Leveraging the ASEE Annual Conference Robot Competition to Increase ECE Recruiting and Retention

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Abstract:

In 2008 a corrective action plan was implemented at the University of Oklahoma to reverse drastic declines in ECE undergraduate enrollment. The ECE enrollment numbers in fall 2008 were 246, but by fall 2014 they soared to 440. The research that went into the plan revealed that a freshman engineering course is a critical place to start. In response, multiple ECE led freshman engineering orientation sections were created that were open to all engineering majors. These courses were found to produce good results in retention and also in non-ECE students matriculating into ECE. In the fall 2014 semester new ECE led freshman orientation sections were created that would utilize many innovative practices. These new sections would use the robotics competition at the 2015 ASEE Annual Conference to set the curriculum and provide motivation for the students to learn. Each section was challenged at the beginning of the semester with creating a robot that could compete in the ASEE Robot Competition and during the course of the semester background knowledge needed to complete the project was provided in hands-on focused lab exercises. This paper describes the curriculum of this course, learning objectives, and how a mentoring structure was established with ECE robotics-based student organizations.

I. Background

In 2008 a corrective action plan was implemented at the University of Oklahoma (OU) to reverse drastic declines in ECE undergraduate enrollment.[1, 2] The ECE enrollment numbers in fall 2008 were 246, but by fall 2014 they soared to 440. The research that went into the plan revealed that a freshman engineering course is a critical place to start. The American College Testing Program performed a detailed study comparing different retention practices at 228 different accredited 4-year public colleges. The retention practice reported to have the highest impact was a "for credit" freshman seminar/university course with 46 out of the 228 colleges listing it as one of the three practices that has had the greatest impact on student retention. The second highest rated practice was "learning communities" with 42 colleges listing it in their top three most impactful retention practices. No other practice was reported in the top three at more than 28 colleges.[3] Fostering a learning community environment in a hands-on based freshman engineering "for credit" course was a high priority in the OU-ECE corrective action plan.

At OU all freshmen students majoring in the College of Engineering (CoE) take a course in their first semester titled "ENGR 1411 – Freshman Engineering Experience". This course has two parts. First, all students take a common lecture session where they are given a high level orientation to engineering and told about the resources available to them. The second part involves a discussion/lab section where the students are given the opportunity to go deeper into a particular area of engineering. There were 18 of these discussion/lab sections taught in the fall 2014 semester. Many of these sections have around 20 students, but some have slightly over 50 students. It was in this structure where the OU-ECE based freshman engineering courses were created. Other institutions have also adopted a similar strategy of incorporating freshman engineering courses into their curriculums and found it to be effective.[4-6]

In the fall 2009 semester OU-ECE taught three lab sections with a total of 100 students. Analysis of these sections showed that 12 of the 21 students (57%) that entered the ECE led ENGR 1411 sections without having a declared CoE major and remained at OU after their first year switched to a CoE major. Additionally, 4 of the 72 (5.6%) students that were not ECE majors and remained at OU after their first year switched to an ECE major.[1] After seeing positive results from these three freshman engineering sections in 2009, teaching more sections in future years with improved content and more engaging learning community frameworks became a priority.

II. Inspiration of New Freshman Engineering Course

In the fall 2014 semester new ECE led freshman orientation sections were created that would utilize many innovative practices. These new sections would use the robotics competition at the 2015 ASEE Annual Conference to set the curriculum and provide motivation for the students to learn. Each section was challenged at the beginning of the semester with creating a robot that could compete in the ASEE Robot Competition and during the course of the semester background knowledge needed to complete the project was provided in hands-on focused lab exercises. Since the students enrolled in the course were first semester freshman and most of them had very little experience in robotics the activities were interesting to them and the thought of creating a functional robot that could compete at a high level served as excellent motivation as shown in the assessment section of the paper.

