Session: FB2-4

HOW THE CAPSTONE CLASS STUDENTS PERCEIVE THEIR KNOWLEDGE BASE

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Abstract

The Senior Capstone Course is a year long, 5-credit Research and Development course covering all aspects of project development and implementation, entrepreneurship, innovation, creativity, team-work, and technical communication. The philosophy behind the course is to provide training and real-world, small-scale project experience for the students. This is where students work in teams and apply the culmination of their knowledge in the computer engineering technology program. The paper presents how students in the Senior Capstone Course perceive their knowledge base. This self-assessment is conducted in the first day of the class and the second one is conducted after the final examination. In addition, instructor asks knowledge-base questions, questions regarding the work experience, hours worked, credit hours taken currently, membership in professional organizations, expected date of graduation, and expectations from the course. Additional comments on strengths and weaknesses of the course represent the qualitative questions. The analysis of the information gathered at the beginning of the semester help the management team to understand the composition of each team, their strengths and weaknesses, how much each team member can contribute to their team, whether the combination of hours worked and credit hours taken are in line with the University of Houston guidelines, etc. During the first week of the semester, once the results are tallied, one-on-one meetings were held with the students that were identified as having potential conflicts and who realized to have time constraints. Timely advice is given to these students so that they are successful to complete the course. Once the results of the self-knowledge at the end of the semester are tallied, they are compared to the results at the beginning of the semester, conclusions are drawn, and action items are identified that can help the curriculum remain current and in focus.

1. Introduction

The Senior Capstone Course in its present format can accommodate a maximum of 48 students. It is presently a two semester long course. The students work in teams of four or else a team of three students (due to enrollment issues). Students are provided the freedom to choose their team members. Two student surveys are conducted during the start of the session – a self-assessment survey and a time block survey. The first survey is a self-assessment of the student's knowledge in this field and also gives information about their work schedule. The second is a time block survey for deciding the open laboratory hours (hours outside the normal class and lab hours). As a result, students can make a proper schedule for their work and utilize better time management.

The work schedule is necessary to avoid employment conflicts since most of the students work either part time or full time. The Senior Capstone Course presently has three graduate students, down from five due to budget constraints, who are hired through an intensive interview process and are provided training and orientation for their jobs. Each graduate assistant works for four to five semesters.

2. The Components for Students to Perceive Knowledge

The Senior Capstone Course uses several components which aid the students to perceive knowledge. These components are very well standardized and distributed over the entire two semesters which ensures the complete and continuous learning of the students. These components are:

Senior Capstone Course Components [1-8]

Books- Two books are assigned during the first semester, often known as the proposal phase. One on engineering design and the other covers creativity. Reading assignments from current technology magazines are given routinely. Effective spring 2010, another book will be assigned during the second semester, often known as project phase.

Lectures- Nine lessons are presented during the first semester. The lectures are synchronized with the two books and are supplemented with additional information. The lectures are presented in the form of discussions rather than the traditional lectures. The first lesson is an overview of the entire course. Students have access to the lecture notes through the course web portal, discussed later. During the second semester, case studies are mostly discussed.

Homework- Each semester, there are four to five homework assignments. The homework has five to six questions and students work on the homework individually. Each homework is designed to address specific knowledge requirements and often are open ended. Most assignments require a degree of research and they are drawn from the author's years in the industries and consulting for the high-tech companies.

Exams- Closed book and notes midterm exam and final exam is given during the first semester. Most questions are drawn from the two books, lessons, guest speaker presentations and workshops which ensures and tests their grasp on the contents. The questions given during the second semester are case study questions and scenario type questions.

Workshops- Three workshops are given at the beginning of the first semester. The first workshop is a three-hour hands-on training to use the Microsoft Project. The Microsoft Project is used for Gantt chart to track teams' progress and is conducted by the Information Technology trainer at the University of Houston (UH). In the second workshop, students are introduced to the UH policies regarding intellectual property and patent. The workshop is conducted by the office of Research and Intellectual Property Management. The third workshop is on research in technical and science libraries and is presented by the College of Technology Librarian.

Guest Speakers-The guest speaker series is designed to introduce students to the real- world challenges. The speakers are engaged in the cutting age of their industry. They often bring in a new perspective to the senior project. A few of the speakers are members of the ET industrial advisory board and are familiar with the curriculum and provide valuable feedback for the improvement of the senior project course. Others are entrepreneurs and CEOs and enlighten the students by discussing the success of their companies. These guest speakers influence the students a lot as they not only learn about the various phases of project cycle but are also exposed to the latest trends in the technical fields.

ET Faculty Speakers- Volunteer faculty members who are interested in mentoring students present their research and expertise during the first semester. A separate policy governs the ET faculty mentorship.

Laboratory Assistants Presentations- All assistants assigned to the Senior Capstone Course are formally introduced to the students. Each assistant makes a short presentation and students will get to know them and understand the areas of their expertise. These presentations often give an idea to the students regarding their project topic and help them to learn from their experiences.

Progress Reports- Each team submits a weekly progress report. Specific guidelines and requirements are provided to the students. The format of these reports follows strict industry standards which enhance their technical writing skills.

