site by Dr. Beth Eschenbach, Professor of Environmental Resources Engineering (ERE), Marty Reed, Technician and Erin Cearley a female ERE student.

The participants spent the week learning the engineering design process by working in groups on projects the Discovery Museum, a local children's science museum. The museum's director, the project client, met multiple times with the teachers over the course of the week. Each team produced a design and built a hands-on simple machine exhibit. Assessment methods and results are reported below.

Figures 1 - 3: DYF Teacher institute participants work in teams on their Simple Machine exhibits for the Discovery Museum

Educator and Engineer Community Building

Two main efforts contributed to building community between regional K-12 educators and engineers: a kick-off dinner and a web site for listing engineers' availability to partner with teachers.

On the fourth evening of the five day institute, the teachers attended a dinner with local professional engineers to brainstorm on strategies for meeting North Coast Engineering Academies DYF goal *to facilitate more engineering concepts be presented in K-12 classrooms*. Both the engineers and the teachers were excited to brainstorm on prospective partnerships. The following questions/tasks were provided to outline the discussion: 1) Identify needs from both an educator's and an engineer's perspective. 2) Identify the challenges from both an educator's and an engineer's perspective and 3) Identify strategies from both an educator's and an engineer's perspectives.

The teachers' main stated needs were funding, resources and long term support. The engineers from both the private and government sectors pointed out they needed more engineers in the workforce. The main challenges stated by both the teachers and the engineers were time and money. However, some of the engineering consultants noted that their companies' had new expectations of engineering professionals, which included more visible public service. Engineers working for the state noted that they had support to mentor within their organization, so possibly mentoring teachers would be acceptable.

The teachers and engineers had a wide range of strategies. Some ideas included:

- service learning projects with engineering mentors
- local PBS shows on local engineering projects
- summer and job shadow opportunities for high school students
- curriculum developed by engineers and teachers that meets state standards
- partnerships with local professional organizations such as ASCE and Engineers Without Borders
- an online community for teachers and engineers
- engineer mentors for K-3 teachers
- engineering project site visits by K-12 students.

The objective of the http://www.dyfference.org/ website, developed by Lonny Grafman is to further community building. The site, which is still underdevelopment, creates a hub for the current main constituents of the North Coast Engineering Academies Design Your Future project: students, teachers, engineers and DYF program directors. Figure 4 is a diagram of the purpose and uses of the website (future uses are shown in purple). Students can use the website to learn more about the class before they sign up and to see what other students are doing. Teachers can use the website to find mentors and to see what other teachers are doing. Engineers can use the website to contribute to the community by offering mentoring services. The DYF program directors coordinate these efforts and utilize the website for community outreach, such as finding more teachers to implement engineering in their curriculum and more engineering mentors.

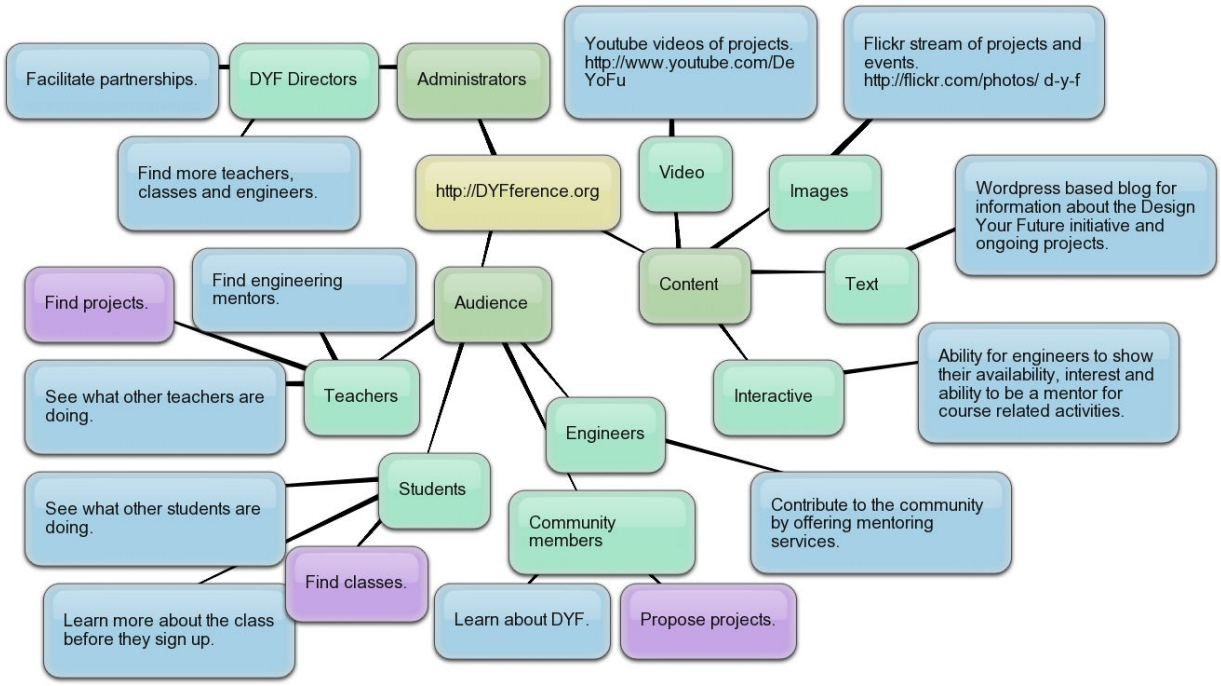

Figure 4: Diagram of the purpose and uses of the DYF website, http://dyfference.org, broken down into administrators, audience and content. Purple boxes represent proposed future uses of the site (e.g. Teachers - Find projects; Students - Find classes; Community members - Propose projects). (diagram by Lonny Grafman)

Currently the dyfference.org website uses the open source blogging platform Wordpress to share information about ongoing DYF efforts, such as invitation to Teacher Institutes. Augmenting the Wordpress architecture is Flickr for DYF photos, YouTube for DYF videos and Google Spreadsheets/Forms for interactive contact information for engineering mentors. The photos and videos allow for multimedia presentations of current and past DYF activities, such as Rube Goldberg inventions, student projects and events. The interactive form allows engineering professionals to post their availability, interest and ability to be a mentor for course related activities. Currently the website hosts information from one summer Teacher Institute, one high school Introduction to Design class, a few past on campus HSU Introduction to Design classes and seven engineering contacts.

The goal of the website is to further the mission of the Design Your Future program through outreach and by enabling the four major constituents to work together. This goal has been partially achieved. The website is working well for a small amount of outreach, educating some teachers, students and engineers about the DYF program. In addition, the website has partially met its goal of allowing the constituents to work together. Currently, teachers can more easily find engineers as mentors for their projects. Figure 1 also depicts, in purple, proposed future use enabling s students to find classes and teachers to post desires. In addition, in the future the site could incorporate one last and important constituent – the community. To more holistically address the goals of DYF, community members would not only be able to learn about the program, but also post community projects. Students in DYF courses could engineer solutions these service-learning projects with mentoring from local teachers.

The website is still in its development phase and has not yet been assessed. We are still developing our community of participants from our four constituent groups.