Besides the past experience in ECE recruiting and retention gains from robotics-based freshman courses, another reason this approach was considered resulted from a failed experience at the 2014 ASEE Robot Competition. A student group at OU named Sooner Competitive Robotics (SCR) that focuses on competing in numerous robotics competitions per year decided to add this freshman/sophomore based competition to their schedule in the 2013/14 academic year. They thought it would be a good way to get younger ECE students involved in the student organization and serve as a pipeline to the more advanced robotics competition teams. After much difficulty finding willing participants, the ASEE robot team was formed. The students on the team enjoyed the process, but were only able to finish in the middle of the pack in the final standings. One disadvantage they felt that contributed to their lackluster finish was that many other teams had some form of course that went along with the competition so the unskilled students could obtain background knowledge and have structured time to work on the project instead of learning and creating everything on an extracurricular basis. With this in mind this robot-based student organization looked to use the course described in the paper as the first step at forming the 2015 ASEE robot team as well as an opportunity to recruit and mentor many future organization members. The remaining sections of this paper will describe the curriculum of this course, learning objectives, and the mentoring structure with the ECE student organization, but first a brief overview of the ASEE 2015 Robot Competition is provided.

The overall objective of the ASEE 2015 Robot Competition is to construct an autonomous robot that can collect as many colored fish cutouts and then deposit them in corresponding colored fish tanks. Figure 1 in the next section shows a picture that is a replica of the fish and fish tanks that will be used in the June 2015 ASEE competition. The robots competing will have maximum time of 120 seconds in each of their four allotted trials. A poster session will also be included in the competition and will factor into each team's overall score. Additional details of this 2015 competition and all past ASEE robot competitions since 1999 can be viewed at http://faculty.tcc.edu/PGordy/ASEE/. Due to the time constraints of the course and the limited incoming knowledge of the freshman students in the ENGR 1411 – Freshman Engineering Experience course the color detection part of the competition was not required. The ENGR 1411 students would therefore focus on getting as many fish into the fish tanks, regardless of color.

III. Course Objectives and Curriculum

During the progression of the 16 week semester the students worked on various electronic, programming, and robotics activities with the ultimate goal of producing a working robot. The desired functional level of this robot was for it to be able to complete a subset of the ASEE Robot Competition requirements with a realistic goal of being able to spend the spring semester completing the robot in an extracurricular basis in time to be ready for the competition in June. There were four primary objectives of this freshman engineering introductory course.

Course Objectives:

1) Introduce the students to the exciting world of engineering.
2) Increase the students understanding and knowledge in ECE and robotics.
3) Motivate ENGR 1411 students to get involved in robotics-based student organizations.
4) Give students involved in robotics-based organizations an opportunity to mentor and share their passion with new freshman engineering prospects while giving them a reason to get ready for the ASEE competition earlier.

In order to evaluate the objectives of this new course design the following metrics were created.

Success Metrics:
1) Retain the students in engineering and cause the matriculation of students into engineering.
2) Retain the students in ECE and cause the matriculation of students into ECE.
3) Increase student involvement in robotics-based student organizations.
4) Improve performance of SCR in the 2015 ASEE Robot Competition.

Success metrics 1 and 2 will be discussed in the Assessment section of the paper, while metrics 3 and 4 will not be able to be adequately assessed at the time this paper goes to press, but a progress report is included in the assessment section. Table I shows details of the course curriculum, including the lecture topics each week and the hands-on activities worked on in the laboratory. In order to give others a blueprint to replicate this course at their universities the lectures and activities for each week listed in this table will be summarized.

