# Outcomes Assessment Results of a Multi-disciplinary First -Year Engineering Course at the University of New Haven

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Abstract

An assessment of the effects of a multi-disciplinary first-year engineering course was conducted at the University of New Haven during the spring, 1998. It is the students' first exposure to engineering and probably their first meaningful design experience. It starts with engineering applications and concepts in problem solving, and ends with introduction to design. This is the first place the student is introduced to industrial quality design tools through the use of design environment that provides such features as simulations, animation and virtual laboratory.

The assessment tools for this course include course profiles, classic tests, projects, oral presentations, written reports and student surveys. Two surveys were conducted during the semester, one at the beginning and one at the end of the semester. The first survey was designed to measure student perceptions about themselves and their skills in several topics such as mathematics, computer usage, and team and communication skills. The second survey was designed for outcome assessment of achieving the course objectives and the level of increasing their skills.

The assessment results show a very strong correlation between student satisfaction measured by the survey and active experience in the classroom. The assessment of the course by students has led to increased hands-on projects, multimedia technology usage, computer simulations, and assignments linked more closely to real-world applications.

## I. Introduction

ES 107, Introduction to Engineering, is a three semester-hour course introducing students to engineering disciplines, professional practice and ethics, creative problem solving, basic computer skills, team skills, and technical presentations. The course is required for all freshman engineering students and a majority of non-engineering majors at the University of New Haven take it as a scientific methodology elective. The course introduces future engineers as well as non-engineering students to various disciplines of engineering, the fundamental concepts of design, representation of technical data and theoretical concepts. This course is conducted as a lecture course with several computer simulations as well as virtual and hands-on projects assigned throughout the semester.

ABET's new assessment criteria require faculty to demonstrate that the graduates are

acquiring the necessary knowledge and skills, and, where deficiencies exist, they are being corrected [1-5]. This led the faculty to assess the course and to measure the knowledge the students acquired. The assessment of the course by students has led to increased hands-on projects, multimedia technology, computer simulations, and assignments linked more closely to real-world applications.

## II. The Course Goals and Contents

The primary objectives of this course are to provide a foundation for lifelong learning of computer, teamwork, creative thinking, professional, and personal development skills. Heavy emphasis is placed on computer skills, hands-on experience and the development of team and communication skills. Students work in teams on their projects. These projects include bridge design and investigating a topic in advanced technology. Lecture and discussion topics include the design process, engineering concepts, probability and statistics, introduction to manufacturing processes, and basic mechanical and electrical components.

The main goals of ES 107 are to able to:

- understand engineering disciplines and professional expectations
- use computers and computer software
- effectively and professionally communicate ideas and technical information to the public and to fellow and other professionals in written and oral report
- work effectively in multi-disciplinary teams and, when necessary, to pro-actively resolve problems with team dynamics
- use programs that simulate real world problems
- understand how to use the information superhighway, or Internet
- identify, formulate, and solve engineering problems.

The outline of the course syllabus is given below

| Week | Date in 1998 | Lectures | Subject | Reading | Activity |
|---|---|---|---|---|---|
| 1 | Sept 2 | | Introduction to the Course | | |
| 2 | Sept 7-9 | 1A-C | Engineering &Science | Class Notes | HW #1<br>Due Sept23 |
| 3 | Sept 4 | 2A<br>3A-B | History of Technology<br>Scope of Modern Engineering | Class Notes | |
| 3 | Sept 14<br><br><br><br>Sept 16 | 4A-B | Engineering Concepts<br><br><br>Using the Internet<br>How to create Homepage | Library & Internet | Lab 1: Internet Resource Exercise<br><br>Lab 2: Creating your own Web Homepage |
| 4 | Sept 21 - 23 | | How to create Homepage | | Lab 3 : |

