ERC-RMB Education and Outreach

2009-2010 Assessment Report

In 2009-2010 the ERC-RMB Education and Outreach engaged in multiple activities. These included: (a) implementing REU/RET, (b) implementing the Nano-to-Bio Summer Camp for Secondary Students, (c) piloting three classes intended to fold into the Bioengineering graduate curriculum, (d) implementing a weekly seminar focused on ERC research and related teaching and learning, (e) providing supplementary lectures related to creativity, innovation, and entrepreneurship, (f) piloting the Young Scholars program, (g) providing on-/off-campus teaching and learning activities with the local public schools, (h) co-sponsoring National Educators Workshop, (i) submitting proceedings papers to ASEE, and (j) presenting at national conferences (EE Awardee, National Educators Workshop, RosEvaluation Conference).

An extensive assessment was conducted to evaluate the effectiveness of the ERC-RMB's E&O activities. The assessment report finds that the program made positive strides in meeting its vision and obtaining its proposed outcomes. The following report is sub-divided as follows:

I. The REU/RET program was successful in helping participants link their intensive research experiences with (a) enhanced understanding of the bioengineering field, (b) personal academic and career goals in bioengineering, and (c) helpful applications to societal problems. Follow up information suggested that REU/RET participants continued to value their intensive research experiences.
II. Nano-to-Bio Summer Camp participants reported high levels of satisfaction with their week-long experience and increased understanding of tissue engineering.
III. From the point of view of curriculum development, data inform student satisfaction with teaching and learning in MEEN 785: Cell Biology I for Bioengineers, including agreement that the class was important to their academic and career development. Student reports also indicate that the supplementary lectures related to creativity, innovation, and entrepreneurship were helpful. Assessment data for MEEN 685: Fundamentals of Nanoscience and Engineering and for MEEN 785: Principles of Biodegradable Metallic Alloys are still being collected and fully due by the end of the current semester.
IV. On-/off campus teaching and learning activities with local public schools were well received and appreciated.
V. Feedback from conference participants indicates that the National Education Workshop was successful in contributing to participant professional development and in furthering their understanding of bioengineering.
VI. Members of the ERC-RMB Education and Outreach team were productive producing two papers for conference proceedings publication and presenting at multiple national conferences. Following is an in-depth assessment report surrounding activities for 2009-2010.

We anticipate continuous assessment of all the E&O activities for future reporting periods.

I. REU/RET

Interventions Overview

The purpose of the Research Experiences for Undergraduates and Teachers is to provide meaningful opportunities for involvement of undergraduate students, K-12, and community college educators in intensive research experiences. In summer 2009 research experiences for undergraduates (REUs) and teachers (RETs) were developed and implemented introducing participants to leading edge research currently underway. These experiences were intended in part to fulfill the mission to create a diverse pipeline of future practitioners and educators in the Biomaterials field

The Research experiences for undergraduates and teachers were six weeks in duration and ran concurrently. K-14 teacher participants derived from middle schools and community colleges, and undergraduate participants came from both the lead home and partnering institutions. Each REU and RET was teamed with a research mentor (i.e., lead researcher) and a graduate student. REU and RET participants had primary research responsibilities which were carried out over a five-week period. In the remaining sixth week, participants rotated through each laboratory to gain familiarity with all research areas. In addition to scientific research; weekly technical programs, enrichment activities, and trips were conducted, the goals of which were to foster creativity and innovation, diversity in thinking, and entrepreneurship; and to broaden participant imagination in the area of Biomaterials.

RETs also participated in professional development sessions centered on classroom instruction and designed to help them translate their new scientific knowledge into a one-week inquiry-based teaching module. Modules were aligned with the state's K-12 Science Curriculum introducing K-12 students to the basic concepts of bio-engineering. Additional module goals included increasing K-12 student 1) knowledge of math and science; 2) awareness of and appreciation for the field of engineering; 3) ability to link this knowledge to real-life experiences; and 4) capacity for scientific engagement in the classroom. RETs were able to implement a portion of the module with high school students at the end of the summer.

The REU and RET participants were assigned to work together in teams. Each team undertook a different research activity. The basic team structure was: a lead researcher mentor, a graduate research assistant, a REU participant and a RET participant. The team then collaborated to perform the assigned research. This primary research experience was conducted for five weeks. The remaining week was a rotation through the research labs. This allowed the REUs and RETs to gain familiarity with all the research areas. This rotation week occurred nearly midway through the six week program.

The research conducted was meant to ultimately contribute to applications of metallic bio-materials in the following areas: craniofacial and orthopedic applications; cardiovascular devices; and bio-sensors for implants. The actual more narrowly focused research that was conducted consisted of the following: DC magnetron sputtering of magnesium-titanium coatings, pore structure characterization of porous magnesium, extrusioin of magnesium wires, pulsed laser deosition of Mg and Mg-alloy thin films, fabrication and characterization of TiN

nanowires, Paclitaxel (Taxol) embedded polyesterurethane (PEUU) coatings on titanium substrate using direct-write printing, TiN as a biometallic material, four point resistivity measurements, MgO + Fe thin film composites for biosensor applications, and titanium dioxide photo catalyst.

In addition to the scientific research, the REUs and RETs jointing attended a weekly professional development series during the six weeks. This activity consisted of: technical programs, enrichment activities and trips. The goals of these activities were to stimulate: creativity and innovation, diversity in thinking, and entrepreneurship; broadening the imagination of the participants in the bio-materials area.

During the six week program various technical seminars and enrichment activities were given. The following technical subjects were presented in seminar format: Laboratory Safety, Principles of Atomic Forch Microscopy, Introduction to Thin Film and Nanotechnology, and Computational Modeling and Simulations in Materials Processing and Nanoengineering. The following enrichment topics were carried out. During the opening program, a diversity icebreaker/mixer activity was done to establish interactions between participants to facilitate team building and later team work. Also, seminars on: intellectual property and patient rights - The How and Why of Data Collection, a case study in biomedical ethical issues and dilemmas, funding sources and technical grant writing, a presentation by state Biotechnology Resource Center, oral presentation skills, a plant trip to a producer of ostomy and wound supplies, and a trip to an incubation center for entrepreneurship were done.

Clinical faculty from the University's School of Education worked with RETs to facilitate the development of teaching modules. The purpose of the teaching modules was to bring inquiry-based learning opportunities to students predicated on scientific knowledge obtained through summer research experiences. Using a hybrid format of classroom-based instruction and virtual seminar, the clinical faculty aided RETs in producing their individual teaching modules. As part of this effort, an online learning community was open to RETs, where they could access various resources associated with the ERC, including the virtual seminar, instructional handbook, inquiry-based classroom activities, and collaborative discussion. A full array of RET teaching module related products, including the instructional handbook, are accessible online. As well, individual teaching modules may be found at the following links.

NCAT ERC Teaching Module (Editable)
http://docs.google.com/Doc?docid=0AYW4plEa1W5wZGNrazM4cW1fMTU0eHM4bTYyZ3o&hl=en

Extrusion Power Point (Editable)
http://docs.google.com/present/edit?id=0AYW4plEa1W5wZGNrazM4cW1fMTIyZHpmNmpzY3I&hl=en

Nano-Hero Adventure PP Template (Editable)
http://docs.google.com/Doc?docid=0AYW4plEa1W5wZGNrazM4cW1fMTNjbXhrY2podA&hl=en

Pulsed Laser Deposition Power Point (Editable)
http://docs.google.com/Doc?docid=0AYW4plEa1W5wZGNrazM4cW1fMTQ4Z2pwYndzcTc&hl=en

Sputtering Power Point (Editable)
http://docs.google.com/Doc?docid=0AYW4plEa1W5wZGNrazM4cW1fMTUxYzl4ODNmZ2s&hl=en

Drop on Demand Lesson Plan (Editable)
http://docs.google.com/present/edit?id=0AYW4plEa1W5wZGNrazM4cW1fMTVkZGZkazZjaA&hl=en

Nanotechnology Web-Quest (Editable)
http://docs.google.com/present/edit?id=0AYW4plEa1W5wZGNrazM4cW1fMjhnN25qcG1jYg&hl=en

Lab Safety Activities (Editable)
http://docs.google.com/present/edit?id=0AYW4plEa1W5wZGNrazM4cW1fMzlnd2RwMjlkYw&hl=en

Drop on Demand Power Point (Editable)
http://docs.google.com/present/edit?id=0AYW4plEa1W5wZGNrazM4cW1fNDFmcXpyZ2pjZA&hl=en

Assessment Plan with Results

REUs and RETs participating in the six-week research experience were asked to volunteer for the entrance/exit, one-to-one interviews. The interviews were conducted by an advanced-level graduate research assistant, specifically trained in dynamic, interpersonal communication, and supervised by faculty. Survey questions were open-ended in nature and were designed to encourage RETs and REUs to explore their thinking surrounding "research and development in a multidisciplinary environment that values diversity of thinking, innovation, and entrepreneurship." Survey questions were subdivided into topics such as bioengineering, creativity and innovation, entrepreneurship, impressions from the research experience, and short-/long-term career and academic goals. A sixth topic addressed participant individual learning goals. Parsimonious interpretation of assessment data suggests that REU/RET research activities netted gains in participant understanding of bioengineering, creativity and innovation, and entrepreneurship, including a significant change in self-assessed proficiency levels relative to individual learning goals. Once the interviews concluded, tape recordings were transcribed into a word document, and responses were subsequently aggregated according to specific questions. Data were subsequently analyzed for keywords. Institutional Review Board approval and Informed Consent were obtained prior to data collection. Demographic data are found in the table below.

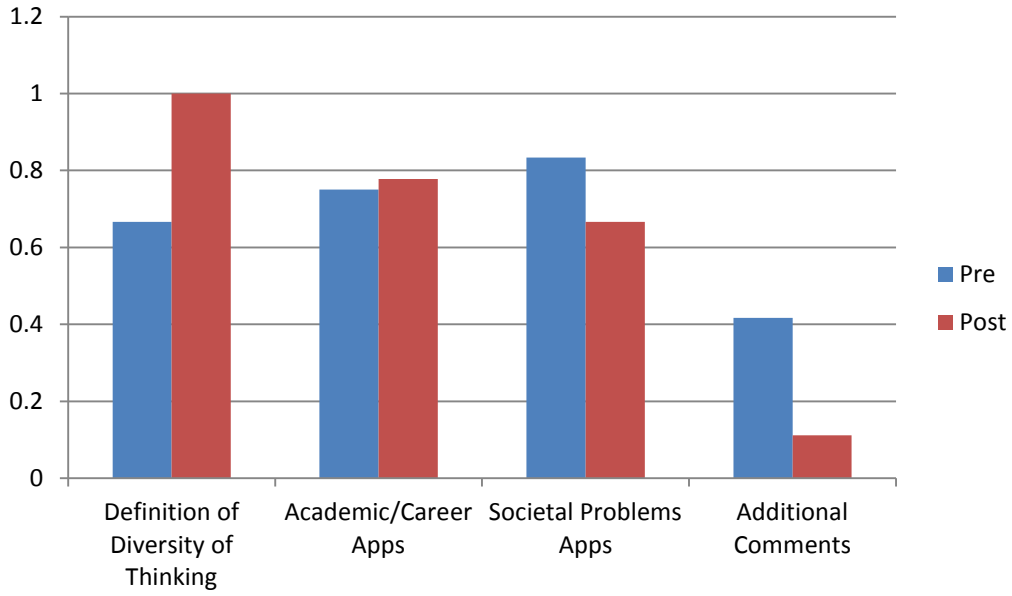
REU/RET Participant Demographic Information

Demographics	REUs (*n=7*)	RETs (*n=5*)
Mean Age	21	39
Gender		
Females	2	2
Males	5	3
Race/Ethnicity		
African American	4	1
Asian	1	1
Caucasian	2	3
Geographic Regions		
Southeastern US	4	5
Northeastern US	2	0
Western US	1	0
US Citizenship		
Citizen	6	5
Permanent Resident	1	0
Teacher Experience		
Licensed >4 years experience	n/a	4
Licensed <4 years experience	n/a	1

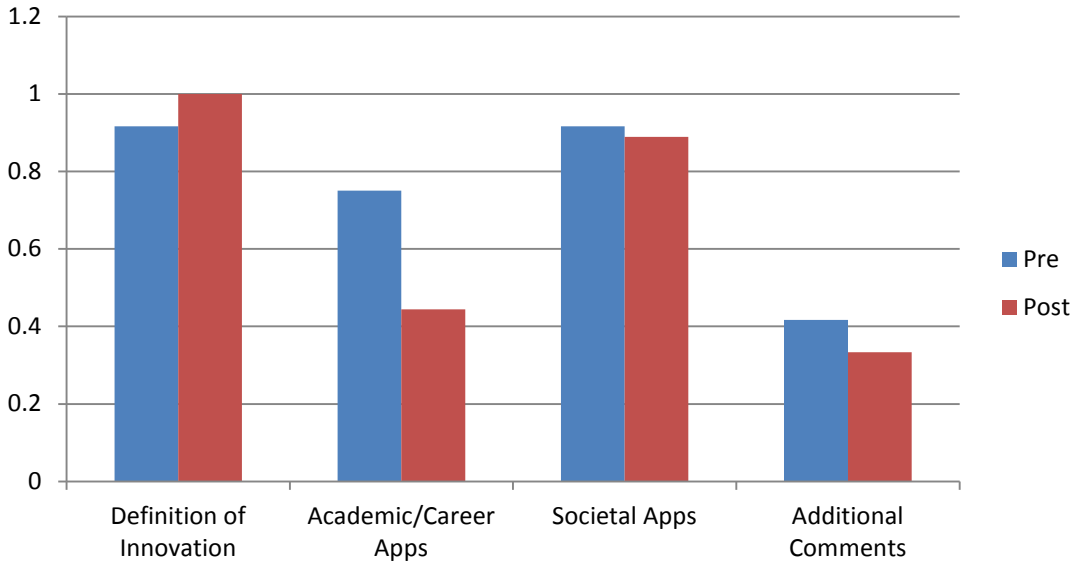
Participants were also asked to talk about their perceptions of the REU/RET program upon their future academic and career goals. In every case but one, participants agreed at exit interview that the intensive research experience for undergraduates and teachers forwarded their academic and/or career goals, as well as their "dream" goals. The exception related to one respondent who indicated that his/her primary focus was upon biology, not engineering. It is notable that both undergraduates and teachers could link their research experiences with their future academic/career and "dream" goals. In other words, for undergraduates who wish to pursue graduate work in bio-engineering, the connection between their goals and the research experiences is largely intuitive. For teachers, the link may "feel" less obvious; yet, RETs made strong connections between their summer research and their future goals. For example, one participant stated: "It has opened my mind up to a Masters, not in literacy. It's possible that I would look for something in science education or maybe even a particular science." Yet another said: "There is a possibility of co-writing a grant. I would like to do more research at the community college."

As part of their entrance/exit interview experiences, participants were asked to identify at least one individual learning goal for the six-week research experience. In every case except one, participants identified more than one learning goal. There were twelve participants available for entrance interviews. As well, there nine participants available for exit interviews; and of these, seven participants provided goal attainment scores related to their individual learning goals. Once each participant identified his/her goals, the participant was then asked to self-assess current proficiency levels using a Goal Attainment Scaling. Goal Attainment Scaling is a method for quantifying an individual's assessment of his or her proficiency level. (Royse, Thyer, Padgett, Logan, 2006). Using a five-point scale (-2 to +2, where 0 is average), participants were asked to score their proficiency level for each individual learning goal during both entrance and exit interviews. A composite score was subsequently computed for each participant, and then standardized as *t-scores* (M = 50; SD = 10). Using SPSS 17.0, a paired t-test was computed (critical $t_{(.05,\ 6)} = 1.9431$; two-tailed) to compare pre-/post- GAS scores. A t-value of $2.9_{(.05,6)}$ was obtained. A full rendering of the entrance/exit interview transcripts are available upon request. Figures below inform changes in participant pre-/post- perceptions in bioengineering, diversity of thinking, innovation and creativity, and entrepreneurship. Descriptive data were analyzed for keywords. Keywords included:

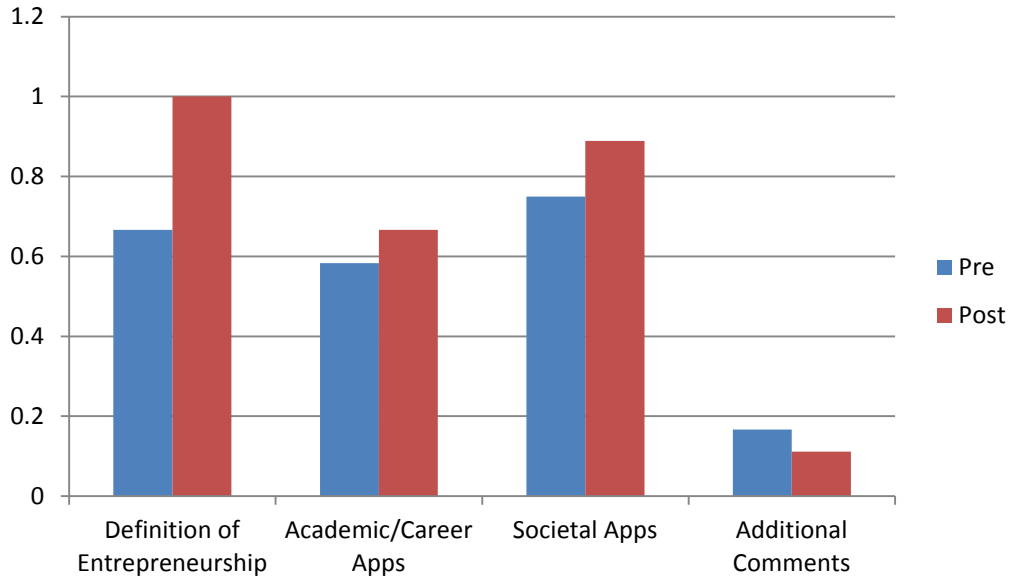
I. **Bioengineering:** Engineering, Human Body, Bioengineering, Biology, Biologic Sciences, Biomedical;
II. **Diversity of Thinking:** Creative thinking, "Out of the Box," Connecting New Ideas, Original Problem-Solving;
III. **Innovation and Creativity:** Creative, New, Idea, Revolutionize, Novel, Original;
IV. **Entrepreneurship:** Business, Product, Marketability, Ownership, Small Business.