Project Proposal- The project proposal consists of a pre-proposal presentation and report and final proposal presentation and report. Each team must clearly address the following items in their presentations and reports:

- Benefits of the product or process to the end customer
- Project objectives tied to the project specifications
- Strategy for achieving project objectives
- Detail plan of action divided into a number of tasks to be performed by individual member of the project team to achieve the project objectives
- Time schedule depicting weekly progress and individual/team assignments
- Cost analysis
- Design verification procedures
- Procedures to quantify prototype performance

Students are required to select their proposals from the following broad categories:

- Medical Technology
- Bio-Medical Technology
- Security Technology
- DoD Technology
- Technology for Mobile Robots
- Space Technology
- Technology Impacting Societies
- Technology for Developing/Underdeveloped Countries
- Technology to Assist Elders

- Technology to Assist People Who Are Physically Disadvantaged
- Technology for Alternate Energy
- Forensic Technology

Final Project- The final project consists of a preliminary project and final project presentations, and reports. Following the final presentations, students will demonstrate their prototypes. This is the most exciting event for the students and the department. UH Faculty, industry guests, staff and other students are invited during the presentation and demonstration. The final report consists of an Executive Summary, Newsletter, Product Requirements, Design Specifications & Description, Construction Details, Cost Analysis, User Instructions, etc. Multiple assessment instruments are used during this event.

The above components were an essential component in the Senior Capstone Course for spring 2009 semester and investigated student perceptions of their skills in these areas at the beginning and end of each semester. The data is categorized in the following areas:

- Real Project Experience
- Customer Interaction
- Research Skills
- Writing Skills
- Presentation Skills
- Hardware Skills
- Leadership Skills
- Team Player Skills
- Professional Ethics

The following data is taken in form for a carefully designed **Beginning of the Semester Survey** [See Appendix 1] and **End of the Semester Survey** [See Appendix 2]. These surveys provide the data and metrics to measure the growth of the students in the above mentioned skill areas and gives a direct estimate of the knowledge perceived by the students.

2.1 Real Project Experience

This Senior Capstone Course provides students an environment similar to a real-world industrial environment. Students have an opportunity to apply theoretical concepts to real hardware and software designing of the products. This course demands professionalism from students and helps them in making the transition from student life to the real world. The development of real project skills is evident in Fig. 1. This outcome is expected given the project-based nature of the course. Regardless of the starting level, all teams reported an increase in real project skills over the course of the semester.

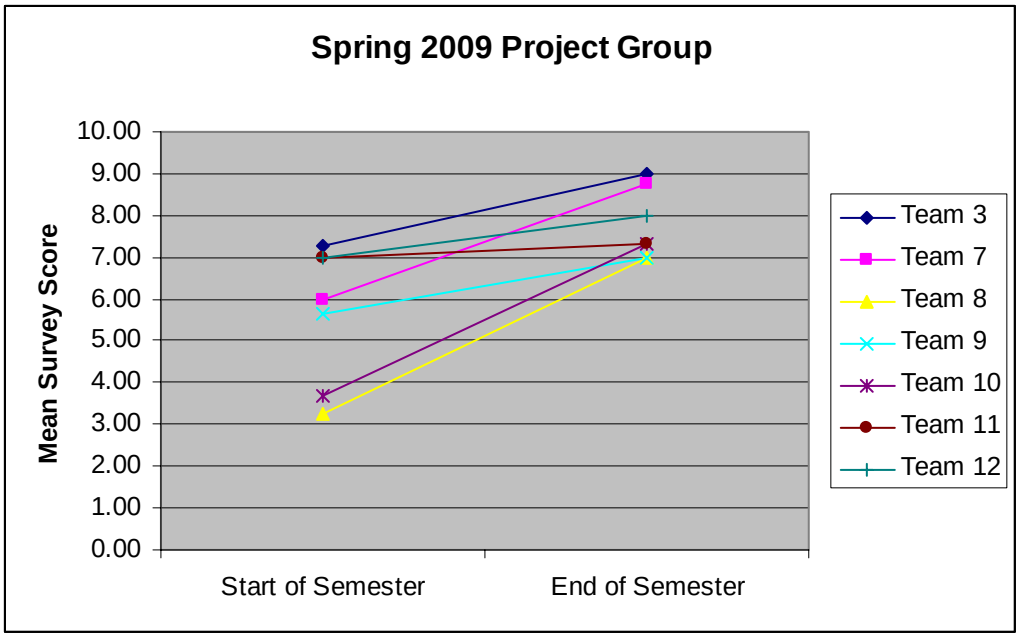

Figure 1. Real project experience

2.2 Customer Interaction

Customer interaction is a necessary component of the product life cycle. Customer feedback informs decisions regarding the feasibility of the product in the marketplace by helping gauge demand. Therefore, it is suggested that students look for customers for their products. Student perceptions of their own customer interaction skills are presented in Fig. 2.