| | | | | | |
|---|---|---|---|---|---|
| | | 6A | Problem Solving Strategy | | Interactive Problem solving |
| 5 | Sept 28 - 30 | Notes 4 | Quiz # 1<br>Speaker: Ethics in the Workplace.<br>Introduction: Spreadsheets | | |
| 6 | Oct. 5- 7 | Notes 4 | Field Trip<br>Intro to statistical measurements | Class notes | Lab 4: Lotus exercises |
| 7 | Oct 12 - 14 | Notes 5 | Linear regression, curve fitting | Class Notes | Select a topic for your final project |
| 8 | Oct 19 -21 | Notes 5 | Mechanics: Engineering concepts | Class notes | |
| 9 | Oct 26- 28 | Notes 5 | Design Process | Class Notes | |
| 10 | Nov 2 - 4 | | Modeling and simulation | | Lab 5: Bridge design |
| 11 | Nov 9 - 11 | Notes 6 | Technical communications<br>Computer-aided Presentation | | Project 2: design a bridge |
| 12 | Nov 16 - 17 | | Speaker: Engineering profession--what is it?<br>Field Trip | | |
| 13 | Nov 23 - 25 | | Quiz # 2<br>Open Week | | |
| 14 | Nov 30<br>Dec 2 | | Review<br>Oral Presentation | | Final project due |
| 15 | Dec 7-9 | | Oral Presentation | | |

III. The West Point Bridge Design Challenge

The students were given various projects through out the course. The design specification given to students for the " West Point Bridge Designer" is: design the most economical bridge which satisfies the specifications below [6]:

1. The new structure will be a truss bridge. It will consist of a single span, with length of 24 meters measured from support to support.
2. The bridge will rest on a pinned support at one end and a roller support at the other end.
3. The roadway will be level.
4. To provide clearance for over head power lines, the height of the bridge will not exceed

8 meters.

5. To ensure that the bridge is not submerged during flooding, the depth of the bridge will not exceed 6 meters.

Each student was assigned a team. Each team consists of two students of different disciplines and were given one week to complete this project. They were graded based on the satisfaction of the above specification and the total cost of designing the bridge.

## IV. Outcomes Assessment

The purpose of the evaluation was to assess how much knowledge the students acquired in the course. One hundred students from 15 majors, equally divided between male and female, were surveyed in the second week and at the end of the semester. The most critical phase of the assessment was the development of the qualitative outcomes assessment tools. The survey was developed using the following steps:

1. The course goals and expected outcomes were identified.
2. Specific criteria and assessment tools for the course were designed.
3. The assessment schedule was established.
4. Assessments were conducted and recorded

The assessment tools for this course include course profile, classic tests, presentations, written reports and student surveys.

Course Profile: a course profile was developed by the instructor to describe the course objectives and the classroom activities associated with specific learning goals.

Assignments: the assignment is a short scenario that sets up the context of an engineering problem. Students were asked to describe the process they would engage to solve the problem.

Presentations: a team of two or three students works in a project and present their work to the class. Students complete self/peer evaluations of each team. Self/peer evaluations make students more aware of, and responsible for, their own development.

Student Surveys**:** were used to gage student satisfaction during the course. Two surveys were conducted during the semester, one at the beginning and one at the end of the semester. . These surveys were reconciled with the course profiles provided by the instructor to see if the faculty objectives were met and with the performance assessment to see if there were any correlation between satisfaction and attainment.

Survey Results (Student Feedback and Comments):

Two surveys were conducted during the semester to assess students in the course at both the beginning and the end of the semester. The first survey was designed to measure student perceptions of their skills in topics such as math, computer, team skill and communication. The second survey dealt with outcome assessment. The purpose of the evaluation was to assess how much knowledge the students acquired in the course.

V. Beginning of the Semester Survey

The first survey was presented in the beginning of the semester. Students were asked to rate their skills in the areas listed below and the importance of these subjects. Students were also asked about the subjects needing their greatest and least attention:

a. Writing skills
b. Oral communication skills
c. Ability to work with others
d. Commitment to become engineer
e. Professional and standards
f. Positive attitude toward life
g. Computer skills
h. Proficiency in mathematics
i. Participation in student organization
j. Degree you work collaboratively with others
k . Time and energy devoted to study
l. Time spent on Campus
m. Overall grade point average

Results of the First Survey

Students' Goals

The list of goals that students wanted to achieve in life was varied. Included in the list were the following:

1- Obtain college degree
2- Stay as debt free as possible
3- Get a rewarding job
4- Obtain good grades
5- Have a happy family
6- Form long lasting friendship (find a soul mate)
7- Get a graduate degree
8- Have own business
9- Have own house and car
10- Acquire physical fitness

