



# Connecting Research to the Broader Community: Developing and Implementing a Graduate Course Across an Engineering Research Center's Partner Universities

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# **Connecting Research to the Broader Community: Developing and Implementing a Graduate Course Across an Engineering Research Center's Partner Universities**

## **Abstract**

The Center for Bio-mediated and Bio-inspired Geotechnics (CBBG), a National Science Foundation (NSF) third generation (Gen-3) Engineering Research Center (ERC), developed, implemented, and evaluated across its four partner universities and a fifth invited university a one-credit graduate-level course on connecting research to the broader community. The curriculum developed for this course is aimed at educating graduate and senior-year undergraduate students on the skills necessary to connect their research to broader technical and non-technical issues within the engineering profession and the global community. Content is aligned with the Center's and the NSF ERC program's shared goal of educating students in five areas: Entrepreneurship, Life Cycle Sustainability Assessment, Leadership, Diversity, Equity and Inclusion, and Professional Development.

The five-week, one-credit course was developed through collaboration among faculty at each of the partner universities. The course included both synchronous and asynchronous components delivered through video conferencing and a common learning management system to students from the four partner institutions, Arizona State University, Georgia Institute of Technology, University of California – Davis, and New Mexico State University, and from a fifth invited participating university, the University of Washington. The course was initially launched during the 2020 Fall semester with 30 students. To measure the Center's strategic goal of developing students with the desired skills and preparing them to be successful in industry and academia upon graduation, the mastery of the curriculum by the students was evaluated by an external evaluation team through a web-based survey. Findings from this survey, along with modifications and adjustments that were incorporated into the curriculum when the course was offered again in Fall 2021, are discussed herein.

## **Background**

As described in the NSF solicitation, one of the key features of a Gen-3 ERC include an Engineering Workforce Development program that produces “graduates who will be U.S. innovators in a globally competitive economy” [1]. The University Education Program specifically includes the expectation to provide students with curriculum and training on broad professional skills. The CBBG desired skill set [2], developed during the first year of the Center, is aligned with the educational and overall strategic goals of preparing graduates to be innovative, creative, and entrepreneurial, adept at assessing the sustainability of developed technologies, experienced in leadership, effective communicators, skilled at working on teams, knowledgeable in industrial practice, and life-long learners in the areas of diversity and inclusion. By cross-listing courses, newly developed curriculum can be integrated across the lead and partner universities.

## Course Design

Representatives from all four CBBG partner universities met during the 2019 CBBG Mid-Year Meeting to collaborate on the design, development, and implementation of a fundamental course for educating graduate and senior undergraduate students on the skills necessary to connect their research to broader issues within their profession and the community. During a breakout session, a curriculum team of both engineering and education experts was formed and produced a general outline and objectives of what this new course would include. Experts were then assigned to develop 2-3 modules on each of the topics.

## Course Format

The 1-credit, 5-week course was offered online or in-person, live and instructor-led, with two synchronous modules and one asynchronous module including assessments per week. The course was designed to be taught in person at each of the institutions and synchronously with the partner universities. Since all four institutions used the same Learning Management System (LMS), each campus created their own course for the Fall 2020 semester and then added the shared materials. To reduce confusion, only one LMS course was created (through ASU) for the Fall 2021 semester and students at the other institutions were given courtesy accounts to access the posted information.

Each campus modified a common syllabus for the course, as needed, which included relevant time zones and any school-specific information [3]. The lead faculty member at each partner institution then created a line number for the course at their institution. The procedure for doing this varied by institution. At ASU, the procedure is to grant a schedule line number as an extension to a generic course number (i.e., CEE 598) to the lead instructor upon request. After the course has been taught successfully twice, a permanent course number can be issued upon request of the faculty member. Grading for the course at each campus was pass/fail. Content for the live sessions can be seen in Table I below.

Table I  
FALL 2020 COURSE SCHEDULE AND CONTENT

| Date   | Content  |
|--------|--|
| Oct 16 | Introduction   |
| Oct 16 | ERC Entrepreneurship (sync) I  |
| Oct 23 | ERC Entrepreneurship (sync) II<br>ERC Entrepreneurship async. online module and assessment ready to students                   |
| Oct 23 | LCSA & Sustainability (sync) I   |
| Oct 30 | NSF Site Visit – CBBG Annual meeting (No class)  |
| Nov 6  | LCSA & Sustainability (sync) II  |
| Nov 6  | LCSA & Sustainability (sync) III<br>LCSA & Sustainability async. online module and assessment ready to students                |
| Nov 13 | Leadership (sync) I<br>Leadership async. online module and assessment ready to students  |
| Nov 13 | Diversity, Equity & Inclusion (sync) I   |
| Nov 20 | Diversity, Equity & Inclusion (sync) II<br>Diversity, Equity & Inclusion async. online module and assessment ready to students |
| Nov 20 | Professional Development (sync) I<br>Professional Development async. online module and assessment ready to students            |

The schedule was the same for all students, regardless of where they registered for the class. Students were expected to complete asynchronous modules and assignments offline.