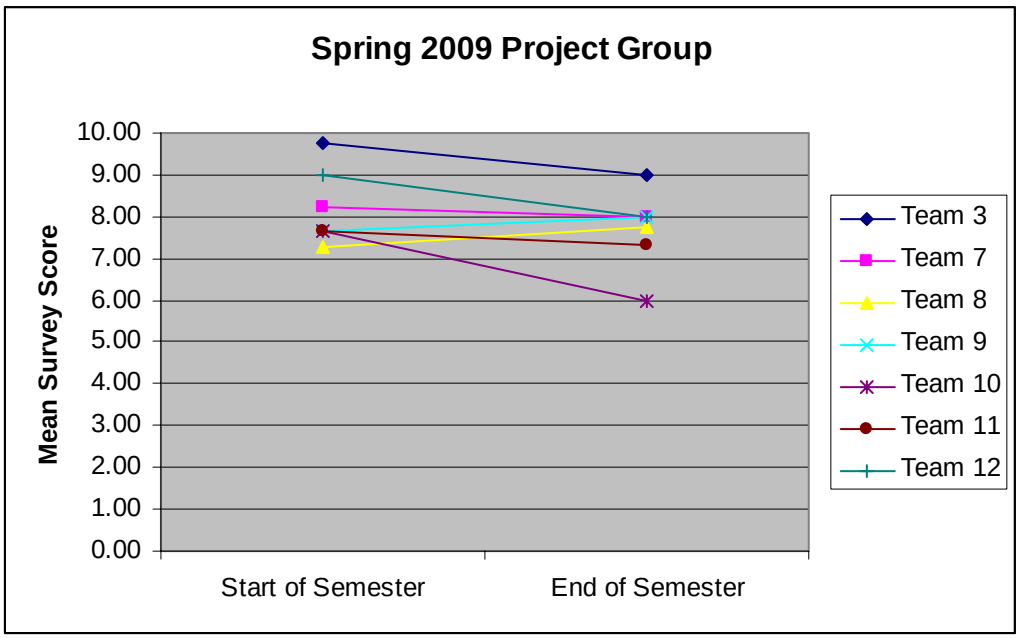

Figure 2. Customer Interaction

The results of the pre-post survey indicate the course needs to improve the opportunities presented to students for development of customer related skills since there was a general downward trend through the semester.

2.3 Research Skills

Research is the backbone for creating a new product. Research is required at every stage of product cycle from the initial brainstorming to making the final product and even to market it. The students are given a library session to help them in researching ideas for their projects through databases, patents, books, online articles, etc. Figure 3 shows the results from the pre-post survey indicate that students generally perceive themselves as having made improvements over time. However, the instructor should make note of the two teams (11 and 12) that either showed no improvement or declined somewhat.

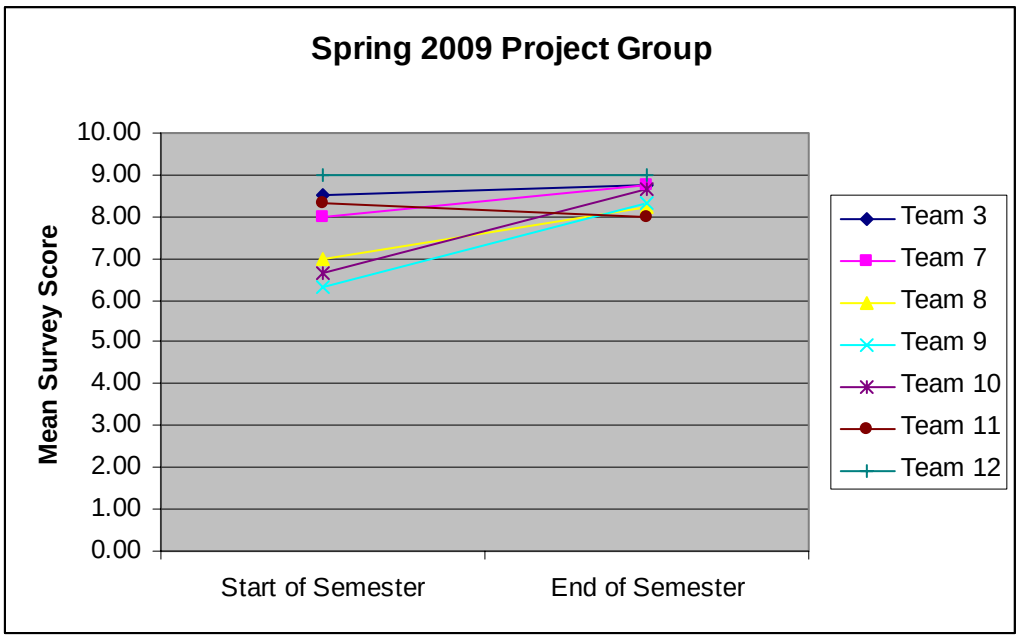

Figure 3. Research Skills

2.4 Writing Skills

The ability to communicate an idea through writing is a valuable skill in any industry. As such, there is a healthy amount of writing for the class. Students are required to write Weekly Progress Reports that include descriptions of what they accomplished the previous week, their plan for the following week, and the challenges they are facing. Students must also write proposals and final project reports. As suggested by Fig. 4, all but two teams indicate improvement in writing skills.