Pilot Run of Introduction to Design at Hoopa Valley High School

The third component of the North Coast Engineering Academies – Design Your Future (DYF) program at Humboldt State University was offering the Fall 2008 ENGR 215 for college and high school credit at a local high school. Dual enrollment or co-curricular courses, such as those used in the ACE program at Sacramento State University provide high school students an opportunity to earn college credit for classes they take through their high school. Students who complete such courses in high school are more likely to apply and attend the college from which they took the courses[6]. These college-like experiences have been shown to be particularly effective at recruiting low income, first generation and underrepresented students because the students establish a relationship with the university before applying to college[6]. These students are also more likely to be retained once they enter the university[6]. In addition, students who have taken engineering in middle school or high school are more likely to enter and be retained as engineering majors[4].

The objectives of the ENGR 215 Introduction to Design co-curricular course were:

- Recruit participants into engineering, science or computer studies
- Encourage students to attend HSU
- Promote/support skills development
- Encourage science, engineering, or computer preparatory pre-college course work
- Encourage science, engineering, or computer careers
- Increase students' confidence in their ability to succeed in college.

Principal Jennifer Lane agreed to pilot the ENGR 215 Introduction to Design co-curricular course at Hoopa Valley High School, which is located within the boundaries of the Hoopa Indian Reservation, and is the only public high school located on a reservation in the State of California. The school has about 230 students with the following ethnic breakdown: 78% American Indian, 17% white, 1% Hispanic, and 4% declined to state an ethnicity. Most students (83.2%) live below the state guidelines for poverty and the district claims 100% free and reduced lunch counts for the school[13].

Mr. Forrest Stamper, one of the DYF 2008 Teacher Institute participants agreed to co-teach the course. Sixteen students were selected for the course, 5 seniors, 9 juniors and 2 sophomores. All students were required to have at least a B grade average. The first week of the semester, the students traveled one hour to come to the HSU campus where they registered for their class and received their HSU library cards. They met Dr. Jacquelyn Bolman, Director of the HSU Indian Natural Resources Science and Engineering Program as well as ENGR 215 lecturer Lonny Grafman.

The first three weeks the students worked in four teams designing Rube Goldberg Devices (Figures 5-7). The last 16 weeks of the semester they developed design documents for their service learning project – a school garden. (The high school had earlier received a $2500 grant for a school garden). Three teams developed three designs for the garden. The course content was delivered to the students via the Moodle courseware management system. Students communicated with Professor Eschenbach using the Moodle message system. A senior HSU engineering student visited the high school campus twice a month to help the students develop computer skills. Professor Eschenbach visited the campus twice a month to assist with the student projects. Dr. Bolman and Lonny Grafman served as a design judges for student projects.

Figures 5-7: Hoopa Valley High School Rube Goldberg Devices from teams Sizzle Your Pits, The INJUNeers, and Hoopa Bear Traps

At the end of the fall 2008 semester, each of the three design teams submitted a significant design report. This spring semester, as part of their high school class (but no longer part of ENGR 215) the students have developed a final design for their school garden and are spending the semester building the garden (Figures 8 - 13). We anticipate that other students at the school will be intrigued by the garden building process and be interested in taking ENGR 215 in future semesters. Assessment methods and results are presented below.

Figures 8 – 10: Garden concept drawn by Kavi Engle with Google SketchUp. Hoopa Valley High School students break ground for the school garden. Kavi Engle holds his carved salmon for end of garden trellis.

Figures 11-13 Pateisha Ferris and Sara Chase decorate the garden entrance with wood burnings of native plants using both Hupa and common names.

Assessment Methods

The following sections describe the assessment activities for the DYF Teacher Institute and the DYF ENGR 215 class taught at Hoopa Valley High School.

DYF Teacher Institute

Fifteen K-12 educators participated in the DYF institute including six men and nine women. We used two mechanisms for assessment: a pre/post-institute knowledge and attitude instrument (Appendices B & C), and a modified focus group that Dr. Virnoche and Ms. Mills facilitated at the close of the institute (Appendix D). The pre/post instrument was designed to test changes in knowledge about engineering and the engineering design process, interest and confidence in teaching engineering concepts, as well as motivations for attending the institute. The modified focus group was designed to identify key strengths and areas for improvement.

Pilot ENGR 215 Introduction to Design

With support from Principal Lane (Appendix E) we requested permission for parents (Appendix F) and the students (Appendix G) to assess the students' experiences in the class. We again used two mechanisms for assessment: pre/post-surveys (Appendix H), and a modified focus group that we facilitated after the class was complete (Appendix I). Both these approaches are described below.

<u>Pre-Post Surveys</u>

AWE[14] Pre and Post Surveys were adapted to include questions keyed to specific objectives of the ENGR 215 Introduction to Design Co-Curricular course (listed above). The survey instruments contained both formative items to provide information on how to improve ENGR 215 and summative items designed to ascertain if ENGR 215 met its intended objectives. Specifically, the surveys assessed the following topics:

- Course-taking plans for high school
- Whether participant intends to study engineering
- What participant knows about what engineers do
- What factors (if any) about being an engineer appeal to participant
- Events or persons that influenced participants' study plans
- What participants plan to do after high school
- Participant satisfaction with the quality of the course.

Focus Groups

To acquire qualitative feedback regarding the DYF ENGR 215 course, focus groups were facilitated Ms. Atkins and Ms. Raymond after the post-survey was administered. Students were asked to discuss and write answers to the following questions:

1. How well did the course do in teaching you about the engineering design process? How come?
2. How have your ideas about what engineers do changed? How did this class affect your ideas about career possibilities?
3. This class was for "college credit." How has your experience affected your interest in attending college and what that might be like?
4. Considering this class will be taught to high school students in the future, what would you keep in class?
5. Considering this class will be taught to high school students in the future, what would you change about the class?

After 20 minutes of small group discussions, the classroom was arranged into a semicircle for a full group discussion. The large group discussion synthesized themes from small groups and identified points of agreement, as well as variation in experiences. Results are presented below.

DYF Teacher Institute Assessment Results and Discussion

Improving Teacher Understanding of Engineering and the Engineering Design Process

One of the main objectives of the DYF Teacher institute was to

- *Provide opportunities to experience the engineering design process first hand; teacher teams will complete a hands-on engineering design project at the institute.*

The purpose of this objective was to help teachers have a better understanding of engineering and the engineering design process. As mentioned earlier, most teachers are unfamiliar with the practice of engineering and engineering pathways[7].

Tables 1 and 2 provide five examples of the 15 teacher participant responses to the pre and post survey questions "What is engineering?" and "What is the engineering design process?". On the first day of the institute, teachers were provided multiple definitions of engineering and the engineering design process. They experienced the design process the entire week.