## Methods

### *Participants*

The *Connecting Research to the Broader Community* 1-credit, 5-week course has been offered to 45 graduate and senior undergraduate level students. The first time was during the Fall semester of 2020, with a total of 30 students registered from the four partner universities (Arizona State University, Georgia Institute of Technology, New Mexico State University, University of California, Davis) and the University of Washington. The second instance of the course was offered in the Fall of 2021, with 15 students across three of the partner schools (Arizona State University, New Mexico State University, and University of California, Davis).

### *Course Evaluation*

At the end of each semester, the students were asked to complete a web-based survey sent out by the Center’s external evaluators to evaluate the course. The survey included multiple choice, Likert-type, and open-ended questions. Students were asked demographic questions related to their location and time spent with CBBG, and then more specific questions about each of the five course topics (entrepreneurship, Life Cycle Sustainability Assessment (LCSA), leadership, Diversity Equity Inclusion (DEI), and professional development). Table II presents the questions included in the survey, separated by question type.

Table II  
QUESTION TYPE AND CORRESPONDING SURVEY ITEMS

| Type of Question  | Corresponding Survey Item   |
|-------------------|---|
| Multiple Choice   | What is your current university? <ul style="list-style-type: none"> <li>• Arizona State University (ASU)</li> <li>• Georgia Institute of Technology (GT)</li> <li>• New Mexico State University (NMSU)</li> <li>• University of California, Davis (UCD)</li> <li>• University of Washington (UW)</li> <li>• Other (please specify)</li> </ul>   |
| Open-Ended        | How many years have you been in graduate school, including this year?   |
| Open-Ended        | How many years have you been in CBBG, including this year?  |
| Likert-Type Scale | Please indicated the extent to which you agree with the following statements below regarding each of your course modules. <ul style="list-style-type: none"> <li>• The module was well organized.</li> <li>• The module had clear learning objectives.</li> <li>• It was easy to engage in this module.</li> <li>• The instructional materials in this module were inclusive of my cultural background and/or experiences.</li> <li>• The amount of work require for the out-of-class assignment for this module was appropriate.</li> <li>• The information in the module was related to my research area and/or future career.</li> <li>• This module was a valuable use of my time.</li> </ul> |
| Multiple Choice   | Select the statement that best represents your learning in this module: <ul style="list-style-type: none"> <li>• I have seen all of this material before and do not believe I learned anything new.</li> </ul>  |

|                   |  |
|-------------------|--|
|                   | <ul style="list-style-type: none"> <li>• I have seen some of this material before but learned to think more deeply about the topic in this session.</li> <li>• Most of the material was new to me and I learned a lot.</li> </ul>  |
| Open-Ended        | Please share anything else you would like about this module.   |
| Likert-Type Scale | Please indicate the extent to which you feel confident in the following tasks taught within the various course modules. <ul style="list-style-type: none"> <li>• Describing different modes of entrepreneurship</li> <li>• Recognizing the steps for protecting intellectual property</li> <li>• Recognizing the approaches to commercialize intellectual property</li> <li>• Identifying conflicts of interest</li> <li>• Describing the basic steps in a life cycle sustainability assessment (LCSA)</li> <li>• Critically interpreting the results of an LCSA study</li> <li>• Recognizing actions that are categorized as leadership</li> <li>• Recognizing the inter-relationships between management and leadership</li> <li>• Understanding the science of underrepresentation</li> <li>• Identifying bias in educational settings</li> <li>• Responding to bias in educational settings</li> <li>• Applying inclusive practices in the classroom</li> <li>• Developing and practicing skills required to work collaboratively on teams</li> <li>• Investigating job outlook and resources related to career paths</li> <li>• Developing and practicing networking skills needed to advance professionally</li> </ul> |
| Likert-Type Scale | Please indicate the extent to which the following course modules were helpful to you in your quest to develop the skills needed to connect your research to broader issues within your desired profession and community. <ul style="list-style-type: none"> <li>• Entrepreneurship</li> <li>• Life Cycle Sustainability Assessment</li> <li>• Leadership</li> <li>• Diversity, Equity, and Inclusion</li> <li>• Professional Development</li> </ul>  |
| Open-Ended        | Thinking about all the course modules, please list 2-3 things you found most beneficial to your learning experiences.  |
| Open-Ended        | What other modules would you like covered in the future?   |
| Open-Ended        | What recommendations do you have to enhance your experience with course modules in the future?   |
| Open-Ended        | Anything else?   |

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## Results

### *Response Rate*

Out of the 30 students registered for the Fall 2020 course, 18 responded to the survey (60%). The Fall 2021 course had a higher response rate of 73.3% (11 out of 15 students).