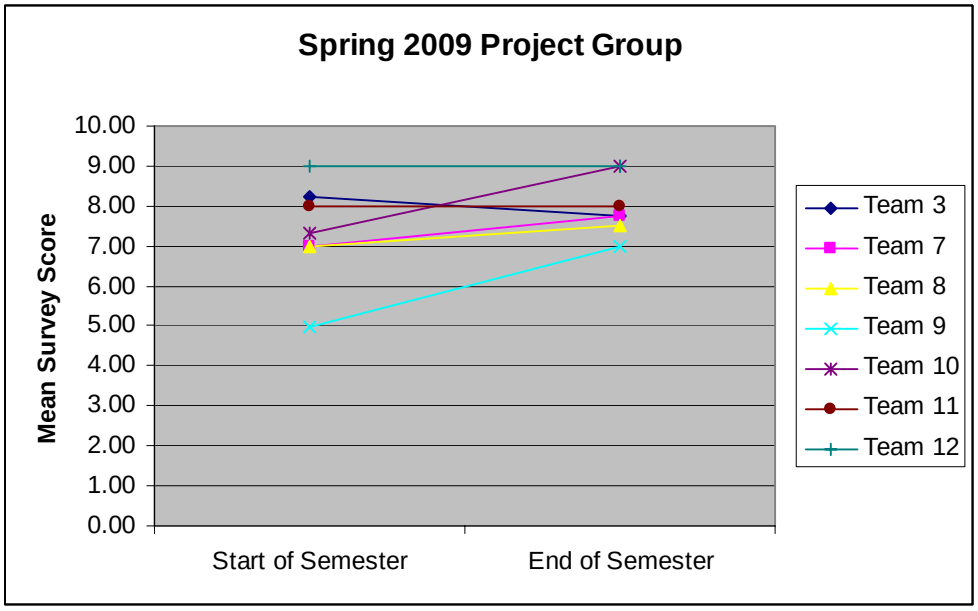

Figure 4. Writing Skills

2.5 Presentation Skills

The ability to deliver a coherent presentation is critical for helping audiences to understand a concept or product or simply to communicate an idea. Students are expected to give a proposal presentation once they have developed a final idea. They must also make a final presentation and demonstration after the completion of their project. Most students reported small gains in this area. However, three teams (3, 11, and 12) show no gains or a slight decrease. It should be noted that Team 3 had already self-reported a high level of presentation skills. The results are shown in Fig. 5

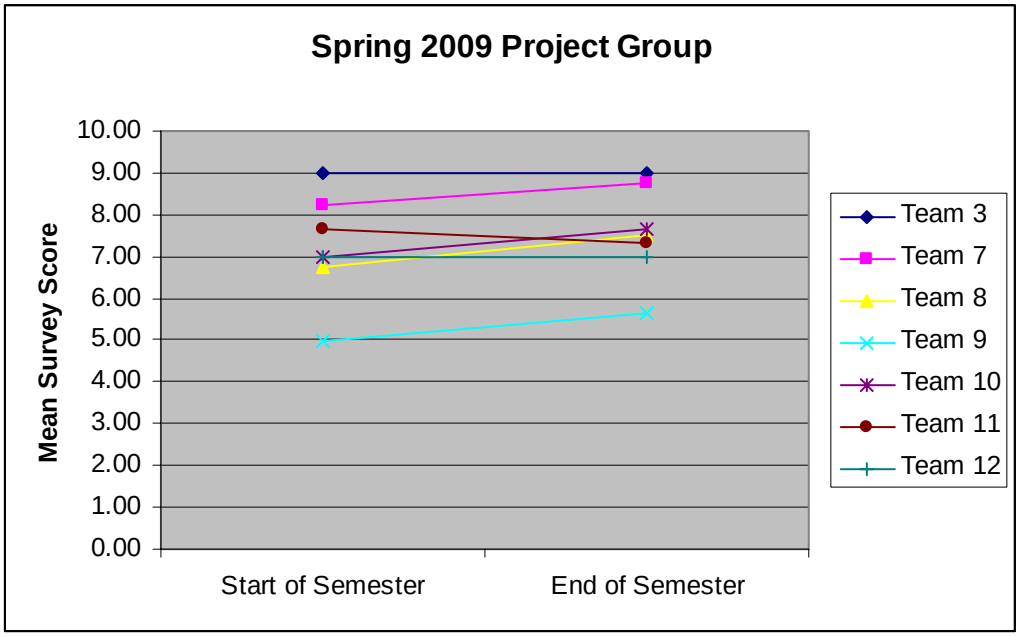

Figure 5. Presentation Skills

2.6 Software Skills

Software skills are an integral part of the project in this course. Part of their classroom experience includes hands-on training with MS Project. The various skills learned by students are applied to the project. As suggested by the results in Fig. 6, most teams reported increases in software skills over the course of the semester. However, two teams (3 and 9) reported no gains or a decrease in the skill set.

