



Interdisciplinary Collaboration: Getting Engineering Majors to Work with Students in Other Disciplines on Issues Impacting Society

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Abstract

Despite all of the physics problems engineering majors learn to solve assuming ideal conditions, engineering problems rarely exist in a vacuum. Engineers are impacted in their work by laws, regulations, and policy, standards, business practices, and communication. This paper showcases a research-based course for Honors College students at East Carolina University (ECU). Honors College students from all disciplines across campus are required to enroll in a course that introduces them to research in their chosen field. The various sections of the course were divided based upon the students' chosen major. This paper focuses on one section of the course comprised of students majoring in Engineering, Technology, Political Science, Mathematics, Communication, and several majors in the College of Business. The students worked in teams of 4-5 on research projects with each team having student members from at least 3 different major disciplines. Each project focused on researching a problem that had not only an engineering component, but also an issue related to policy and business. Each team had to research policies or regulations that relate to their topic, determine the stakeholders for the problem, and develop a study to investigate the issue. Given the limited time of one semester to develop and complete their study, all groups conducted survey-based research or observational studies. Each group learned about ethics in research and was required to complete human subjects based research training and to submit their study to the university institutional review board.

A total of six research projects were completed with each requiring a problem statement and/or research questions, literature review, development of data collection procedures, experimental design, data analytics, oral presentations, and a final written paper with several chapters submitted as deliverables throughout the semester. Students were introduced to qualitative and quantitative data collection and analysis procedures. Research questions were formulated through the lens of researchers from various disciplines. This paper presents an outline for how the course was structured, discusses the projects the students conducted, and describes the findings of the various studies. Included is an evaluation of the strengths in the implementation and some advice for structuring such a course in the future. The course topics are also compared with core competencies identified in the literature for engaging in interdisciplinary scholarly research. End of semester student survey results are analyzed to determine the strengths of weaknesses of this course and project implementation.

Overall it is believed that an interdisciplinary research course like this allows students to gain a greater understanding of how their field of study is influenced by professionals in other disciplines through researching public policy, business regulations, marketing strategies, and design decisions that influence their field. This class gave students the opportunity to collaborate

with those outside of their own major field, modeling how companies and other agencies assemble professionals from various backgrounds to advance the corporate mission and the state of the art.

Introduction

While many projects require the work of people from a variety of disciplines, the people who have studied each of those disciplines often view the problem in a very different way from those with training in other fields. Professionals often view themselves as belonging to a particular “tribe” and having a certain “territory” where their area of expertise contributes (Becher, 2001). Most modern day design problems, however, require professionals from a variety of disciplines to come together at the intersection of their territories. One way for students to learn to participate in a diverse workforce is by working in interdisciplinary project teams and conducting undergraduate research.

Interdisciplinary research is widely recognized as valuable to enhancing the scholarship of a variety of fields by informing scholarship through the lens of multiple areas of research. While interdisciplinary research is valued, little training is offered to scholars about how to develop collaborative interdisciplinary research projects and until recently the core competencies required for researchers to conduct interdisciplinary research have not been identified. In 2007, Gebbie et al. published the results of a Delphi study aimed at understanding the core competencies required for conducting and contributing to interdisciplinary research in the health field. This study identified 17 competencies in three categories that are general enough that they can be applied to nearly all areas of interdisciplinary research, not simply the areas of health. The core competencies identified by Gebbie et al (2007) state

“The scholar who has completed doctoral work with an emphasis on interdisciplinary research is able to:

Conduct research

- Use theories and methods of multiple disciplines in developing integrated theoretical and research frameworks
- Integrate concepts and methods from multiple disciplines in designing interdisciplinary research protocols
- Investigate hypotheses through interdisciplinary research
- Draft funding proposals for interdisciplinary research programs in partnership with scholars from other disciplines
- Disseminate interdisciplinary research results both within and outside his or her discipline

Communicate

- Advocate interdisciplinary research in developing initiatives within a substantive area of study
- Express respect for the perspectives of other disciplines
- Read journals outside his or her discipline
- Communicate regularly with scholars from multiple disciplines
- Share research from his or her discipline in language meaningful to an interdisciplinary team
- Modify his or her own work or research agenda as a result of interactions with colleagues from fields other than his or her own
- Present interdisciplinary research at venues representing more than one discipline

Interact with others

- Engage colleagues from other disciplines to gain their perspectives on research problems
- Interact in training exercises with scholars from other disciplines
- Attend scholarly presentations by members of other disciplines
- Collaborate respectfully and equitably with scholars from other disciplines to develop interdisciplinary research frameworks
- Author publications with scholars from other disciplines”

Some courses such as the one discussed by Larson et al (2011) tackle the problem at the graduate or working professional level, which is appropriate given that the Gebbie study identified these competencies for professionals who have completed doctoral studies.