Participant Pre-/Post- Perceptions of Innovation and Creativity and Its Application to their Academic/Career Goals and Societal Problems. Keywords: Creative, New, Idea, Revolutionize, Novel, Original.



Participant Pre-/Post- Perceptions of Entrepreneurship and Its Application to Their Academic/Career Goals and Societal Problems. Keywords: Business, Product, Marketability, Ownership, Small Business.

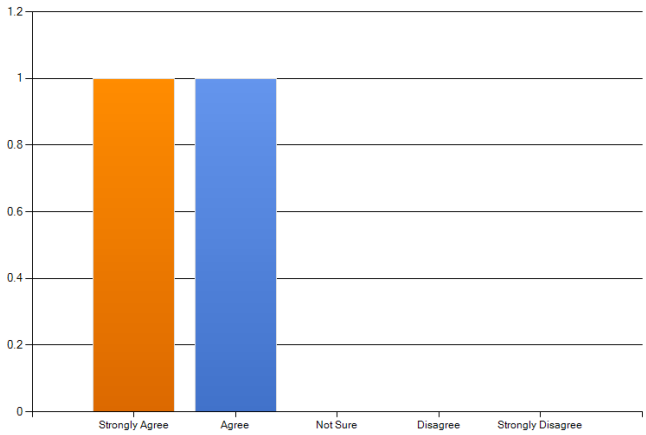


REU/RET participants were contacted six months after completing their intensive research experiences. Though the *N* response rate was small (*n = 2*), a positive trend was indicated. Those Likert responses are graphically depicted in the figures below.

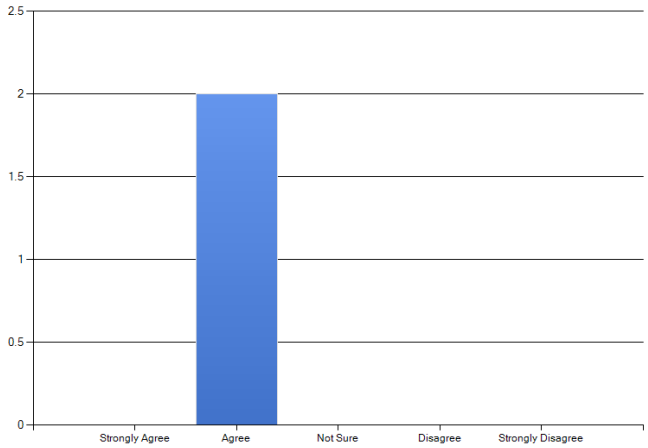
REU/RET Follow UP Survey

(n=2)

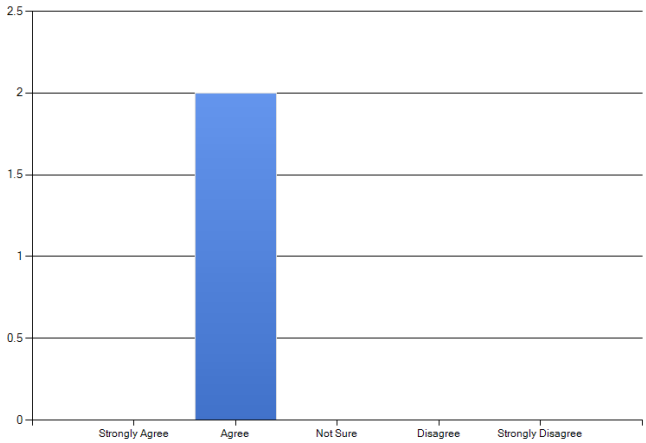
I see the value of this REU/RET summer experiences as they relate to bioengineering studies.



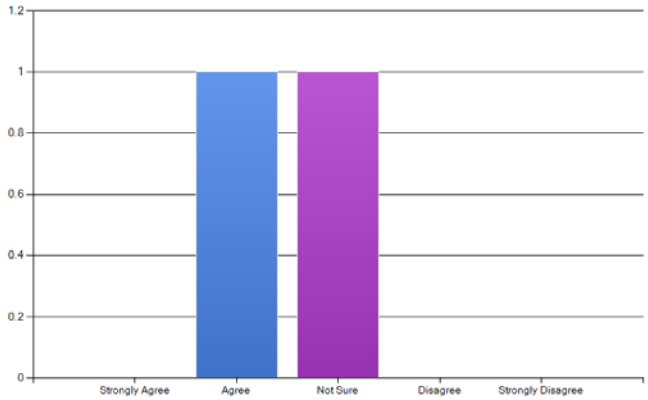
I would engage in the REU/REU 6-week summer program again, if possible.



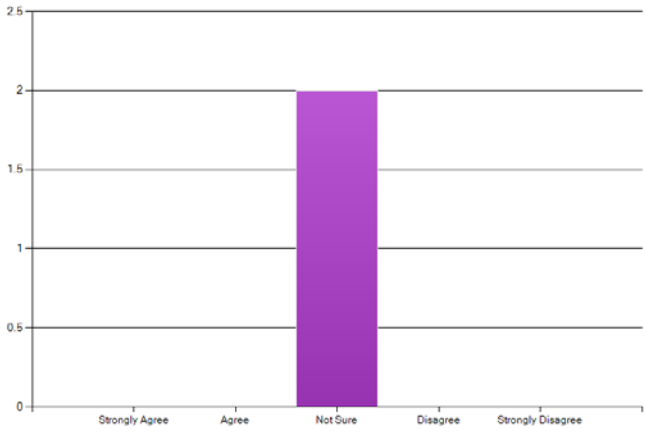
I found the instructors and leaders to be friendly and helpful, and I believe that they worked to support my success in the program.



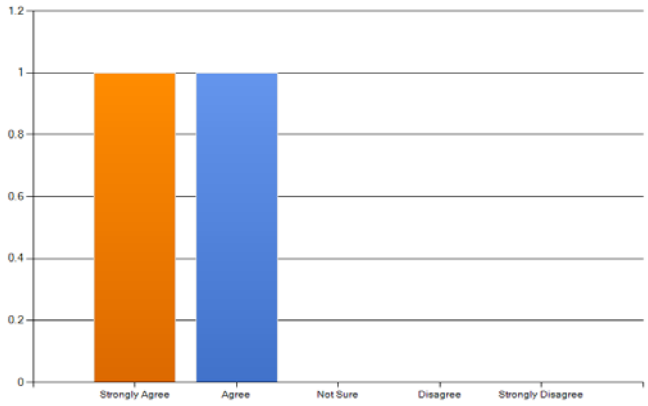
At this point, I think I could present a poster presentation at a state, regional or national conference on the content presented last summer and its link to bioengineering. If strongly agree or agree, please provide a hypothetical "title" for your poster.



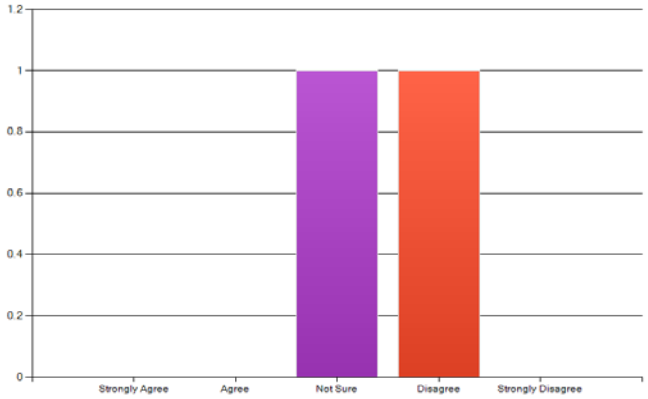
I believe that today I am still using the content presented in summer experiences in my work as a graduate student or teacher.



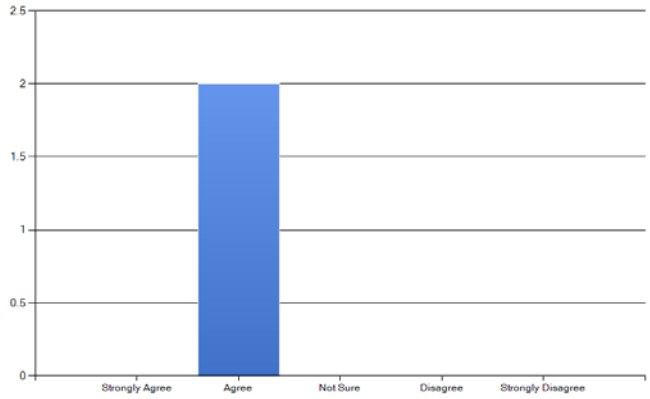
I believe this course helped me get-to-know other members of the bioengineering community.



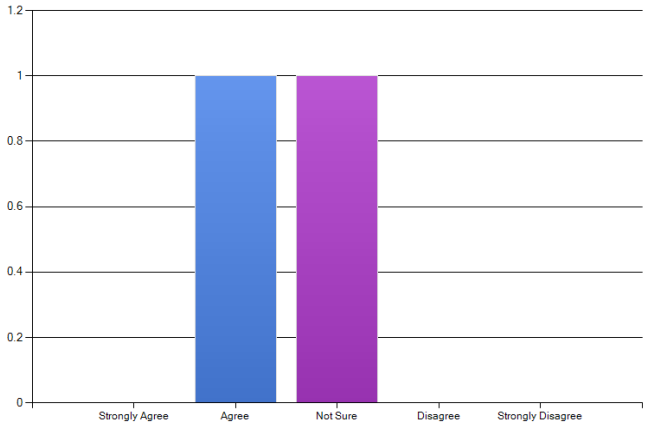
I would not participate in the REU/RET experiences again, if asked.



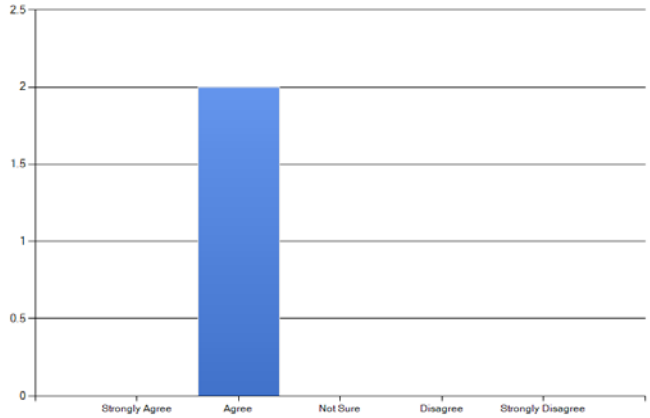
Feedback from instructors and leaders was prompt and helpful, supporting my academic/career goals.



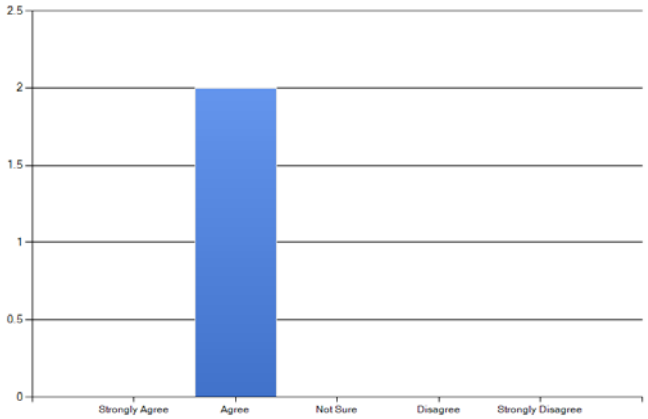
Beyond the research experience/laboratory setting, I do not find myself thinking a lot about the content covered in the research experiences. If disagree or strongly disagree, please provide an example(s) of some of the ideas you've pondered since last summer.



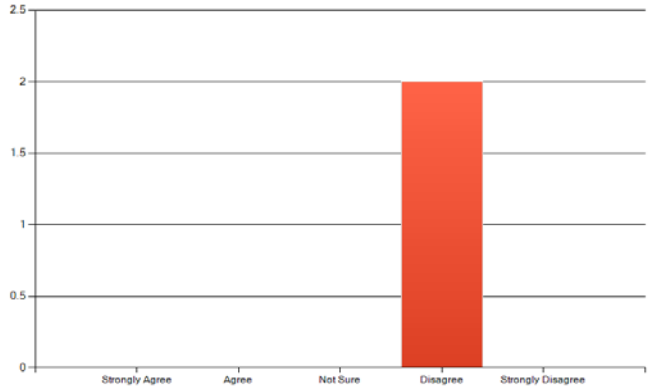
In talking with and listening to my REU/RET cohort members, I felt we shared many similar opinions about the learning experiences.



I have a better understanding of the concepts of creativity and innovation, diversity of thinking, and entrepreneurship.



I don't see a connection between the concepts of creativity and innovation, diversity of thinking, and entrepreneurship and the concepts of cell biology, bioengineering, and the process of scientific discovery and inquiry.



Responders also provided additional comments to the following prompt: “In my opinion, the intensive research experience greatest strength was:”

- Collaborative efforts and mentorship
- Learning more about nanotechnology and its use in daily life

Responders also provided additional comments to the following prompt: “In my opinion, the intensive research experience primary area for improvement was:”

- Some areas needed a little more organization.
- More coordination is needed such that no time is wasted and every minute is utilized.

Future Plans

The 2009 REU/RET projects appear to have produced substantive building points for similar future activities. That said, future intensive research experiences should implement changes incorporating feedback from the 2009 participants. These recommendations included: (a) improved programmatic organization, systematization, and implementation, and (b) addition of K-14 participants. REU/RET projects from 2009 were impacted by logistical difficulties typical to any start-up program. For instance, “getting the word out” about the REU/RET came later in the academic semester, a traditionally hectic and compressed time of year in every academic arena. The entrance and exit interviews generated useful descriptive data, but they were time-consuming.

Discussions about ways of enhancing the REU/RET project for 2010 are underway. The following action list is in partial response to information gleaned through the assessment process. It is expected these efforts will set a positive organizational trend enhancing the REU/RET project and carrying forth through the summer.

- Returning key personnel
- Increasing seamlessness between intensive research experiences and ongoing ERC research
- Strengthening links between REU/RET project, ERC research, and industrial partners
- Systematic advertising through multiple modalities to “get the word out” to local points of contact (e.g., public school teachers and administrators) to bolster interest in bioengineering among underrepresented groups (initiated January 2010)
- Competitive application and review process
- Web-based online fillable application
- Developing and piloting a survey to assess pre-/post- REU/RET content knowledge and REU/RET learning outcomes
- Developing and piloting a survey to assess pre-/post- REU/RET experiences.

II. NANO-TO-BIO SUMMER CAMP

Interventions Overview

The Nano-to-Bio Summer Camp was a multi-dimensional endeavor with activities specifically designed for pre-university education (K-14) and secondary students interested in learning more about bioengineering. Held in summer 2009, the Nano-to-Bio Summer Camp was the result of a major collaboration among partnering institutions, utilizing faculty and mentors from two geographically distant campuses. This five-day commuter camp was comprised of a diverse group of high school sophomores, juniors and seniors, deriving from geographically disparate locations throughout North Carolina. The camp provided intensive, hands-on learning experiences for campers. Science (K-14) teachers (who also were participants in the University's RET program), undergraduate students in bioengineering and professors in mechanical engineering and bioengineering served as camp instructors.

