Interdisciplinary graduate student learning in ChE 696: Microbial Soft Matter

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Motivation

Context: Graduate programs frequently use coursework to create interdisciplinary learning opportunities for students. Little has been done to investigate how graduate courses impact interdisciplinary learning.

Research Questions:

- Does a single graduate elective impact interdisciplinary learning?
- Do graduate students increase their usage of skills and language from disciplines outside of their own during a single semester elective course?
- Does a graduate elective that is designed to be interdisciplinary change student self-perception of interdisciplinary learning outcomes?

Methods: Course & Logistics

Course Description:

We studied the impact of ChE 696: Microbial Soft Matter, an elective course about bacterial biofilms, on student interdisciplinary learning. The following steps were taken to encourage interdisciplinary learning:

- Two course instructors from different departments (ChE and emergency medicine)
- Recruitment of students from three different graduate programs
- Guest speakers from medicine, environmental engineering, and army research laboratories to bring new perspective to topics
- Project presentations and reflection on the projects of peers

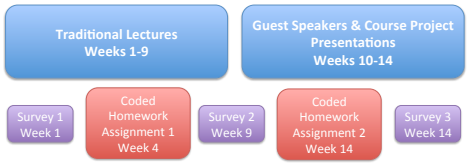
Student Demographics:

Department	All students N=15	Enrolled Students N=11
Chemical Engineering (ChE)	8	6
Civil and Environmental Engineering (CEE)	4	3
Microbiology and Immunology (M&I)	3	2

*Students from chemical engineering, civil and environmental engineering, and microbiology and immunology were enrolled in the course. Four post-doctoral students audited the course, but still participated in surveys.

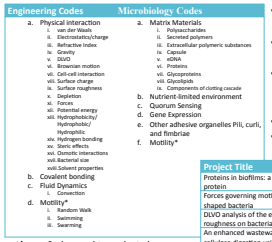
Timeline of Data Collection

The course was divided into two segments. Three surveys were conducted, and two assignments were coded (one from each course segment).



Methods: Data Collection & Analysis

Qualitative Data Collection and Analysis



Above: Codes used to evaluate language used in homework assignment 1.

Right: Titles and group compositions for project assignments that were reflected upon in the second coded assignment.

Project Title	Group Composition
Proteins in biofilms: a brief look at the biofilm-associated protein	1 Microbiology & Immunology student
Forces governing motion, adhesion, and clearance of rod-shaped bacteria	1 ChE student
DLVO analysis of the effect of surface material, geometry, and roughness on bacterial adhesion	1 ChE student
An enhanced wastewater treatment system: optimizing cellulose digestion using ruminant fungi	2 ChE students
Biofilm formation by methanotrophs	2 CEE students
COMSOL simulation of bacteria absorbing in a biofilm	1 ChE student & 1 CEE student
Prevention and treatment of dental plaque	1 ChE student & 1 Microbiology & Immunology Student

- Opening, axial, and selective coding were performed on 2 homework assignments.
- Codes were created for words relating to microbiology and words related to engineering.
- The ratio of number of engineering codes to number of microbiology codes was used to determine which field students relied upon in their response.
- Homework 1 was on how bacteria stick to a surface.
- Homework 2 was a reflection on 2 course projects.

Quantitative Data Collection and Analysis

An IRB-approved survey instrument* was administered three times via email during the course to assess student self-perception of 4 learning outcomes:

1. Interdisciplinary skills (i.e. reading about topics outside of field; taking ideas from other fields and synthesizing them to better understand problems)
2. Recognizing disciplinary perspectives (i.e. recognizing the kinds of evidence other fields rely on; identifying kinds of knowledge that are distinctive to different fields)
3. Reflective Behavior (i.e. frequently stopping to think about where you might be going wrong; reflecting on if you might be missing something)
4. Teamwork Skills (i.e. ability to work with others to accomplish group goals, put aside differences to get work done, and work in teams with people from other fields)

Statistical Analysis: Survey items were averaged across domain for each student and baseline differences were compared across student discipline using one-way ANOVA. Changes in features over time were analyzed using linear mixed effects models.

* The survey instrument used was based on the work of Lattuca et al., *ASEE Annual Conference* (2011).

Results: Graduate students in Microbial Soft Matter increase fluency across disciplinary boundaries

Comparison of disciplinary language used in coded assignments

	Coded Assignment 1 (Bacterial adhesion)	Coded Assignment 2 (Project peer-reflection)
Began to use some language outside of major field of study	82% (9 students)	82% (9 students)
Majority of response was grounded in major discipline	73% (8 students)	36% (4 students)
Response was either interdisciplinary or predominantly outside of discipline	27% (3 students)	64% (7 students)

- Use of language outside a student's major field of study increased between homework coded at the beginning and end of the course.

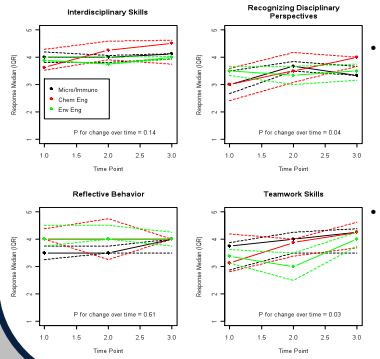
Results: Impact of course on self-perceived interdisciplinary learning outcomes

Baseline interdisciplinary features do not vary across discipline

	ChE	CEE	M&I	P value (ANOVA)
Interdisciplinary skills	3.6 (3.5, 4.3)*	3.9 (3.9, 4.0)	4.0 (3.8, 4.2)	0.82
Recognizing disciplinary perspectives	3.0 (2.4, 3.6)	3.5 (3.3, 3.7)	3.0 (2.7, 3.5)	0.53
Reflective behavior	4.0 (4.4, 4.5)	4.0 (3.8, 4.5)	3.5 (3.3, 3.8)	0.25
Teamwork skills	3.1 (2.8, 4.2)	3.4 (3.1, 3.6)	3.8 (2.9, 3.9)	0.97

There were no significant differences in baseline averages across student type: ChE, CEE, or M&I, as indicated by $p > 0.05$.

Changes in interdisciplinary features by discipline over time



- Statistically significant increases were seen over the course of the semester in self-perception of recognizing disciplinary perspectives & teamwork skills.
- Changes were not significant in self-perception of learning outcomes related to interdisciplinary skills and reflective behavior.

Conclusions & Future Work

- Increases in interdisciplinary learning occur in a graduate elective intentionally designed to promote interdisciplinarity, specifically in areas of recognizing disciplinary perspectives and teamwork skills.
- Fluency across disciplinary boundaries increased during a single semester, as revealed through coded responses.
- This study serves as a pilot study for advancing the understanding of interdisciplinary learning in the graduate classroom.
- Determining if these findings hold true in other interdisciplinary classes or with other interdisciplinary classroom techniques is necessary to prove how single graduate courses impact interdisciplinary learning.

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