Undergraduate research experiences are very influential in the decision students make to pursue graduate work. In a study conducted by the University of Delaware on alumni from their College of Engineering, it was determined that students who participated in an undergraduate research experience were much more likely to pursue graduate studies with 80% of survey respondents who had participated in an undergraduate research program indicated that they either had obtained a graduate degree or were enrolled in a graduate program compared with less than half of students who had no exposure to undergraduate research (Zydney, 2002). Positive research experiences can greatly contribute to a student’s attitude toward research and pursuit of graduate studies, but many undergraduate students have anxiety when learning how to conduct research for the first time. In one study of undergraduate education majors in a research methods course, it was determined that female students on average experience greater levels of anxiety than male students (Papanastasiou, 2008). In order to encourage strong students to pursue graduate study and to prepare for research-based professional positions, a strong exposure to

undergraduate research is critical and the experiences students have with conducting undergraduate research can be very influential in continuing education decisions.

Undergraduate engineering students also are often not exposed to the roles people outside of their major play in projects they may work on in their careers. In a recent study, Coso et al. (2010) researched second year engineering students conducting an interdisciplinary research project to identify the personnel who should be involved in the creation of a retaining wall to prevent flooding. While the engineering majors often considered the engineering personnel who should be involved in such a project, they often did not consider many non-engineers who would be involved in such a project such as construction workers, businessmen, architects, and contractors. When students were asked to identify personnel who should be involved in such a project, the teams ranged in size from 3 to 12 members and had on average fewer than 2 non-engineers.

This paper presents a course designed for undergraduate Honors College students that is a first step toward instilling several of these competencies, recognizing that the students are only sophomores and have just begun studies in their chosen field.

The Course and the Honors College

At East Carolina University, approximately 100 students in each graduating class are invited to join the Honors College. Honors College students are all awarded a scholarship and agree to complete additional coursework requirements beyond the requirements for their chosen degree. Additionally, all Honors College students are expected to conduct research and complete a senior honors research project in their chosen discipline. In the fall of their sophomore year, all Honors College students are expected to take an Honors College Research Colloquium course. This course introduces various types of research and how research is different in various disciplines. Students are guided through how to design a research study, introduced to various qualitative and quantitative methods of data collection and analysis, and are instructed on several data presentation techniques.

During the Fall 2014 semester, this course was divided into 5 sections clustered by students' academic major. During some of the course meetings all of the students enrolled in the course met together with a common speaker or for a common lesson and during other course meetings they met in their own sections in order to drill down into research methods in their own fields. The section of this course that is the focus of this paper included students majoring in engineering, technology, political science, communication, and various business fields such as finance, marketing, business administration, and management.

Course Themes

In addition to showcasing how research is conducted in a variety of disciplines, one of the themes of this particular section was that the research being conducted in one discipline rarely is

isolated to one field in a silo. Engineering is influenced and constrained by public policy. The ability to market a product determines how successful it will be. Business decisions influence investment in research and development. Students were tasked with developing and conducting a research project that was informed by each of their disciplines

Course Enrollment and Project Group Assignment

A total of 105 students were enrolled in this research course with students divided into sections based upon their academic major. In the focus section of this course, 25 students were enrolled including 6 engineering majors, 1 technology major, 4 political science majors, 1 communication major, 3 mathematics majors, and 10 business majors. In order to ensure that research projects were diversified, the students selected groups using a fantasy sports-style draft. The students drew out of a cup slips of paper with the numbers 1-25 written on them. The numbers 1-6 were captains of the draft and responsible for picking the other members of the team. Teams were constrained in that each team was required to have an engineering major and at least one major from the College of Business. The captains took turns picking their next team member until the entire roster was filled with 5 teams of 4 and one team of 5 students.

Choice Activities

In addition to weekly class lectures and group assignments, students were required to choose at least five “choice activities” to attend. Some of these choice activities occurred during the scheduled class period, such as a presentation on how to use SPSS software or how to present data using Excel. Other choice activities included attending a workshop on how to write a grant proposal to fund undergraduate research or attending a state-wide undergraduate research conference. Each section of the course required certain choice activities and gave students the freedom to select from other choice activities in order to fulfill the requirement to participate in 5 activities. The focus section of the course required attending a workshop on survey design, a workshop showcasing how to use SPSS software to analyze data, and required completion of IRB training modules in order to learn how to conduct studies involving human participants. Additional choice activities included laboratory safety training, a session on Big Data, and attending research presentations hosted by several departments on campus.