Table 1 Definition of Engineering – Selected DYF Teaching Institute Pre and Post Survey Results

Write your best definition of engineering. Assume that you are writing for students who are 16 years old.		
	Pre Institute Results	**Post Institute Results**
Respondent 1	*Engineering is hands-on, creative outlet to enhance the ability to interact with your environment through the construction of tools and systems.*	*The application of teamwork, creativity, technical writing, analysis and problem solving to create/construct tangible items/tools and systems.*
Respondent 2	*Engineering is how things work.*	*Engineering is a field that finds solutions to problems and tries to improve existing situations through the engineering design process.*
Respondent 3	*Engineering is using math, physics geology, etc to solve a perceived problem or to create something of benefit. This may concern the environment like river restoration or man/environment interactions such as a bridge or a dam.*	*Engineering is a field of science that uses many other sciences (math, geology, biology, technology) to design solutions to problems or benefit society)*
Respondent 4	*Engineering is a science that shows how things work in the natural world, from electrical to water flows, to design and development, mechanics and construction.*	*The process of design and implementing ideas and strategies about/how something works.*
Respondent 5	*The combination of design and physics ????*	*Engineering is a process: define problem, decide on criteria, research related issues, develop alternative solutions, evaluate solutions based on criteria, implement final solution, reflect and revise.*
Respondent 6	*Engineering is the incorporation of math and science to solve a problem in various fields, including bio, geo, electrical, etc.*	*Engineering is solving a problem using math and science. Implementing the design process in coming up with a solution.*

The selected responses shown in Tables 1 and 2 demonstrate that the teachers came to the institute with varied levels of prior knowledge of engineering. For example, one physical science teacher completed his EIT in mechanical engineering before becoming a teacher. Respondent 2's pre-institute entry in Table 2 identifies a few of the design process steps, and recognizes the iterative nature of the design process. Respondent 4's pre-institute entry in Table 2 self identifies as "clearly no engineering background".

The teachers came away from the DYF Teacher Institute with a much better understanding of what engineers do and what the engineering process is. Respondent 1 recognized engineers' need for teamwork, creativity and technical writing skills as well as recognizing the iterative nature of the design process (Table 2). Respondent 2's post-institute definition of engineering

(Table 1) became more focused on problem solving and improving existing designs. Respondents 2 and 6's definition of the design became more refined (Table 2). Respondent 3's definition of engineering did not change much (Table 1), however his or her definition of the design process is much improved (Table 2). Respondents 4 and 6's definition of engineering became more focused on the design process (Table 2). Respondent 4's understanding of the design process moved from the scientific method and more toward the design process (Table 2). Respondent 5 did not feel confident in the pre-survey for either response. For the post-survey responses Respondent 5 provided a detailed description of the design process (Tables 1 & 2).

Table 2 Definition of the Engineering Design Process – Selected DYF Teaching Institute Pre and Post Survey Results

Write your best definition of the engineering design process. Assume that you are writing for students who are 16 years old.		
	Pre Institute Results	**Post Institute Results**
Respondent 1	*Engineering design is a creative discovery of materials and instrument that can be transformed from a raw state to a useful device or system.*	*The engineering process is an iterative analysis of possible designs or specific strategies/solutions to meet the needs of a a common goal: Defining a problem, establishing criteria, gathering information and selecting possible solutions to then rate and choose a best design.*
Respondent 2	*Problem → ideas to solve problem → implement ideas → evaluate process (start again or adjust ideas if necessary).*	*Five basic steps: 1) Define problem, 2) Gather information 3) Generate solutions 4) Analyze solutions and pick one 5) Test solution and implement (fix, go back to any step if necessary).*
Respondent 3	*The design process is?*	*The design process is a series of steps taken to evaluate a need or problem, brainstorm on a solution, evaluated your solution and finally come up with a design.*
Respondent 4	*The design process in engineering follows the scientific method. First you ask a question (how something works) then develop an experimental design to answer the question.*	*The design process involves asking a question, creating a problem and developing a strategy to solve the problem. → Research, brainstorm, analyze, develop prototype.*
Respondent 5	*1. Decide on a set of desired characteristics* *2. Mathematically justify that the structure is sound.* *(Clearly … no engineering background)*	*Engineering is a process: define problem, decide on criteria, research related issues, develop alternative solutions, evaluate solutions based on criteria, implement final solution, reflect and revise.*
Respondent 6	*I am assuming it has something to do with the idea, then design, then build, test repeat?*	*Design idea → gather info → alternative solutions → best solution → design and implement.*

DYF Teacher Institute Participants Likely to Incorporate More Engineering Curriculum

Two of the DYF teaching institute objectives revolve around creating a community of teachers interested in using engineering approaches:

- *Develop awareness of existing engineering secondary school curriculum, K-12 engineering education research (see www.teachengineering.com).*
- *Develop a community of teachers interested in pursuing engineering approaches to teaching math and science.*

The pre and post surveys assessed the likelihood of teachers adapting their teaching approaches. The 15 participants spent an average of 28 out of 180 instruction days each year teaching engineering concepts. They anticipated that they could potentially teach engineering concepts on an average of 67 days. Even at the beginning of the institute, they reported being very likely to integrate more engineering into their curriculum (M = 8). While this likelihood increased by the end of the institute (M = 9), the change was not statistically significant.

In the focus group discussion participants were impressed with the multidisciplinary nature of engineering. They were excited that teaching engineering offered an opportunity to integrate math, science, public speaking, writing, service learning, creativity and teamwork. Participants suggested that in the future, the program be marketed to teachers of all subjects since teaching engineering is often an interdisciplinary effort; specifically, participants mentioned the importance of including language arts teachers because of the technical writing skills required, and social science teachers because of the research skills required to complete an engineering project.

Overwhelmingly the greatest critique of the institute was that the course content was not as expected. Many participants felt that one of the stated goals of integrating engineering into high school courses was not met; rather, the institute focused primarily on providing participants with the opportunity to experience a lower division engineering course: ENGR 215. It was suggested that meeting both course goals as stated in the marketing would be very difficult to meet in a one-week course. The participants suggested that one week be focused on experiencing the ENGR 215 course and a second week focus on integrating engineering into math and science curriculum.

Strong Organized Curriculum, But Not Enough "Take-a-Ways"

One of the DYF Teacher Institute objectives was:

- *Provide opportunities for reflection and curriculum planning during the institute. Participants will leave with tangible products to use during the school year.*

Via the focus group discussion, many participants expressed their appreciation for the opportunity to again take on the identity of a student. This experience reminded them of both of the frustrations that their students face when they do not understand ideas, but also of the satisfaction of perseverance and reaching goals. They were encouraged to shift from a student to a teacher role throughout the week and journal their experiences and ideas. Yet because of the pace of the institute and the project demands, most participants did not take enough time for this type of thinking and reflection.

Future Co-Instructors for ENGR 215

The final DYF Teacher Institute objective was

- *Identify teaching partners for teaching ENGR 215 Introduction to Design to high school students for 3 units of college credit in Spring 2009 or later. High school students will take ENGR 215 at their high school campus. Instruction would be available online from Humboldt State. Teacher partners will facilitate student projects and assignments.*

The 15 teachers that attended represented 4 different high schools (including Hoopa High School) and three middle schools. One additional high school partner was identified, Fortuna Union High School (FUHS). ENGR 215 will be taught at FUHS this fall semester.

Other DYF Teacher Institute Feedback

Modeled Hands-On Collaborative Learning

The focus group discussion identified that the hands-on, collaborative learning pedagogy was another strength of the institute. The participants appreciated the opportunity to do practical problem solving for a real client. Though they noted that they initially felt overwhelmed with the tasks at hand, they felt their hard work was "worth it" in the end. Each group successfully created a simple machine exhibit for the Discovery Museum.