TABLE I – ENGR 1411 SCHEDULE

Week	Topic	Laboratory Work
1	Course Introduction, Introduction to Electrical and Computer Engineering Presentation	Familiarization with Lab Instruments
2	Ohm's Law, Resistors, Breadboards, DC Measurements	Circuit construction on a breadboard, Multimeter measurements (Voltage, Current, Resistance), Power Supply exercise
3	Engineering Design Process, ASEE 2015 Competition Introduction, Arduino Introduction	Initial Robot Design, Install Arduino IDE & drivers, Arduino "Blink" sample sketch, Arduino-Blink an LED,
4	Diodes, Transistors	Arduino-Motor Lesson 1 (Transistor Switch)
5	PWM, H-Bridge	Arduino-PWM Lesson (Fade an LED), Arduino-Motor Lesson 2 (H-bridge, PWM)
6	PWM & H-Bridge continued, Analog and digital input	Arduino-Momentary Push Button toggle LED, Arduino-Switch “Debounce”
7	Programming concepts (variables, conditional statements, loops, logical operators, assignment operators), Arduino Language, Arduino documentation	Develop a decision tree, Arduino-Momentary Push Button combined with Motor Lesson 2
8	Servos: Positional Rotation (180 degree), Continuous Rotation (360 degree), Linear (Translation of motion)	Arduino-Standard Sweep, Arduino-Continuous Rotation
9	NA	Teams work on robots
10	Project 1	Autonomous robot with H-Bridge control
11	IR Sensing(Photo Diode & IR LED)	Breadboard IR detector circuit
12	IR Sensing (Photo Diode & IR LED)	Arduino-IR Line Detection
13	IR Range Detector, Arduino Libraries	Arduino-Sharp IR Range Sensor
14	NA	Teams work on robots
15	Final Project	Mock ASEE Competition

The first week of class began with a review of the syllabus and an overview of ECE. Specific details regarding the job outlook for Electrical and Computer Engineering students and the types of jobs Electrical and Computer Engineers perform in industry were described. Next, the ASEE 2015 Robot Competition was explained and the rules were handed out to each student. The students were told that the final project would require them to create a robot that could compete (or be close to ready to compete) in the ASEE Robot Competition and each week a new skill set needed to complete the robot would be explored in the lab exercises.

During the second week of class teams where assembled by way of a random drawing. Each team included 4 to 5 students. For the remainder of the semester each team would work on the project together and perform the in-lab exercises together. The lab exercises in week 2 focused on the fundamentals of circuit construction and testing in the laboratory. The lecture began with a discussion of Ohm's Law and other basic circuit analysis principles and was followed by hands-on exercises. The hands-on exercises involved learning to use the DC power supply and multimeter to measure resistance, current, and voltage. The students were then taught how to use a breadboard and design, construct, and measure simple circuits such as a voltage divider.

In the third week of class each team received an Arduino Uno microcontroller board that was used throughout the semester. Each student downloaded the Arduino IDE and drivers from the Arduino website (http://arduino.cc/en/Main/Software). Once the students successfully downloaded and installed the Arduino IDE each team compiled and ran the sample Arduino sketch named "Blink" which blinks an on-board LED. By successfully compiling and running the "Blink" sample sketch the students gained confidence in their engineering ability and allowed them to become comfortable enough to attempt more advanced projects with the Arduino on their own. After completing the hands-on Arduino exercise a discussion of the engineering design process was conducted as a prelude to the final robot project. A key component to this discussion was the concept that the design process is cyclic and that the goal is to incrementally improve the design of the solution in an iterative fashion. After discussing the design process a review of the ASEE 2015 Robot Competition Rules was performed and followed by a question and answer period. During this time the first two steps of the engineering design process (<u>Identify</u> and <u>Research</u>) were re-emphasized and the students were guided carefully through the rules of the competition. The different types of subsystems that the robot will require (Electrical, Mechanical, Software, etc…) are also discussed to ensure the students included these systems in their design and showed them the importance of the upcoming lab assignments.

Week four discussed how to turn a motor on and off using the Arduino and a transistor as a switch. Diodes were also discussed and shown how they can be used to protect other circuitry from the voltage spikes produced from starting and stopping the motor. To demonstrate these concepts each team built a circuit that that included a fly back protection diode, a transistor, a DC motor, and the Arduino. The Arduino "Fading" sample sketch was then used to send a PWM signal to the transistor thereby turning the motor on at different speeds.