Course Outline

This 3-credit hour course met once per week for 14 weeks. The following outline showcases the activities conducted and assignments submitted each week.

Week 1

During the first class meeting all of the students enrolled in the course met together at the beginning of the period. The dean of the Honors College provided an overview of research and the diversity of research being conducted at the university. The faculty introduced themselves

and discussed course expectations and the assignments the students would complete over the course of the term. The university director of undergraduate research spoke to students about opportunities undergraduate students have to apply for internal research funding awards and to present their work during a university research showcase. Students also completed a team building activity designed to help them understand how they work together in groups in order to learn how to relate better to people who may work in a way different from their own personal style. During the second half of the course meeting the individual sections broke off from the large group. The focus section instructor gave an overview of how engineering, business, and political science are interrelated, discussed course project expectations, and conducted the team assignment draft.

Week 2

During the second week of the semester, a guest speaker from the university's Institutional Review Board (IRB) spoke to the class about the importance of getting IRB approval for research involving human participants. Students were introduced to some of the history of why IRB approval is now required and the importance of conducting research ethically. The students then broke off into their sections and began to formulate ideas about their research projects. The students were introduced to how to write a project statement and summarize the need for their research. A goal of their research statement assignment was to showcase how their study topic is of interest to people from a variety of disciplines. Students were assigned to complete online modules in order to become trained in human subjects-based research.

Week 3

During the third week of the semester the students met at the university library and were introduced to several databases that would be of interest to their research projects. The instructor worked with the research librarians to introduce the types of research projects the students would be conducting and the librarians prepared a talk about appropriate available resources. The students turned in an individual problem statement describing what they were researching. The point of starting with an individual research statement assignment was to ensure that each student was able to encapsulate the point of the research study from their own lens. Upon receiving feedback from the instructor, the individual statements were synthesized by the group into a group problem statement due during week six along with a comprehensive literature review. The students began to gather background information from various sources to complete an individual annotated bibliography and were instructed to examine their topic of interest from the lens of their own discipline.

Week 4

During the fourth week of the semester students once again met in the library and began to put together a narrative of the topic they were researching and began to summarize the previous research and findings in their field.

Week 5

In the fifth week of the semester, students once again met in a large group with all of the students in the course. A professor delivered a talk about qualitative research and qualitative research methods. A member of the Honors College faculty also met with students to discuss the College's expectations for their senior honor's project and the timeline for developing a research proposal and conducting the research. Although the students in this class are largely sophomores, it was important to make a connection between how this course introduces them to research and methods and how over the next two years they will formulate a research proposal and then implement that proposal as their senior honors project. The remainder of the class was spent in project groups working on putting together their final group problem statement and literature review. The instructor met with each group individually to discuss their research project and to give them feedback and guidance.

Week 6

During the sixth week of the semester, students were introduced to quantitative research methods and how to collect quantitative data. Their revised problem statement and literature review papers were submitted. Students began developing their study methodology and deciding who the participants should be in their study, how they were going to collect data, and what data was needed in order to draw conclusions about their topic of interest.

Week 7

This week of the course further discussed how to implement projects and discussed the importance of ethics in research. Several case studies were introduced to help students understand the importance of ethical research practices including falsifying data and plagiarism. Students continued working in their groups to develop their study. All of the projects the students in this section developed involved collecting data either through observation or survey, so they began to develop their submission for approval of their studies to the Institutional Review Board. Students also worked on an assignment that required them to describe in detail their plan for data collection and management, clearly identifying who their study participants would be, how they would be recruited, what methodology would be used to collect data, how the data would be stored, and their plans for analysis of the data.

Week 8

During this week the students received further instruction on implementing their project and analyzing data. Students also attended a session on how to use SPSS software to perform statistical analysis of their data. Their paper on their data management plan and their study

methodology was submitted. They continued to work in groups to work through the logistics of collecting data including determining whom they should contact to gain access to participants or to setup their study.

Week 9

During week 9, students continued fleshing out the details of their data collection and prepared materials for their study including surveys and observation protocols. All students in the focus section also attended a session on how to use Microsoft Excel software to present data using a variety of plotting techniques.

Week 10

During this week students were introduced to how to analyze quantitative data. Various statistical methods were introduced including the use of ANOVAs and paired T-tests. Students worked through analyzing several simulated sets of data for practice. They also worked on their plans for analyzing the data collected in their own studies.

Week 11

This week's lesson introduced students to qualitative data analysis including transcription of interviews and observational studies. Videos were presented to show types of qualitative studies and analysis including ethnographic studies, focus groups, and interviews. Students also attended a presentation on big data analytics and the use of large datasets in research.

