The Impact of a Course-Based Undergraduate Research Experience on Non-Major Community College Chemistry Students

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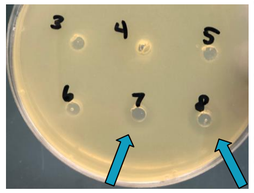
Course-Based Undergraduate Research at JCCC

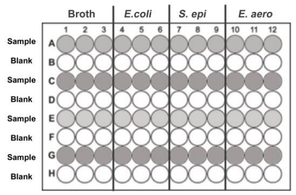
Course-based undergraduate research experiences (CUREs) are being championed as scalable ways of involving more undergraduates in meaningful research. There are many advantages and benefits for both the students and faculty to conducting authentic research as part of a regular laboratory course. An interdisciplinary partnership between the students and faculty in the Microbiology Lab course and an introductory organic and biochemistry lab course (CHEM 140: Principles of Organic and Biological Chemistry) was developed at JCCC. This research with a focus on crowd-sourcing the search for new antibiotics using CUREs in two different lab courses partners with the Tiny Earth Network. Each semester, the Microbiology Lab students discover and identify bacteria that produce antibiotics through a CURE. The best candidates are further explored by the students in CHEM 140 with their CURE. Each semester all the students at JCCC that participate in these CUREs present their findings at a research poster session on campus.

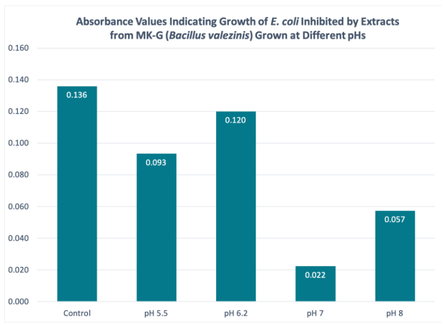
The chemistry students are focused on extracting and isolating the antibacterial compounds produced by these bacteria. Developing methods for reliably testing the extracts has been the primary focus of the research, but soon their efforts will move towards separations.

Tiny Earth Chemistry Project



The students have been testing their extracts against safe relatives of ESKAPE pathogens, such as *E. coli*, *S. epidermidis*, and *E. aerogenes*. They have collected both **QUALITATIVE** and **QUANTITATIVE** data. The qualitative data is less reproducible since it is highly dependent on concentration and the time the bacteria being tested is allowed to grow before results are observed or measured. The arrows above point to zones of inhibition seen with MK-G and *E. coli* when grown in a well-plate (7 and 8). These same samples were tested in broth and the absorbances were measured at at 600 nm.



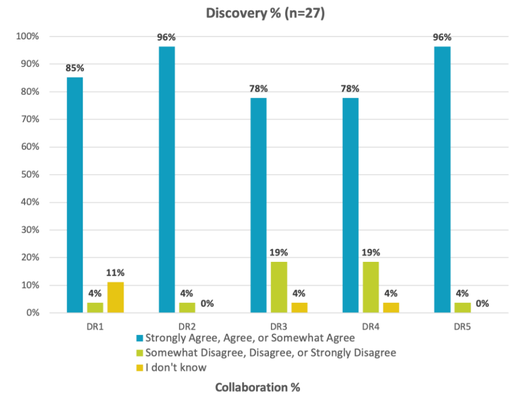


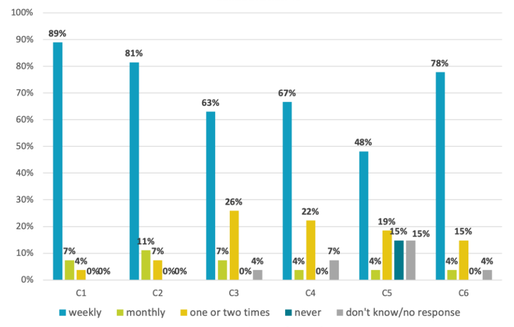
Laboratory Course Assessment Survey (LCAS)[1]

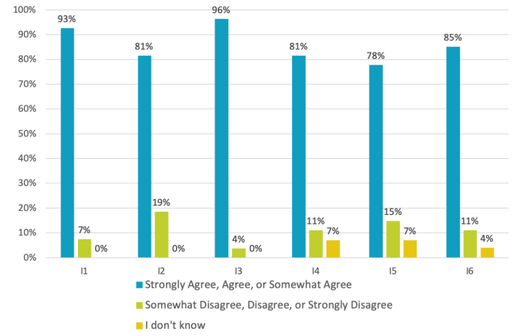
Five Key Elements[2] of CUREs

- Use of Scientific Practices
- **Discovery**
- Broadly Relevant or Important Work
- **Collaboration**
- **Iteration**