Adding to the overall experience was the opportunity to work with excellent and energetic colleagues. One participant noted, "It's nice to know that not all teachers are burned out." They also found it satisfying to reach group project goals and to watch their peers meet goals throughout the week. Because participants enjoyed working with their colleagues, they suggested more time for collaboration and sharing.

Facilitated Contact with Engineers

The contact and quality of interactions with engineers was a central strength of the institute. Participants were inspired by the enthusiasm of the engineering instructors, as well as the community engineers. The presence of local engineering professionals at the dinner, and the general support offered by program coordinators, was evidence of community support for their K-12 teaching efforts. They were pleased with the community contacts and the interest and willingness of professionals to visit their classrooms. This network of contacts was a tangible benefit of the institute.

Participants requested that more time be spent with local professionals. They suggested short internships for teachers, opportunities to shadow professionals, and providing each group with a client engineer. In the latter case, they talked about working with a local engineer on one of the engineer's projects. But some participants noted that engineers did not always make the best teachers and that this type of pairing might not always be the best learning strategy.

Three weeks after the institute, a press event was held at the Discovery Museum and was attended by DYF Teacher Institute participants and local engineers. The teachers enjoyed showing their creations to the professional engineers.

Participants were also grateful to experience a "homey" and comfortable environment during institute activities, specifically mentioning snacks, coffee, and an on-site lunch service. The on-site services allowed them to stay focused and saved valuable time for project work.

Follow-Up Activities Should Focus on Integrating Concepts

Most participants expressed interest in creating or sharing guidelines to integrate engineering concepts into curriculum. This interest is consistent with previously mentioned findings from the focus group. Participants wanted to learn more about actual projects implemented in classrooms. Additionally, several participants wanted to spend some time following up with the teacher(s) who implemented the ENGR 215 course. Other suggestions included spending some time planning for next year's institute, follow up on Discovery Museum projects, hosting a county-wide Rube Goldberg design contest, and further networking with engineers.

As noted in the introduction to this report, most K-12 teachers are not familiar with the practice of engineering, nor the pathways to engineering careers. Their limited knowledge leads them to define engineering as difficult and reserved for those with superior abilities in math and science. Neither is an inspiring career message for their students. The institute reinforced the challenge of engineering education. Yet it also supported new definitions of engineering. Specifically the teachers were deeply satisfied with the collaborative work environment, their experiences addressing real client needs, and delivering an engineering product in a relatively short time.

While they never used the word "fun," there was a sense of enthusiasm and satisfaction with the experience. In addition, and perhaps most significantly, the teachers had a great deal of contact with "real" engineers. This exposure may go a long way in creating for their students more nuanced messages about the practice of engineering and the people who work in the field.

DYF ENGR 215 Introduction to Design Assessment Results and Discussion

The objectives of the DYF Introduction to Design class were to

- *Recruit participants into engineering, science or computer studies*
- *Encourage students to attend HSU*
- *Promote/support skills development*
- *Encourage science, engineering, or computer preparatory pre-college course work*
- *Encourage science, engineering, or computer careers*
- *Increase students' confidence in their ability to succeed in college.*

The data below show that the last objective was met. However, the data do not support that the other objectives have been met.

Pre-Post Surveys

Data from the Pre and Post Surveys was entered into SPSS and analyzed using paired samples t-tests. The difference of the means of variables were compared from the pre and post tests to see if there was an increase in interest to attend college, attend Humboldt State University, or study Engineering.

We were unable to obtain statistical differences between the means of the pre and post-survey measures of attitudinal changes. We attribute this lack of statistical difference to our small sample size of 10. Although 15 students were present to take the pre-survey, only 10 students took both the pre and post-surveys. Observed patterns on measures of course-taking plans or post high school plans were also difficult to assess.

For example, we predicted that students' interest in attending college and their interest in attending HSU would increase after the DYF course. The results of a one-tailed paired samples *t* test did not support this hypothesis, [$t(10) = 1.17$, $p > .05$] and [$t(10) = .516$, $p > .05$]. We also predicted that students' interest in studying Engineering would increase after the DYF course. The results of the paired samples *t*-test also did not support this hypothesis, [$t(10) = .289$, $p > .05$]. Table 3 reveals the significance levels for our measures of attitudinal changes for three questions from the pre and post surveys.

Focus Groups Analysis

The majority of students (10 of the 12 participating) reported having enjoyed the class and stated that they would recommend the course to other students. They believed that students should have the opportunity to take this class, as their school has few elective offerings. Regarding the structure of the class, most participants agreed that the information received before the class began helped them participate successfully. Furthermore, students found the instructions they received during the class to be effective and helpful. Most students reported that if they needed help in solving a problem or if they had a question during the activity, it was readily available. However, in the full group discussion, many students commented that they would have liked to have a teacher present in class more often and that it would have been beneficial to work with instructors who were more familiar with the topic. Along this line, students often felt the class was not well organized and that assignments were often given by email in between classes which interrupted the learning schedule they had already planned out. Students also felt that the projects and assignments were given too frequently. Breaks between assignments were requested in order for the students to have time to feel like they had accomplished something.

All students in the class favored the hands-on activities and projects over the written work and considered these activities to be valuable. Many students professed that they enjoyed feeling a sense of community in the classroom and that working in teams enhanced this attribute. Additionally, students generally agreed that working in groups helped them to manage their time better.

Table 3: Paired Samples Tests on Measures of Attitudinal Changes

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	What is the chance you will go to college?	.36364	1.02691	.30963	-.32625	1.05352	1.174	10	.267
Pair 2	If you decide to go to a college or university, what is the chance that you will study Engineering?	.18182	1.16775	.35209	-.60269	.96632	.516	10	.617
Pair 3	What is the chance that you will go to Humboldt State University?	.09091	1.04447	.31492	-.61077	.79259	.289	10	.779

*p < .05, one-tailed

Students' interest in attending college changed very little after the completion of the first semester of the DYF course. Most students who enrolled in the DYF course were already interested in pursuing college after high school (11 of the 12 that participated, with the 12th student planning to go into the military). However, the focus groups and full group discussion revealed that the DYF course made students feel less intimidated by the idea of college. The students reported that being successful in a college- level class made them feel more confident in succeeding in higher education. Students commented on appreciating the opportunity to learn new computer programs or improve their existing skills in programs (i.e CAD, Microsoft Word, Excel).

Students revealed that their perceptions of what engineers do broadened because of their participation in the DYF course. After completing the first semester of the DYF course, students realized that engineers do a lot of planning and preparation before applying ideas. However, when it came to the students' views on engineering as a course of study or as a career, student interest declined. The reason for not wanting to pursue engineering as a field of study or as a career, was mostly due to the realization that engineers do "too much paperwork."

Challenges of High School and University Collaboration

Organizational, cultural and technological differences between high school and college campuses presented challenges for the DYF distance education component. Because most Internet content is blocked from students on high school campuses, ENGR 215 students did not have ready access to content and information delivered through email, YouTube, and even Moodle, the courseware management system. The allotted time for class meetings varied by day and by week: Some days the class met for 70 minute and other days they it met for less than an hour. Computer systems were slow and broke down: Accessing the work took time away from doing the actual activities. In addition, the severe weather delayed class meetings and course schedules.