There were two over-arching goals for the camp, specifically, to introduce campers to bioengineering and to encourage campers to pursue a baccalaureate degree in tissue engineering. The content for camp teaching and learning largely focused upon tissue engineering, and more broadly bioengineering, a field of study which centers on crafting functional, healthy, replacement tissues and organs for those that are damaged, diseased, or missing. One partner campus created teaching and learning modules in their tissue engineering center. These modules included Tissue Engineering (TE) and Regenerative Medicine, both, revolutionary technologies offering hope to people with compromised tissue function. The camp theme was: "A Biomedical Challenge: Restoring Gold-Medal Performance to LeBron James' Injured Leg."

The week-long camp was formatted from a developmental perspective. In completing camp activities (e.g., chicken leg dissection), special emphasis was placed upon the importance of teamwork and peer collaboration and "thinking outside of the box" in the scientific discovery process. Campers arrived at the laboratory by 9:00 AM each morning, ready to continue their study from the previous day. As the week progressed, campers moved from simple chicken leg dissections to more advanced areas of regenerative medicine (i.e., growing stem cells).

Assessment Plan and Results

The assessment plan was developed and implemented to answer the following question: *How effective is the summer camp in forwarding the purpose of the ERC Education and Outreach Program and the overall vision of the Engineering Research Center?* Campers were asked to complete pre-/post- general and content-specific written assessments. An advanced-level graduate research assistant, specifically trained in research design and procedures and supervised by faculty, administered the assessment instruments. Data were subsequently analyzed for keywords. Prior to data collection, Institutional Review Board approval and camper and parental Informed Consent were obtained. Demographic data is found in the table below.

Nano-to-Bio Summer Camper Demographic Information

Demographics	Campers (*n = 17*)
Mean Age	16.3
Gender	
Female	9
Male	8
Race/Ethnicity	
African American	14
Caucasian	3

Summer campers reported high levels of satisfaction with the Nano-to-Bio Summer Camp experience, including enhanced understanding of complex concepts such as the relationship between human tissue and the processes of bioengineering. Seventeen high school students completed the general and content-specific pre-assessment instruments. In the general pre-assessment, the majority of participants reported they learned about the summer camp primarily through their parents and to a lesser degree through their friends. One student indicated that he/she was introduced to the program through a teacher; and three students stated they found out about the program through contact with University representatives. Fifteen of the high school students affirmed they had at one time participated in a Science Fair. Most students wanted to learn more about biomedical and skin engineering (strongly agreed *n = 5*; agreed *n = 9*; non-committal *n* = 2; strongly disagree *n = 1*). Similarly, students said that they were interested in science and engineering prior to the summer camp (strongly agreed *n = 6*; agreed *n = 7*; non-committal *n = 3*; disagree *n = 1*). Students generally reported that they expected to learn more about engineering, biology, science, and college life while participating in the camp.

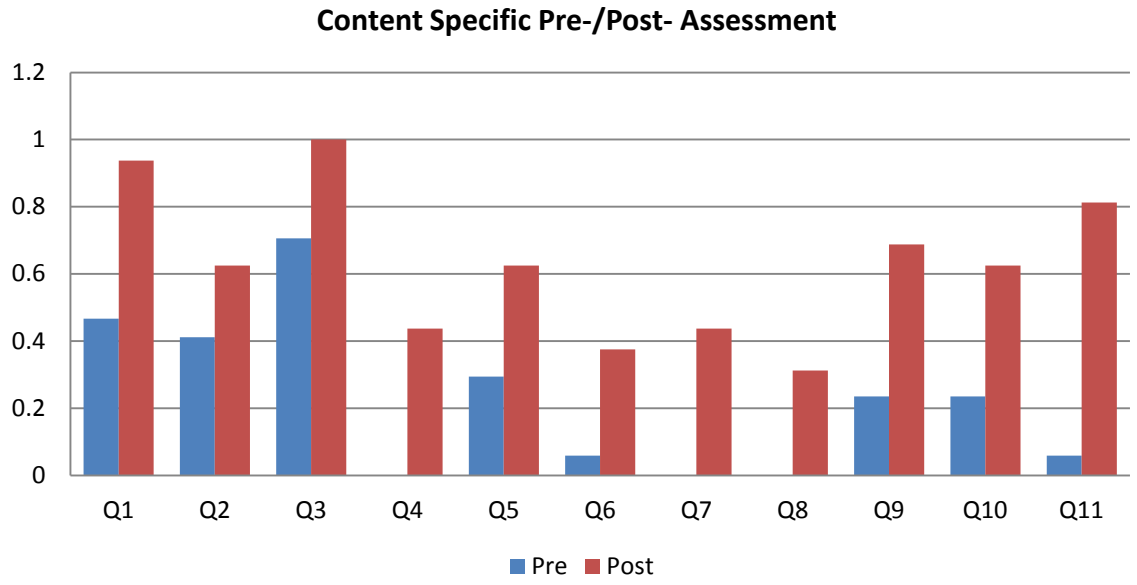
Sixteen high school students completed the general post-assessment instruments. (One participant did not attend the final day of camp.) The general post-assessment clearly indicated that students enjoyed the summer camp. The majority of students responded that since participating in the summer camp their interest in science, engineering, and medicine had increased (strongly agree *n = 12*; agree *n = 2*; disagree *n = 2*). Similarly, most reported that they would like to learn more about tissue engineering (strongly agree *n = 6*; agree *n = 8*; non-committal *n = 1*; disagree *n = 1*). Overwhelmingly, students enjoyed the camp and participating in camp activities (strongly agree *n = 14*; agree *n = 1*; no response *n = 1*). Students cited various experiments they enjoyed, two of which most frequently cited were dissection of the chicken leg and creating skin. Students indicated that they enjoyed hearing the speakers, particularly one representative from industry (strongly agree *n = 11*; agree *n = 4*; noncommittal *n = 1*).

They also commented favorably on the food. Students generally reported they would like to attend another ERC summer camp in future (strongly agree *n = 9*; agree *n = 6*; disagree *n = 1*). Students also responded that they were likely to take more science classes in the future (strongly agree *n = 7*; agree *n = 6*; noncommittal *n = 2*; disagree *n = 1*; unclear response *n = 1*). When asked to list specific ideas they had learned during camp, students indicated the following: stem cells, scaffolding, tissue engineering, tissue, organ, and limb regeneration, and the medical applications of nanotechnology.

Sixteen students completed the content-specific post-assessment. (One participant did not attend the final day of camp.) As may be expected, students generally demonstrated less certainty in their responses to the content-specific post-assessment. However, they also informed growth and learning when compared to the corresponding pre-assessment. Questions from the pre-/post content-specific assessments are outlined in the table below. As well, keywords suggesting understanding of concepts are provided. Descriptive data were analyzed to determine the presence of specific keywords, and changes in conceptual understanding between pre- and post-assessments are graphed below.

Pre-/Post- Content-Specific Assessment Questions and Related Keywords

Questions	Keywords
Q-1: What is tissue engineering	Tissue, engineering, creating Regenerating, growing
Q-2: What do you think is going on in the process of human development? List as many processes as you can.	Growing, cell, division, Regeneration, differentiation
Q-3: What are tissues made of?	Cells
Q-4: How do cells or tissues communicate with each other?	Signals, mRNA, DNA
Q-5: What are cells internal set of instructions called?	DNA
Q-6: All cells of the embryo contain the same set of instructions. Based on this idea, how can different cells arise with different structures and functions?	DNA, Extra Cellular Matrix
Q-7: What two repair processes are used by the body to heal a wound?	Scabbing, scarring, Regeneration
Q-8: What are three approaches used by tissue engineers to fabricate (grow) a new tissue?	Scaffolding, cell, stem cell, Regeneration, imprinting
Q-9: What cells are most commonly used when trying to grow a new tissue?	Stem, cells
Q-10: Where might scientists find stem cells?	Embryos
Q-11: What do you think eventually happens to an implanted scaffold?	Degrades, degenerates, Disappears



Pre-/Post- Content-Specific Inventories Indicating Change in Understanding

Future Plans

The 2009 Nano-to-Bio Summer Camp appears appear to have produced substantive building points for similar future activities. That said, future camps should implement changes incorporating feedback from the 2009 participants. These recommendations included: (a) increase the length of the camp, (b) include more lab tours and field trips, and (c) schedule lectures at a time other than after lunch. The Nano-to-Bio Summer Cam encountered logistical difficulties typical to any start-up program. For instance, "getting the word out" about the camp came later in the academic semester, a traditionally hectic and compressed time of year in every academic arena. The pre-/post- general and content-specific inventories generated useful assessment data, but these data could have been enhanced with descriptive data gathered from focus groups.

Discussions about ways of enhancing the camp for 2010 are underway. The following action list is in partial response to information gleaned through the assessment process. It is expected these efforts will set a positive organizational trend enhancing the summer camp project.

- Returning key personnel
- Increasing seamlessness between summer camp experiences and ongoing ERC research
- Strengthening links between summer camp, REU/RET project, ERC research, and industrial partners
- Systematic advertising through multiple modalities to "get the word out" to local points of contact (e.g., public school teachers and administrators) to bolster interest in bioengineering among underrepresented groups (initiated January 2010)
- Competitive application and review process

- Web-based online fillable application
- Developing and piloting a survey to assess pre-/post- camper content knowledge with specific learning outcomes
- Developing and piloting a survey to assess pre-/post- attitudes about bioengineering as an academic and career choice.

III. BIOENGINEERING CURRICULUM DEVELOPMENT

A. MEEN 785: PRINCIPLES OF CELL BIOLOGY I FOR ENGINEERS (FALL 2009)

Interventions Overview

In fall 2009 and in collaboration with faculty from the University of Pittsburgh and University of Cincinnati, a distance learning course was implemented to teach introductory cell biology to graduate students in mechanical engineering (NCA&T) and bioengineering (Pitt and UC). The syllabus describes the course as follows: "This is the first part of a 2-semester required (core) graduate course. Topics covered in this part of the course are bio-macromolecules, protein purification and regulation, cell membrane, microscopic techniques, genetics (chromatin organization, DNA replication, recombination, transcription, translation and control of gene expression) and molecular biology techniques including concepts of forward and reverse genetics." The complete syllabus is available upon request.

The course was delivered through weekly 4-hour teleconferencing lectures and small group tutorial. There were two course coordinators, Dr. Devdas Pai from NCA&T and Dr. Sarah Pixley from the University of Cincinnati. Dr. Partha Roy from the University of Pittsburgh developed the course syllabus. Course instructors were: Drs. Partha Roy, Sarah Pixley, William Wagner (Pitt), and Bridget Deasy (Pitt). In addition, students at NCA&T meet weekly for small-group tutorial with Ms. Aliza Alston and Ms. Latisha Taylor, graduate teaching assistants from the NCA&T Biology Department. Dr. Robin Guill Liles (NCA&T) provided three 1-hour lectures focused upon creativity, innovation, and entrepreneurship. The purpose of these brief lectures was to help students link engineering and cell biology to the mission of the ERC Education and Outreach program "to train future engineers for industry, research and development in a multidisciplinary environment that values diversity of thinking, innovation, and entrepreneurship."

As stated, this course was designed in hybrid format. The rationale for using technology in delivering course content was to optimize exchanges between faculty and students among ERC campuses. Research suggests that students are increasingly drawn to hybrid – or blended – class formats (Garrison & Kanuka, 2004; Orton-Johnson, 2009). Students appear generally satisfied, or even prefer, online learning environments, and adult learners often report appreciation for the flexibility of the online format. Menchaca and Bekele (2008) indicated that online learning experiences could be significantly enhanced when emphasis was given to: (a) technological tools facilitating student-to-student and student-to-instruction interaction and learning community development; (b) technical proficiency for both students and instructors, including tutorials; (c) positive and sufficient instructor support, made possible through optimal

technological tool access and flexibility; and (d) positive instructor and student attitude. By contrast, students reported diminished learning experiences when encountering (a) unresponsive instructors; (b) unclear course guidelines and expectations, and (c) persistent technical difficulties.

Assessment Plans and Results

The assessment plan for this course included three components. The first component assessed student learning of MEEN 785.002: Principles of Cell Biology for Engineers content knowledge. The second component included evaluation of students' overall satisfaction with MEEN 785 teaching and learning. The third component included evaluation of students' overall satisfaction with the hybrid class format. (A subset of this component involved assessment of student understanding of ways principles of cell biology link to concepts of creativity and innovation, diversity of thinking, and entrepreneurship.) IRB approval was obtained prior to collecting assessment data. The student distribution is found in the table below.

MEEN 785: Principles of Cell Biology I for Engineers Student Distribution

Demographics	MEEN 785 Students (*n = 16*)
Gender	
Females	6
Males	10
Race/Ethnicity	
African American	8
Asian	8

Related to student learning of course content, there were three student learning outcomes as identified in the syllabus. These SLOs were:

- Students will learn different macromolecules in cells.
- Students will understand the different principles of cell structure and functions, mainly focusing on fundamental genetic mechanisms
- Students will learn about the experimental tools used to understand cellular function such as molecular genetic techniques, biochemical analysis, and microscopy.

Midway through the semester, MEEN 785: Principles of Cell Biology I for Engineers students (*n = 12*) were issued a survey gathering formative data related their growing understanding of course content and their opinions of course delivery. A review of these data suggests that generally students were "following" and enjoying course lectures and materials. A full outline of these data is found below.

Mid-Semester Survey of MEEN 785: Principles of Cell Biology I for Engineers

(*n = 12*)

Part 1

Topic A: Cell structure (Pixley)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.		1	1	5	5
Slides were clear and adequate for study.		1	1	2	8
Verbal presentation was clear: allowed understanding of subject.				5	7
Quiz/exam questions related well to the lectures.		1	1	4	6

Written comments to explain your reason for any of the above ratings will be very helpful:

a) Overall material was understood because we spent time on it.
b) Like the way Dr. Pixley designed slides for non-biology majors
c) The TA's helped a lot with the understanding of this section
d) The material I this section I found to be of ease. I do understand the complications of connecting this info to following section from an educators' point of view. The quiz and exams are based on this section and I don't believe enough emphasis is present in the lectures. Maybe this could be tweaked, so that the oral connects more with the slides and what we should have to know for our edification.
e) Great teacher! This is the most clear of all the lectures. After her explanation everything became clear, she made it more understandable and I didn't feel the need to memorize much.

Topic B: Biochemistry (Wagner)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.	2	4	4	1	
Slides were clear and adequate for study.	2	2	5	1	1
Verbal presentation was clear: allowed understanding of subject matter	1	1	3	5	1
Quiz/exam questions related well to the lectures.		2	5	3	1

Written comments to explain your reason for any of the above ratings will be very helpful:

a) Some materials too in depth
b) Too much info way over our heads; verbal presentation not at our level
c) Not easy even for chemists. A lot of information, not easy to comprehend without basics in organic chemistry.
d) Can't connect the engineering and the science/medicine.
e) We are tested on knowledge that we do not have the basis for.
f) Do not make the class easy but more connective.
g) The class needs a lab.
h) Understand a lot more from BMES
i) 201 slides too much

Topic C: Lipids (Deasey)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.		1	4	7	
Slides were clear and adequate for study.		2	5	3	1
Verbal presentation was clear: allowed understanding of subject.	1		4	6	1
Quiz/exam questions related well to the lectures.	1	1	5	4	1

Written comments to explain your reason for any of the above ratings will be very helpful:

a) Deasey did good using examples
b) It was hard to extract the main ideas from the verbal presentation, even the reviews did not help. Probably it would be better to point the major important issues, especially for engineering students.

c) Importance of this section not stressed. Had problems understanding the lecture.
d) Bringing the topic of research 1st and then work might help.
e) Very difficult section, she should relate her work to the lecture.
f) The material covered was too much, when explained it's clear, but there is no way for anybody without a Chemistry and Biology background to be able to understand and remember all this material in one semester.

Topic D: Cellular ion control and bioenergetics (Smith)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.	2	3	4	2	1
Slides were clear and adequate for study.	2	1	4	3	2
Verbal presentation was clear: allowed understanding of subject matter	1	3	2	5	1
Quiz/exam questions related well to the lectures.	1	2	4	4	1

Written comments to explain your reason for any of the above ratings will be very helpful:
a) During the lectures I did not understand 50% of the material, but after online repeating it became very clear.
b) Great lecture, heavy chemistry, relevant, makes some connection to cellular dynamics.
c) Info rushed and no relation similar to Dr. Deasey.

