FRESHMAN RESEARCH IMMERSION PROGRAM

Walk in a freshman - Walk out a researcher.

Making the most of course-based research experience
CRE = Course-based Research Experience

- Engaging students in scientific practices
- Emphasizing collaboration
- Examining broadly relevant topics
- Exploring questions with unknown answers that expose students to real discovery
- Integrating iteration into course, thus how research builds on itself

Nationally students are becoming disengaged and leaving the sciences.

Fewer than 40% of students entering college with intention of majoring in STEM complete a STEM degree!
But why a three-course sequence of CREs?

Freshman fall -- Research Methods Seminar

Freshman spring -- Research Stream lab pt 1

Sophomore fall -- Research Stream lab pt 2
UREs broaden diversity in science

UTA-FRI participation increased by 17% the graduation rate of STEM students

From Univ-Texas-Austin’s FRI: Rodenbusch, Hernandez, Simmons, & Dolan, CBE-Life Sciences Education, June 2016
FRESHMAN RESEARCH IMMERSION PROGRAM

Walk in a freshman -
Walk out a researcher.

• FRI began fall 2014
• Gradually added research streams
• University-wide STEM
• In AY2017-18, 9 research streams
• 270 freshmen per year
• ~80% continue as sophomores with third course
Research streams (= tracks)

• Biofilms (microbiology)
• Biogeochemistry (environmental science)
• Biomedical Anthropology (genetics, biochemistry)
• Biomedical Chemistry
• Community & Global Public Health (mining big data)
• Ecological Genetics
• Environmental Visualization/Geospatial Sensing
• Image & Acoustic Signals (computer science)
• Neuroscience
• Smart/Clean Energy (materials science & engineering)
First – Research Methods Seminar
(2 credits, “O” oral communication gen ed)

Second – Research Stream, pt 1
(4 credits, “L” laboratory science gen ed)

Third – Research Stream, pt 2
(4 credits, “C” composition gen ed)
Pre-proposal from Biomedical Chemistry

Fall freshmen – not in lab yet - students learn how to:

• Read journal articles
• Work in teams
• Select a topic for project
• State hypothesis
• Create schematic of system
• Create synthesis figure from articles that supports their hypothesis
• Make a conference poster
• Talk about their project to audience
Pre-proposal from Biomedical Chemistry

Abstract

Modern medical treatments are currently evolving to increase efficiency and reduce recovery time of various conditions. Introduction of new technologies to the medical field, such as 3D printing, has the potential to revolutionize common medical practices, resulting in shorter recovery times. 3D printing, also called additive manufacturing, is when three-dimensional objects are printed layer by layer, on top of each other. Since it was introduced, 3D printing has rapidly been used to create human organs and is in the beginning stages of pharmaceutical treatment and surgery. Implementation of 3D printing can be in a variety of ways to improve treatments and surgery, helping with new research methods as well.

This project investigating how 3D printing directly affects the treatment of burn victims. Here victims are currently treated using skin grafting methods. Skin grafting is when the skin is harvested from another part of the body and is surgically attached and left to grow. The area of damaged skin is then treated, as a temporary measure for healing purposes, preventing the wound from becoming infected and improving how well the skin heals. 3D printing is a technology that has the potential to significantly improve the way we treat skin injuries and could be the future of burn treatments.

Evaluation of Current Treatment

- Each year 11,000 people in the U.S are hospitalized for major skin burns.
- Most severe burns have 3rd degree burn.
- Skin grafting completely destroys the epidermis.
- Numbness to touch damage to dermis.
- Usually requires full-thickness skin graft.
- Full-thickness skin grafts are usually donated from the patient’s back or abdomen.
- Not always available.
- Requires intensive preparation.
- Skin grafting is the transferring of healthy skin.
- Transfer site must be thoroughly cleaned and treated to avoid infections.
- Transfer skin is then treated inside the wound and allowed to heal.

Figure 1. Representation of skin layers and layers of skin grafts.

3D Printing One Layer of Skin at a Time

- 3D Printing

Figure 2. Depiction of a skin grafting in three steps. Shows the retrieval of healthy skin from the patient’s donor site. The skin is then shaped through a shaping machine in order to expand the donor site. The forming machine then connects with the mesh of blood vessels in the donor site, forming a temporary skin.

The problems regarding skin grafting relies on the method of skin grafting and the site it comes from. Skin grafting often uses skin from the victim, and often if the burn is widespread, there are not enough skin grafts for that. In addition, it often causes infections and it takes a long time to main and treat.

It is hypothesized that the use of 3D printing to treat burn victims will allow for the negative aspects of skin grafting and provide better methods to heal burn victims.