In week five the concept of PWM was discussed as well as the ability to reverse the direction of the spinning motor. To further demonstrate the PWM another hands-on exercise was completed. This exercise utilized the same Arduino "Fading" sample sketch and one of the Arduino PWM outputs. The Arduino was directly connected to an LED on a breadboard and the students were encouraged to change the duty cycle of the PWM to see the effect on the brightness of the LED. In addition to discussing PWM, the concept of reversing the direction of a motor was also discussed. To demonstrate this idea the students directly connected a motor to the power supply causing it to spin in one direction then the students were asked to change the leads of the power supply thereby reversing the direction of the motor. This experiment lends itself well to discussion of how to accomplish this in electronics and the use of an H-Bridge.

Week six was a continuation of the motor control and also included a discussion of analog and digital inputs and outputs on the Arduino. The students were given an H-Bridge Integrated Circuit, datasheet, and a breadboard schematic that included the H-Bridge, motor, potentiometer, momentary switch, and the Arduino. In this experiment the students read the state of the switch and reversed the direction of the motor by sending a digital output to the H-Bridge. The students were also asked to read the voltage across the potentiometer and vary the duty cycle of the PWM output that is connected to the H-Bridge thereby varying the speed of the motor based on the voltage that is dropped across the potentiometer.

Until week six of the semester all software programming had consisted of making slight modification to existing Arduino sample sketches. In week six the students were required to make significant modifications to a sample program that was provided to them. They needed to read the external inputs, the momentary switch, and the potentiometer and then change the speed and direction of the motor. The task of adding completely new logic to an existing program turned out to be very difficult for many of the students. As a result a survey of the students was conducted to determine how many students had previous knowledge of software programming. The results of the survey showed that less than 25% of the students had any previous knowledge of software programming. As a result a change to the syllabus was made and week seven was used to discuss basic programming principals and concepts.

In week seven the following programming principles were emphasized: variables, conditional statements, loops, logical operators, assignment operators, functions, and variables. Each of these topics was discussed by reviewing Arduino sample sketches that had been used in previous week's experiments. In addition to discussing basic programming principals an in-class exercise was conducted where each team created a decision tree on the board and then wrote pseudo-code for each step in the decision tree. Finally, each team converted the pseudo-code into an actual Arduino sketch. The discussion and exercises performed in week seven made a noticeable difference in both the students' ability to write code and their confidence to solve problems in the software.

The lab exercises and discussion topics for week eight were focused on servo motors; both continuous and positional. Servo motors were an important topic for many of the students because their initial robot designs included some type of arm with a gripping device. There were two experiments in week eight. The first was to control the speed and direction of a continuous rotation servo with an Arduino. The second experiment consisted of changing the position of a positional rotation servo based on the voltage drop across a potentiometer. In addition to discussing servos in week eight the first project assignment was handed out and discussed. The goal of the project was to have a fully autonomous robot that could be turned on and off via a switch and travel in a straight line a distance of more than 10 feet. The key points of project 1 were the control of a motor using an Arduino and an H-Bridge, interfacing to a mobile power supply (battery pack), and the integration between the three main subsystems: electrical, mechanical, and software.

During week nine teams were allowed to work on their robots for project 1 in class. Additionally, a soldering exercise was conducted to help students with the construction of their robot as many of the students had never used a soldering iron. Project 1 competition was held in week ten. The results of the competition where promising. All teams successfully constructed a robot and traveled the minimum distance of 10 feet.

Weeks eleven through thirteen focused on use of Infrared sensors to follow a line and detect objects. These were two key components needed to successfully compete in the final competition. The line detection was used as the primary means of navigation whereas the object detection was used to locate the fish and the bins that the fish where to be placed. In week eleven the concept of infrared sensing was introduced. Infrared LEDs, photo diodes, and photo transistors where discussed followed by an experiment where the students constructed an IR emitter/detector pair circuit that was used to turn on and off an LED when the infrared beam was interrupted. In week twelve the emitter/detector pair that was constructed in week eleven was connected to the Arduino and used to turn a motor on and off when a line was detected. In week thirteen every team was given infrared distance measuring sensor, a datasheet, and an Arduino library designed to interface to the range sensor. The lab experiment for week thirteen consisted of importing the Arduino library and using the library to take readings from the range sensor and turn the motors of the robot on and off when an object was detected within a given distance.