Topic E: Protein Techniques (Roy)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.	1	1	3	5	2
Slides were clear and adequate for study.	1	1	4	3	3
Verbal presentation was clear: allowed understanding of subject.	1		2	3	6
Quiz/exam questions related well to the lectures.	1	2	2	5	2

Written comments to explain your reason for any of the above ratings will be very helpful:
a) Spend more time on material use more examples to explain the material. This comment is

applied to all Dr. Roy's lectures

b) Quiz/Exam questions was pointing on deep details which requires good understanding of techniques. Again, take into account the whole volume of info to memorize - it is impossible. I think the analytical techniques should be a separate course.

c) Slides were good. Bring the lab into the classroom. Connect the science or research of today or yesterday to help us understand the origin and where medicine wants to go.

d) Very clear in his teaching, very good teacher, but I think his material alone should take semester to finish, not combined with 4 other teachers' material.

Topic F: Microscopy (Roy)

Aspect of topic coverage	SD (Strongly Disagree)	D (Disagree)	N (Neutral)	A (Agree)	SA (Strongly Agree)
Material was easy to comprehend.	2	1	3	2	4
Slides were clear and adequate for study.	2	2		3	5
Verbal presentation was clear: allowed understanding of subject matter	1		2	3	6
Quiz/exam questions related well to the lectures.	1	2	2	3	4

Written comments to explain your reason for any of the above ratings will be very helpful:

a) Some materials are too in depth and I'm not sure how to relate this materials to later usage

b) Important section, explained very well, very knowledgeable on topic, related to quiz and exam.

Mid-Term Survey Part 2
Is the overall course fulfilling your needs?

I. What were your expectations for this course?

- **a.** Biocompatibility, in vivo and in vitro experiment test
- **b.** To get a clear understanding of how biology relates to what we do in the ERC (2)
- **c.** Learn everything about the cells. Will we ever learn how to manipulate cells? Such as Atomic Force Microscope. What about other techniques to design something that is properly for the cells? For example, the use of lithography as a mean to filter out red blood cells from other junks.
- **d.** Do better than I am doing
- **e.** Learn how biology and engineering relate. Did not know the class was going to go so fast. Also I thought the material would include more engineering stuff.
- **f.** Basic concept about biochemical engineering for research
- **g.** I think this course will help me to understand the terminology used in the

biomedical application. Right now, I am working on corrosion properties of materials which we have developed. I think this course will help me to understand related topics of my research.

h. I was expecting to get an introductory level of biology for *engineers*, the material might all be relevant to our research area, but it should be paced out better, not all crammed into one semester.

II. How is it meeting or not meeting those expectations?

a. Is not meeting my expectation

b. Most part meets my expectations as far as understanding cell biology as a whole. I don't quite have a thorough understanding of how the body reacts to different materials that is put inside of it from a biological point of view

c. I think I am on track but time will tell

d. It's getting there..very painful one step at a time

e. need more study

f. Not meeting my expectations. I don't think it is right to give an exam with so much study material in a little amount of time.

g. I have been taught many subjects that I have never heard before, some of them are very interesting, it is meeting my expectation

h. Till now in my research work, we are finding the mechanical properties of the materials, which we have developed. In future, think this class will help

i. more than expected

j. Surpassing with leftovers

k. I am learning a lot, a little too much for this short period of time. I would like to gain knowledge of everything taught, but I feel overwhelmed and don't know how to memorize (I'm an engineer after all). So slowing the pace down would be definitely more beneficial

III. Do you think that you will be better able to understand your biology colleagues after completion?

a. yes 6

b. yes at least terminologies and function

c. No in the timeline we following right now

d. no question. We have great learned professors! If I do, and I can not find the answer I can ask you.

e. I definitely know more biology now than I ever did in my life; I have no biology background whatsoever.

Mid-Term Survey Section 3
Your General Suggestions to Improve the Course

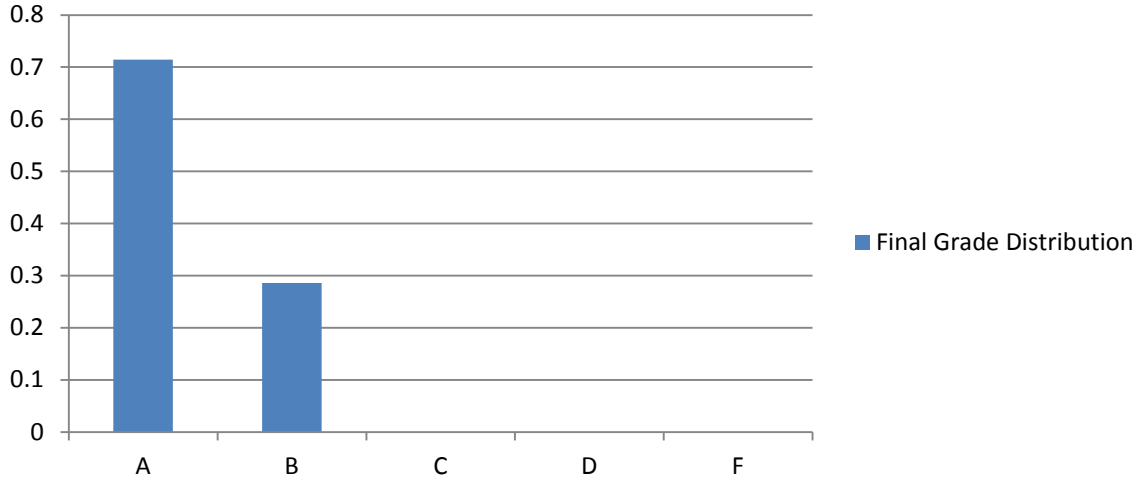
1. Homework to ensure we are reviewing the material weekly. If we were given it on Friday we could turn it in and review it during recitation. Quizzes periodically could be used to make sure we are studying and understanding the information (3)
2. Class should be 2 hours ONLY! We had almost 100 slides per lecture so far. Try to reduce it. Do not crush all the biology in one course, better make them understand and enjoyable to the student.
3. Break down the tests, meaning instead of 2 test we should have 3 so there would not be so much material to memorize. We are, at least I am not familiar with memorizing so much info at once.
4. Have more than 1 grade before midterms
5. Please have a summary for each class
6. How can we improve our grades from the midterm so can we think of other ways to improve our grades in this class
7. I don't think the extra credit assignment given in the beginning is enough to pull up our grades
8. I think it is fair to let us know how the grading scale would be like at the end of the school year. I know someone said there would be a curve at the end. But this does not tell us if we need to drop the class or not.
9. Is the grading going to be the same for all schools? If so it is unfair for those who have no biology background.
10. Materials covered so much material. Can the professors of each section give us tests or assignments to help us understand the slides
11. Maybe short quizzes after the lecture so we can understand the main ideas and help in preparation of big exams.
12. Teaching is a close encounter even though a distant course. I cannot just stop by one of the professor's office, but this helps me to figure out things for myself. The book is good, the resources are good. Maybe a lab class or getting involved with our biology department? (Wake, Chapel Hill, Doctors Hospital) There is not much 1 can do to prepare for this class, but we wanted the opportunity and I am thoroughly enjoying it. Thank you all for your time
13. Slow down pace

Summative data indicate that students completed MEEN 785 with highest marks. Grade distribution (4.0 scale) is outlined in the figure below.

MEEN 785: Principles of Cell Biology I for Engineers

Final Grade Distribution (4.0 scale)

(*n = 14*)

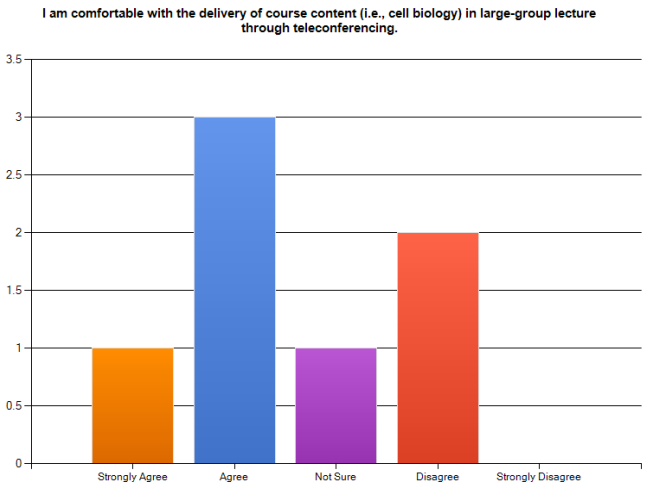


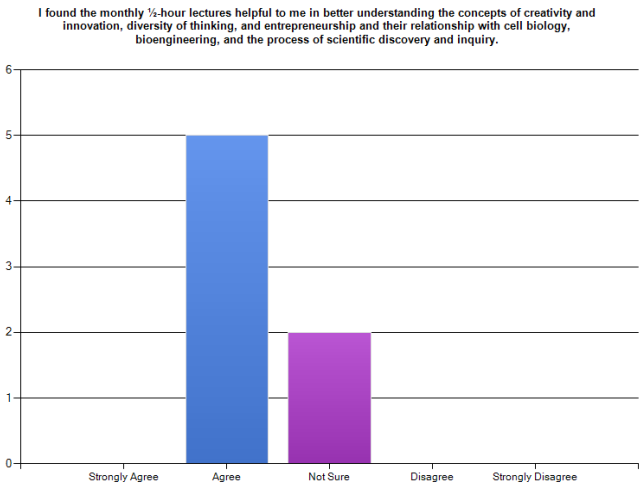
MEEN 785 students also indicated overall satisfaction with the course's hybrid format. Figures below represent Likert scale responses (*n = 7*) (with additional comments) to the online "Survey of Student Satisfaction with the Hybrid Course Format." Additional figures found below are also Likert scale responses (*n = 2*) to the "Survey of Student Satisfaction with Course Content and Learning (MEEN 785; Fall 09)."

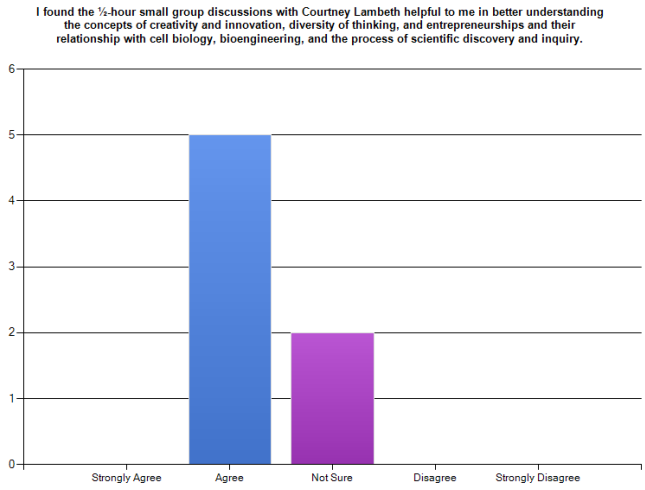
MEEN 785: Principles of Cell Biology I for Engineers

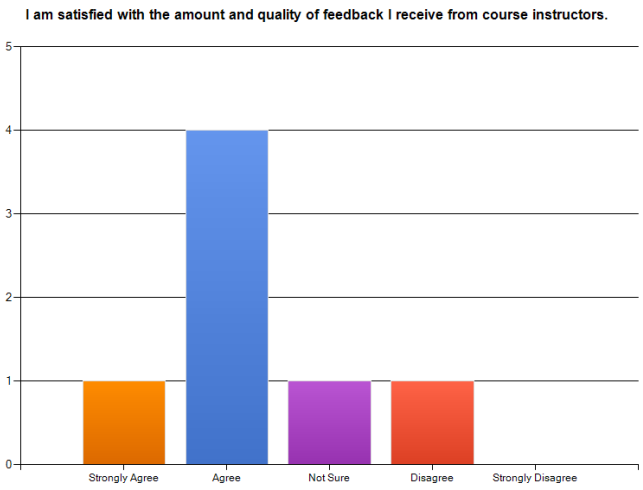
Survey of Student Satisfaction with the Hybrid Course Format

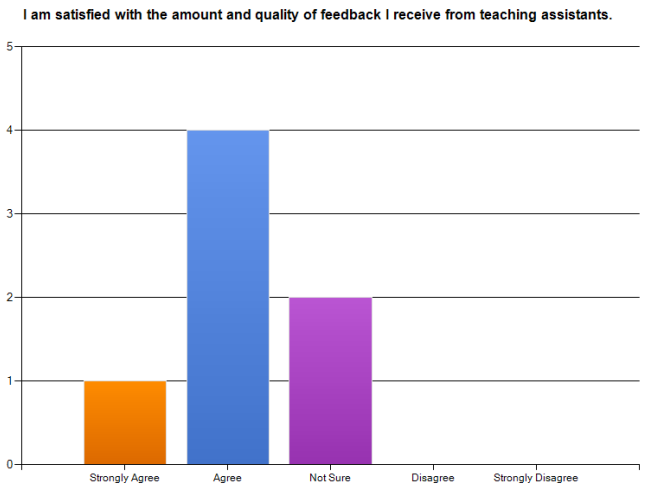
($n = 7$)

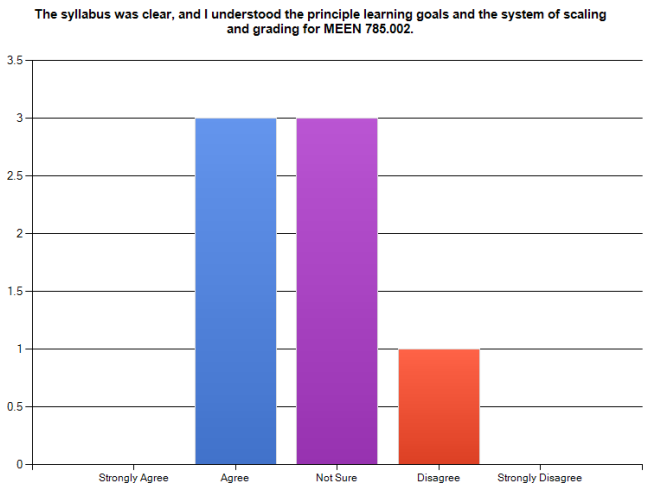


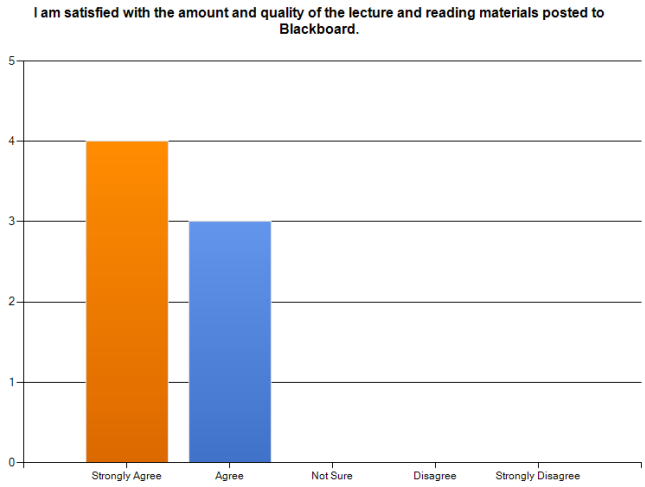


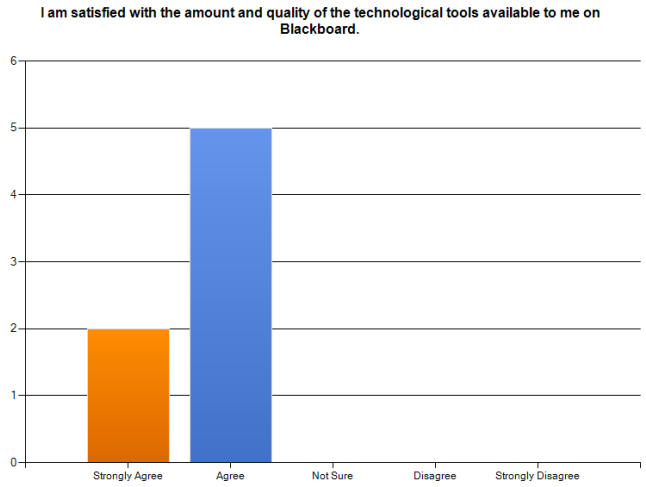












There were additional written comments in response to the prompt: “I have one recommendation for improvement which I believe will help me obtain the MEEN 785 learning objectives.”

