Learning through research: the undergraduate research experience in a community college.

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LARAMIE COUNTY COMMUNITY COLLEGE WYOMING

WYOMING INBRE IDeA Networks for Biomedical Research Excellence NIH

Abstract

The typical hands-on experience in science coursework is often limited to predetermined laboratory activities involving little exploration. Undergraduate research departs from this paradigm and instead allows the students to experience first-hand what is entailed in making an intellectual contribution to their discipline. At Laramie County Community College, we offer the opportunity for students to initially experience the nature of science, and then engage with and conduct novel research both through course work and through independent study. This program has had far reaching successes with the use of federal funding to further engage and prepare our students for their future education and careers.

Background

Undergraduate research in the community college is slowly overcoming the traditional paradigm that suggests 1) research is separate from teaching, and 2) community colleges are places of the distribution, not the creation of new knowledge. This shift is the result of the recognition that students, including those at community colleges, are capable of and benefit from research experiences in a variety of ways [1, 2], and to exclude them from these opportunities is a disservice to them and our society. For example, students that engage in scientific research have increased skills, greater persistence in STEM degree programs and careers, and are often motivated to pursue more advanced degrees than originally intended. Students also gain in less easily measurable ways, such as increased confidence in their abilities as scientists and expansion in the use of critical thinking. Further, in the last 10 years, various professional groups of scientists and educators have increasingly recommended that the teaching of science move to a depth versus breadth format, and include more 'practice' of actual science [3]. This has ultimately translated into recommendations that colleges should provide research opportunities for students in their first 2 years [4], hence, while at LCCC. This coupled with the fact that community colleges serve 46% of all college undergraduates underscores the need for these experiences to be available for our students to remain competitive. Locally, the student population at LCCC is about 4,000 individuals 46% are first generation, 43% are Pell eligible and 18% identify as minorities. Despite our relatively rural location, we are in driving distance of 3 research universities and are uniquely poised to directly impact the pipeline of students going into science. Regionally, there is a push to increase participation in the sciences as seen through the 500+ students participating in an annual Undergraduate Research Day at the University of Wyoming. Ultimately, implementation of research across the curriculum at LCCC would ideally produce a showcase day and/or an undergraduate journal made up of communications from a wide swath of our own students.

57% Female **46% 1st generation** **43% Pell eligible**

Mission and Vision

Our mission is to provide access to an authentic research experience for any interested and motivated undergraduate student wanting to enhance their academic experience.

Our vision is to accomplish this through:

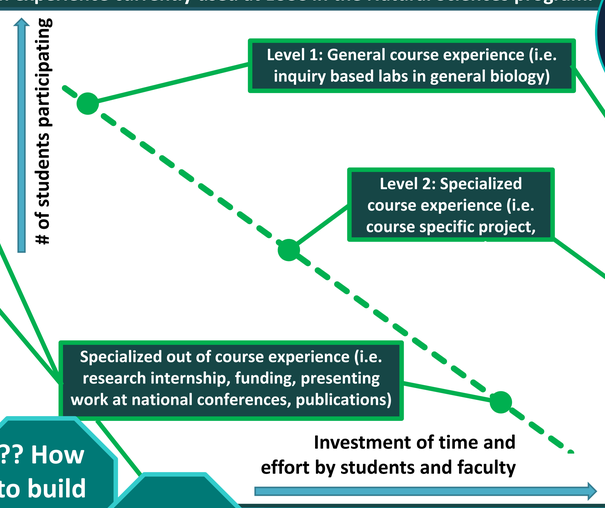
- Providing research opportunities through classes and independent study in both lab and field-based projects using contemporary and applicable instrumentation.
- Active recruitment and retention of student scientists.
- Support for involvement of other CC and UW faculty.
- Development and maintenance of relationships with community agencies and surrounding institutions.

Figure 1. Variety of mechanisms for research experience currently used at LCCC in the Natural Sciences program.

Peer Reviewed Research Articles (*LCCC undergraduate student):

Botha E, Stonehouse G, Lima LW, Fakra SC, ***Aguirre B,** Wangeline AL, Xiang J, Honging Y, Zsuzsa J, Soof, A, Dernovics M, Pilon-Smits EAH (2019). Selenium Tolerance, Accumulation, Localization and Speciation in a Cardamine Hyperaccumulator and a Non-Hyperaccumulator. Science of the Total Environment, *in press.*

Lindblom SD, Wangeline AL, Valdez Barillas JR, ***Devilbiss B**, Fakra SC, Pilon-Smits EAH (2018). Fungal Endophyte *Alternaria tenuissima* Can Affect Growth and Selenium Accumulation in Its Hyperaccumulator Host *Astragalus bisulcatus*. Frontiers in Plant Science 9:1213.