Self Assessment:

2. Rate yourself on a scale of 0 to 10 ( 10 being highest) on the following:

| Item | Description | Average |
|---|---|---|

| | | rating |
|---|---|---|
| a. | Writing skills | 6.6 |
| b. | Oral communication skills | 6.9 |
| c. | Ability to work with other people | 8 |
| d. | Commitment to becoming an engineer or ----------(specify) | 6.9 |
| e. | Professional and ethical standards | 8.4 |
| f. | Positive attitude toward life | 8.2 |
| g. | Computer skills | 6.3 |
| h. | Proficiency in mathematics | 6.3 |
| i. | Participation in student organization | 4.5 |
| j. | Degree you work collaboratively with other students | 6.6 |
| k. | Time and energy devoted to study | 6.6 |
| l. | Time spent on Campus | 5.9 |
| m. | Overall grade point average | 7.5 |

Table 1 - Student Perceptions

Table 1 shows the average of all responses of all questions regarding the evaluation of Student's skills in the thirteen areas listed in the table. The nontechnical skills of critical thinking, ability to work with others, professional and ethical standards, a positive attitude toward life are given the highest rating. The students give themselves average scores in writing skills and oral communications. The rating was below average in math and computer skills

What do students think?

3. Rate items below on a scale of 0 to 10 (10 being highest) as to their importance:

| Item | Description | Average rating |
|---|---|---|
| a | Writing skills | 7.8 |

| | | |
|---|---|---|
| b | Oral communication skills | 8.6 |
| c | Ability to work with other people | 8.8 |
| d | Commitment to becoming an engineer or ----------(specify) | 7.2 |
| e | Professional and ethical standards | 8.8 |
| f | Positive attitude toward life | 8.8 |
| g | Computer skills | 8 |
| h | Proficiency in mathematics | 7.2 |
| i | Participation in student organization | 5.0 |
| j | Degree you work collaboratively with other students | 7.1 |
| k | Time and energy devoted to study | 8.2 |
| l | Time spent on Campus | 5.1 |
| m | Overall grade point average | 8.1 |

Table 2 - Student Responses about the Importance of Various Skills

Table 2 shows the average of all responses to the questions on the survey regarding the importance of the thirteen skills listed in the table. Communication skills, computer skills, and proficiency in mathematics are given the highest average importance. The majority of students think it is very important to master communications skills, computers and mathematics. The ability to work with others was also rated very highly by students. Students rated very low the importance of spending time on campus as well as participation in student organizations.

Subjects Need Student Greatest Attention

Computer skills and proficiency in math are the subjects rated as needing the students greatest attention, followed by writing and oral communication skills. The survey stresses that communication skills, computer and mathematics proficiency are important but also need students' greatest attention. The survey also shows that students say that time spent on campus, ability to work with others, and participation in students organization require the least attention by students. The average response for the technical skills tends to suggest teaching some of these skills in separate courses, in particular mathematical analysis and computer software.

Student's Expectations of Faculty

Six things that students would like their professors do for them in addition to providing them with classroom instruction are:

1. Be a role model.
2. Provide guidance and challenges.
3. Help find job/internships.
4. Show real life experience.
5. Give career advising..
6. Assist in networking.

VI. End of the Semester Survey

At the close of the semester, an extensive survey was administered to the students in three sections of 100 students. The survey focused on 11 areas.

Topics Covered in the Course:

The first part of the survey asked addresses topics in the course that students would like to see covered in more depth, eliminated or minimized. The majority of students said that most topics were covered adequately, as implied in the following results.

88% of students feel engineering disciplines were adequately covered
38% think more depth is required in computer skills
43% say computer graphics requires more depth
74% think field trips during the course were adequate
32% would like to have more speakers from industry
83% believe spreadsheets and computer-aided presentation were adequately emphasized
92% of the students say oral presentation was OK as is.
71% believe hands-on projects are covered reasonably well.
91% say written communication were covered reasonably well
89% feel engineer ethics was properly covered
74% believe design processes were adequately covered

Student Improvement

The third question asked the students to rate their improvement in the following areas: visual thinking, appreciation of engineering field, oral and written communication skills, team skills, basic mechanical and electrical hardware, material usage and selection, computer skills, awareness of design process and appreciation for good design.