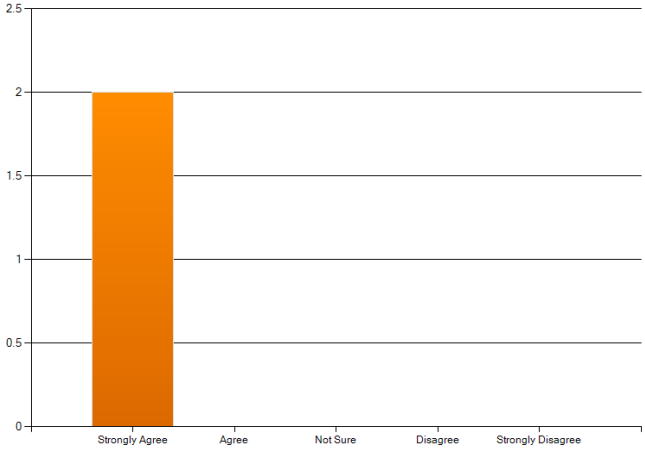
- Course like this need [sic] to break down to different sessions of the week instead of 3 hours long lecture in one day.
- Provide a clear understanding of how this course enables the student to further his/her knowledge on how the NSF ERC related research in biomaterials is impacted by biology and medicine.
- Teach information that is relevant to the goals of the ERC. (i.e. The body’s reaction to different materials.)
- The course should be tailored towards engineering the lecture time should be reduced

MEEN 785: Principles of Cell Biology I for Engineers

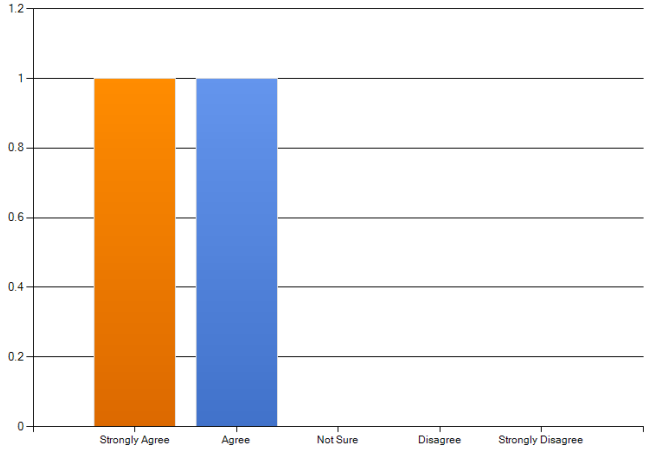
Survey of Student Satisfaction with Course Content and Learning

(n = 2)

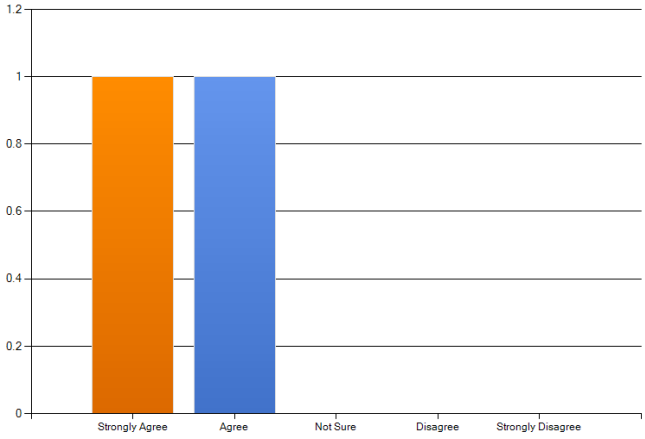
I see the value of this course as it relates to bioengineering studies.



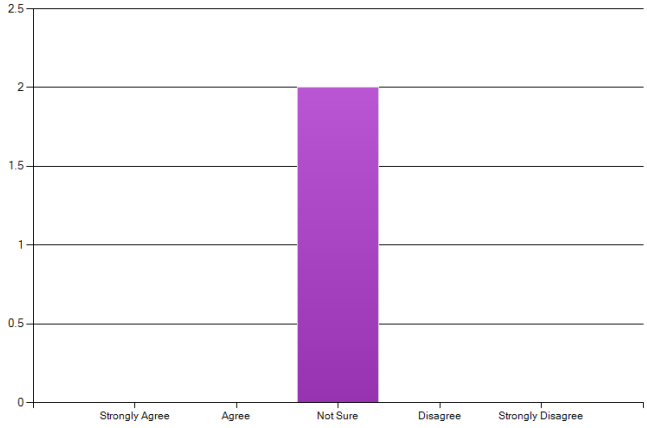
I would take this course again even if it wasn't required.



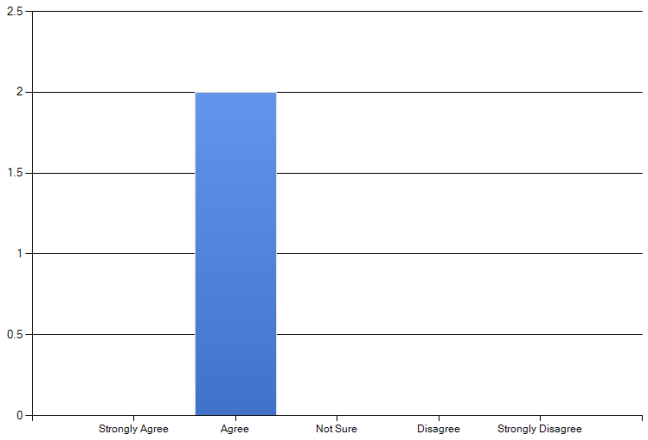
I have found the faculty and teaching assistants to be friendly and helpful, and I believe that they work to support student success.



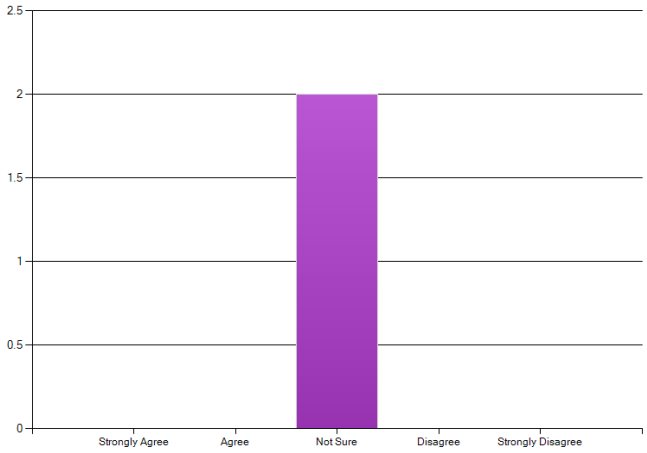
At this point, I think I could present a poster presentation at a state, regional or national conference on the content presented in this course and its link to bioengineering. If strongly agree or agree, please provide a hypothetical "title" for your poster.



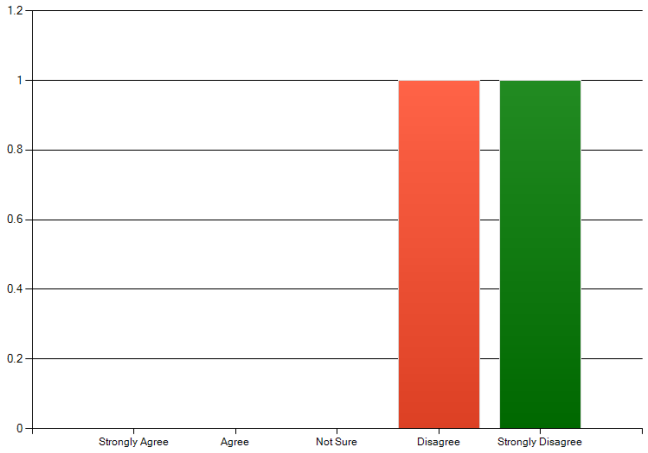
I believe that today I could use the content from MEEN 785.002 to make some contribution to the ERC test investigations.



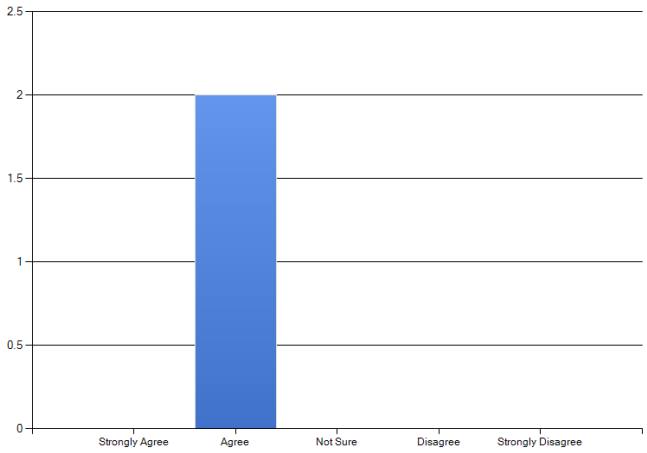
I believe this course helped me get-to-know other members of the bioengineering cohort.



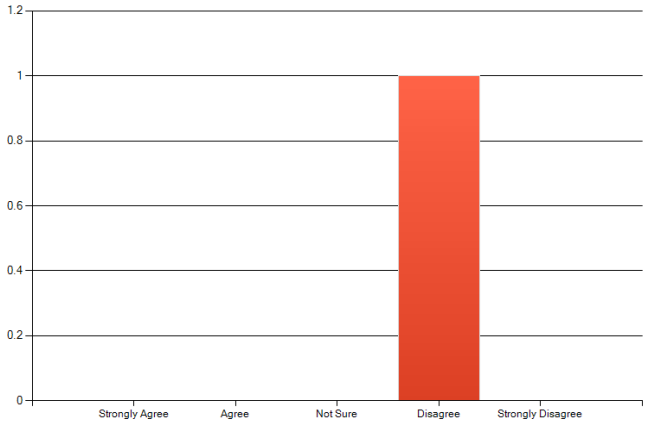
I would not take this course if it wasn't required.



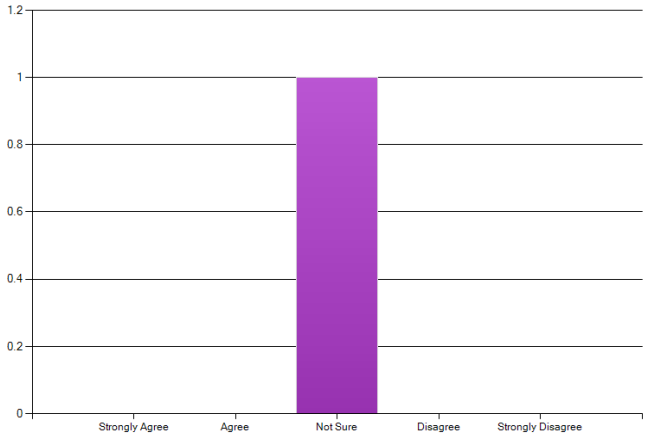
Feedback from faculty is prompt and helpful, supporting student learning.

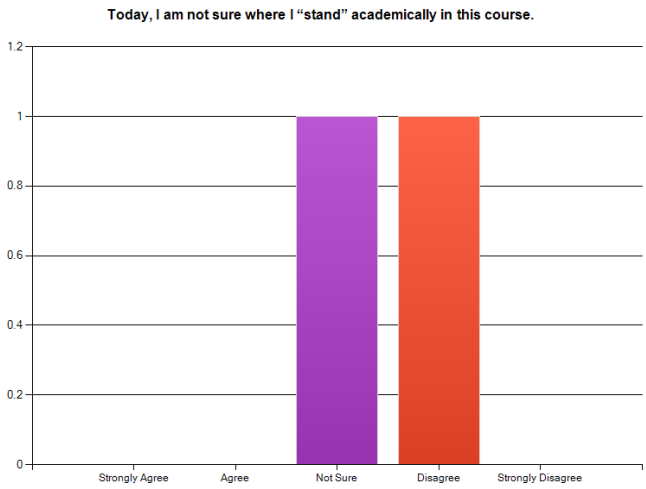


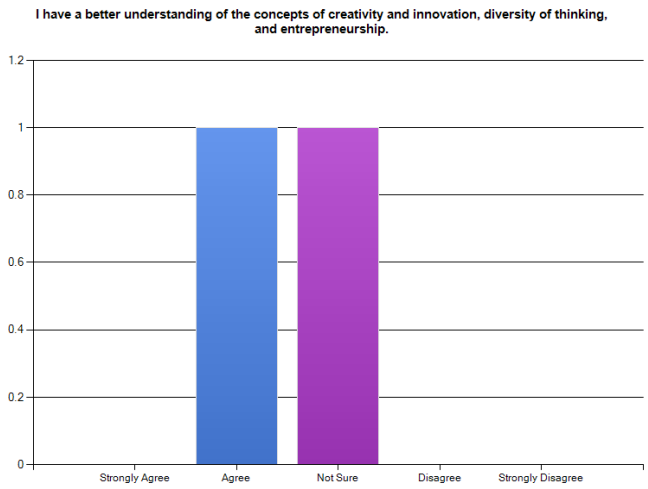
Beyond the classroom setting, I did not find myself thinking a lot about the content covered in this course. If disagree or strongly disagree, please provide an example(s) of some of the ideas you pondered while taking this course.

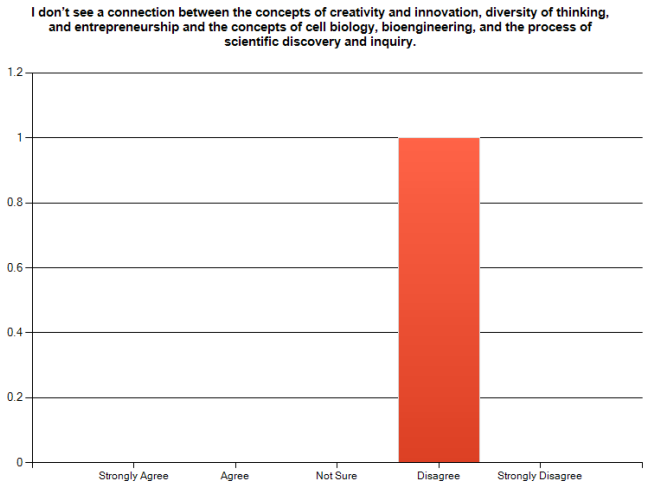


In talking with and listening to my classmates, I felt we shared many similar opinions about the large- and small-group learning experiences.









There were additional written comments in response to the prompt: "In my opinion today, this course's greatest strength is:"

- To know biology
- The broad amount of material covered. It is truly a survey of molecular cell biology.

There were additional written comments in response to the prompt: "In my opinion today, this course's primary area for improvement is:"

- To take quiz more
- Organization. In the collaboration of the professors and in the presentation of the material. We shouldn't have to have extra classes during the week to finish the material.

Focus groups were also conducted at the end of the semester. A review of transcripts (descriptive data) provided the following information. A copy of the focus groups transcript is available upon request.

- Innovation and Creativity: Participants easily made connections among scientific discovery, innovation, and creativity. They placed emphasis on asking the right questions and looking in new ways to find the answers to those questions. Therefore, there is a clear connection with diversity of thinking and innovation and creativity.

- Diversity of Thinking: Participants repeatedly connected the concept of diversity of thinking with working in groups and particularly interdisciplinary collaborations. There is an emphasis on communication and sharing knowledge either through interaction or reviewing previous research.
- Entrepreneurship: Participants made the connection of entrepreneurship occurring when innovation fills a need in society that makes the product or service profitable. Some participants indicated that bioengineering is a possible area for entrepreneurship in the future.

- Multi-stage System: Participants were able to define multi-stage systems as an entity with multiple parts which work together to meet a specific goal. They were able to conceptualize this in multiple ways including the ERC and their own professional development.

Future Plans

MEEN 785: Principles of Cell Biology I for Engineers will fold into the proposed bioengineering curriculum. In the next iteration of the course, coordinators and instructors should consider looking for ways to build upon current strengths of the course (i.e., course content and its relationship to bioengineering). As well, particular attention should be given to (a) making the course more discussion-friendly, with emphasis upon enhancing interactions between students and faculty across participating campuses and (b) structuring the class to ensure that three hours per week are sufficient for necessary instruction.

B. MEEN 685: FUNDAMENTALS OF NANOSCIENCE AND ENGINEERING (SPRING 2010)

Interventions Overview

As stated in the syllabus, the purpose of MEEN 685: Fundamentals of Nanoscience and Engineering is to offer a fundamental perspective in areas related to the structure, stability and functional characteristics of nanoscale materials and interpretation of results with the help of available theoretical models, with an emphasis on the interrelationship between materials properties and processing.

MEEN 685 takes into account the need for a better marriage between theory, experiment and applications. Hands-on exposure is provided to students in the areas of synthesis, processing and manufacturing of nano-components and nano-systems, characterization and measurement of

nanostructured systems and devices, and the design, analysis and simulation of nanostructures and nano-devices. This is accomplished by providing students with classroom instruction heavily aided by laboratory learning, with a systems emphasis.