Week 12

At this point in the semester, most students had already gone through the data collection process and were in the process of analyzing data and preparing final presentations. All of the students in the course met together again to hear from a university faculty member who coaches students in the delivery of oral presentations. Students then broke up into their individual sections and worked with their research project groups to prepare their presentations.

Week 13

This was the last week of the semester when the students met in their individual sections. Each group presented their study methodology and results and reported their conclusions. Each section took a vote for the best presentation group to represent them at a research showcase the following week.

Week 14

The culmination of the semester was a research showcase. All of the students in the class were required to attend and the winners of the vote in each section presented their work. This was quite an interesting showcase that allowed the students to see the diversity of the research

opportunities at the university. Sections with students from the life sciences presented on research projects involving plants, students from the performing arts delivered a presentation on feelings of immersion during live theater events, students from health sciences presented an observational study on the habits of college students in bars. This was a great opportunity to showcase some excellent interdisciplinary work and various university administrators and officials were invited to attend.

Throughout the semester

Outside of the weekly class meetings, students also had other assignments to engage them in scholarship. In early September, various departments and colleges recruited faculty to showcase the research currently being conducted by their department and the opportunities undergraduate students had to get involved in research. Students also were required to select one faculty member whom they might select as a mentor for their research and interview that faculty member to find out more about their work and opportunities that exist to work in their lab or on a particular project. Students were also encouraged to attend a state-wide undergraduate research conference and the Honors College sponsored a bus to take attendees to this conference.

Student Research Projects

Each of the 6 groups in this section of the Honors Research Colloquium course developed different research projects. Some required surveys, one involved an intervention and pre and post testing, and one used an observational study. In all cases, students submitted a research plan for approval to the institutional review board. This section discusses the projects conducted by students.

Feasibility of the Corporate Average Fuel Economy Standards

One group, consisting of an engineering major, a physics and mathematics double major, a business administration major, and a management information systems major researched the influence of governmental fuel economy standards on consumer behavior. As the government continues to raise fuel economy standards for vehicle manufacturers, manufacturers must respond with innovative technological changes in order to meet these standards including new materials, electric options, weight reduction, and aerodynamic styling. Consumer habits also change as a result with some customers valuing fuel economy highly while other customers place more importance on vehicle features, cargo space, safety, color, or other options. This project included researching the history of governmental policy regarding fuel economy standards, examining the technology used to increase fuel efficiency and the methodology used to rate a vehicle at a certain fuel efficiency as seen on each vehicle's window sticker on dealership lots. This group developed a study to determine the motivation of vehicle consumers and the factors that most influenced their buying habits. They wrote a survey and selected local car dealerships to visit in order to interview customers. Dealership customers were asked about their driving habits, including what they currently drive and how far they drive each week. The customers

were then asked to rank the following characteristics in order of importance to the customer: vehicle performance, fuel efficiency, features, safety, and size. The students found that vehicle safety was of the highest importance to customers and the importance of fuel efficiency was variable with some rating it highly, some not considering it, and some valuing it, just not as highly as other considerations.

Can Local Humanitarian Charities Fully Prosper in a Business Market?

A second group, consisting of an engineering major, an accounting major, a mathematics and psychology double major, and a political science major examined the marketing strategies used by local charities and how those techniques influence their overall impact and efficiency. This group selected two local charities to examine and interviewed representatives from both charities to determine how they market their organization and how much money they invest in their marketing plan. This group attempted to define the success of charities based upon their financial sustainability as well as their work toward achieving their mission. They also examined donor habits and what contributors look for when choosing a charity to donate to. The group developed a survey of the general population of the local community and asked if they had ever heard of two different local charitable organizations. Survey respondents were asked to identify the purpose of the charity, their opinion on the reputation of the charity, if they felt the charity was making a notable impact in the community, how often they hear about the charity through word of mouth, how often they hear the charity advertised through the media, and to estimate the percentage of the charity's income they put toward their cause. This group was able to talk to officials at one of the selected charities to find out information about their marketing plan and budget, but they found that the second organization did not want to be interviewed. The students found that many people did not recognize the names of the local charities and even fewer could identify the cause the charities worked toward. The group determined that one of the two charities was more recognizable in the community.