Future Work

Continuation of DYF ENGR 215 Assessment

At the end of the spring 2009 semester, the Hoopa Valley High School ENGR 215 students will submit a second post-assessment to monitor how their attitudes about engineering have changed. We also plan a second focus group session at the same time. We anticipate that the students will have completed their gardens and experienced the satisfaction of seeing their designs implemented. Their attitudes about pursuing engineering may be more positive at this time.

Future DYF Teacher Institutes

This spring there will be two Saturday DYF Teacher Institute Follow-ups. These follow-ups will be co-designed by the teachers to meet their stated needs.

This summer there will be at least two Design Your Future Teacher Institutes. One will be similar to the pilot course offered in Summer 2008 and will recruit potential co-instructors for ENGR 215 Introduction to Design. The second institute will offer small curricular approaches to integrating engineering concepts into secondary math and science courses. This institute will make use of the resources from Teach Engineering[15], Engineering the Future[11] and Project Lead The Way[12]. Participants will experience the curriculum and then have time to develop an approach that will fit their own curriculum. Planning for a third institute for K-6 instructors is also being considered.

Future DYF ENGR 215 Courses

Hands-on activities and group work will remain central to future DYF Introduction to Design courses. Students felt that working in teams was one of the most successful components of the DYF course. Computer work contributed to student confidence about pursuing college. Discussing the importance of education and continuing on to college is another aspect of the course that should remain. One student stated that the class showed him he could succeed in college and inspired him to pursue higher education in the future.

High School students much preferred the hands-on curriculum over the design documentation based curriculum. One option would be to add more of a hands-on element to the class and reduce the design documentation component. However, this type of curriculum change needs to be vetted at the HSU campus so that ENGR 215 for high school students remains a college credit class.

Future ENGR 215 courses should strive for better coordination between the on-site high school teachers and the university-based faculty members. High school teachers should be asked to play a central mentoring and instructional role as students work through assignments and projects. To ease the transition from high school to college level coursework, the on-site high school teacher should expect to build in more prompts and checks to support the successful completion of deliverables by deadlines. Support materials for high school teachers and students should draw on transcripts from Fall 2008 communications between faculty and students. And finally, as suggested by students, future ENGR 215 courses should incorporate small (and more frequent) assessments of content knowledge over the course of the semester: Online mini-quizzes on the steps of the design process would serve this purpose.

Conclusion

Humboldt County's Work Investment Board has identified 6 areas for sustained economic growth. Engineering is part of one of those areas and the county has identified the need to train more engineers for working in the area[16]. The Associate Superintendent of Humboldt County Office of Education has expressed great interest in furthering the goals of DYF so that workforce development can start in the high schools. Our local engineering firms also share this vision. Our hope is to further develop our DYF Teacher Institutes, online Introduction to Design course and our DYF website to allow educators, engineers and students to work together to build a sustainable local economy.

Acknowledgements

This project was supported with funds from the Humboldt State University's Chancellor's Office, the Humboldt State University President's Office and Provost's Office and the Redwood Science Project. HSU engineering undergraduate Tai Morgan graciously shared his enthusiasm, energy and expertise with the Hoopa Valley High School students. The authors thank the ENGR 215 students at Hoopa Valley High School for an opportunity to learn together while we experimented with this class.

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Appendix A Invitation: Introduction to Engineering Design Teaching Institute

The DYF Teacher Institute presents an engineering problem solving framework that can be used to teach science and mathematics in a rich, problem based learning context. Institute participants experience the design process, reflect on that experience and then plan how to integrate the design process into their teaching. This institute is for two audiences: The first audience is secondary math and science teachers who want to provide more real world context for learning. The second audience is high school math and science teachers interested in offering an Introduction to Design course at their school in partnership with Humboldt State University. High school students receive college credit for the Humboldt State University course ENGR 215: Introduction to Design, while taking the course at their high school. Part of the course would be offered online with HSU faculty.

Making a DYFference - DYF Institute Goals and Objectives

- Provide opportunities to experience the engineering design process first hand; teacher teams will complete a hands-on engineering design project at the institute.
- Provide opportunities for reflection and curriculum planning during the institute. Participants will leave with tangible products to use during the school year.
- Develop awareness of existing engineering secondary school curriculum, K-12 engineering education research (see **www.teachengineering.com**).
- Develop a community of teachers interested in pursuing engineering approaches to teaching math and science.
- Identify teaching partners for teaching ENGR 215 Introduction to Design to high school students for 3 units of college credit in Spring 2009 or later. High school students will take ENGR 215 at their high school campus. Instruction would be available online from Humboldt State. Teacher partners will facilitate student projects and assignments.

Benefits for DYF Institute Participants

In addition, to the benefits described above, Institute participants will receive:

- Resource materials to support the work as well as academic year consulting.
- A $875 Teaching Fellowship: $625 for the summer institute, $250 for two follow-up days in AY 08-09.
- Course credit options.
- Opportunity to team-teach a university course for university credit at institute participant's high school.

Commitment from DYF Institute Participants

- Attend the 5 days of DYF Institute: July 14th-18th
- Attend two follow up sessions (during academic year 08-09 two days release, dates TBA)
- Integrate elements of the engineering design approach during regular content instruction.
- Work with the DYF Research and Evaluation Team to facilitate our understanding of what works.

Appendix B Letter to Participants

Redwood Science Project + CSU Engineering Academies Initiative
Design Your Future Teacher Institute 2008
Humboldt State University

Participant Code: _____

July 14, 2008

Dear Institute Participant:

Thank you for participating in the program evaluation of the CSU Engineering Academies Initiative. Participation in the evaluation is voluntary, but your involvement will help all of us be more effective with the multiple facets of our program.

If you choose to participate in the evaluation, you will complete pre and post experience instruments that will assess knowledge, experience and attitudes about engineering education. In addition, you will be asked to participate in a post-experience facilitated discussion about the workshop. Most evaluation will take place during institute time. You may receive a short mail survey that asks about changes to your future teaching.

Individual responses from the program evaluation will be anonymous. You are asked to choose a participant code comprised of four digits or numbers. You may wish to record your code up above (or elsewhere) for your records. Please write this code on evaluation instruments.

While I do not anticipate that your involvement in this evaluation will pose any risks to you, you may find a benefit in reflecting on your interests and expectations regarding this workshop.

If you have any questions or concerns, please feel free to contact me by phone at 707-826-4569, or email at Mary.Virnoche@Humboldt.edu. If you would prefer, you may direct questions or concerns to Humboldt State University's Institutional Review Board at 707-826-3949.

Again, thank you for your participation!

Sincerely,

Dr. Mary E. Virnoche
Associate Professor and Chair
Department of Sociology

Appendix C Pre-Post Institute Instrument

Redwood Science Project + CSU Engineering Academies Initiative
Design Your Future Teacher Institute 2008
Humboldt State University

As part of our efforts to provide an effective institute experience this week, we would appreciate responses to the questions below. Please create a code (4 digits or letters) that you will remember for the week. This code will allow us to connect your pre experience responses with your post experience response, while also maintaining your anonymity. Thank you!