A description of the course format includes the following parameters:

- Created as a three-credit course
- Provides undergraduates a foundational perspective in areas related to the structure, stability and functional characteristics of nanoscale materials
- Interpretation of results with the help of available theoretical models with emphasis on devices and systems
- Course is a combination of theory and experiments.
- Course is being offered as a technical elective undergraduate course at junior/senior level
- Advantage of course at the junior level is that students have already completed the necessary pre-requisite courses and have built sufficient background to pick up the interdisciplinary concepts of nanotechnology

MEEN 685 Student Learning Outcomes are:

- Students will understand nanoscale dimension and basics
- Students will learn Synthesis Methods
- Students will learn Structural characterization
- Students will learn C- nanostructure & Bioengineering
- Students will learn Device applications

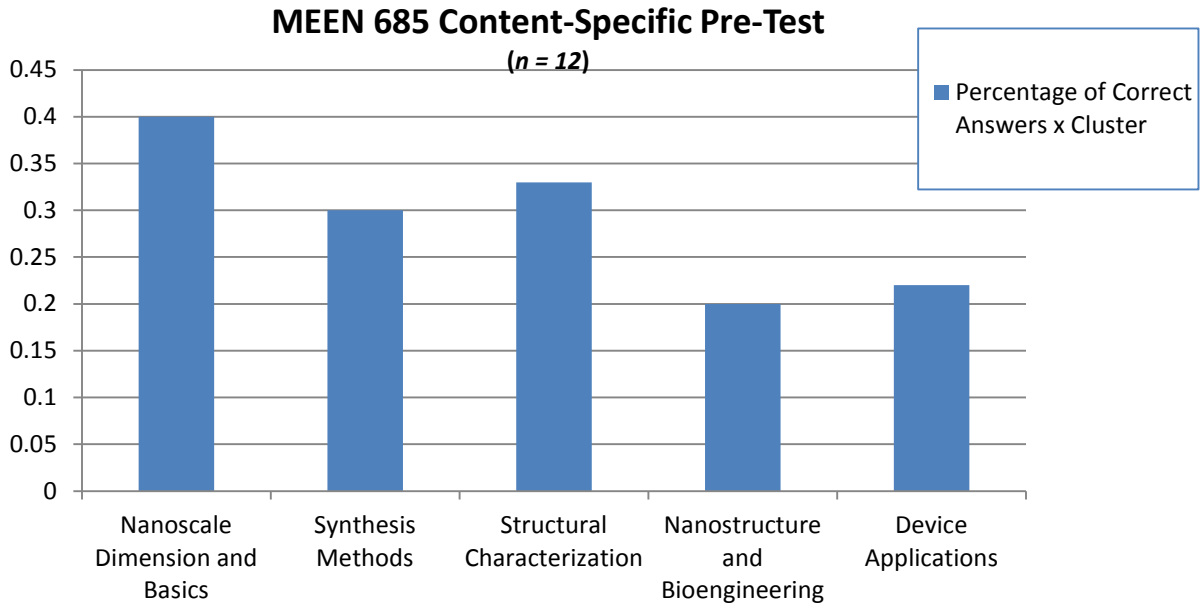
Assessment Plan and Results (to date)

To study the efficacy of the MEEN 685, a mixed-method design was proposed. Undergraduate students will complete content-specific, pre-/post-tests. Researchers who have expertise in nanotechnology undergraduate education in engineering expertise will develop these items. To establish preliminary validity (i.e., criterion-related and concurrent) and reliability (i.e., split-half) methodologies will be utilized (Thorndike, 2005). Though stated desired *n* is small, the class will be open to taking more students as available. Paired-t statistics will be computed to determine significance in differences in pre-/post-test scores.

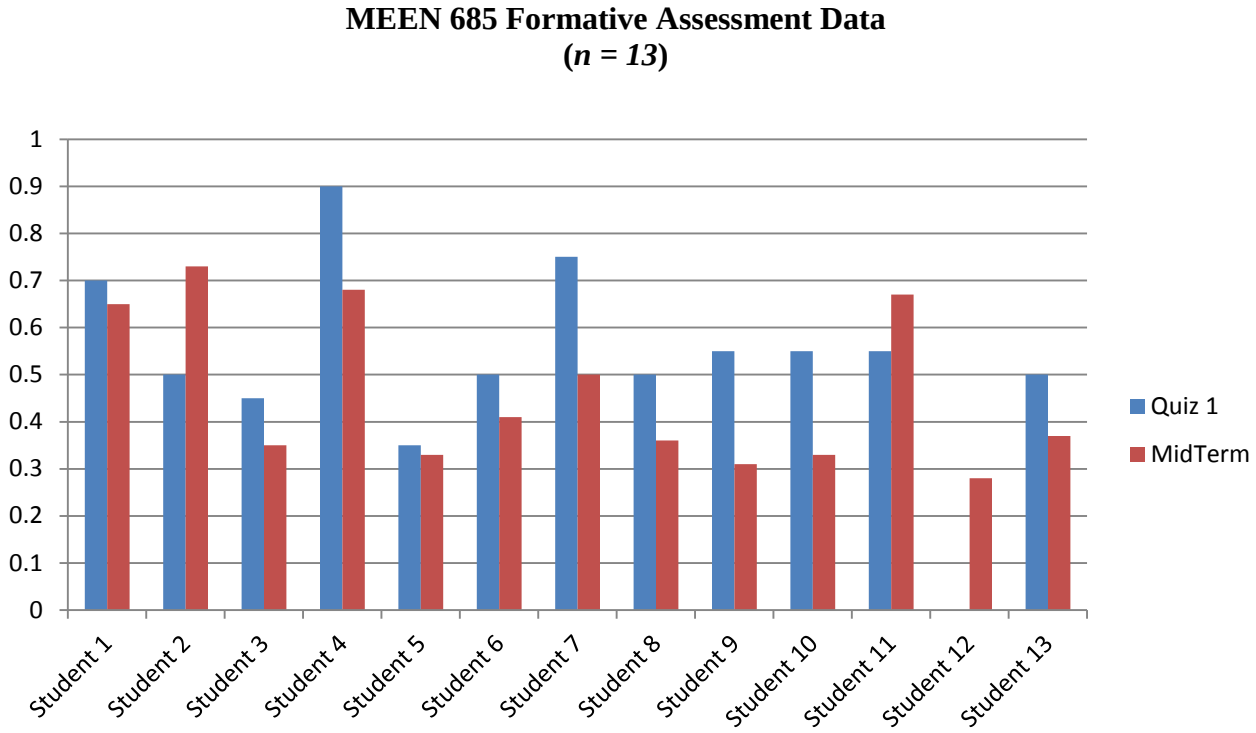
Undergraduate students will also complete written surveys delivered online and designed to measure student perceptions of nanotechnology undergraduate education and (a) applied value in the field of engineering entrepreneurship and (b) its relationship with the NSF-ERC for Revolutionizing Metallic Materials. Undergraduates will be invited to participate in an exit, phenomenologically-based interview (Hanson, Creswell, Plano Clark, Petska, & Creswell, 2006), conducted by a professionally-trained interviewer.

As stated above, students will be asked to complete pre-/post- content-specific inventories. A full copy of the inventory is available upon request. Inventory items are clustered across five domains, including: (a) Nanoscale dimension and basics, (b) Synthesis methods, (c) structural characterization, (d) C-nanostructure and Bioengineering, and (e) Device applications.

The pre-test was administered in January 2010 and percentages of correct responses (by cluster) were computed. Response rates to the pre-test inventory are reflected in the figure below.



Formative data informing student learning have also been collected, including one quiz and a midterm examination. These data are reflected in the figure.



MEEN 685 students have yet to complete their content-specific post-tests. As well, data coming from online surveys measuring student perceptions of nanotechnology undergraduate education, its applied value in the field of engineering entrepreneurship and its relationship with the ERC-RMB will be completed at semester's end. Copies of the survey instrument are available upon request. Undergraduates will engage in their exit interviews in the last week of April and first week of May. Questions proposed for exit interviews are also available upon request.

Future Plans

All summative data have not yet been collected for MEEN 685: Fundamentals of Nanoscience and Engineering. However, plans include folding the course into the proposed bioengineering curriculum.

C. MEEN 785: PRINCIPLES OF BIODEGRADABLE METALLIC ALLOYS (SPRING 2010)

Interventions Overview

To study the efficacy of the MEEN 785, a mixed-method design was proposed. Graduate students will complete written surveys delivered online and designed to measure student perceptions of principles of biograd metallic alloys, its applied value in the field of bioengineering and entrepreneurship, its relationship with the NSF-ERC for Revolutionizing Metallic Materials. Written surveys will include evaluation of students' overall satisfaction with MEEN 785 teaching and learning and evaluation of students' overall satisfaction with the hybrid class format. Copies of these surveys are available upon request.

Assessment Plan and Results (to date)

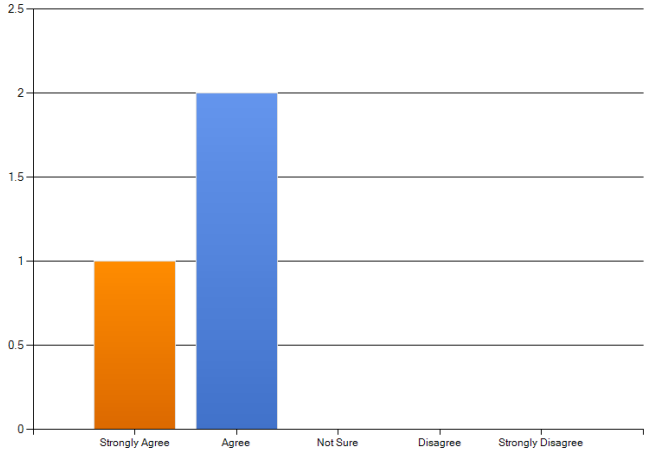
The assessment plan for this course included three components. The first component assessed student learning of MEEN 785.002: Principles of Biograd Metallic Alloys content knowledge. The second component included evaluation of students' overall satisfaction with MEEN 785 teaching and learning. The third component included evaluation of students' overall satisfaction with the hybrid class format. (A subset of this component involved assessment of student understanding of ways principles of course content link to concepts of creativity and innovation, diversity of thinking, and entrepreneurship.) IRB approval was obtained prior to collecting assessment data. Summative data describing student learning will not be available until semester's end. Data describing the second and third components of student overall satisfaction are graphically depicted below.

MEEN 785: Principles of Biodegradable Metallic Alloys

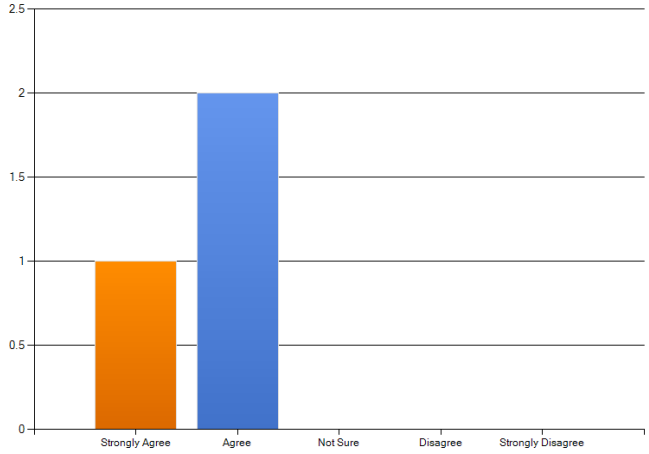
Survey of Student Satisfaction with Course Content and Learning

(*n* = *3*)

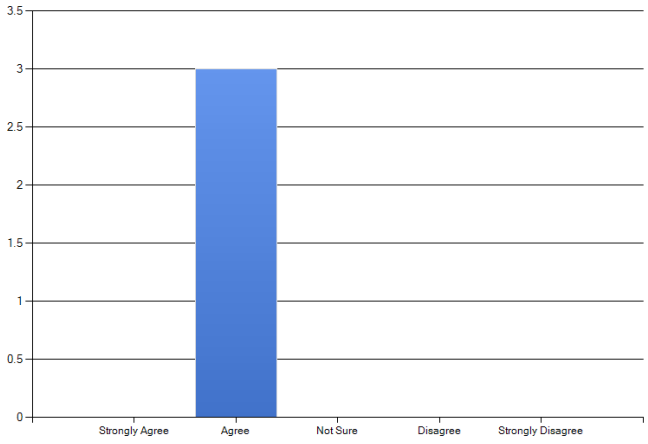
I see the value of this course as it relates to bioengineering studies.



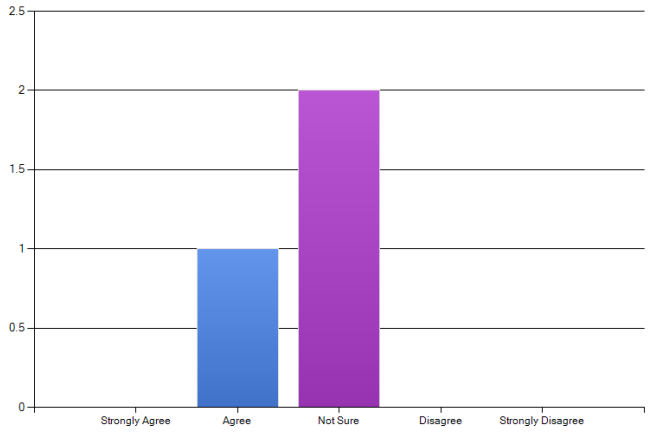
I would take this course again even if it wasn't required.



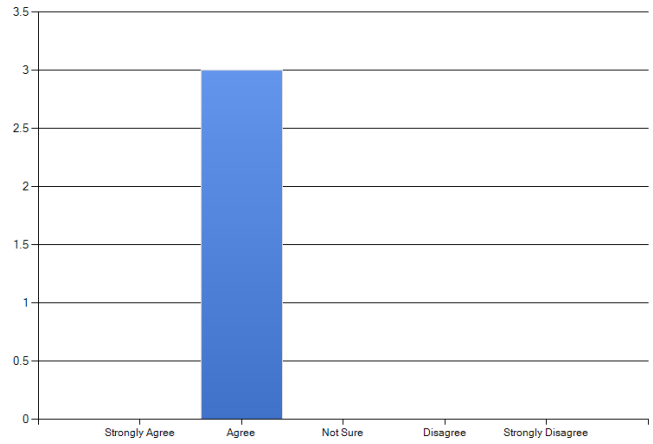
I have found the faculty and teaching assistants to be friendly and helpful, and I believe that they work to support student success.



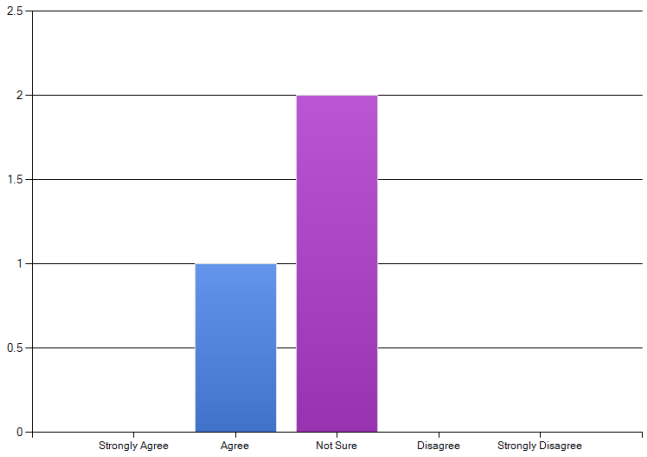
At this point, I think I could present a poster presentation at a state, regional or national conference on the content presented in this course and its link to bioengineering. If strongly agree or agree, please provide a hypothetical "title" for your poster.



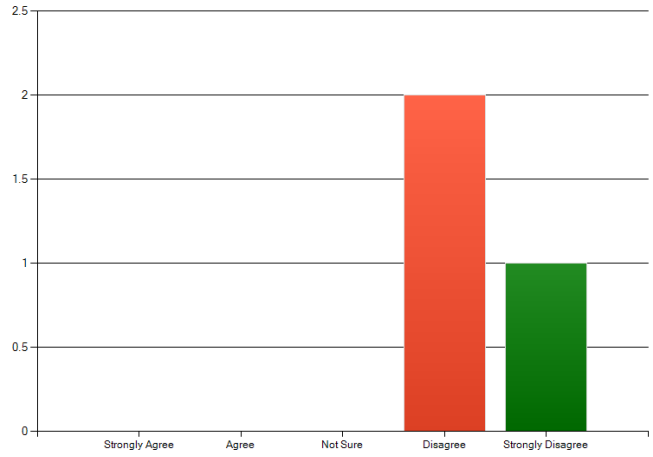
I believe that today I could use the content from MEEN 785.002 to make some contribution to the ERC test investigations.