The Social Trade-offs of Suite and Traditional-Style Dormitories

A third group, comprised of an engineering major, a finance major, a mathematics major, and a political science major researched the social implications of student living arrangements comparing the student experience in suite-style dorms to traditional hall-style dorms. Retention of students is a major concern at many universities. Retention strategies are more successful when students feel a sense of community and belonging on a campus and have an overall positive experience during their time studying at the university. Social interaction can fuel that sense of belonging and social isolation can reduce the sense of belonging. While the current trend in dormitory construction on campus is to build suite-style dormitories where college students reside in small communities with a roommate and few rooms share a common bathroom and living space, the previous trend in college architecture was to build hall-style dormitories where college students share a room with a roommate and many rooms are connected along a hallway with a common bathroom. This group examined ECU's master plan which includes a

plan to reduce the density in the dorms by demolishing older hall-style dormitories and replacing them with new suite-style dormitories. They then conducted an on campus survey at one of the campus dining facilities asking students to identify their current living arrangement, whether they were part of one of the themed living communities on campus, and how many interactions they had with other people during an average day. Survey respondents were also asked how often they interacted with their resident advisor and how many people on their hallway they considered to be a friend. The survey asked students about the noise level on their hall, how much they felt like they belonged in the dorm, and how likely they were to return to a dorm next year. The group found that students who live in traditional hall-style dorms tend to have more social interaction with others and more friends on their hall. Suite residents reported a better sense of belonging and a more desirable experience. Those living in traditional hall-style dorms also reported being more adversely affected by noise in the dorm. The students believed that more studies should be done on overall student satisfaction with dormitory living and this should be used to influence the policy driving decisions about university residence hall architectural layout and design.

Waste Disposal Accuracy

A group of five students consisting of an engineering major, a design and industrial engineering technology double major, a finance major, a management major, and a political science major investigated how policy, advertising, and industrial design impacted customer compliance with recycling of waste in an on-campus dining hall. This group created an observational study and watched from a distance as patrons of a campus dining facility disposed of their trash. They noted how many students properly sorted recyclable material into the appropriate receptacles separate from the regular waste. The group then created an intervention by placing a sign encouraging proper recycling near the waste disposal area in the dining facility. They noted how many patrons saw the sign and how many of those who saw the sign went on to properly sort their waste. The group researched recycling legislation and university policies on recycling and how the design of recycling containers, particularly the shape of the opening of the containers, contributes to recycling compliance.

Investigating the Correlations Between Increased Staff Education and the Overall Understanding of Medical Waste Disposal

A group of four students comprised of an engineering and music double major, a management major, a management and music double major, and a finance and marketing double major studied the influence of staff training on medical waste disposal costs. Due to the risk of spreading infectious disease, biological waste is disposed of separately from regular waste in medical facilities and is incinerated. Unfortunately, many workers in medical settings have some confusion over the type of waste that can be disposed in a regular trashcan as opposed to the waste that must be disposed of in biohazardous disposal bags. The cost to dispose of biohazardous waste is high compared to the disposal of ordinary trash, so failure to comply with

waste disposal standards could result in additional cost to medical facilities while the failure to dispose of medical waste in proper disposal bags could lead to the spread of disease and other negative health and sanitation consequences. Additionally, the environmental impact of incinerating biological waste should be considered. This group examined the knowledge of medical professionals about the type of waste that should be disposed of in biohazardous disposal containers. They researched the relevant laws and facility policies in place at the Department of Surgery at ECU's Brody Medical School. They then created an online survey for professionals to take to evaluate their understanding of laws and policies and their attitudes regarding the disposal of medical waste. Following the initial survey, they provided medical professionals with an educational document describing the regulations and policies governing the disposal of medical waste, allowed time for the staff to read the information, and gave a follow up survey to evaluate knowledge gained. Based on the data collected, the education program was successful and workers gained in their knowledge of waste disposal practices and their attitudes shifted to a more positive view of proper waste disposal.

Umbilical Cord Blood Stem Cells: A Study on the Public's Knowledge of the Benefits of Donating and Storing Umbilical Cord Blood

The final group in the class consisted of a communication major, an engineering major, a political science major, and a finance major. This group was interested in determining the public's knowledge of the benefits of donating the umbilical cord blood of a recently born child. They were particularly interested in finding out what information was communicated to expectant mothers regarding their options for storing the blood in the umbilical cord of their child upon delivery. This group was also interested in the public's opinions about who should bear the responsibility for funding such storage costs and whether it should be funded privately by families who wish to keep the cord blood or if insurance companies should cover this as a benefit or if it should be funded through government support. This group developed a survey to ask new mothers at a daycare facility on campus about the information they were given on cord blood storage options.

A First Step Toward the Development of Interdisciplinary Research Competencies

Through the project work and various lessons in this Honors College research colloquium, students began to learn how to conduct interdisciplinary research and were exposed to several of the competencies discussed by Gebbie (2007).

1. Students were able to "use theories and methods of multiple disciplines in developing integrated theoretical and research frameworks." Many of the methods used in their studies were drawn from several disciplines.
2. Students developed surveys and observational studies that allowed them to collect and analyze data on issues spanning several disciplines and began to

“integrate concepts and methods from multiple disciplines in designing interdisciplinary research protocols.”