### *Fall 2020*

Most students in the Fall 2020 course were from Georgia Institute of Technology (44.4%) and had been with the Center for one year (38.9%). After being asked specific questions on each of the five modules, students were asked to indicate the extent to which each of the course modules were helpful in developing the skills needed to connect research to broader issues within their desired profession and community. As shown in Fig. 1, the Professional Development module received the highest rating with 12 respondents (70.6%) indicating it was “extremely helpful/very helpful.”

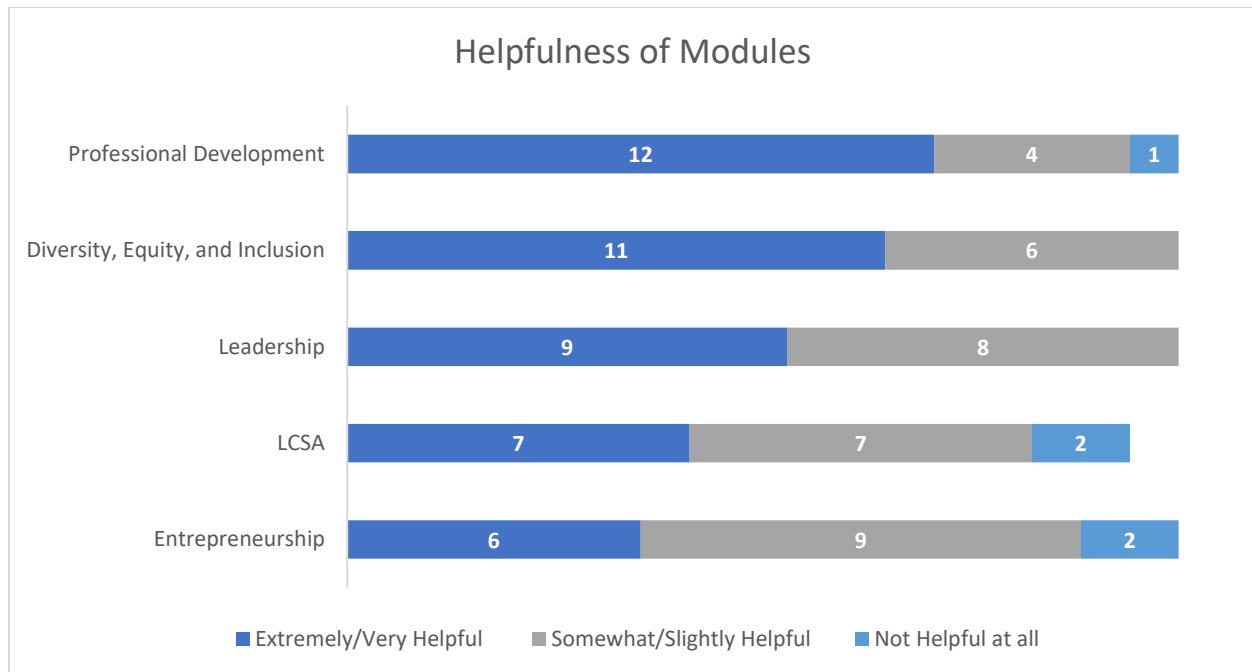


Fig.1. Extent modules were helpful in developing skills

The open-ended questions revealed several recommendations for improving the course, which were shared with each of the course instructors to be considered when modifying and improving the course for the following year.

Some of the recommendations from the Fall 2020 course included:

- “I would like to hear more about the research work outside of the university...”
- “Perhaps a longer professional development module.”
- “During the two-hour block, I was able to focus better when the two 1-hr lectures were about separate topics.”
- “...it would be beneficial to the modules to have more interactions and existing examples for each topic...”

### *Fall 2021*

The Fall 2021 course was primarily made up of students from Arizona State University (50%) and were newer to the Center, with 9 students (69.2%) reporting being with CBBG for one year or less. As shown in Fig. 2, (10, 90.9%) the students felt that the Leadership, Professional Development, and Diversity, Equity, and Inclusion modules were “extremely helpful/very helpful” in their quest to develop the skills needed to connect their research to broader issues within their desired profession and community.