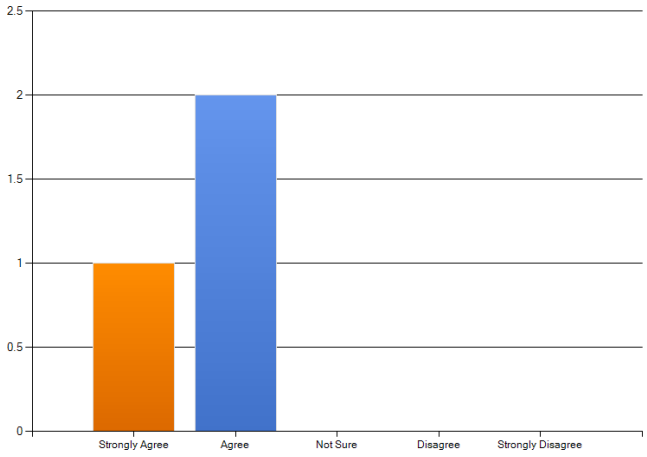
I believe this course helped me get-to-know other members of the bioengineering cohort.



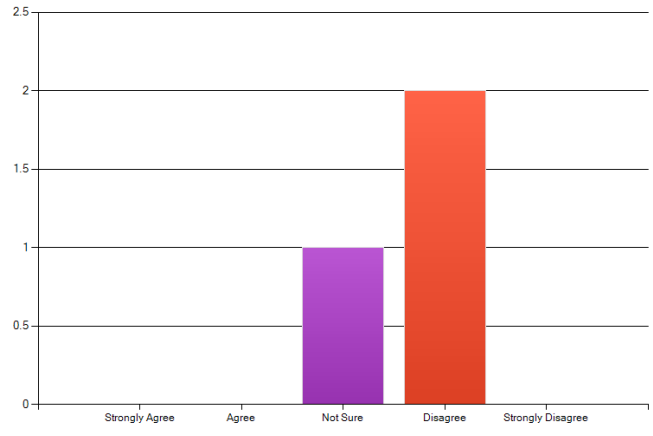
I would not take this course if it wasn't required.



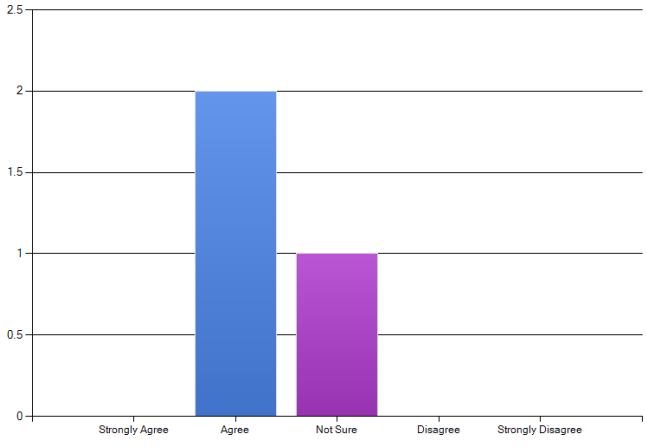
Feedback from faculty is prompt and helpful, supporting student learning.

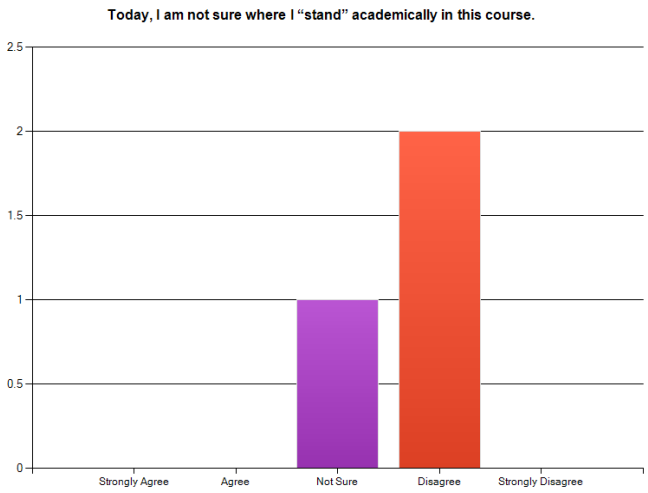


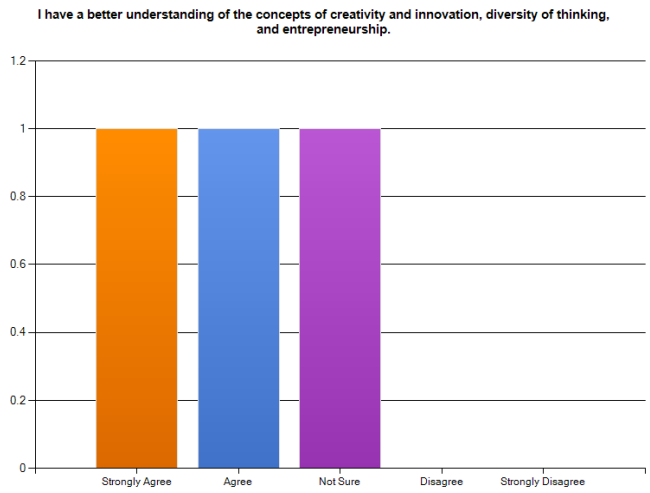
Beyond the classroom setting, I did not find myself thinking a lot about the content covered in this course. If disagree or strongly disagree, please provide an example(s) of some of the ideas you pondered while taking this course.

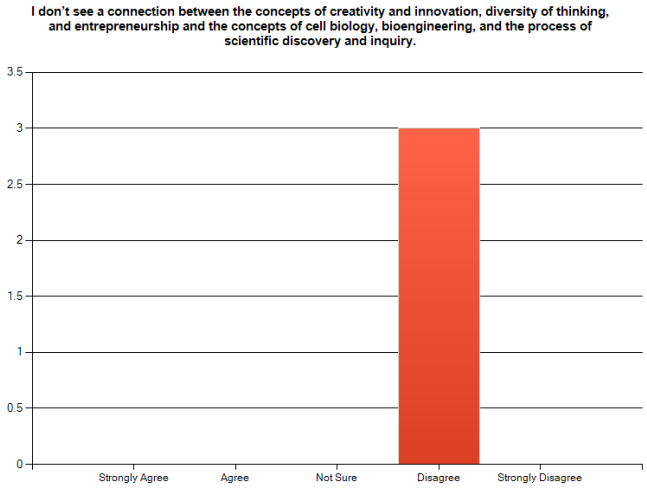


In talking with and listening to my classmates, I felt we shared many similar opinions about the large- and small-group learning experiences.









When asked what students believed was the greatest strength of the class, additional comments included:

~Applying the class content to the research we're doing in our labs.
~I have learned a lot about biomaterial and bioengineering.
~Introducing the use o metallic alloys as bio-implants and factors that need to be taken into consideration the development and design of such materials.

When asked what students believed was the greatest area for improvement in the class, additional comments included:

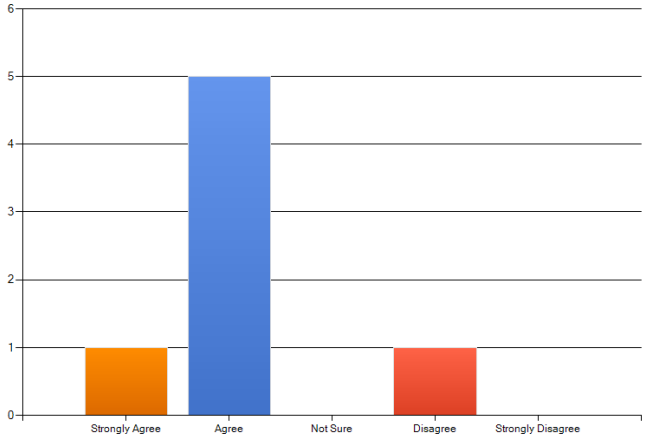
~Sometimes the powerpoint notes are really wordy.
~More discussion and homework
~Reduce the coverage of materials science fundamentals and increase focus on the various aspects of design for biodegradable materials as it relates to implants and the goals of the ERC.

MEEN 785: Principles of Biodegradable Metallic Alloys

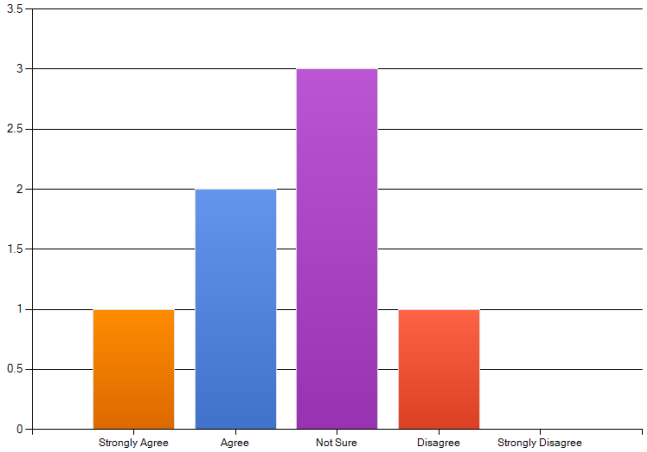
Survey of Student Satisfaction with Hybrid Course Format

(*n* = *7*)

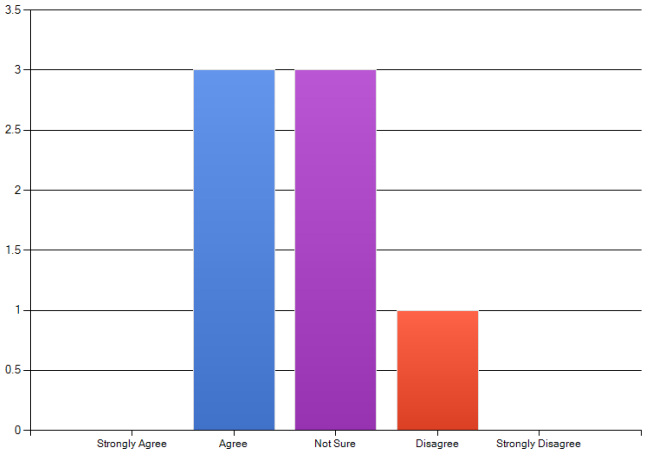
I am comfortable with the delivery of course content (i.e., biograd metallic alloys) in large-group lecture through teleconferencing.



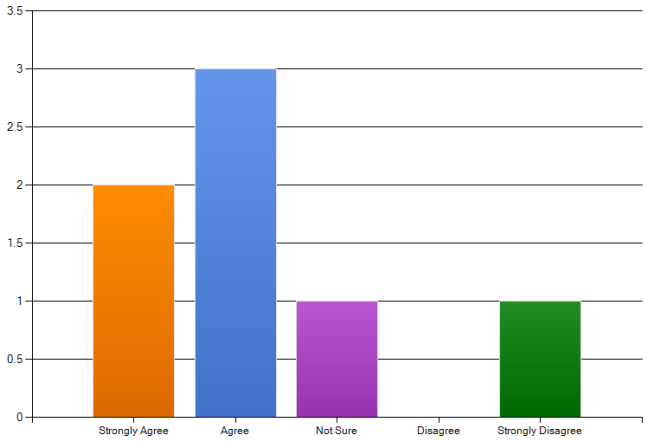
I am satisfied with the amount and quality of feedback I receive from course instructors.

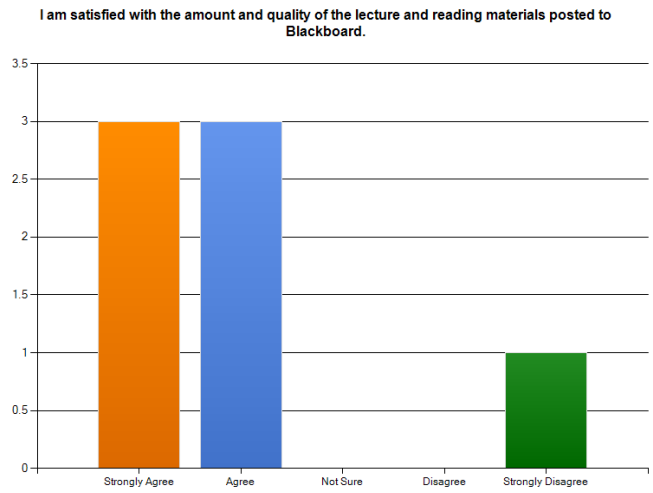


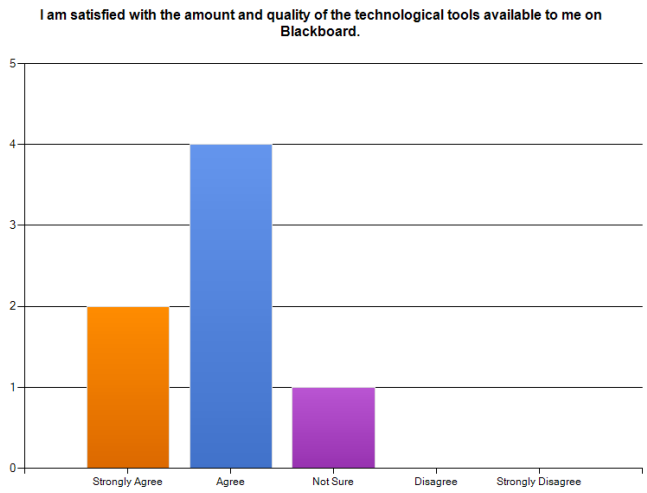
I am satisfied with the amount and quality of feedback I receive from teaching assistants.

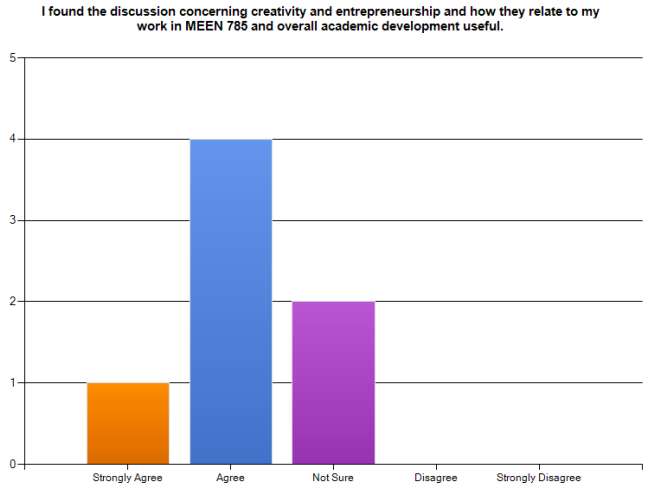


The syllabus was clear, and I understood the principle learning goals and the system of scaling and grading for MEEN 785.002.









Written comments were also gathered in response to the prompt: *I have one recommendation for improvement which I believe will help me obtain the MEEN 785 learning objectives.*

~No recommendations that I can think of.
~Expand the class to three days a week.
~More interactive
~In-class teaching with well-defined syllabus
~I would like the instructors to try to make the lecture sessions/material more interactive to promote more discussion among students across campuses.
~The notes should be organized well next time.

Future Plans

MEEN 785: Principles of Biodegradable Metallic Alloys will fold into the proposed bioengineering curriculum. In the next iteration of the course, coordinators and instructors should consider looking for ways to build upon current strengths of the course (i.e., course content and its relationship to bioengineering). As well, particular attention should be given to (a) making the course more discussion-friendly, with emphasis upon enhancing interactions between students and faculty across participating campuses and (b) clarifying syllabus lecture specifics and student and faculty expectations.

IV. On and Off Campus Teaching and Learning Activities with Local Public School Children

Claxton Elementary Science Day
March 19, 2010

Undergraduate and Graduate level students from the Engineering Department at North Carolina Agricultural and Technical State University assisted Claxton Elementary students during the science day activities. The day began for the university students at 8:00am in the Claxton Elementary cafeteria with a welcome from the organizing teacher, Mr. Lovelady. He explained that Science Day was intended for grades 3-5 to allow the elementary students a chance to have fun and learn without all the paperwork and stress associated with their upcoming EOG tests. Mr. Lovelady shared that the focus of this year's Science Day would be building a Puff-mobile. Puff-mobiles could be built with paper, wooden beads, tape, paper clips, binder clips, straws, and coffee stirrers. The goal was to use air blown through a straw to make one's Puff-mobile go farthest in a given period of time. Students were to design, construct, test, and modify their puff mobiles in preparation for the final races that would take place within each class, between classes, then eventually between grades. There were 15 classes involved in the activity with approximately 24 students in each class. Therefore, there were 120 student teams. The Engineering Students' (ES) role in this activity was to serve as advisors helping the students build and test their Puff-mobiles.

