Best Practices in Discovery-Based Research at Two-Year Undergraduate Colleges

Panel: James Hewlett, Finger Lakes CC
Daisy Zhang, Rob Hatherill, Del Mar CC
Carole Twichell, Collin College
Linnea Fletcher, Austin CC

Facilitator: Bridgette Kirkpatrick, Collin College
Undergraduate Research at the Community College

Professor James A. Hewlett
Executive Director – CCURI
President and CEO – STEMsolutions llc
Rationale for UR as a pedagogy
Finding the How: Best Practice Difficult to Capture

Apprentice model
- Low F:S ratio
- Outside coursework
- Summer / Paid

CURE model
- High F:S ratio
- Course Embedded
- Academic Year / Credit
CCLI, TUES, IUSE, Helmsley : $5.95M Total Funding (current IUSE: $1.5M)

2016-2017: 259 faculty and 3,815 students participated in a URE
PI
James Hewlett
Executive Director

Co-PIs
John VanNiel
Darren Mattone

Heather Bock
Project Director

Co-PIs
Diana Spencer
Virginia Balke

PARTNERS
Anoka Ramsey CC
Austin CC
Capital CC
Central Wyoming College
Cochise College
Edmonds CC
Everett CC
Florida Keys CC
Gaston College
Glendale CC
Ivy Tech CC
Kapiolani CC
Lake Wash Inst. Of Tech.
McLennan CC
Mesalands CC
Messa CC
Midland College
Moreno Valley College
Muskegon CC
North Hennepin CC
Piedmont Tech College
Portland CC
Redlands CC
Seminole State College
Truckee Meadows CC
Tulsa CC
Volunteer State CC

New Partners
Del Mar Community College
Estrella Mountain Community College
Lone Star Community College
Los Medanos Community College
Mesa Community College
Pueblo Community College
Trinidad State
Citrus College
Baton Rouge Community College
Queenborough Community College
Broome Community College
LaGuardia Community College
Broward College

ATE supplement
IUSE

COLLABORATORS
Bellvue Community College
Mass Bay Community College
Montgomery County Community College
### Barriers Exist

#### Barrier Analysis for CURE; Create New Course

<table>
<thead>
<tr>
<th>Gain admin support</th>
<th>ROW TOTAL</th>
<th>1394 (sum total of barriers)</th>
</tr>
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<tbody>
<tr>
<td>WEIGHT</td>
<td>4.29</td>
<td></td>
</tr>
<tr>
<td>WEIGHTED TOTAL</td>
<td>5987.86</td>
<td></td>
</tr>
<tr>
<td>TOP 3 Barriers</td>
<td>Lack of Funding, Lack of help from fac/admin/staff, Curriculum approval process</td>
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</table>

<table>
<thead>
<tr>
<th>Gain department support</th>
<th>ROW TOTAL</th>
<th>1321 (sum total of barriers)</th>
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</thead>
<tbody>
<tr>
<td>WEIGHT</td>
<td>3.77</td>
<td></td>
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<tr>
<td>WEIGHTED TOTAL</td>
<td>4983.77</td>
<td></td>
</tr>
<tr>
<td>TOP 3 Barriers</td>
<td>Faculty pushback, Lack of help from fac/admin/staff, Curriculum approval process</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Recruit students</th>
<th>ROW TOTAL</th>
<th>1286 (sum total of barriers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEIGHT</td>
<td>3.84</td>
<td></td>
</tr>
<tr>
<td>WEIGHTED TOTAL</td>
<td>4939.40</td>
<td></td>
</tr>
<tr>
<td>TOP 3 Barriers</td>
<td>Financial Aid restrictions, Lack of help from fac/admin, staff, credit limit regs</td>
<td></td>
</tr>
</tbody>
</table>

78% of the CCURI partners use modifications to existing courses
Barrier: Incompatible Culture

- Lack of training on innovation (faculty and leadership)
- Incompatible promotion, merit and tenure structure
- Risk aversion at the decision making level
- **Risk management and command and control response**
- Centralized decision-making powers (micromanagers)
- The concept of the “job description”
- The silo effect (ex. Departments, Colleges, Institutions)
- Rigorous applications of policies and procedures

*Results from a 2016 Sabbatical Project/Study*
Opportunities Exist

"As part of my most recent research experience..."