3. Students formulated hypotheses informed by a variety of fields and began to “investigate hypotheses through interdisciplinary research.” Students learned about statistical methods of generating a null hypothesis and rejecting that null hypothesis using statistics.
4. Students learned about making oral presentations and written reports and were able to “disseminate interdisciplinary research results both within and outside his or her discipline.”
5. Through working with project team members from a variety of fields and incorporating their views into their study, they were able to “express respect for the perspectives of other disciplines.”
6. The literature reviews developed by student teams were expected to include literature from a variety of fields, so students brought forth research collected in their own field and contributed it to a multidisciplinary literature review. This is a first step toward preparing students to “read journals outside his or her discipline.”
7. Students had several opportunities to “communicate regularly with scholars from multiple disciplines” as part of this course including attending research presentations, working with course instructors from other disciplines, hearing presentations from a variety of fields, and working weekly with a team of students from a variety of majors to develop and carry out a research project.
8. Students had opportunities to write and present their research findings and were encouraged to use the appropriate language of scholarship in their field. Each student was able to “share research from his or her discipline in language meaningful to an interdisciplinary team.”
9. The teams that presented their work at the final research showcase had an opportunity to “present interdisciplinary research at venues representing more than one discipline.” All of the students also had opportunities to do this within the focus section of the course as each of the research topics were unique.
10. Through their interdisciplinary research projects, students were able to interact with each other and also to work with professionals from a variety of disciplines and backgrounds in order to gain access to facilities to conduct their research. They were able to “engage colleagues from other disciplines to gain their perspectives on research problems.”
11. This course was designed to be a training exercise in how to conduct research and present results. Many of the choice activities provided training on how to develop research instruments and analyze data. Students were thus able to “interact in training exercises with scholars from other disciplines.”

12. Through several activities inside and outside of class, students were encouraged to “attend scholarly presentations by members of other disciplines.”
13. While some groups had some issues with group dynamics and combative personalities and egos, the students began to learn how to “collaborate respectfully and equitably with scholars from other disciplines to develop interdisciplinary research frameworks.” Concerns noted on peer evaluations were addressed during team meetings.
14. The various deliverables throughout the course including the final course paper were designed to teach students to “author publications with scholars from other disciplines.”

Course Assessment

At the end of the semester the students in all sections of this Honors Research Colloquium were given a survey to determine whether or not they felt that they had achieved the course objectives and were asked which of the activities that were part of the course were most beneficial to their learning about how to conduct research. This survey was administered in person during the research showcase held during the last class meeting. A total of 105 students participated in the survey including students in the focus section of the course and the other four sections of the course comprised of honors students from all colleges across campus. The surveys were anonymous so it is unfortunately not possible in most cases to isolate the responses from students in the focus section from other students in the course, the exception being when students mention requirements of their specific section.

Students were asked Likert-style questions about whether they agreed or disagreed that they had met the following course goals. The scale ranged from 1 (strongly disagree) to 5 (strongly agree). The results are summarized in Table 1 and discussed below.

Table 1 Student Assessment of Their Attainment of Course Goals

	Mean	Standard Deviation
1. I have the knowledge to conduct responsible and ethical research	4.37	0.66
2. I have the knowledge to appropriately report research results	4.27	0.65
3. I am able to demonstrate how to find and use existing research results	4.21	0.68
4. I understand the different methods for research and scholarship	3.92	0.71

In response to question 1, 54 students agreed and 43 strongly agreed that they have the knowledge to conduct responsible and ethical research. Only 2 students out of 105 survey

respondents disagreed with this statement. When asked which portions of the course helped them to best achieve this course objective, 36 students identified class lectures and discussions, 19 identified the completion of human subjects based research training, and 17 identified preparing a submission to the IRB for their course project.

In response to question 2, 54 students agreed and 37 strongly agreed that they have the knowledge to appropriately report research results. In regards to which portions of the course were most helpful in preparing them to report research results, 33 students identified the class lecture and other resources provided by their instructor, 24 identified the feedback they received on their written assignments from their instructor or their peers, 13 identified their work preparing for an oral presentation of their findings, 11 identified interactions with their professor outside of regular class meetings including office hours, 6 identified the choice activity on using Microsoft Excel to graph data, 4 identified the choice activity on how to use SPSS software to analyze data, 3 identified the support of their team members, and 2 identified the course textbook.