During week fourteen teams were allowed to work on their robots for the final competition. The mock ASEE competition was held during week fifteen of the class. The mock competition consisted of two items: the poster session and the robot time trials. The poster session required each team to construct and present a poster board that would describe the design evolution, operation, and fabrication methods of their robot. Finally, each team participated in the robot time trials. Figure 1 below shows a picture of one of the robots that was constructed in the course performing the required tasks on a full scale replica of the ASEE 2015 competition ring.

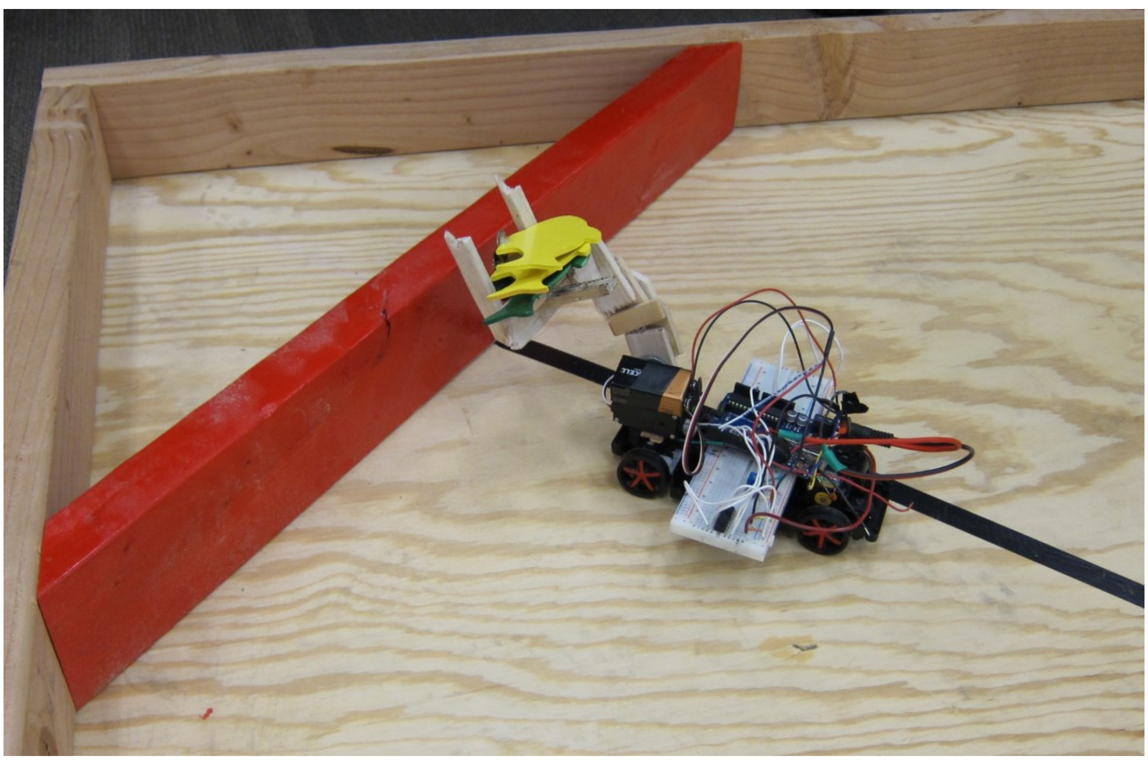

FIGURE 1: AN ENGR 1411 ROBOT NAVIGATING THE ASEE COMPETITION RING REPLICA.