- I presented a talk or poster to other students or faculty on my campus. (N=588)
  - 62%

- I presented a talk or poster at a professional conference (off campus). (N=586)
  - 19%

- I have won a grant, award, or scholarship based on my research. (N=587)
  - 8%

- I have written or co-written a paper that is published in an undergraduate research journal. (N=587)
  - 6%

- I have written or co-written a paper that is published in an academic journal. (N=584)
  - 6%
## Opportunities Exist

<table>
<thead>
<tr>
<th>Metric</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3yr Graduation Rate</strong> (pre/post research program)</td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>24%</td>
</tr>
<tr>
<td>After</td>
<td>37%</td>
</tr>
<tr>
<td><strong>3yr Graduation Rate</strong> (research vs. non-research students)</td>
<td></td>
</tr>
<tr>
<td>No research</td>
<td>35%</td>
</tr>
<tr>
<td>Research</td>
<td>47%</td>
</tr>
<tr>
<td><strong>Transfer degree Completion time</strong></td>
<td></td>
</tr>
<tr>
<td>No research</td>
<td>5.3 yrs to degree</td>
</tr>
<tr>
<td>Research</td>
<td>3.9 yrs to degree</td>
</tr>
</tbody>
</table>

| I enrolled in additional science courses because of my research experience | 40.9% |
| I plan to transfer to a science program at a 4-year college because of my research experience | 36.4% |
| I am much more confident in my laboratory skills | 81.8% |
| Research gave me an internship or employment opportunity that would not be available without it | 36.4% |
| My research experience helped me obtain scholarship support | 22.1% |
| I have plans to continue my education in science beyond a four-year degree because of my research experience | 13.1% |
CURE Embedded URE

Introductory Biology/Chemistry case study: “oxidants are no accident”

Biotechnology techniques coursework: QC Applications, HPLC

BIO 291: The cellular protective effects of nutriceuticals
UGR implemented courses: BIOL 1406, BIOL 1407, BIOL 1414, BIOL 1415

Two tenured faculty member and one adjunct member. One full-time and one part-time lab technician

**Student Profile:** Majority of students are freshman with 2-3 post-baccalaureate and 1-2 HS students per semester
Individual research projects on campus (AAAS Poster Competition WINNER!)
Fall Annual Natural Sciences Student Poster Sessions

Fall 2014 Natural Sciences 9th Annual Del Mar College Student Poster Session
Come & join the student scientists as they present their poster and share their summer internship experiences

When: Thursday August 28, 2014
12:30 pm – 2:00 pm
Where: Lobby – Garcia Science Building

• Shared UG research knowledge and experiences within AC2
• Discussed advantages and barriers to successful implementation
• Discussed Mentor Network for UG Research

Sense of accomplishment for students. Recruit new students into the program. Bring the community together and create academic atmosphere for the college.

CCURI is funded by
NSF DUE 1524353

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Third NSF Community College Innovation Challenge rewards top entries

Judges recognize projects that slow antibiotic resistance and enhance STEM education

June 16, 2017: Teams from Texas and Colorado received first and second place awards, respectively, in the National Science Foundation’s (NSF) Community College Innovation Challenge. The American Association of Community Colleges (AACC) co-sponsors the annual event, which fosters students’ interest in science, technology, engineering and mathematics (STEM) careers by asking them to offer creative solutions to real-world problems. Read more.

First Place 2017

Del Mar College, Texas: Slowing Antibiotic Resistance with EnteroSword

This project advocates the use of tailor-made viruses that target bacteria that are resistant to conventional antibiotics treatment methods.

Photo: Students John Ramirez, Danial Nasr Azadani and Reavelyn Pray with their display at the Finalists’ Reception on Capitol Hill. Credit: NSF/Bill Petros

Second Place 2017

Red Rocks Community College, Colo.: Cyber Lab Learning Environment

The Red Rocks Community College team uses printed and digital material to demonstrate the power of the Cyber Lab Learning Environment.