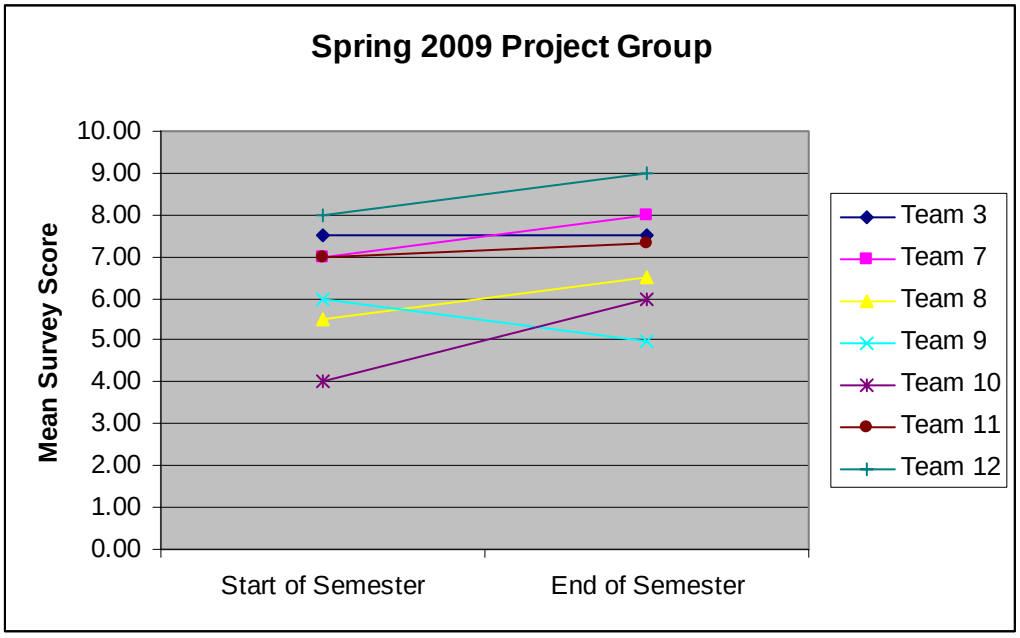

Figure 6. Software Skills

2.7 Hardware Skills

Hardware skill is an indispensable component of the Senior Capstone Course. Students need to integrate the hardware and software for successful completion of their project. Results of this aspect of the survey, shown in Fig. 7, indicate a need to revisit the hardware component of the course. Only two teams reported increases in hardware skills. Although, it should be noted both of these teams self-reported skill levels below all remaining groups. Most of the other groups reported no change with the exception of Team 3 which indicated a noticeable decline. The instructor for the course will need to revisit this aspect of the project to develop an improvement strategy.

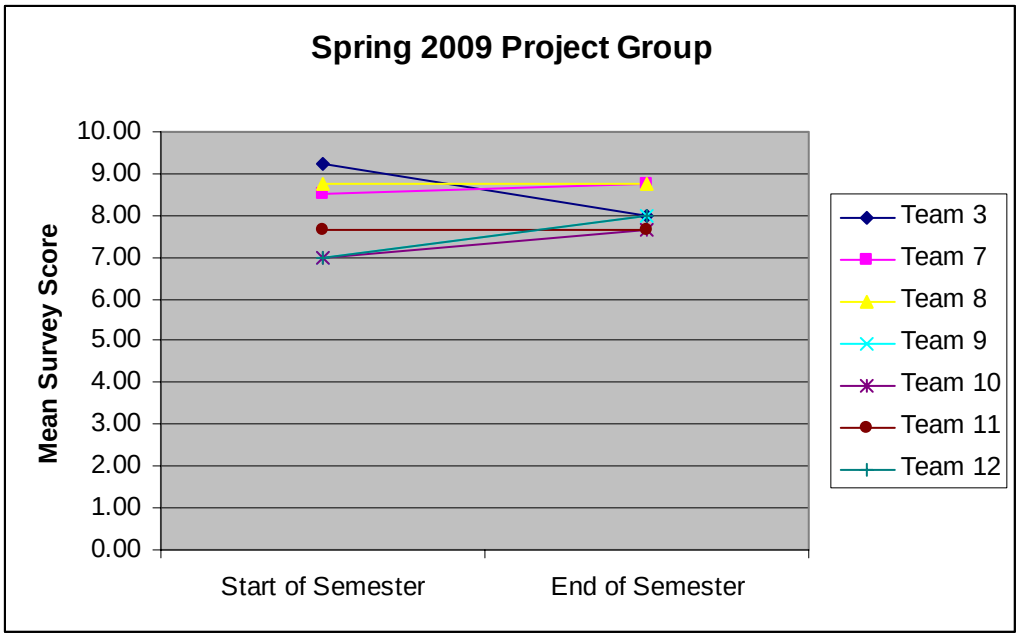

Figure 7. Hardware Skills

2.8 Leadership Skills

Every group has to choose a group leader among them. The leader decides the line of action for the group with suggestion from other members. Figure 8 shows the results and indicates a wide range of patterns on a team by team basis. Teams 10 and 12 – starting from slightly different places – indicated roughly two point gains in leadership skills. However, Team 3 reported a nearly equivalent drop. The remaining groups reported minimal changes to leadership skill levels over time.