Participant Code __ __ __ __

1. Approximately how many days of the school year do you on average devote to teaching engineering concepts?

2. Approximately how many days of the school year could you devote to teaching engineering concepts if you were so inclined?

For Questions 3 through 13, circle the number that best reflects your response on the given scale.

3. How confident are you in teaching engineering concepts to your students?

(Not Confident at All) 1 2 3 4 5 6 7 8 9 10 (Very Confident)

4. How interested are you in teaching engineering concepts to your students?

(Not Interested at All) 1 2 3 4 5 6 7 8 9 10 (Very Interested)

5. How likely are you to integrate more engineering concepts into your curriculum?

(Not Likely) 1 2 3 4 5 6 7 8 9 10 (Very Likely)

In terms of your motivation for attending this workshop, how important were the following:
6. Enhance my math & science content knowledge and skills

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

7. Enhance math & science teaching strategies

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

8. Get to know and collaborate with other educators in the region

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

9. Interact with university faculty and personnel

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

10. Receive Course Credit

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

11. Receive a Stipend

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

12. Network for Job opportunities

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

13. Other (please state) _____

(Not Important) 1 2 3 4 5 6 7 8 9 10 (Very Important)

14. Write your best definition of engineering. Assume that you are writing something for students who are 16 years old.

15. Write your best definition of the engineering design process. Assume you are writing something for students who are 16 years old.

(The following question appeared only on the post-institute instrument)

16. What suggestions do you have for how to best spend our time at our Fall Follow-up? (The follow-up will be on a Saturday in either October or November.)

Appendix D Assessment Questions for Teaching Engineering Workshop
Individual Reflection

The Teaching Engineering Workshop was designed to provide middle and high school teachers with knowledge of fundamental concepts in engineering, experience with hands-on classroom exercises and activities and exposure to the professions and practices in the fields of engineering.

How and to what extent have your experiences in this workshop met these objectives?

1. Developed knowledge of fundamental concepts in engineering

2. Gained experience with hands-on classroom exercises and activities

3. Developed familiarity with the practices in the fields of engineering

Another goal of the Teaching Engineering Workshop was to increase interest and confidence in teaching engineering and/or connecting curriculum to engineering.

4. How and to what extent has the workshop increased your interest in teaching engineering?

5. How and to what extent has the workshop improved your confidence in teaching engineering?

6. What were the strengths of the Teaching Engineering Workshop?

7. What were the weaknesses of the Teaching Engineering Workshop?

8. What suggestions do you have in order to change and improve the workshop?
Assessment Questions for Teaching Engineering Workshop
Small Group Assessment

In your group please discuss and, where possible, build consensus on the following questions. Note divergent experiences as well.

What were the strengths of the Teaching Engineering Workshop?

What were the weaknesses of the Teaching Engineering Workshop?

What suggestions do you have in order to change and improve the Teaching Engineering Workshop?

Appendix E Cover Letter from High School Principal

August 25, 2008

Dear Parent or Guardian:

Thank you for taking time to review the "Design Your Future: North Coast Engineering Academies Concurrent Enrollment" information included with my letter. I have been working with Professor Eschenbach, an engineer at Humboldt State University, to increase the number of Hoopa High School graduates that pursue a college degree in science, engineering or mathematics.

Your son or daughter has selected to take ENGR 215 Introduction to Design at Hoopa High School this fall for Humboldt State University college credit. This fall is the first time this course will be taught at Hoopa. Your child is eligible for this program because of his or her strong academic performance. Research has shown that high school students that take college classes in high school are more likely to pursue university studies. Those students that take engineering classes in high school are more likely to major in engineering.

We want to assess this program so it is as effective as possible. As indicated in the enclosed materials, your child's privacy will be protected: his or her name will not be included in any reports produced by the project.

We want to provide as many opportunities as possible for our students. Please help us assess the effectiveness of this effort and return the materials provided.

Sincerely,

Jennifer Lane
Hoopa High School Principal

Appendix F Researchers' Letter to Parents or Guardian

HUMBOLDT STATE UNIVERSITY
Environmental Resources Engineering

Design Your Future
North Coast Engineering Academies
http://www.humboldt.edu/~dyf

August 24, 2008

Dear Parent or Guardian:

Your child is invited to participate in a study assessing the effectiveness of teaching ENGR 215 Introduction to Design to Hoopa High School students. If you give permission for your son or daughter to participate, he or she will be asked to participate in a pre and post survey and may also be invited to participate in a 1-2 hour small group discussion about the course and career decision-making. [Please note that participating in the study will not impact your child's grade in ENGR 215. Students taking ENGR 215 for college credit must abide by all university policies, including drop and withdrawal dates].

If you give permission for your child to participate in the assessment study of ENGR 215, you also have the right to withdraw your consent at any time. Your son or daughter may discontinue participation at any time and he or she also has the right to refuse to answer any question associated with the study. Your child's privacy will be maintained in all published and written materials resulting from this study. His or her name will not be used in any written materials generated from discussion group audio recordings and surveys. Any audio recordings will be destroyed at the close of the project. Any records that could link your child's identity with the information she provides for the study will be kept in a secure location. So while I do not see any risk to your child's participation, your child may benefit from having this outlet to express his or her feelings about the program and contribute to program improvement.

This project is partially funded by the California State University Engineering Academies project. The study is directed by Dr. Beth Eschenbach at Humboldt State University. If you have any questions or concerns, please contact Beth at by phone at (707) 826-4348 or by email at eae1@humboldt.edu. You may also contact Chris Hopper, Interim Dean for Research & Graduate Studies and Graduate Programs at (707)826-3949, cah3@humboldt.edu. You will find more information about the Design Your Future North Coast Engineering Academies project on the Internet: http://www.humboldt.edu/~dyf.

Sincerely,

Elizabeth A. Eschenbach, Ph.D.
Professor
707-826-4348, eae1@humboldt.edu

Please keep one copy of this letter and return a signed copy to Forrest Stamper

I give permission for _____ to participate in the study discussed above.
(Print Girl's First and Last Name)

Ethnicity _____ School _____ Year in School _____

Address _____ _____
City _____ Parent or Legal Guardian Name (Please Print)
Zip Code _____ _____ _____
Phone Number _____ Parent or Legal Guardian Signature Date

Appendix G Assent Form

HUMBOLDT STATE UNIVERSITY
Environmental Resources Engineering

Design Your Future
North Coast Engineering Academies
http://www.humboldt.edu/~dyf

AGREEMENT TO PARTICIPATE

Assessment of ENGR 215 Introduction to Design

You are asked to participate in a 2 surveys to determine the effectiveness of teaching ENGR 215 Introduction to Design at Hoopa High School. One survey will be given at the beginning of the semester and one at the end of the semester. They will be given during class time at Hoopa High School. We will use the information from the survey responses in order to improve the class for future Hoopa High School students and to help others that want to teach similar classes. We may also invite you to participate in a 1-2 hour small group discussion about the course and career decision-making.

Please know your participation is voluntary. Your grade will not be impacted by your participation in the pre and post assessments or the group discussion. You do not have to answer all the questions and you can leave the discussion at any time. Your name will not be used in reports that are written. So while I do not see any risk to your participation, you may benefit from having this outlet to express his or her feelings about the program and contribute to program improvement.