Photo: Students Bruno Salvatico, John Sanchez and Isaac Kerley with their display at the Finalists’ Reception on Capitol Hill. Credit: NSF/Bill Petros
Connections and Collaborations and Articulations!

USDA – ARS, Arid-Land Agricultural Research Center, AZ
TAMUCC, Corpus Christi, TX
InCell, San Antonio, TX
Lawrence Berkeley National Laboratory, CA
Corpus Christi Water Department, CC, TX
National Natural Toxins Research Center TAMUK, Kingsville, TX
Boise State University, Boise, ID
Texas A&M Agri-Life Research Service, Corpus Christi, TX
University of North Texas, Denton, TX
University Hospital Hamburg, Germany
MD Anderson Cancer Center, UT-Houston, TX
Diagnostic BioSystems, Inc., CA
Bioo Scientific, Austin, TX
The positive impact on the biotechnology program at DMC

### Biotechnology Course Completion

<table>
<thead>
<tr>
<th></th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Completions (Grades A-C)</td>
<td>17.9%</td>
<td>8.3%</td>
<td>6.5%</td>
<td>7.1%</td>
<td>4.5%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Withdrawals</td>
<td>82.1%</td>
<td>93.5%</td>
<td>88.1%</td>
<td>90.9%</td>
<td>81.6%</td>
<td>100%</td>
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### Annual Statistics

<table>
<thead>
<tr>
<th></th>
<th>2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
<th>2012-13</th>
<th>5-Year Average</th>
<th>4-Year % Change</th>
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<tbody>
<tr>
<td>Sections</td>
<td>7</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Enrollments</td>
<td>62</td>
<td>92</td>
<td>106</td>
<td>100</td>
<td>76</td>
<td>87</td>
</tr>
<tr>
<td>Average Class Size</td>
<td>8.9</td>
<td>9.2</td>
<td>11.8</td>
<td>9.1</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>Semester Credit Hours</td>
<td>209</td>
<td>341</td>
<td>412</td>
<td>393</td>
<td>293</td>
<td>330</td>
</tr>
<tr>
<td>Contact Hours</td>
<td>7,560</td>
<td>11,776</td>
<td>13,984</td>
<td>12,432</td>
<td>10,448</td>
<td>11,242</td>
</tr>
<tr>
<td>% Summer Contact Hours</td>
<td>34.2%</td>
<td>36.0%</td>
<td>43.1%</td>
<td>25.2%</td>
<td>40.0%</td>
<td>35.0%</td>
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</table>

### Fall Statistics

<table>
<thead>
<tr>
<th></th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
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<tbody>
<tr>
<td>Sections</td>
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<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Enrollments</td>
<td>30</td>
<td>36</td>
<td>33</td>
<td>42</td>
<td>22</td>
<td>38</td>
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<tr>
<td>Avg. Class Size</td>
<td>10.0</td>
<td>9.0</td>
<td>11.0</td>
<td>10.5</td>
<td>11.0</td>
<td>12.7</td>
</tr>
<tr>
<td>Semester Credit Hours</td>
<td>100</td>
<td>129</td>
<td>132</td>
<td>168</td>
<td>86</td>
<td>152</td>
</tr>
<tr>
<td>Contact Hours</td>
<td>2,720</td>
<td>3,552</td>
<td>3,696</td>
<td>4,704</td>
<td>2,464</td>
<td>4,256</td>
</tr>
<tr>
<td>% Summer Contact Hours</td>
<td>17</td>
<td>31</td>
<td>17</td>
<td>42</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>No. of Majors</td>
<td>17</td>
<td>31</td>
<td>17</td>
<td>42</td>
<td>34</td>
<td>50</td>
</tr>
</tbody>
</table>

CCURI is funded by NSF DUE 1524353

www.ccuri.org
Comparison of Figure 2 for a SEA-PHAGES Course and a Traditional Laboratory Course

Figure 2: Percentage of students in your class likely to continue or not continue in the sciences by psychological measures on the PITS survey

**BIOL 1406 - Biological Concepts I (Biology for Science Majors I) SEA-PHAGE:**
Surveys Completed: 21; Class Participation Rate: 84% of total enrollment, Fall, 2016