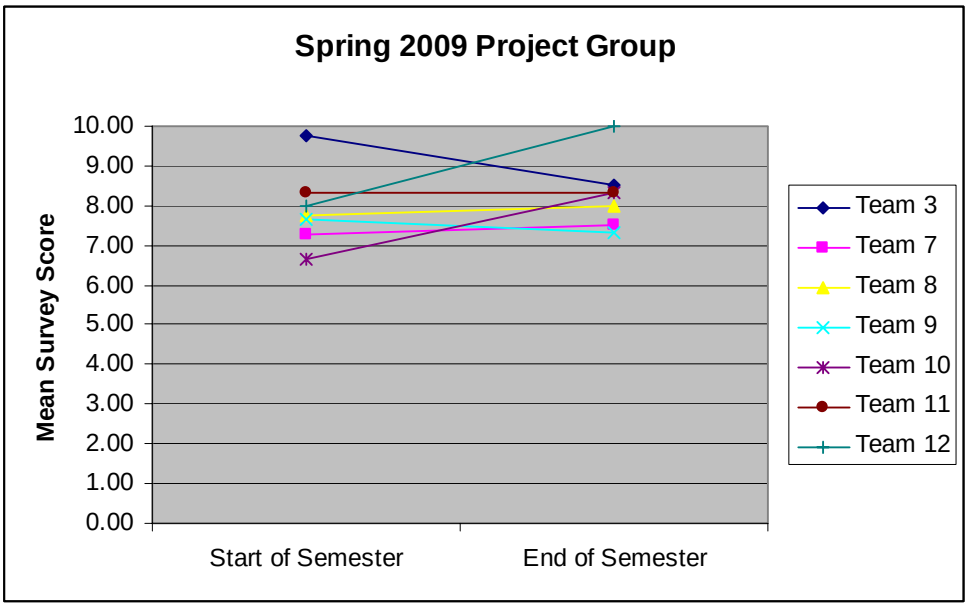

Figure 8. Leadership Skills

2.9 Team Player

A team is a group of people who come together to achieve a common goal. Students form a team of four and work together to achieve their goal. All members need to be good team players for better coordination among themselves and success of their work. If there is a rift amongst them then they can lag behind the desired schedule. Figure 10 shows the interpretation of results in this case is muddled by the fact that all teams generally rated themselves very high on team work skills in the beginning. No team averaged below 8 on the initial rating. Generally, there was an upward trend in skill development with only two teams reporting no gains or a slight decrease. However, in each of these cases, the final reported level was still high.

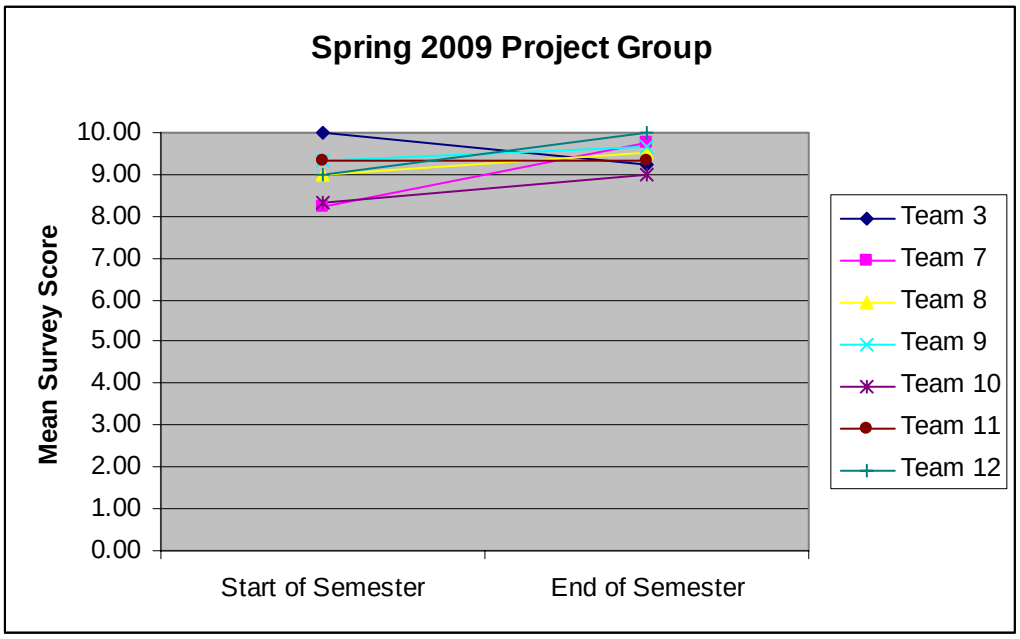

Figure 9. Team Player

2.10 Professional Ethics

This Senior Capstone Course strives to reflect the expectations of a professional working environment. The recognition and application of professional ethics is embedded in this context. Students are expected to adhere to practice ethical behavior in terms of completing their work. In particular, students must be mindful of issues like plagiarism and proper citation of research that has informed their projects. Figure 10 reflects team level perceptions of their growth and understanding of professional ethics relative to their involvement in the course. Overall results for this characteristic were mixed. Three groups indicated gains in their understanding of professional ethics while three groups suggested declines. One group, remained largely unchanged. However, all self-ratings in this area were relatively high with all but one group rating themselves a nine or higher on the final survey.

