Developing And Implementing Course Embedded Undergraduate Research Experiences (CUREs)

Allison D’Costa, Clay Runck, David P. Pursell, Judy Awong-Taylor

Georgia Gwinnett College

Game Changing
Aims Of This Session

- Background
- CUREs
- Impact
- Successes & challenges
- Discussion
Models of Undergraduate Research

- **Traditional**: Independent study
  - Selected students

- **CURE**: Course embedded Undergraduate Research Experience
  - Large number of students
  - Builds research skills
  - Builds confidence to do independent research.
The 4YrURCE model: 4-year Undergraduate Research & Creative Experience

All STEM majors participate in research and creative activities all 4 years of their undergraduate career.
The 4YrURCE model: General Biology Track

Freshman
- BIOL 1107K & BIOL 1108K, Principles of Biology I & II
- CHEM 1211K & CHEM 1212K, Principles of Chemistry I & II

Sophomore
- BIOL 3400K, Cell Biology
- CHEM 2212K, Organic Chemistry II

Junior
- BIOL 3500K, Ecology

Senior
- STEC 4500, Research
- BIOL 4560, Research Methods in Biology
- BIOL 4800, Internship
- BIOL 4570, Experimental Methods

The 4YrURCE model: General Biology Track
Research & Creative Experiences

- Research is novel to the students
- Multiple research experiences build problem solving & critical thinking skills
- Build confidence for faculty mentored research
- Graduate with STEM skills and competencies
Developing and Implementing CUREs

- Funding from USG STEM Initiative II
- **Internal Mini-grant Program**
- Encouraged faculty buy-in to redesign courses
- Stimulated faculty to be innovative and creative in designing CUREs
- Incentivized faculty to get involved in STEM SoTL
Integrated CURE: Biology Barcoding Project

Principles of Biology
BIOL 1108
Biodiversity

Species Identification

DNA Barcoding
Cell Biology
BIOL 3400
Biodiversity wiki page: Contains information on 386 insect specimens.

Documented and uploaded by students.
Calculus I (MATH 2200)

Students fly drones and collect data, and use derivatives and integrals to investigate relationships among position, velocity, and acceleration.
Programming Lab (ITEC 2120)

ITEC students hack away at code to program autonomous flights

- Simple Function Calls
  ```python
  from ggc_drone import *
  drone = GGC_Drone()
  drone.takeoff()
  # Move Forward For 4 Seconds
  drone.move(1, 0, 4)
  drone.land()
  ```

- Complex Loops
  ```python
  f_step = -0.25
  r_step = 0.25
  move_time = 0.5 * step
  for i in range(n):
      drone.move(f, r, move_time)
      f += f_step
      r += r_step
      if f >= 1 or f <= -1:
          f_step *= -1
      if r >= 1 or r <= -1:
          r_step *= -1
  ```
CURE: Organic Chemistry Synthesis Project

Before CURE

✓ Organic I Lab: build lab skills
✓ Organic II Lab: apply skills in ~ 7 standard named rxns, 2 weeks/rxn

With CURE

✓ Organic I Lab: same
✓ Organic II Lab: apply skills in a semester-long, student designed, synthesis project, culminating in a journal style article

CURE: Synthesis Project Outline

students issued 2 mL

students select from a library of 13 targets

students determine all the details
CURE: Organic Chemistry Synthesis Project

Students’ perspective
✓ Applied existing lab skills to new experimental situations
✓ Value of the literature
✓ Uncertainty and decision making
✓ Soft skills development
✓ Experienced the excitement and disappointment of doing “real” science
✓ Enhanced “critical thinking” ability by developing experiments, evaluating results, and adjusting to reach the ultimate goal of synthesizing a sulfa drug

Instructors’ perspective
✓ Sacrificed traditional content
✓ Gave up control to students
✓ Safety the major responsibility
✓ Operate lab like a graduate group
Program Assessment

Four Components:

1. Student attitudinal surveys
2. Course content assessment
3. Faculty Attitudinal Survey
4. Student Performance Data
### Cumulative Impact

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<tr>
<th>Category</th>
<th>Count</th>
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<tbody>
<tr>
<td>Number of proposals submitted</td>
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<tr>
<td>Number of mini-grants funded</td>
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<tr>
<td>CUREs</td>
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<tr>
<td>SoTL</td>
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<tr>
<td>STEC 4500</td>
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<td>SST Special Initiatives</td>
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<td><strong>Number of courses impacted</strong></td>
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<td>Freshmen level</td>
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<td>Sophomore level</td>
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<td>Junior level</td>
<td>19</td>
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<td>Senior level</td>
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<td><strong>Number of faculty participating in mini-grants</strong></td>
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<tr>
<td>Number of students impacted</td>
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<td>Faculty presentations &amp; posters</td>
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<td>Student presentations</td>
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<tr>
<td>Published Manuscripts</td>
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</tr>
</tbody>
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Faculty led and driven
Collaboration among faculty
Faculty are incentivized & energized
Innovative and creative ideas and projects
Work counts as scholarship
Scholarly products
Administrative commitment to sustainability
Challenges

- Assessment
- Time commitment
- Faculty leadership, coordination/integration in multi-section courses
- Faculty knowledge, skills, and ability to embed research experiences in courses
- Concerns about loss of content from “cook-book” labs
- Concerns about publishing work
Discussion

Questions?
Comments?
Examples of similar approaches?
Other undergraduate research models?
STEM Initiative Committee

Thomas Mundie, Dean SST  tmundie@ggc.edu
Judy Awong-Taylor, Biology  jawongta@ggc.edu
Allison D’Costa, Biology  adcosta@ggc.edu
David Pursell, Chemistry  dpursell@ggc.edu
Clay Runck, Biology  crunck@ggc.edu
Tirza Leader, Psychology  tleader@ggc.edu
Bernadette Peiffer, Education  bpeiffer@ggc.edu
GGC IEE Goals are to demonstrate/apply:
1. written and oral communication
2. creativity and critical thinking
3. effective use of information technology
4. collaboration in diverse and global contexts
5. human and institutional decision making
6. moral and ethical principles
7. leadership principles
8. quantitative reasoning

Synthesis Project Goal:
enhance organic synthesis capability

Synthesis Project Objectives:
1. research primary literature - IEE 1 & IEE 3
2. report results and findings (oral & written) - IEE 1
3. design & troubleshoot synthetic path to target - IEE 2
4. maintain documentation to replicate experiments - IEE 2
5. collaborate with peers in research - IEE 4 & IEE 7
6. collect and analyze quantitative data - IEE 8