A post-survey (LCAS) was given to students after participation in this CURE asking them about their experience. They were given statements about discovery and iteration and asked about frequency of experiencing elements of collaboration:







1. Corwin, L.A. et. al. The Laboratory Course Assessment Survey: A Tool to Measure Three Dimensions of Research-Course Design", **2015** *CBE Life Sciences Education* 14: 1-11.
2. Auchincloss et. al. "Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report", **2014** *CBE Life Sciences Education* 13: 29-40.

Student Understanding of Science and Scientific Inquiry Questionnaire (SUSSI)[3]

6 Sections (4 Likert-type questions and 1 open-ended question)

- Observations and Inferences
- Change of Scientific Theories
- Scientific Laws vs. Theories
- Social and Cultural Influence on Science
- **Imagination and Creativity in Science Investigations**
- Methodology of Scientific Investigation

❖ Only one Section showed a Significant Change: Imagination and Creativity in Science Investigations

Four Questions (True or False Statements) Asking Students SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree), SD (Strongly Disagree):

A. Scientists use their imagination and creativity when they collect data
B. Scientists use their imagination and creativity when they analyze and interpret data
C. Scientists do **not** use their imagination and creativity because these conflict with their logical reasoning
D. Scientists do **not** use their imagination and creativity because these can interfere with objectivity.

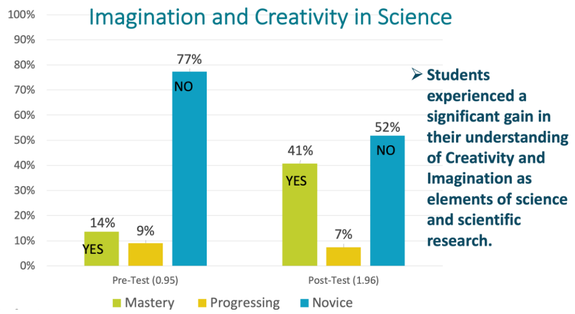
Handling of Qualitative Likert Scale Data:

- Each student was given a score out of 4 possible.
- One point for choosing Agree or Strongly Agree for a true statement or for choosing Disagree or Strongly Disagree for a false statement
- Zero points for "Uncertain"
- Zero points for agreeing with a false statement or disagreeing with a true statement

0-1 Novice 2 Progressing 3-4 Mastery

Example Scoring:

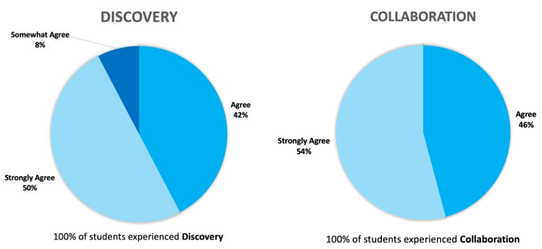
Example	5A (T)	5B (T)	5C (F)	5D (F)	Score
Student response	SA	U	D	SD	3 Mastery

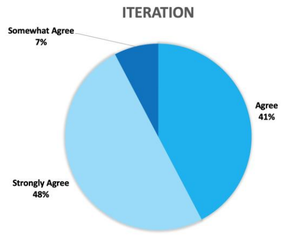


➢ **Students experienced a significant gain in their understanding of Creativity and Imagination as elements of science and scientific research.**

3. Liang, L. L. et. al. "Assessing preservice elementary teachers' views on the nature of scientific knowledge: A dual-response instrument", **2008** *Asia-Pacific Forum on Science Learning and Teaching* 9 : 1-20.

Conclusions and Future Directions





- **100% of the students identified some elements of Discovery, Collaboration, and Iteration in their research experience.**
- **Students experienced a significant gain in their understanding of Creativity and Imagination as elements of science and scientific research.**

- Note: Open-ended questions were coded using consensus coding. Changes in current data were not statistically significant and could be attributed to natural variance—no pairing of pre- and post-tests.
- Use spectrophotometry and quantitative data analysis with students in course has allowed for more sensitive and reproducible data collection.
- Further development of chromatography protocols for this project with options for students will be developed.
- In 2019-2020, data with be collected with paired pre- and post-surveys and points will be offered to students for completion.

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