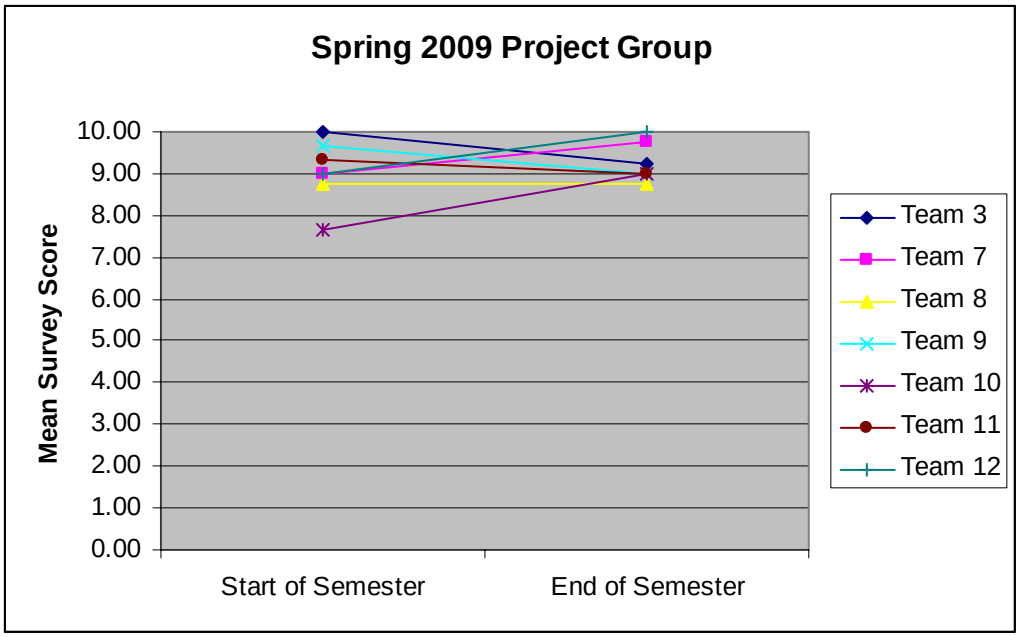

Figure 10. Professional Ethics

3. Conclusion

When examined at the aggregate level, pre-post survey results for the Senior Capstone Course suggest four areas of greatest gains. These were: 1) Real Project Experience; 2) Software Skills; 3) Research Skills and 4) Writing skills. The category of real project experience had by far the largest gains. This outcome makes sense since the course is primarily focused on the completion of a functional real world project. The emphasis on research and writing surrounding the project also helps explain the strength in these areas. See Fig. 11 for overall course results.

Only two characteristics had overall declines in self-reported ratings. These were the Customer Interaction and Website Creation categories. The instructor will have to revisit these areas as well. The remaining characteristics showed small gains.

While the strength and primary focus of the course remains building project and research experience, these results suggest areas of improvement that would facilitate the development of well-rounded students ready to enter the workforce. The program will continue to utilize student feedback to make informed, evidence-based decisions about the direction of the course.

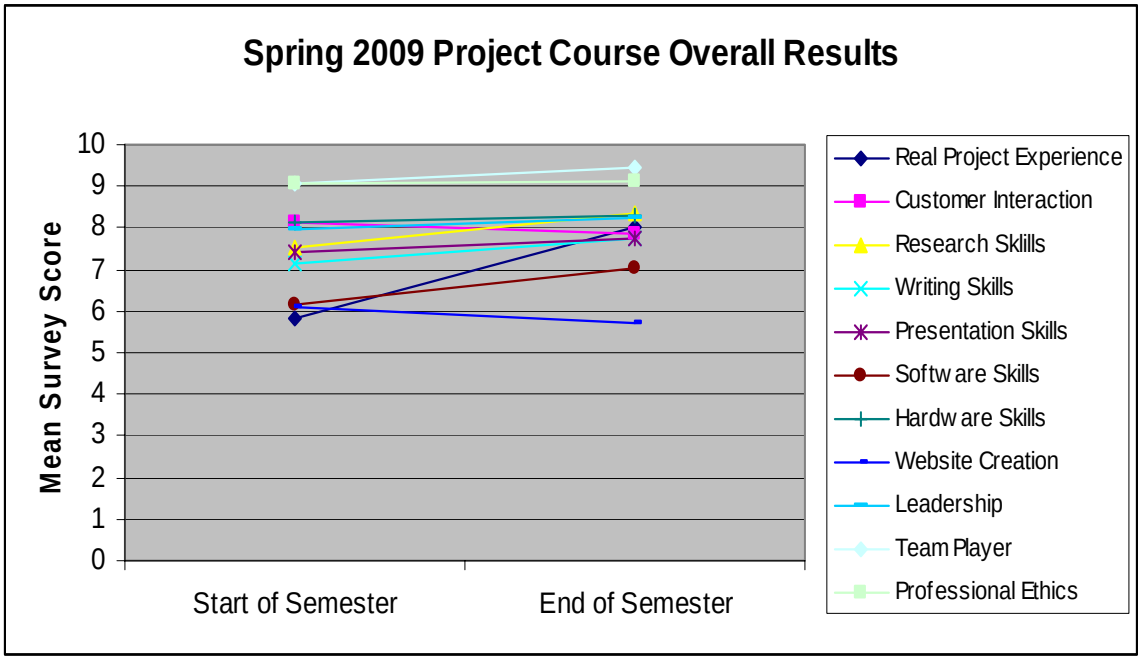

Figure 11. Overall Pre-Post Survey Results for Spring 2009 Project Course

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Biographies

FARROKH ATTARZADEH earned his PhD in Electrical Engineering from the University of Houston in 1983. He is an associate professor in the Engineering Technology Department, College of Technology at the University of Houston. He teaches software programming, operating systems, digital logic, and is in charge of the senior project course in the Computer Engineering Technology Program. He has developed a concept referred to as EMFA (Electromechanical Folk Art) as a vehicle to attract young students to the STEM fields. He is the Associated Editor for student papers at *the Technology Interface Journal* (http://engr.nmsu.edu/~etti/), and Chair, Conference/Organization Member Affairs for IAJC (http://www.iajc.org/). He is a member of ASEE and has been with the University of Houston since 1983. Dr. Attarzadeh may be reached at FAttarzadeh@central.uh.edu

ENRIQUE BARBIERI received his Ph.D. in Electrical Engineering from The Ohio State University in 1988. He was on the faculty of the Electrical Engineering Department (1988-96), and Chair of the Electrical Engineering & Computer Science Department (1996-98) at Tulane University. In 2002 he joined the University of Houston as Professor & Chair of the Department of Engineering Technology. In September 2009, he was appointed Associate Dean for Research & Graduate Studies for the College of Technology. His teaching and research interests are in control systems and applications to electromechanical systems. He is a member of IEEE and ASEE and represents the Texas Gulf Coast region on the Executive Council of the Texas Manufacturing Assistance Center. Dr. Barbieri may be reached at EBarbieri@central.uh.edu