The results of the competition varied greatly among the 12 teams. Three of the twelve teams successfully located one or more fish, picked them up, and located a bin. Of these three teams one team successfully deposited the fish into the bin and returned to the ring in search of more fish. The remaining 9 teams all successfully constructed a robot that would autonomously navigate the competition ring and search for fish. Considering that all 52 students were first-year students with little to no experience in electronics, robotics, or software development and all of these skills where introduced in one 16 week semester the results of the competition were encouraging. The fact that all teams were able to come together and produce a functioning robot that met many of the competition goals indicates that the format of the course fosters student involvement and creativity. One area were the course format can be improved is in the area of software development. It became evident as the semester progressed that students struggled with the programming aspect of the course and that more attention to this topic should be addressed earlier in the semester.

IV. Assessment

The students' perceived value of the course was assessed using an optional online survey that can be taken outside of class time. In order to assure data was not biased by students feeling forced to take the survey in class or respond in a positive manner, additional questions were added to the standard CoE evaluations given at the end of the semester. Furthermore, truthful responses are expected because students are made aware that the evaluations are anonymous and the collective results are not released to the instructors until after grades are submitted. Table II shows the average responses on a 5 point Likert scale. The percentage of positive (4 or 5) and negative (1 or 2) responses are also included in the table. The first four survey statements are included in the standard evaluations for all courses. For comparison purposes the average scores of all ENGR courses are shown in parentheses on these four statements. The next five survey statements were created specifically for the 52 students taking the three sections of the ENGR 1411 course discussed in this paper. The data includes responses from the 45 students (86.5%) that chose to fill out this optional course evaluation.

The survey data in Table II shows the ENGR 1411 sections discussed in this paper scored an average of 15.4% higher than other ENGR courses in the four survey responses included (shaded gray in the table). The other ENGR courses in the overall average scores (shown in parentheses in Table II) include the other 15 sections of ENGR 1411 and other ENGR courses, which are courses that generally have a multidisciplinary student composition. The average ENGR evaluation numbers are also likely inflated from a course titled ENGR 2002 – Professional Development that had over 200 students in the fall 2014 semester and always has very high evaluation scores since it was redesigned.[7]

The additional 5 survey statements at the bottom of the survey that were added to assess the robotics-based format of the course produced very encouraging results. An average score of 4.6 out of 5 was received for the statement: "Working on the robot-focused projects in this course was interesting and/or enjoyable". Additionally, 42 out of 44 (93.8%) responded positively to this statement while only 1 out of 44 (2.2%) responded negatively. Since the students were freshman it was of utmost importance to introduce them to the exciting world of engineering and producing an experience that was considered "interesting and/or enjoyable" by the students was a top priority. These results gave some assurance that objective # 1 that was previously listed was addressed effectively. The second and fourth survey statements were related to objective # 2: "Increase the students understanding and knowledge in ECE and robotics". The responses concerned with increasing the students learning and understanding also scored exceedingly high with both having only 1 student out of 45 (2.2%) who responded negatively and the rest of the 44 students (97.8%) all responded positively.

TABLE II – COURSE SURVEY RESULTS

Survey Statement	Average	% Positive	% Negative
Class time was well used and contributed to my learning of the material.	4.60 (3.94)	93.3%	2.2%
The way in which the course was taught helped me develop analysis and design abilities.	4.38 (3.67)	93.3%	4.4%
Homework and other assignments contributed to my learning of the course material.	4.31 (3.72)	88.9%	2.2%
In general, the instructor taught this course effectively.	4.6 (4.17)	97.8%	2.2%
1) Working on the robot-focused projects in this course was interesting and/or enjoyable.	4.60	93.3%	2.2%
2) Working on the robot-focused projects in this course increased your learning of the material.	4.62	97.8%	2.2%
3) The idea of creating a robot to compete in a national competition (with additional work in the spring semester) served as motivation in the course.	4.22	82.2%	11.1%
4) This course gave you a better understanding of Electrical and Computer Engineering.	4.58	97.8%	2.2%
5) This course increased your interest in Electrical and Computer Engineering.	4.07	75.6%	6.7%