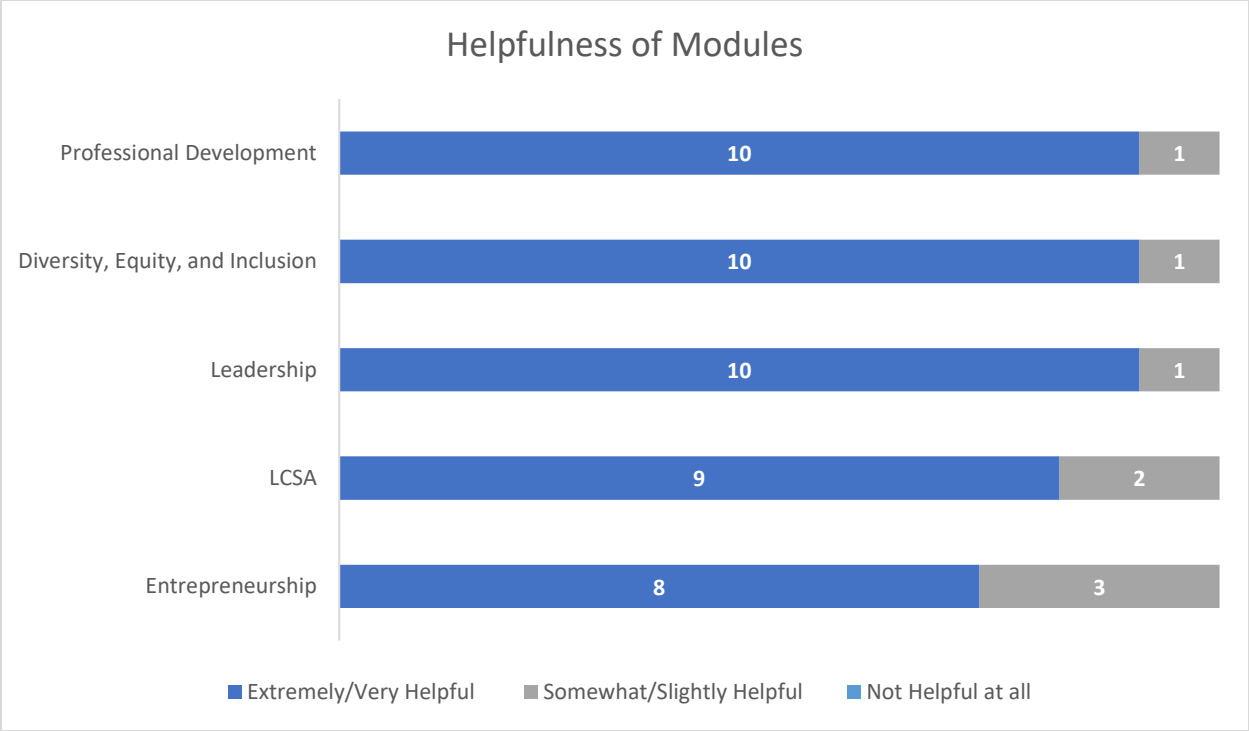


Fig.2. Extent modules were helpful in developing skills

The overall results from the Fall 2021 course survey were again shared with the instructors, as were the module-specific results. Students from the Fall 2021 cohort did not respond to most of the open-ended questions, including “What other modules would you like covered in the future?” and “What recommendations do you have to enhance your experience with course modules in the future?” When asked “Thinking about all of the course modules, please list 2-3 things you found most beneficial to your learning experiences,” one student replied:

I really liked the fact that there was always the attitude in each and every one of our class interactions that all are welcome to participate. I haven't had the privilege of being a part of many groups like that throughout my lifetime thus far, and let me tell you, that feeling here in CBBG is very special. I also found the entire module over LCSA to be highly intriguing and important. I had never been presented with any kind of information on LCSA before, and I found that the module in this course on the subject is very effective in its introduction of the topic while stressing the importance of all of the components.

**Summary**

Based on course recommendations from the students, several modifications have been made to improve the course. For example, the instructor and focus of the entrepreneurship modules was changed for the 2021 semester, and the number of LCSA live modules were reduced from three to two. The objectives of some of the modules were also adjusted to align better with the content students were hoping to cover in the course. Moving forward, the instructors will incorporate the recommendations from the students to improve the material each semester. This cross-partner

course will continue to be offered at the beginning of each academic year to CBBG senior undergraduate and graduate students at all four partner universities.

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