MIGUEL A. RAMOS earned his Ph.D. in Educational Research, Measurement and Evaluation from Boston College in 2004. He is the Assistant Dean for Assessment and Accreditation Services in the College of Technology at the University of Houston. Dr. Ramos has worked as Program Evaluator for Boston Connects, a school-community-university partnership designed to address non-academic barriers to school success via a web of coordinated health and social service resources in ten public elementary schools. He has also worked as a federal education researcher for the Southwest Educational Development Laboratory evaluating the effectiveness of reform models developed to improve student academic performance by enhancing systemic coordination of academic resources. In addition, Dr. Ramos has served as a consultant in a variety of contexts investigating a range of issues including program effectiveness, organizational communication, assessment and public policy, and research methodology. Dr. Ramos may be reached at MaRamos3@central.uh.edu

Appendix 1

ELET 4308/ELET 4208 Senior Project Class Self-Knowledge Survey
Spring 2009 – At the Beginning

Name: _____ E-mail: _____
Major: _____ Minor: _____
Daytime Phone: _____ Employer: _____

1. The senior project class tracks student performances over several years. Please state if you have taken any of the courses listed below as a *pilot* or *full deployment* through the CLABS initiative. Please check appropriate boxes below if it applies to you

❑	ELET 1100 (DC lab)	☐ Pilot	☐ Full deployment	☐ None
❑	ELET 1101 (AC lab)	☐ Pilot	☐ Full deployment	☐ None
❑	ELET 2103 (Digital lab)	☐ Pilot	☐ Full deployment	☐ None

2.

❑ Working fulltime
❑ Working part-time
❑ Not working

If working, provide a brief job description.

Hours worked per week? _____ On Campus or off campus? _____
Credit hours enrolled this semester? _____
Expected date of graduation? _____
Plan to go to a graduate school? _____
If yes, when, where, and what field (please explain)?

3. In this class, all students are resources. What are some of your abilities/strengths as they might relate to this class?

4. What are some of your weaknesses or areas you would like to improve?

5. What are you most interested in learning from this class?

6. Are you currently working on a project or have you recently completed one? Please describe the project below.

7. For the senior design project, team members will need skills in several areas. Please rank yourself on a scale of 1 to 10 (10 being best) on each of the skills listed below.

	Scale (1-10)
❑ Real project experience	_____
❑ Customer interaction	_____
❑ Research skills	_____
❑ Writing skills	_____
❑ Presentation skills	_____
❑ Software skills (project management software & programming software(C/C++, Assembler)	_____
❑ Hardware skills	_____
❑ Web site creation	_____
❑ Leadership	_____
❑ Team player	_____
❑ Your understanding of professional ethics	_____
❑ Your training skills	_____
❑ Your mentoring skills	_____
❑ Knowledge working with K9 or under students	_____
❑ Knowledge working with K10-K12 students	_____
❑ Knowledge of robotics	_____
❑ Knowledge of sensors	_____
❑ Interest in working with 9-16 years old	_____

8. Are you a member of IEEE? ☐ Yes ☐ No

9. Expected graduation date _____.

10. List your questions, concerns, or comments about this course here.

ACADEMIC HONESTY:

I have read and understand the policies regarding academic honesty. I understand how they apply to the senior project class (ELET 4308/ELET 4208), and I pledge myself to abide by the policies and work to create an atmosphere of academic integrity on the campus.

Signature: _____ Date: _____

Appendix 2

ELET 4308/ELET 4208 Senior Project Class Self-Knowledge Survey
Spring 2009-End of the Semester

Name: _____ E-mail: _____
Major: _____ Minor: _____
Daytime Phone: _____ Employer: _____

Are you a Transfer Student? _____, If yes, where from and when? _____

1.

- ❑ Working fulltime
- ❑ Working part-time
- ❑ Not working

If working, provide a brief job description.

Hours worked per week? _____ On Campus or off campus? _____

2. Answer each of the following questions

Credit hours enrolled this semester? _____
Expected date of graduation? _____
Plan to go to a graduate school? _____
If yes, when, where, and what field (please explain)?

3. In this class, all students are resources. What was some of your abilities/strengths as they related to this class?

4. What were some of your weaknesses at the beginning of the semester and areas you had improved?

5. What were the most interesting concept, subject, and experience that you learned and gained in this class?

6. Are you currently working on a project (besides the senior project) or have you recently completed one? Please describe the project below and explain your role on this project.

7. For the senior design project, team members were required to have certain skills and knowledge in several areas. Please rank yourself on a scale of 1 to 10 (10 being best) on each of the knowledge and skills listed below.

	Scale (1-10)
❑ Real project experience	_____
❑ Customer interaction	_____
❑ Research skills	_____
❑ Writing skills	_____
❑ Presentation skills	_____
❑ Software skills (project management software & programming software)	_____
❑ Hardware skills	_____
❑ Web site creation	_____
❑ Leadership	_____
❑ Team player	_____
❑ Your understanding of professional ethics	_____

8. Are you a member of IEEE? ☐ Yes ☐ No
If yes, please state what you did this semester for IEEE.

9. Are you a member of any other organizations? If yes, please list them below and explain what you did for each organization this semester.

10. List any questions, concerns, or comments here.