The results show that:

- 92% of students believe that their visual thinking has improved
- 93% believe they now have a better understanding of engineering
- 83% think their oral communication skills are enhanced
- 80% say their written skills have improved
- 89% say their computer skills are better after taking this course
- 89% stated that their team skills are enhanced

- 97% say that their skills in design process have improved

Lectures Contributed the Most to the Overall Learning Experience

The fourth question required the students to identify lecture contributed the most to the overall learning experience. Computer skills, ethics in the workplace, design process and computer-aided presentation were the most frequently mentioned. Some comments made by students were:

*- Computer aided programs taught me how to put my presentation in slides and what have you*
*-Ethics in the workplace*
*-I liked the design process it showed how engineers go about solving problems*
*-Building of objects and making sure they work (bridges) I never knew how much work was put into these processes*
*-Spreadsheets they are handy for everyone to use*

Lectures Contributed the Least to the Overall Learning Experience

The history of engineering and solar car lectures contributed the least to the overall learning experience. A student said:

*- Automotive, because there is not much to say about a car meaning we know what the chassis does we know what the wheels do etc.*

What Would Students Say about the Course?

The sixth question requested information about the course. 92% said they would recommend the course to other students. Here are some comments made by students:

*-Yes, take it. Very interesting*
*-Out of the 4 choices required in the humanities section I would tell them to take this course, but I really think the school needs to eliminate this section as a requirement.*
*-Yes, because it deals with the basics of engineering and it is not impossible to learn.*
*-It is the best of the scientific electives to take*
*-You really should. You get the big picture on engineering and computers.*
*-You can learn a lot of information in this course and you should take it*
*-Yes, because it is a course where you learn things not taught in any other class*
*-Interesting course which teaches you the basics to engineering, which is general enough to absorb information but detailed enough to introduce to new field*
*-Yes I learned about a field that I had very little knowledge of the purpose of education to become well rounded*
*-I will say yes and I would encourage them to take it because of the computer skills that I got in this course I would say yes*
*-Yes because it is necessary to understand why things work*
*-Yes it was interesting. Projects were good.*
*-Yes, it was a good course and I am a new student and I learned a lot*
*-It depended on who asked me and what their major was*

*-Yes, it is a good introduction to the field of engineering.*
*-I enjoyed it very much.*
*-Be prepared to work*
*-Yes, it was a great survey of many topics which can really help to improve computer and team working skills*
*-Take it! (It is) a good class that emphasizes team work and problem solving*
*-Yes, it comes in handy and is great for other people who are not engineering majors*
*-I would recommend it. It enhances many different skills.*

Course Overall Rating

The seventh question in the survey allowed students to rate the class overall.

20 % of students rated the course excellent
48 % rated the course good
31 % rated the course OK
1 % rated the course poor

Student Commitment Toward Engineering

The eighth question in the survey addressed increased commitment or enthusiasm for engineering as a career. 39% of the students say this course increased their commitment or enthusiasm for engineering as a career.

Class Activities

The ninth question required students to rate the value of each class activities as a learning experience for sophomore level students. Regarding learning experience, the following observation were made:

- 96% say the student presentations were an ok, good or excellent part of learning process
- 98% feel bridge design was an ok, good or excellent part of learning process
- 95% believe computer-aided presentation contributed to the learning process
- 96% think speakers from industry contribute greatly to learning process
- 97% say field trips are a good idea

Degree of Difficulties of Topics Covered in the Class

The tenth question required students to rate the degree of difficulty of each topic covered in class. 78% of students think that the degree of difficulty of the projects and class activities were average.