The third survey statement dealt with student motivation. The premise of the course was that letting the students participate in a national robotics competition would peak their interest and inspire them to care more and spend extra time working on their robots. Their responses might have been slightly lower than the other statements because they were likely unable to ascertain their potential of finishing the project in the spring when they didn't have dedicated class time to work on the project. However, the 4.22 average response results were still encouraging. 37 out of 45 (82.2%) responded positively, while 5 out of 45 (11.1%) responded negatively. Since the ASEE competition framework of the course also had objectives that focused on the benefit of robotics-based student organizations these responses were acceptable. Any course framework that increased student learning and interest in ECE would be acceptable, but the ASEE competition served a dual purpose as seen when comparing objectives 1 and 2 versus objectives 3 and 4. This leads to the final survey statement that scored an average value of 4.07 and addressed whether or not the students increased their interest in ECE. More students responded neutrally to this statement (8 out of 45). This is likely because some students were set on what major they wanted to pursue and it would be very difficult to sway them. Only 3 out of 45

(6.7%) responded negatively, while 34 out of 45 (75.6%) responded positively. This provides some encouragement that the retention and matriculation success metrics (redefined below) might produce good results.

Success Metric # 1 states: "Retain the students in engineering and cause the matriculation of students into engineering". Similarly, success metric # 2 states: "Retain the students in ECE and cause the matriculation of students into ECE". The primary goal was to have a positive impact on the number of students majoring in engineering and the secondary goal is to increase the number of students majoring specifically in ECE. In other words, it is more important to get non-engineering majors to switch to engineering than a non-ECE engineering major to switch to ECE. Analysis was performed on all 52 students in these three sections of ENGR 1411 and summarized in Table III.

TABLE III – RETENTION AND MATRICULATION RESULTS FROM FALL 2014

Category	Beginning of Semester	End of Semester
Total	52	52
CoE Majors	44	50
non-CoE Majors	8	2
% CoE Majors	84.6%	96.2%
ECE Majors	12	17
non-ECE majors	40	35
% ECE Majors	23.1%	32.7%

First, data supporting success metric # 1 will be presented. Table I shows at the beginning of the fall 2014 semester 44 of the 52 (84.6%) students in the 1411 courses were pursuing degrees in the CoE and at the end of the course 50 of the 52 (96.2%) students were a declared CoE major. With a net change of 6 students in CoE an 11.5% increase resulted. By looking at the non-CoE statistics the data can be compared to the 2009 study (mentioned previously) as follows:

- Fall 2014: 52 students, 8 non-CoE students initially, (-6) net change, 75% decrease.
- Fall 2009: 100 students, 21 non-CoE students initially, (-12) net change, 57% decrease.

This data shows that both past and current ECE led ENGR 1411 sections had some success in small sample sizes in moving non-CoE students into the CoE. It should be noted that other ECE led ENGR 1411 sections were also taught in the fall 2014 semester, but data was not collected because it was not part of this study.

Next, data supporting success metric # 2 shows that at the beginning of the fall 2014 semester 12 of the 52 (23.1%) students in the 1411 courses were majoring in ECE. At the end of the course 17 of the 52 (32.7%) students were declared an ECE major, which equates to a 9.6% increase. This data can be compared to the 2009 data while looking at the non-ECE statistics as follows:

- Fall 2014: 52 students, 40 non-ECE students initially, (-5) net change, 12.5% decrease.
- Fall 2009: 100 students, 72 non-ECE students initially, (-4) net change, 5.6% decrease.

This shows that a larger net change of students switching from a non-ECE classification to an ECE major was achieved in the fall 2014 ENGR 1411 sections while starting with far fewer non-ECE students than in 2009. These results are encouraging, but a larger sample size would be needed to make any definite claims.