**BIOL 1406 - Biological Concepts I (Biology for Science Majors I) – Traditional.**
Surveys Completed: 24; Class Participation Rate: 104.3% of total enrollment, Fall, 2016
**Comparison of Figure 2 for a SEA-PHAGES Course and a Traditional Laboratory Course**

**SEA-PHAGES Course**

- **Completeness:** Surveys completed: 7.
- **Participation Rate:** 47% of total enrollment.
- **Spring, 2017**

**Traditional Laboratory Course**

- **Completeness:** Surveys completed: 23.
- **Participation Rate:** 96% of total enrollment.
- **Spring, 2017**

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**BIOL 1415 – Biotechnology II (SEA-PHAGE):** Surveys Completed: 7; Class Participation Rate: 47% of total enrollment, Spring, 2017

**BIOL 2421 – Microbiology I (PARE):** Surveys Completed 23; Class Participation Rate: 96% of total enrollment, Spring, 2017

**www.ccuri.org**
Other Thoughts:
You don’t have to have a grant to start:

- Research Interests of Faculty
- Experienced Interns Working as Teaching Assistants
- Student’s Proposed Projects
- Collaborating with Industry
- Extension of SEA-PHAGES or PARE

Budget wise, UGR courses could be cheaper.
Be prepared for more work!

This work is supported by the National Science Foundation AC2 Bio-Link Regional Center ATE Grant (DUE 1501207) and CCURI (DUE 1524353).
AC2 Bio-link Regional Center

Carole Twichell
Bridgette Kirkpatrick Ph.D
Linnea Fletcher Ph.D
Embedded Research

• Various course based research projects
  • Arabidopsis
  • C. elegans
  • Microbiology related projects

• They did not have enough structure to extend to a broader student population.
Previously-Utilized CUREs

- PARE (Prevalence of Antibiotic Resistance in the Environment)
  Worked for Honors labs
  - Issues: Not enough content for a whole semester
  - Added extension activities to extend content
    - Kirby Bauer
    - Multiplex PCR
    - E-Test

- SEA PHAGES has enough content, but is not scalable for the masses
How to reach more students

• Restricting research experience to select students is elitist
• We are not reaching all students who are gifted/interested
• We may very well be driving students out of science with our current “cookbook” biology labs
• PARE + extensions is appropriate, but prep-heavy
  • Also ran into biosafety issues (subculturing unknowns)
• Proposed model: analyzing cellulase activity in environmental samples and lab strains (double-blind)
Going big!

- **Cellulase from environmental samples**
- Accessible to all or many
- Real-world applications
- Inexpensive to scale for multiple classes/campuses
- Prep is limited (students take part in setting up experiments)
- Extensions are available for honors sections
- Expandable as our enrollment is continuing to increase
  - Currently ~4500 students per year
Support

- Administration is supportive of faculty driven curriculum changes
- Faculty wax and wane in support
  - 2 steps forward 1 step back
  - We pilot new models and get initial buy-in
  - We get push back about whether faculty or students can perform advanced skills such as PCR and sequence analysis
  - Varied levels of experience amidst lab instructors is a problem
    - Potential solution: mandatory CE training for adjuncts?
Things to consider

• When adapting or a new CURE:
  • Prep time, storage and cost-what appears simple on the surface, may not be scalable to more than 1 or 2 classes
    • Going from 1 to 40+ classes can be a game changer
  • Protocols-writing or re-writing in student friendly language
  • Identify allies and opponents-have solid data and an elevator speech
  • Instructors who will be teaching new labs
    • Training involved
    • Resistance to change
    • Technology (techniques and equipment) to be used
Think Big! ACC Project

- College-wide Annual Poster Session
  - Academic Undergraduate Research AND Workforce Internship Posters From High School (Dual Credit) Up through Two Year and Possibly Transfer to 4-Year

Invite Administrators and the Community to View
Invite Industry and Academic Partners to Judge
Have Students Emcee the Event!
Questions

How and in which course did you first implement an undergraduate research experience?
Which CURE project would you recommend for someone just getting started, and why?
Do you have any advice for selling this to administrators and faculty?
How do you recruit students into UGR courses?
How would you think “BIG”?
What are the barriers from your institution other than what has been discussed in this session?