After the brief introduction to the goal for the day, ES were assigned a classroom to assist in for the day. The teachers then introduced the ES and explained that the students would spend approximately 15 minutes brainstorming and designing their Puff-mobiles. During this time the teachers also explained that after the Puff-mobiles were built, students would be able to complete 5 trials and graph their times so that they could make improvements. Most of the students immediately began discussing their ideas. This involved sketching and clarifying their ideas within their groups. The students appeared comfortable in their groups with one student presenting his/her ideas and others asking questions and making suggestions on how to improve the design. During this time there were also some demonstrations of the best ways to fold paper for the various parts of the Puff-mobile. In one classroom, there was a group of three boys who each said that they had an idea for the design. One of them said "We will each draw our plan and lay them side by side."

After brainstorming designs, students began actually building their Puff-mobiles. Some groups organized their materials and work areas before actually beginning to build the various pieces. As the students were building their parts, the teachers reminded them to decide who in the group would be blowing the cart. Within each group, students discussed the reasons that each piece should be built a certain way. One interesting conversation between two students follows: Student 1: "Let me see if this will go." Student 2: "Experiment" Student 1: "Yeah" The time used to build the carts allowed for the most interaction between the ES and students. ES asked students what they why they were building parts the way they were and commenting on their creativity. Students also used this time to ask ES for the best ways to build specific pieces. Common actions of the ES included: acknowledging what materials the students were using, asking reasons for construction, identifying possible issues, suggesting changes, assisting in job assignment within groups, reminding students how much time they have left, and encouraging students when they have questions and ideas for improvement. During this time there were also conversations between students and ES such as this one: The student said, "This is hard; I would rather die." The ES responded, "Don't say that." So the student amended his statement to, "Okay, I would rather be in jail. Is every A&T student here?" The ES explained that the university students at the school were involved in the Engineering Department. The student then asked, "Is it like the best college?" The ES responded, "Around here it is."

After the students built their Puff-mobiles, they had to test them. ES timed these trials, explained how to graph their distances, and encouraged the students to make improvements. One ES demonstrated how a wind turbine works. ES had lunch and left Claxton Elementary following these trials.

Three of the students from the ERC who participated in the Science Day answered questions about their participation.

1. Does participation in Science Day influence your views of creativity and innovation?
   Participant 1: Not Really.
   Participant 2: It did influence my creativity and innovation because we are working with kids. Seeing these kids and how they take these abstract ideas and make them into something. They are using things I've never thought of and thinking outside of the box. It reminds me that I need to look at things differently.
   Participant 3: It does influence my views of creativity and innovation because I see these kids use various supplies and come up with designs that work.
2. What is the Value of this outreach experience?
   Participant 1: One of the goals of the outreach experience is to have a relationship between A&T and the students. This could help to get our name out there as far as the program. We could get them interested at an early age. Also, the kids could go home and talk about what they do today and it could cause their parents to think of A&T for maybe an older child that is getting close to college age.
   Participant 2: It can help to get kids interested in engineering at an earlier stage.
   Participant 3: It is an opportunity to encourage kids to come up with their own design. It can instill engineering by being able to see people in higher education and maybe think that they might be able to attend school as well.
3. How is this outreach experience valuable for the ERC participants?

Participant 1: It could be valuable for the ERC participants because the Board is coming for a visit soon. When they come we will be able to explain the ways that we are working to get people interested. It could be valuable for any students who are planning to go into teaching after graduation.
Participant 2: It reminds me to do stuff outside of the box. I like to volunteer. It is good to do something different. Experiences like this help me to look at things different. Plus I like to work with kids anyway.
Participant 3: We get extra credit. No really it's good to be able to give to the community by giving us the opportunity to meet the kids and advise them.

Two undergraduate students who participated in Science Day also answered questions about their participation.

1. How would you describe your experience today?
   Undergraduate 1: I had fun. I enjoyed being with the kids.
   Undergraduate 2: It was great. I had fun working with kids and getting ideas on how to put the cart together.
2. Did you learn anything today?
   Undergraduate 1: I learned to look at things differently.
   Undergraduate 2: I learned to put the cart together in ways that I wouldn't have thought of on my own.
3. Do you think the kids learned anything today?
   Undergraduate 1: The kids learned to work together.
   Undergraduate 2: Team work definitely. They also learned about wind propulsion. For example, it made a difference to how the cart moved based on where they blew on the sail.

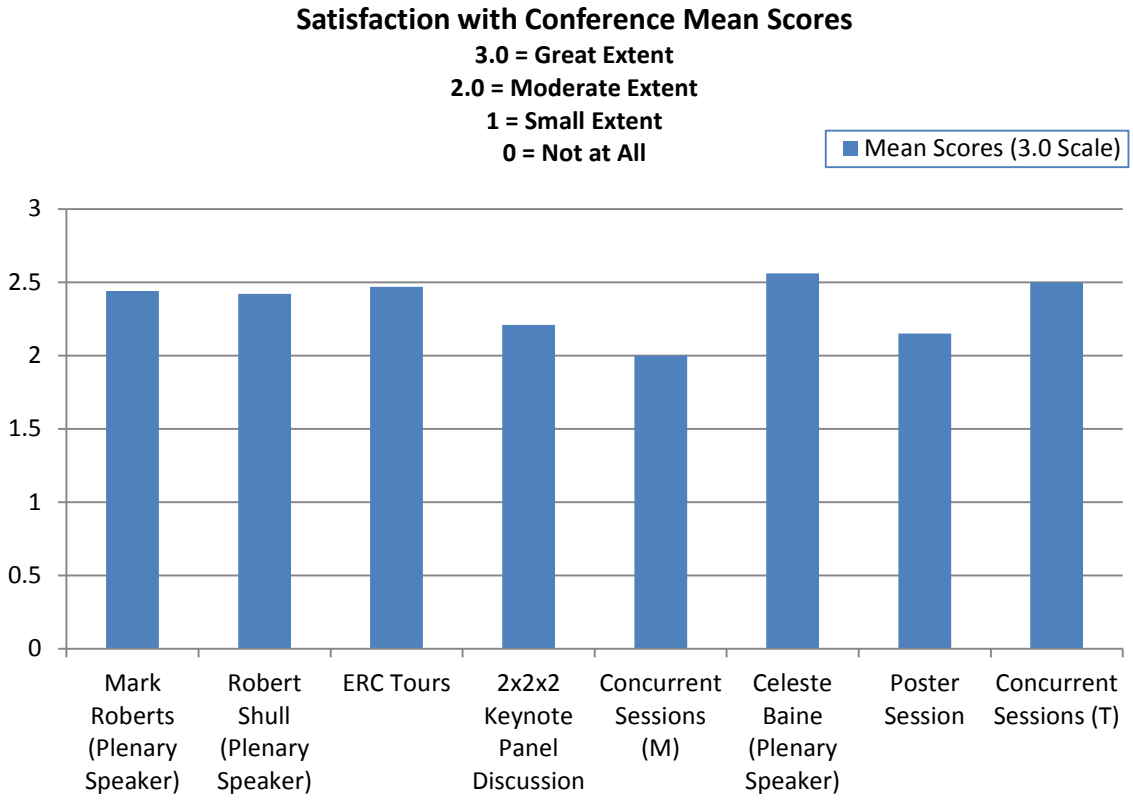
V. NATIONAL EDUCATORS WORKSHOP (MARCH 8-10)

The NCA&T Engineering Research Center for Revolutionizing Metallic Biomaterials hosted the National Educators Workshop, held in Greensboro March 8-10. The purpose of the National Educators Workshop is to enhance and strengthen STEM education in K-14 education. A copy of the NEW Brochure is available upon request.

Conference evaluations indicate moderate to strong levels of enthusiasm for the conference experience. The table below describes conference participant distribution. Conference satisfaction mean scores based on a 3.0 scale is graphically depicted below. A copy of the conference evaluation form is available upon request.

National Educator Workshop Participants Who Completed Conference Evaluations by Academic Rank

Academic Rank	N
Instructor/Professor in Higher Education	10
K-14 STEM Teacher	9
Researcher/Scientist	3
Graduate Student	1
K-14 STEM Teacher/Graduate Student	1
K-14 STEM Administrator/Graduate Student	1
Not Provided	1



Conference participants were also invited to comment on their conference experience. Following are those comments.

Question: Looking back at this year's conference, was there a particular session or event that you found especially valuable? If so, could you share what made this session stand out?

- James Sullivan was great. It's nice to see his enthusiasm and genuine interest in students and their success. (Prof Rank not provided)
- My favorite presentations were from Mark Roberts and Celeste Baine. I enjoyed the information from Mark, and the energy and hands-on activity from Celeste. (K-14 STEM Teacher)
- There were two special sessions for me because they talked about the importance to stimulate students to innovate, create, and try to solve real problems. In fact, I liked very much the sessions "Assessment Planning for Research-Based Educational Programs" and "Flights of Innovation: Future of Flight A Pedagogy Model." (Graduate Student/PhD)
- I'm glad I attended for the experience. None of the sessions really stood out for me. I thought having a postdoctoral for plenary was strange…he seemed so inexperienced (and excited). I thought the lunch speaker pulling out his dead father's Nobel prize was totally unusual and improper. I was disappointed. (Instructor/Professor in HE)
- Talk by Bob Schull. (Instructor/Professor in HE)

- Connecting with colleagues was nice. I particularly liked the evening sessions because there was not a formal agenda and we were free to talk and explore possible collaborations. (Instructor/Professor in Higher Ed)
- I think that there were sessions about education programs to high school, showing the necessity of innovation, creative ideas, and pedagogy model. The sessions, in general were very interesting. But I'm very interested on [sic] with Liles and Salo-Ulvin speakers. (Researcher/Scientist)
- Composites break-out session; Core study approach, very valuable and well presented. (Researcher/Scientist)
- Cindy Waters - Tissue Building (hands-on). (Instructor/Prof in Higher Education)
- The skin and bone session were great. Very usable materials for students. (K-14 STEM Teacher)
- James Sullivan: SI-MA-TECH ~Inspiration for how STEM can be fun and extremely engaging for middle school students. (Instructor/Professor in HE)
- The tour of the ERC was very interesting. The networking opportunities were many. (K-14 STEM/Grad Student)
- I really enjoyed meeting other STEM educators. I also enjoyed the hands-on sessions. I met two graduate students at lunch Monday, and I believe that was my favorite experience. Sitting with them, hearing, in laymans [sic] terms, about their projects was just wonderful. (K-14 STEM)
- The hands-on activities that can be easily brought to the classroom. (K-14 STEM)
- Principles of Technology provided inspiration for low budget, low performing student problems. (K-14 STEM)
- I especially enjoyed the SCI-MA-TECH session as I found this speaker to be very inspiring and innovative. I'd like to take this idea back to my school and discuss the possibilities with my colleagues of initiating something similar. (K-14 STEM)
- Liked the hands on; Celeste's hands on session was great - teamwork, creativity, etc. (K-14 STEM)
- The session Biology, Forensics and Integrated Sciences was by far the most valuable session for me. This high school course integrates rigor, collaborative learning, reliance on previously learned course work, organizational and problem solving skills and FUN! This is the type of course that turns high school students to careers in sciences. (Instructor/Professor in HE)
- They were all great workshops and breakouts! (K-14 STEM; Instructor/Professor in HE)

Question: A central goal of this meeting was to support the dissemination of information concerning STEM education to K-14 and higher educators. In what ways do you believe this goal was/was not achieved?

- Nice integration of STEM in early stages of careers. Lots of good information. Need to get the word out more, maybe try to find funding, to bring in more middle, high school and CC teachers. (Prof rank not provided)
- At this point, I am left "not knowing" the information you wished to disseminate. (Instructor/Professor in HE)

- I appreciate the collaboration in this conference between different levels of education - high school career & tech ed, college, university, workforce. I don't think K-8 teachers were reached, but I honestly don't this this conference would fit very well for them. (K-14 STEM)
- Not for me specifically. I was looking for new materials lab. Modules that I could adopt for my classes. (Instructor/Professor in HE)
- Variety of topics, activities, and grade levels. (Instructor/Professor in HE)
- I learned some new ideas that I can use for outreach and in the classroom. Very good. (Instructor/Professor in HE)
- This goal was met because I have learned about valuable STEM resources and activities that I can incorporate into my curricula. (Instructor/Professor in HE)
- Yes, several different venues that I was unaware of were presented. (Researcher/Scientist)
- Was - many modules possible; Was not - not as many teachers as we'd like. (Instructor/Professor in Higher Education)
- I believe the goal was met through the break-out sessions and the Monday evening panel discussion. (Instructor/Professor in Higher Education)
- Would like to see "round-table" discussion sessions with groups mixed to share ideas between K-14 and higher-ed. (Networking opportunities amongst groups). (K-14 STEM)
- By having a variety of activities and disciplines highlighted (K-14 STEM/Graduate Student)
- Oh yes, but as a HS educator, I need lots more. Perhaps something like this at UW for us to go to. (K-14 STEM)
- I found the availability of access to the experts in these fields was especially useful. (K-14 STEM)
- I enjoyed learning about each of the ideas discussed in the sessions, however, many times I did not feel like they were necessarily applicable to my grade level (6th). I think an improvement could be to include grade-specific application in the descriptions of the sessions provided in the brochure. (K-14 STEM)
- Saw great teaching strategies that make it fun. (K-14 STEM/Administrator)
- I believe this goal was met! All participants seemed to be fully engaged in the sharing of information and ideas.
- It was fantastic!

Question: What other comments would you like to offer overall?

- Overall, it was great and learned a lot about education. (Instructor/Professor in Higher Education)
- Great reach out. Nice involvement of university professors, community college instructors and high school teachers. It'd be nice to see (main) - I got the impression that and [sic] education focus was trying to be removed from traditional math and science. We need to emphasize to [sic] need to keep the programs strong, and introduce new programs (like Mat. Sci) to show what opportunities are available with the tools learned in traditional math/science. (Professional Rank not provided)

- Descriptions of the breakout sessions would have been helpful, so that I could select more relevant breakout sessions to attend. (Instructor/Professor in Higher Education)
- Thank you for this opportunity. I enjoyed the conference and connection with so many educators with a similar passion from across the country. I hope to see the conference proceedings online soon - including the dinner presentation from Mary Kay and the presentation from Celeste Baine. Will we also be able to see the pictures that were taken throughout the conference? (K-14 STEM)
- I'd like to thank the reception. Truly it was a pleasure for me to partcipate in that workshop about education, and I could learn very much. In general, I think it's very important to have education programs that can contribute to the adequately [sic] preparation of the students for careers. (Graduate Student/PhD)
- Technical area and number of papers presented were very thin and limited. I wish some information (even a short blip) was available on the concurrent session. I had misjudged/assumed some of the sessions to be different activities or content. (Even just the level, middle school/HS/CC/ vs 4yr). (Instructor/Professor in Higher Education)
- Very well organized; truly enjoyed attending. (Instructor/Professor in Higher Education)
- This was a very nice event. Thank you! (Instructor/Professor in Higher Education)
- This was a very exciting and inspiring conference. I am glad I had the opportunity to participate. I am glad I had the opportunity to participate. This was my first NEW conference. The breakout sessions were nice. The presenters gave a lot of interesting ideas for getting HS students interested in science and engineering. (Instructor/Professor in Higher Education)
- I'm really glad to know great professionals that participate in NEW 2010 and I would like to thank your attention [sic] with me and my co-worker, mainly because its opportunity to show our work in Brazil. I specifically would like to thank Mary Kaye, Mel Cossette, Dr. Pai, and any other that help us in our first time of visit USA. (Researcher/Scientist)
- Long live NEW! (Instructor/Professor in Higher Education)
- Food, except for the banquet, was marginal at best. (K-14 STEM)
- Conference brochure should have more info (brief description) of each break-out session. (Instructor/Professor in Higher Education)
- Great! (K-14 STEM)
- Celeste Baine was absolutely FABULOUS! I enjoyed listening to her talk, her motivation and ambition was refreshing, and I found her to be very encouraging. (K-14 STEM)

VI. PRODUCTIVITY

The table below outlines papers, presentations, and posters coming out of the ERC-RMB Education and Outreach program 2009-2010. Productivity evidence is available upon request.

ERC-RMB Education and Outreach Productivity

Productivity	N
Papers accepted for publication as conference	
Proceedings	2
Presentations	2
Posters	2

References

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4. Royse, D., Thyer, B. A., Padgett, D.K., Logan, T.K. (2006). *Program Evaluation: An Introduction (4th ed.).* Belmont, CA: Thomson Higher Education.
5. Thorndike, R. M. (2005). Measurement and evaluation in psychology and education. Upper Saddle River, NJ: Pearson.