This study is funded by the North Coast Engineering Academies Project. If you have any questions now or later about this project, you can contact Beth Eschenbach at (707) 826-4348 or Beth.Eschenbach@humboldt.edu. Beth teaches environmental engineering at Humboldt.

I have read the above and agree to participate in this study.

_____

Student Name

_____

Student Signature

Appendix H Post High School Student Survey

ENGR 215 Project

Immediate Post-Activity Survey for High School-aged Participants - Engineering

Dear ENGR 215: Introduction to Design students!

Thank you for taking the time to fill out this survey, which will take about 10 minutes to complete.

If you have questions about the survey, ask any of the people administering it or call Beth Eschenbach at 707-826-4348.

Name: _____

(Please **PRINT** your first and last name)

(Participant ID #

Participant ID Number: _____

E-mail: _____

ENGR 215 Project
Post-Activity Survey
January 10, 2009

(Participant ID # provided by or completed by activity organizer)

Participant ID Number: _____
Tell us about you

1. **Gender**:

   ☐ Female
   ☐ Male

2. **Race/Ethnicity**: (You may check more than one, as appropriate).

   ☐ African/Black American
   ☐ American Indian/Alaskan Native
   ☐ Asian & Pacific American
   ☐ Latina/Latino/Hispanic American
   ☐ White American
   ☐ Other: _____

3. **Education**: Check the grade that you are in now or, if it is summer, check the grade you will enter next fall.
   Check only one.

   3a. ☐ 9th ☐ 10th ☐ 11th ☐ 12th ☐ Graduating

   3b. Name of High School: _____
   If home schooled, write "home schooled"

   3c. Year You Graduate from High School: _____

4. From the list below, check which classes you are currently taking in school this year OR, if you have completed a school year, the classes that you plan to take in your next school year. **Check all that apply.**

   ☐ Algebra I
   ☐ Algebra II
   ☐ Calculus
   ☐ Chemistry
   ☐ Computer Applications
   ☐ Computer Science
   ☐ Drafting or CAD (Computer-Aided Drawing)
   ☐ Earth or Physical Science
   ☐ Engineering
   ☐ English
   ☐ Other Language
   ☐ General Math
   ☐ Geometry
   ☐ History/Social Studies
   ☐ Music
   ☐ Physics
   ☐ Pre-Calculus
   ☐ Technology Education
   ☐ Other math, engineering or science courses:_____

		Yes	No	Not Available
4a.	Are you currently enrolled in honors or advanced classes?	☐	☐	☐
4b.	Have you been encouraged to enroll in honors or advanced classes?	☐	☐	☐
4c.	Are you enrolled in a special engineering or science curriculum?	☐	☐	☐
4d.	Do you plan to enroll in honors or advanced classes next year?	☐	☐	☐

5. Has anyone talked to you about the importance of . . .

5a.	Taking classes that will prepare you for college?	☐ Yes	☐ No
5b.	Math to your future career?	☐ Yes	☐ No

6. What do you plan to do when you graduate from high school? **Check only one.**

- ☐ Go to a college or university
- ☐ Attend a technical school (for example: business school, beauty school, technology school, etc)
- ☐ Get a full-time job
- ☐ Join the military
- ☐ Don't know
- ☐ Other: _____

Tell us why you are here

7. My goals for participating in this activity were to: (**Check all that apply**)

- ☐ Have fun
- ☐ Learn more about Humboldt State University
- ☐ Learn about what engineers do
- ☐ Meet other kids with interests similar to mine
- ☐ Not sure
- ☐ Have something to do
- ☐ Learn more about different majors in college (e.g., engineering, science, computers, etc.)
- ☐ Make my parents/guardians happy
- ☐ Prepare me to do well in school
- ☐ Other: _____

8. Help us improve the activity by telling us what you think about the activity by checking the appropriate box:

		Strongly Disagree	Disagree	Agree	Strongly Agree
a)	The information I received about the activity **before** it began helped me to participate successfully	☐	☐	☐	☐
b)	I found the instructions and information I received **during** the activity to be effective and helpful.	☐	☐	☐	☐
c)	If I needed help in solving a problem or had a question during the activity, it was readily available.	☐	☐	☐	☐
d)	I found it easy to get to know the other participants in this activity.	☐	☐	☐	☐
e)	The leaders for this activity were prepared.	☐	☐	☐	☐
f)	This activity was well organized.	☐	☐	☐	☐
g)	My goals for participating in this activity were met.	☐	☐	☐	☐
h)	I learned about the importance of teamwork.	☐	☐	☐	☐
i)	I developed time-management skills.				
j)	I became more confident in using computer soft-wares (eg. Word, Excel, or CAD).	☐	☐	☐	☐

9. How much did participating in this activity impact each of the following?

My participation in this activity:	Not at All	Slightly	Moderately	A Great Deal
a) Helped me understand engineering better.	☐	☐	☐	☐
b) Led me to a better understanding of my own career goals.	☐	☐	☐	☐
c) Increased my interest in studying engineering in college.	☐	☐	☐	☐
d) Made me think more about what I will do after graduating from high school.	☐	☐	☐	☐
e) Made me decide to work harder in school.	☐	☐	☐	☐
f) Made me to decide to take different classes in school (including college) than I had planned to.	☐	☐	☐	☐
g) Made me more confident in my ability to succeed in engineering.	☐	☐	☐	☐
h) Increased my confidence in my ability to participate in engineering projects or activities.	☐	☐	☐	☐

10. Please respond to the following two-part question regarding your participation in this activity (please write in whole sentences):
    a) What did you like best about this activity?

    b) If you were in charge, how would you change this activity?

11. Will you recommend that your friends participate in this activity? ☐ Yes ☐ No
    Please explain why or why not (using whole sentences):

12. What do engineers do?

Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement.

Engineers:	**Agree**	**Disagree**	**Don't Know**
a) Mainly work on machines and computers	☐	☐	☐
b) Mainly work with other people to solve problems	☐	☐	☐
c) Can choose to do many different kinds of jobs	☐	☐	☐
d) Have lots of choices about what they can do in their jobs	☐	☐	☐
e) Mainly work on things that have nothing to do with me	☐	☐	☐
f) I don't know what engineers do	☐	☐	☐
g) Other (please write in whole sentences):			

13. If you go to college, do you think you will pursue a career in an engineering-related field?
☐ Yes ☐ No ☐ Don't Know

14. In your future, do you think you want to be an engineer?
☐ Yes ☐ No ☐ Don't Know

15. Has anyone talked to you about becoming an engineer? ☐ Yes ☐ No

If yes, put a check by everyone who has talked to you about this:

- ☐ Engineering or technology teacher
- ☐ Family members
- ☐ Family friends
- ☐ Guidance counselor
- ☐ Math teacher
- ☐ Science teacher
- ☐ Computer teacher
- ☐ Other (provide kind of person or teacher, not name):
  _____

Tell us about your goals

16. The following statements describe work or jobs you might do in the future. Tell us how important each of the items below is to you in your future work.