In response to question 3, 64 students agreed and 31 students strongly agreed that they can demonstrate how to find and use existing research results. Of the students responding to this question, 33 identified the special session with librarians as being most helpful, 14 students identified class lectures and resources provided by their instructor, 13 students identified the class assignment to complete a literature review, 8 identified the work they conducted on a data analysis assignment, 6 identified the completion of an annotated bibliography assignment, 4 identified the choice activity on using SPSS, 3 identified the choice activity on using Microsoft Excel, and 3 identified the course textbook.

In response to question 4, 50 students agreed that they understand the methods for research and scholarship and 25 strongly agreed. A total of 46 students identified the class lectures and resources provided by their instructor in being the most helpful in understanding the different methods of conducting research. In addition to the class lectures, 27 students mentioned at least one of the choice activities as being helpful including sessions on qualitative research, creating surveys, using big data sets, or using software to analyze and present data.

Assessment of the benefit of the choice activities

The end of semester survey also asked students to indicate on a three-point scale how beneficial the choice activities they participated in were to their learning about research. Students were asked to rate the choice activities they attended as 1-Not beneficial, 2-Somewhat Beneficial, or 3-Very Beneficial. The most attended choice activity and the activity students rated as most beneficial were the departmental research presentations, with a mean score of 2.43. The least attended activity and the one rated least beneficial was attendance at a state-wide undergraduate research conference. This activity was not highly attended because it required students to travel over an hour away from campus and required much more effort than attending on-campus presentations.

Table 2 indicates the number of participants in each choice activity. Items marked with an asterisk indicate choice activities that were required for students in the focus section of the course.

Table 2 Student Evaluation of Benefit of Choice Activities

Choice Activity	# of Participants	Mean Rating	SD
Departmental Research Presentations	83	2.43	0.71
Big Data Presentation	40	2.23	0.73
Survey Writing Workshop*	70	2.15	0.64
Undergraduate research grant writing workshop	18	2.08	0.89
Lab safety training	50	2.05	0.76
Microsoft Excel graphing workshop	74	2.05	0.74
SPSS data analysis workshop*	59	2.00	0.65
IRB training for conducting research with human participants*	84	1.97	0.73
State-wide undergraduate research conference	4	1.60	0.91

*=required activity for students in class section containing engineering majors

Assessment of the benefit of course requirements

The end of semester survey also asked students to rate on the same scale as the choice activities (1= not beneficial, 3=very beneficial) each of the course assignments and requirements. Table 3 lists each course requirement and the perceived benefit of each activity. The most beneficial course requirement was meeting with a potential research mentor. This assignment allowed students to meet with a scholar in their discipline and was eye-opening for many students about the opportunities to do research in their own department. Students also found benefit in the research paper and working with a team to complete the research project. Students least meaningful requirement were the choice activities.

Table 3 Student Evaluation of Benefit of Course Requirements

Course Requirement	Mean Rating	SD
Meeting with a potential research mentor	2.67	0.60
Completing a group paper with a team	2.60	0.60
Data analysis assignment	2.53	0.66
Oral presentation of project	2.50	0.67
Writing a problem statement	2.40	0.62
Developing a data management plan	2.40	0.65
Writing an annotated bibliography and literature review	2.25	0.69
Participating in Choice Activities	2.16	0.61

Qualitative Feedback Received

The student survey also allowed students to give open-ended feedback on what they liked or did not like about the course and how they would change the course in the future if given the opportunity to do so.

In many of the projects, students were required to collect data and analyze it using various statistical tests. One student felt that they would have been better prepared for this course if they had taken a statistics course prior to enrolling in this class

“I believe that the statistics portion of this course should be studied in depth before conducting research. Furthermore, might I add that statistics should be a required course for all honors students during their freshman year so that they won't struggle in [this course]”

The focus section of the course allowed students to create their own research projects and required them to submit their own study for approval by the university Institutional Review Board. Other sections of the course forced students to participate in a research project that was already selected for them. Students in both situations seemed unhappy with one student in this section of the course stating that they wanted “more structured research topics and ideas that are already decided and IRB approved.”

Students in other sections of the course stated “I would like a little more freedom in picking my research topic,” and “I would include more specific projects that were based on the interests of the students and the students got to pick the research”

One student commented on the interdisciplinary team projects stating:

“I really think that [this class] should be exactly like my instructor's class. It was wonderful working across the aisle with other majors and I think that was an invaluable experience alone. We are grouped out and segmented off within our own courses we have to take for our various majors so I think having a class where we have to look at a problem or subject from different majors allows us to come to a more dynamic solution. I really think that working with other people with other majors made me a more well-rounded person and allowed me to experience what it was like in the real world when you do work with other people from different academic and job backgrounds.”