Success metrics 3 and 4 dealt with the hypothesized impact the ENGR 1411 sections would have on robotics-based student organizations. Success metric # 3 states: "Increase student involvement in robotics-based student organizations". There are two prominent robotics-based student groups at OU: SCR and Robotics Club. Like these newly created ENGR 1411 sections Robotics Club also serves as a pipeline to SCR. Many of the older more experienced SCR students teach the less experienced students in Robotics Club exciting things about robotics during the meetings and these students are frequently developed into key contributors in SCR. By allowing the SCR students to interact and mentor the ENGR 1411 students a positive long-term outcome for this metric is logically expected as has been the case with similar interactions with Robotics Club. However, more time needs to pass before any claims can be made on the increase of involvement by the ENGR 1411 students.

The hope is that this mentor-protégé interaction between SCR and the ENGR 1411 students will produce a circular process where the protégés get involved in SCR and then become mentors for the next group of freshmen in ENGR 1411. When more experienced and knowledgeable students invest in freshman students it often results in these protégés seeing the value in doing the same thing in a "pay it forward" type of a relationship. This circular effect was witnessed in a dramatic fashion in OU-ECE student outreach involvement over the last 6 years as undergraduate enrollment numbers rose from 246 to 440. The OU 2011 Robotics Club president and founder of SCR explained it like this: "I was inspired to lead and to teach by older students throughout the years; in theory, the next set of leaders will be inspired by the current set. As long as people remain interested and excited, I believe that some of them will naturally want to pass that on to the next generation".[8] In past studies it was discovered that the rapid rise in OU-ECE undergraduate enrollment numbers was directly correlated to student involvement in ECE outreach efforts and ECE organizations like Robotics Club and SCR. It was found that creating a culture of student-driven recruiting and retention was the key to success of OU-ECE. [8]

Success metric # 4 states: "Improve performance of SCR in the 2015 ASEE Robot Competition". While we won't know for certain whether this will occur until June of 2015 there is high confidence that it will. When comparing last year's SCR ASEE Robot team progression to this year there is a dramatic difference. By getting SCR team members involved as mentors to the ENGR 1411 students they were forced to think about the rules and design strategies much earlier than they did in 2014. They also had to make a competition ring and game pieces for the ENGR 1411 section that they would also use in their preparation. At the recent SCR Critical Design Review the number of people working on the team and the progress that has been made was miles ahead of 2014. This model is not only directed at the 2015 competition, but to all future years as well. The vision for the future looks like this – as the new ASEE Robot Competition is created prior to each fall semester a new group of ENGR 1411 students will begin designing a robot with the help of a new crop of SCR mentors and many of these mentors will be past members of the ENGR 1411 ASEE Robot section.

V. Conclusion

The ASEE Annual Conference Robot Competition served as an excellent framework for creating a freshmen engineering course. This paper provides a blueprint for others to create a similar course. The student evaluation responses produced positive feedback concerning the course objectives. The responses showed the students were motivated to learn many new topics and also produced an increased interest in ECE. It was very encouraging that the results were nearly unanimously positive for the survey statements involving the students' self-perceptions that the course increased their learning from the robot-focused projects and increased their understanding of ECE. A net gain in students with CoE and ECE majors at the conclusion of the course were also very encouraging results. While this ENGR 1411 course produced good retention and matriculation outcomes it also was very successful at engaging freshman students with ECE student mentors and hopes to produce a continuous cycle of new SCR team members.

The student comments section of the evaluations where overwhelmingly positive and gave some good insight into how the students perceived the course. These first two students' comments show how the course was enjoyable and enlightening:

- "This was an enjoyable course that was quite informative and gave me a great look into what I get to look forward to as an engineer".
- "This course has been a great learning experience and was the perfect intro to the world electrical and computer engineering."

Another student stated that he switched majors because of "how fun the class was" and another stated "I really loved this class and has made me seriously consider electrical engineering as a career path." The initial offering of this course showed great promise. There are some things that were learned throughout the process that will be used to improve it the next time it is taught. Getting more SCR mentor support and better training the mentors on how to help the students would be beneficial. In summary, this freshman course has the potential to influence many future students into selecting engineering or ECE majors and also produce a long-lasting mutual beneficial relationship between the freshman students and the robotics-based student organizations.

VI. References

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