How important is it to you to do . . .	***Not Important***	***Somewhat Important***	***Very Important***
a) Work that makes me think	☐	☐	☐
b) Work that allows me to make lots of money	☐	☐	☐
c) Work that allows me to use math, computer, engineering or science skills	☐	☐	☐
d) Work that allows me to tell other people what to do	☐	☐	☐
e) Work that allows me to help solve problems and create solutions	☐	☐	☐
f) Work that is fun to do	☐	☐	☐
g) Work that allows me to have time with family	☐	☐	☐
h) Work that allows me to help my community and/or society	☐	☐	☐
i) Work that makes people think highly of me	☐	☐	☐
j) Work that is satisfying to me.	☐	☐	☐

17. What do you think engineers might make or invent that could make a difference in your life (either good or bad)? (Please write in whole sentences)

Tell us what you do

18. If you encounter a math homework problem that you don't know how to solve, what are you most likely to do? **Check no more than 3 options below.**

- ☐ Ask a parent or other family member for help with the problem
- ☐ Call or meet with a friend who you know is good at math and ask her or him for help so I can solve it
- ☐ Contact Homework Hotline or similar resource
- ☐ Get help from my math teacher on this problem
- ☐ Work it out with my study group
- ☐ Go to the teacher's Web page for help
- ☐ Copy the answer from one of my friends
- ☐ Search the Internet for help
- ☐ Take some time and try to figure out how to best approach solving this problem
- ☐ Other (please specify):

19. This is an example of an advanced math problem:

$$\int \frac{\left(\frac{2}{9}\right)}{x+1}dx + \int \frac{\left(-\frac{4}{3}\right)}{(x+1)^2}dx + \int \frac{\left(\frac{7}{9}\right)}{x-2}dx = \frac{2}{9}\ln|x+1| + \frac{4}{3}\left(\frac{1}{x+1}\right) + \frac{7}{9}\ln|x-2| + C$$

Check the box below that best describes your ability to learn to solve this example math problem? **Check only one.**

- ☐ I can solve this problem now.
- ☐ I can teach myself to solve this problem.
- ☐ I will be able to learn to solve this problem once I take the right classes.
- ☐ Even if I took the right class, I wouldn't be able to learn to solve this problem.
- ☐ I don't think I will ever take a class that has problems this hard.
- ☐ I am not interested in learning to solve this type of math problem.
- ☐ Other (please specify):

20. The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things.

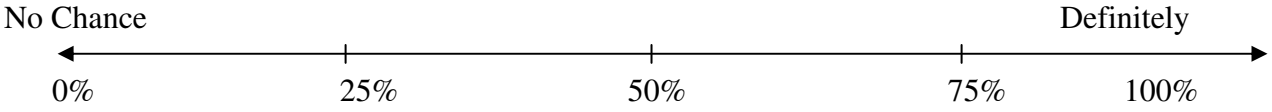
	Never	***Sometimes***	***Very Often***	***Always***
a) When I see a new math problem, I can use what I have learned to solve the problem.	☐	☐	☐	☐
b) I can use what I know to design and build something mechanical that works.	☐	☐	☐	☐
c) In lab activities, I can use what I have learned to design a solution to a problem.	☐	☐	☐	☐
d) I can effectively lead a team to design and build a hands-on project.	☐	☐	☐	☐
e) I know where I can find the information that I need to solve difficult problems.	☐	☐	☐	☐
f) I can use what I have learned to teach myself how to program a computer game.	☐	☐	☐	☐
g) I can explain math or science to my friends to help them understand.	☐	☐	☐	☐
h) I can get good grades in math.	☐	☐	☐	☐
i) I can get good grades in science.	☐	☐	☐	☐

Tell us what you think

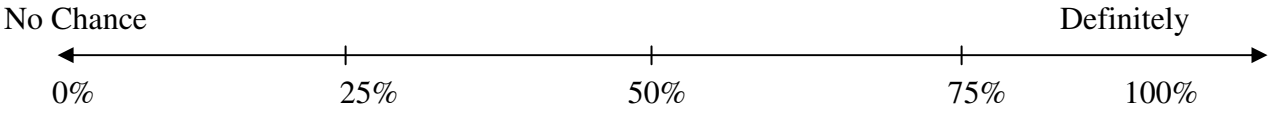
21. Here is a list of statements. Tell us what <u>you</u> think about them. Select a response that indicates your level of agreement.

	How much do you agree or disagree with this sentence?			
	Strongly Disagree	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
a) I look forward to science class in school.	☐	☐	☐	☐
b) I look forward to math class in school.	☐	☐	☐	☐
c) I would rather solve a problem by doing an experiment than be told the answer.	☐	☐	☐	☐
d) More time should be spent on hands-on projects in science or technology activities at school.	☐	☐	☐	☐
e) I would like to (or already do) belong to a science or technology activities club.	☐	☐	☐	☐
f) I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	☐	☐	☐	☐
g) I like to get science books or science experiments kits as presents.	☐	☐	☐	☐
h) I like learning how things work.	☐	☐	☐	☐
i) Science is too hard when it involves math.	☐	☐	☐	☐
j) Science is a difficult subject.	☐	☐	☐	☐
k) Doing experiments in science is frustrating.	☐	☐	☐	☐
l) I feel comfortable with using a computer to make graphs and tables.	☐	☐	☐	☐
m) I am interested in learning more about how computers work.	☐	☐	☐	☐
n) I like to learn to use new computer software.	☐	☐	☐	☐

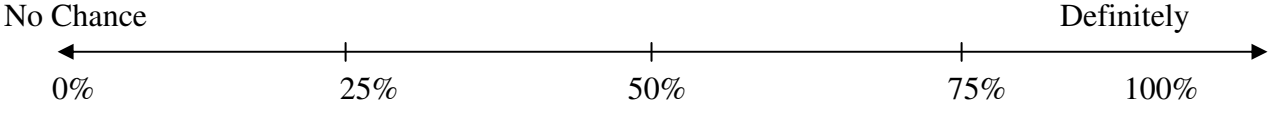
22. What is the chance that you will go to college?
Indicate by marking an "x" on the line below. *If you do not know, check here* ☐:



23. If you decide to go to a college or university, what is the chance that you will study Engineering?
Indicate by marking an "x" on the line below. *If you do not know, check here* ☐:



24. What is the chance that you will go to Humboldt State University?
Indicate by marking an "x" on the line below. *If you do not know, check here* ☐:



Thank you!

Appendix I High School Focus Group Questions

Focus Group Questions for the Design Your Future
ENG 215 *Introduction to Design*

Note: Your participation in this workshop assessment is completely voluntary and your responses are confidential.

Your instructors believe that this class should have helped you learn about basic engineering design ideas and helped you also learn about some of the things that engineers can do. You might even be thinking about becoming an engineer – or perhaps you have decided that engineering is not for you. We would like to find more about that today.

Here are some "warm up questions." We will collect your group's answers. But jotting notes here may help you with the later large group discussions. After a few minutes, we will break up into small groups for you to discuss your answers with your peers. Then we'll talk about this as a large group and discover the range of experiences and ideas that you all have come up with.

1. How well did the course do in teaching you about the engineering design process? How come?
2. How have your ideas about what engineers do changed? How did this class affect your ideas about career possibilities?
3. This class was for "college credit." How has your experience affected your interest in attending college and what that might be like?
4. Considering this class will be taught to high school students in the future, what would you keep in class?
5. Considering this class will be taught to high school students in the future, what would you change about the class?