Lessons Learned

Many Honors College students are accustomed to being group leaders on projects. In many other courses, the top students will often take charge of a project and convince other team members to fall into place behind their ideas and their work plan. In a class like this where every

student is an Honors College student, such strong personalities often clash. Proper course management is key to getting top students to work together in a constructive manner. The instructor of this course gave students an opportunity to do a peer evaluation at the midterm and at the end of the course and regularly sat down with each group approximately weekly to ask how the group dynamics were working and to provide feedback on project progress and deliverables. In many cases it took some coaching to showcase to students that they could not always get their way on projects.

In some sections of this class the faculty member wrote up the paperwork to submit to the institutional review board if needed. The instructor for the focus section thought that submitting IRB paperwork was a good exercise for the students to go through so they could learn how to do that in case they needed to do so as part of their undergraduate research or later on in their careers. An unfortunate drawback to this approach is that the students spent a significant amount of time formulating their study and by the time they had a study developed and submitted, they are ready to collect data, but must wait for the approval of the IRB before they can implement their study. This resulted in a lot of groups falling behind or rushing to gather data at the last minute. In regards to the course schedule and the time delay in waiting for IRB approval, one student stated

“I think that the IRB portion was much too strenuous and too impractical to incorporate. This was incredibly handicapping to our project since we had to have this done before we could even conduct research, which really took away precious time. In the end, only one group in our section had their IRB approved by the end, which means all of the waiting was pointless. I know that certain sections had the teachers make the IRB for the students which, while I think does take away from the experience of developing a research project, does make it much more feasible to complete a project to be completed in half of a semester.”

An unfortunate outcome of this class was an honor code violation. The students in one group ran out of time to collect data for their study and instead of admitting to the instructor that they did not have data, they made up data and presented it as fact. This resulted in a lot of time spent documenting the case and presenting it to the university honor court.

In some cases, the work produced by these Honors College sophomores was on par with the work one would expect from new graduate students. The work quality was excellent in most cases. In many cases these students are still only in their third semester of college and cannot be expected to be domain experts, even in their selected field of study. A course like this may be better suited to later on in the students' academic career, perhaps in the first semester of the junior year rather than the sophomore year.

Conclusions and Future Work

Engineers are influenced in their work by public policy, business decisions, communication, marketing, and financing. In most undergraduate engineering curricula, students take general education classes with students from majors across campus, but when it comes to conducting research projects in their field, they are not exposed to many influences outside of their discipline. This course showcased the synergy that exists between politics, business, and technical fields. It is good for engineering majors to see how their work fits into the big picture so they can gain a greater perspective of how the professional world works and to learn how to interact and communicate with people from a variety of disciplines.

In the focus section of this course, students were able to conduct several research projects informed by multiple disciplines. Students were exposed to several techniques for how to collect and process data. Students also learned how to collaborate with people from a variety of disciplines and were able to communicate using a shared vocabulary. Given more time to develop more extensive research projects, the students would have had greater opportunities to collect and analyze data. While it is important for students to learn about how to conduct research involving human participants, the time delay involved in creating a study and gaining approval to conduct that study from the institution review board proved to be difficult for many groups. In future offerings of the course the instructor may consider gaining IRB approval for the students earlier in the semester and simulating the process of getting IRB approval by having students complete the forms. Some modifications to the course schedule to move some deadlines earlier may also help the experience to be less rushed toward the end of the semester.

While course assessment was done on all sections of the course anonymously, surveying the students in the section with engineering before the semester begins and at the end of the course to determine their appreciation for the engineering field and how it is informed by other disciplines would allow greater investigation into students' understanding of how professionals from multiple disciplines work together.

References

Becher, Tony, and Paul Trowler. *Academic tribes and territories: Intellectual enquiry and the culture of disciplines*. McGraw-Hill Education (UK), 2001.

Coso, Alexandra E., R. Reid Bailey, and Ellen Minzenmayer. "How to approach an interdisciplinary engineering problem: Characterizing undergraduate engineering students' perceptions." *Frontiers in Education Conference (FIE), 2010 IEEE*. IEEE, 2010.

Gebbie, Kristine M., et al. "Training for Interdisciplinary Health Research Defining the Required Competencies." *Journal of allied health* 37.2 (2008): 65-70.

Larson, Elaine L., Timothy F. Landers, and Melissa D. Begg. "Building interdisciplinary research models: a didactic course to prepare interdisciplinary scholars and faculty." *Clinical and translational science* 4.1 (2011): 38-41.

Papanastasiou, Elena C., and Michalinos Zembylas. "Anxiety in undergraduate research methods courses: Its nature and implications." *International Journal of Research & Method in Education* 31.2 (2008): 155-167.

Zydney, Andrew L., et al. "Impact of undergraduate research experience in engineering." *Journal of Engineering Education* 91.2 (2002): 151-157.