Student Experience with Oral Presentation:

The eleventh question addressed improvement of the presentation they made in class if they were to give it again. The majority of students was pleased with their performance and enjoyed the experience. Some comments were:

*-I would use computer- aided presentation instead of overheads, but I would first need more practice using computers.*
*-Make it less technical*
*-Try to get better pictures related to my topic*
*-Have more knowledge*
*-I would use more graphs on the computer.*
*-Pick a topic of interest*
*-I would slow down a bit and be less nervous*
*-More participation from my partner*
*-I would bring in a demo model.*
*-The hardest part of the presentation was narrowing down the topic.*
*-Get more information this time I couldn't get enough resources*
*-Put more information on the computer and less on the index cards*
*-I would have more time to work on it*
*-I would put more pictures and have copies of my paper for everyone*
*-Be less nervous speak more clearly be more organized in terms of what she was going to say and what I was going to say*
*-Go into greater detail during the speech*
*-Go first I got too nervous watching everyone else*
*-Much better because I'm shy and scared to talk in front of people. I guess I would do it much better cause I will not be shy again.*
*-I would add more graphs and hand out flyers*
*-If I was not burdened with anxiety, I would have been able to speak more fluently, and my ideas would have been more coherent*
*-Sound more enthusiastic about the topic and also ask questions for my audience to answer as part of my presentation*
*-More time for preparation on my part*
*-More visual aids and wide use of material*
*-None I thought we did a good job*
*-I need to explain more and improve my presentation*
*-I would speak slower and go over all my material (I left some out)*
*-I would time myself beforehand*
*-I was very nervous it was my first presentation I would practice my speech more*
*-I would bring in objects for people to view and I would have more confidence in myself when I give oral presentations*
*-I would try to get the class more involved in my presentation*

Student Expectations:

Finally question twelfth disclosed student expectations coming into the class that were not met.

- 92% of the students say their expectations were met in this course.

- The overwhelming majority of the students say the hands-on activity allowed them to practice engineering science fundamentals in the solution of real life problems.

Comments included the following students:

*- Yes, to learn design processes and learn how to fix certain problems*
*-I didn't expect to learn so much about the Internet & computer, that was good.*
*-I expected to be challenged more as a student*
*-Most of my expectations for the class were met*
*-I thought it would be worse that it was, all math but it turned out to be really fun*
*-No, I learned a great deal about engineering*
*-At first I did not know what to expect but I am glad I came because I learned things I never knew*
*-My instincts thought this was going to be a very difficult course. The course turned out to be challenging, but the student is not overworked. This is necessary because the program is introductory. This allows the student to fully enjoy the course.*
*-I thought it would be more of how things work*
*-The class was very enjoyable.*
*-I enjoyed this class and the activities we did.*
*-All expectations were met.*

Student Experience in the Course:

Some students said:

- *I enjoyed this class a lot. Your enthusiasm was a great benefit to your teaching style. I would recommend this class to anyone.*
- *The class was arranged for non-engineer majors. This made it better for a student like me.*
- *You did a great job. I appreciate your enthusiasm for teaching.*
- *The course was very enlightening. My computer skills were enhanced. Even though, I work in the law enforcement, it related to my job (presentations and computer skills.)*
- *……understanding the importance of working as a team was one of the most important element of this course*
- *…I have found this course to be very useful in that it covers a variety of topics in a very thoughtful approach.*
- *Each project needs more time to complete properly. But each topic is important and contributes to the overall aspect of engineering.*
- *I thought that it was too much material to absorb*
- *"..The teamwork aspect of the class was great. It gave my partners and I mutual understanding of the topics. We shared knowledge and learned different approaches to attack problems*
- *More computer work, I would like to know more. The interview project was very interesting. I learned a lot about different departments and where things were on campus. Interviewing someone was also fun and interesting. I like oral presentations because I*

*really like talking in front of people. I thought things were good. I learned a lot.*

- *The class was very enjoyable.*

## VII. Conclusions

The results of the surveys show a high degree of acceptance and satisfaction. The results also show that high levels of importance are attached to instruction several non-technical as well as technical skills (communication skills, proficiency in mathematics and computer skills). On the technical side, problem solving, design skills and computer skills are considered very important. On the other hand, theoretical analysis and statistical skills are not considered to be as vital, nor are the non-technical skills associated with engineering history.

Another clear conclusion is that more emphasis should be placed on developing students problem solving and computer skills, in particular by introducing these skills across the curriculum instead of confining them to a single course.

Finally, the results indicate that there is a desire for more hands-on projects, computer simulations, oral presentation and technical writing and design. The results show that students are very curious to know more about engineering skills and technology. It is clear from the survey that computer activities in the classroom make the course enjoyable, interesting and appealing to engineering students as well as non-engineering students.

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