300+ Students take majors BIO each year

20% of participants have gone on to professional or graduate school

Opportunities

- Students practice what they learn
  - *Develop and practice skills in problem solving, information literacy, communication, and collaboration*
- Students make connections with peers and faculty
- Students gain confidence
  - *Gives the students the chance to struggle, troubleshoot, fail and recover*
  - *Can contribute to the knowledge in their field*
- Can help students with future education or career positions

Challenges

- Time to participate (both students and faculty)
- Research credits finding a place in a transfer program
- Sustained funding
- Administrative and cultural support at the community college level varies
- Recruitment of students to participate
- It can be a big jump in responsibility on the students for their own learning
- How and where to implement the research experiences (Figure 1)

Next Steps

- Greater assessment to measure the impacts at the introductory course level
- Continued discussions with administration on research as part of workload
- Development of more accessible models of authentic research experiences
- Possible redesign of the research course to make the work and credit load less onerous

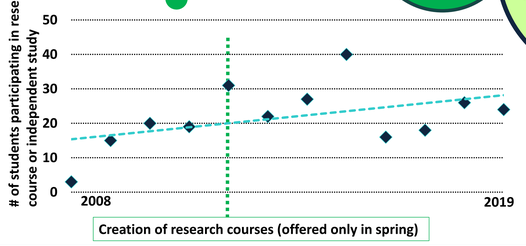
?? Credit transfer

?? Pay students or faculty

?? Research for credit

LCCC Research by the Numbers

Since its inception in 2008, the LCCC research group has served 88 individual students through 5 faculty in levels 2 and 3 as shown in figure 1, with an average of 2 semesters of participation per student. To cover our levels 2 and 3 students, we are at capacity without additional faculty involvement. A 2017 redesign of our General Biology (BIOL1010) course for majors had large increases in skills, inquiry and a greater focus on the nature of science. However, it is unknown if these changes will have similar impacts on student's interest and persistence in the sciences.



Students **88**

2 publications in peer reviewed scientific journals

Collaborating **4** Universities

40 presentations at Undergraduate research day or professional conferences

5 Faculty

References

1. Lisa A. Corwin, Mark J. Graham and Erin L. Dolan, "Modeling Course-based Undergraduate Research Experiences: An Agenda for Future Research and Evaluation." CBE—Life Sciences Education 14: es1-13 (Bethedsda, MD: American Society for Cell Biology, 2015).

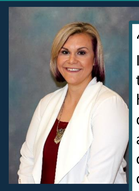
2. CCURI and CUR, "Investing in Impact: The Power of Undergraduate Research." (Washington, DC: Council on Undergraduate Research, 2015). Available at: http://ccuri.org/downloads/investing-impact-power-under-graduate-research;

3. Carol A. Brewer and Diane Smith, eds., "Vision and Change in Undergraduate Biology Education: A Call to Action." (Washington, DC: American Association for the Advancement of Science, 2011). Available at: http://visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf

4. PCAST, "Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics." (Washington, DC: President's Council of Advisors on Science and Technology, 2012). Available at: https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf

"Being part of that research group was really the turning point in my life. I wouldn't have the degree or the passion that I have now. I wouldn't have the respect for the scientific community that I have now." - Berthal Devilbiss, Mycologist

"I took the research class because I was interested in the process of research and wanted to have an understanding of it before I made it my career goal. During the class I really gained a new understanding of the scientific process and have continued my education in science." – Wesley Frain, Climate Scientist



"I was fortunate enough to have Dr. Wangeline as my biology instructor at LCCC and she introduced me to the world of research. I quickly joined the research class and dove into a complex project. This project assisted me in fostering my understanding of the commitment, time management, and communication skills that are needed to conduct a successful project. I learned just how complex a research project can be and gained a further appreciation for the primary literature I read. These skills I learned during my time, assisted me not only with my continued academic endeavors conducting research at the U of Wyoming, but also made me become an avid critical thinker in my current career in pharmacy. I always am thinking of ways in which patient care can be managed more efficiently or ways in which research could lead to incredible changes in medication regimens, and I owe that heightened level of questioning to the research class at LCCC." – Kelsea Zukauckas, Pharm.D.

"I initially participated in undergraduate research for the financial opportunities that were available, but I ended up gaining so much more. While I was able to get many scholarships and grants through research, it also helped open a lot of doors via networking with other scientists and it allowed me to improve my technical writing and communication skills" – Sam Haller, Veterinary Medicine