Conclusions and Future Directions

- 3D Printing
- Needle-free, safer, and more precise
- Reduced recovery time
- Improved with cell culture

References

FRI public poster session in December

- Student teams present conference quality posters
First – Research Methods Seminar
(2 credits, “O” oral communication general)

Second – Research Stream, pt 1
(4 credits, “L” laboratory science general)

Third – Research Stream, pt 2
(4 credits, “C” composition general)
In two subsequent semesters, students:

- Learn stream specific content
- Learn lab protocols
- Learn experimental design
- Write proposal for sophomore fall work
- Complete sophomore fall work
- Write report
- Create poster
• 25 student-team research posters at regional/national conferences
• 105 student co-authors

• Over 700 students involved in FRI
• > 50% continue as peer mentors for FRI
• > 45% enter faculty labs
• More obtaining summer internships
Assessment for BU-FRI

• Deliverables (using standardized rubrics)
  – Research proposal
  – Research report
  – Two research posters
  – Two “elevator talks”

• Reflection essay (on professional & personal growth after each FRI course)

• LCAS (Laboratory Course Assessment Survey)

• CURE (national online survey)
<table>
<thead>
<tr>
<th>Collaboration</th>
<th>Discovery</th>
<th>Iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>DR1</td>
<td>I1</td>
</tr>
<tr>
<td>C2</td>
<td>DR2</td>
<td>I2</td>
</tr>
<tr>
<td>C3</td>
<td>DR3</td>
<td>I3</td>
</tr>
<tr>
<td>C4</td>
<td>DR4</td>
<td>I4</td>
</tr>
<tr>
<td>C5</td>
<td>DR5</td>
<td>I5</td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td>I6</td>
</tr>
</tbody>
</table>

In this course, I was encouraged to ... 
C1 discuss elements of my investigation with classmates or instructors.
C2 reflect on what I was learning.
C3 contribute my ideas and suggestions during class discussions.
C4 help other students collect or analyze data.
C5 provide constructive criticism to classmates and challenge each other's interpretations.
C6 share the problems I encountered during my investigation and seek input on how to address them.

In this course, I was expected to ... 
DR1 generate novel results that are unknown to the instructor and that could be of interest to the broader scientific community or others outside the class.
DR2 conduct an investigation to find something previously unknown to myself, other students, and the instructor.
DR3 formulate my own research question or hypothesis to guide an investigation.
DR4 develop new arguments based on data.
DR5 explain how my work has resulted in new scientific knowledge.

In this course, I had time to ... 
I1 revise or repeat work to account for errors or fix problems.
I2 change the methods of the investigation if it was not unfolding as predicted.
I3 share and compare data with other students.
I4 collect and analyze additional data to address new questions or further test hypotheses that arose during the investigation.
I5 revise or repeat analyses based on feedback.
I6 revise drafts of papers or presentations about my investigation based on feedback.

LCAS results for BU-FRI

Comparison BU-FRI cohorts to national data

Responses by students

What employers and graduate schools want college graduates to have
Freshmen lack appropriate experience for kind of teamwork needed in lab or workplace
Joanna Wolfe’s Team Writing

• Project management
• Team charter
• Task schedule
• Communication styles & diversity
• Trouble shooting team problems
• Exercises at end of chapters
# Contributing to the Team's Work

<table>
<thead>
<tr>
<th>How You Rated Yourself</th>
<th>How Your Teammates Rated You</th>
<th>Average Rating for You and Your Team</th>
<th>Description of Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does more or higher-quality work than expected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Makes important contributions that improve the team's work.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Helps teammates who are having difficulty completing their work.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Demonstrates behaviors described immediately above and below.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Completes a fair share of the team's work with acceptable quality.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Keeps commitments and completes assignments on time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Helps teammates who are having difficulty when it is easy or important.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Demonstrates behaviors described immediately above and below.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not do a fair share of the team's work. Delivers sloppy or incomplete work.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Misses deadlines, is late, unprepared, or absent for team meetings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not assist teammates. Quits if the work becomes difficult.</td>
</tr>
</tbody>
</table>

Research suggests the following behaviors will improve your ratings in this area:

- Do a fair share of the team's work
- Fulfill your responsibilities to the team
- Come to team meetings prepared
- Complete your work in a timely manner
- Do work that is complete and accurate
- Make important contributions to the team's final product
- Keep trying when faced with difficult situations
- Offer to help teammates when it is appropriate

Comparison FRI Biofilm cohorts to national data

Responses by students

Percent of range possible

- Collaboration
- Discovery
- Iteration
- Total

- Traditional
- CURE ref
- FRI C#1
- FRI C#2
- FRI C#3
Key questions for startup

• Identify **institutional issues & priorities** to be leveraged for support for such a program
• Analyze **quantitatively** recruitment, persistence, matriculation, & graduation patterns
• Identify **subpopulations** for success & challenge
• Evaluate **existing courses** for potential as part of a research-course sequence
• Articulate **initial action items** relative to your institution
Strategy for FRI programs

• Development
  – Resources for startup
  – Faculty buy-in
• Implementation
• Sustainability
• Ramp-up over 5 year period
• Space renovation optional
• Plan for sustainability from outset
Faculty buy-in

• Emphasize benefits of FRI
  – FRI contributes real research outcomes for faculty research
  – Faculty have trained UGs longer in lab
  – UGs more mature professionally and technically skilled
  – Faculty participation for NSF Broader Impact statement

• Start with faculty with track record mentoring UG research

• Develop faculty team of sponsors / research stream
  – Spreads responsibility
  – More advocates for course approvals, etc.
  – Facilitates student placement after FRI

• Acquire some resources for support of FRI
Resources for FRI startup

• Analysis to justify implementation
• Administrative office(s) that are supportive of program
  – Seed money for establishing program (even if just by shifting administrative priorities)
  – Mechanism for FRI course credit applied to major
  – Lab space
  – Mechanism for “research educator” providing oversight & mentorship of research track
• External funding (grants, donors, corporate sponsors)
FRESHMAN RESEARCH IMMERSION PROGRAM

Walk in a freshman - Walk out a researcher.

http://www.binghamton.edu/freshman-research-immersion/