Jumping worms, community science & course-based undergraduate research experiences

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Abstract

- Inclusion of undergraduates in authentic research is an effective tool to increase interest and competency in a research career.
- Not all undergraduate students are able to participate in these formal research opportunities.
- To expand the connection of undergraduate students with researchers and educators, a **Course-based Undergraduate Research Experience (CURE)** was developed to engage students through their undergraduate institution.[1,2]
- This CURE provided undergraduate students at the University of Minnesota Rochester (UMR), an opportunity to participate in ongoing environmental and community-based research and increase their interest, familiarity and confidence in research.
- A collaboration was formed between UMR, the University of Minnesota Extension and the Rochester, MN community.
- Students investigated the microbial community of soils with and without invasive jumping worms.[3]

Goals - Pedagocial

Outlined below are the course objectives, design elements, student outcomes, required support and our overall experience with the program. We will examine student perception of discovery, iteration and collaboration in connection with student's sense of ownership using a validated survey instrument to assess the design of the CURE.

Goals - Community Impact

Recent community science data about jumping worms shows that participating in research increases the hope and agency of those impacted by jumping worms. During this UMR project, researchers worked with community members to collect soil samples on their properties in the hopes of further scientific understanding of jumping worms.

CURE: Microbiome of Soils with and without Jumping Worms

Laboratory Learning Objectives:

- Perform basic microbiology techniques in a laboratory setting
- Implement the scientific method through proposal of hypotheses which explain biological phenomena
- Design and conduct experiments aimed to test the proposed biological hypotheses
- Manipulate and analyze numerical data and culminate with an informed conclusion
- Demonstrate an understanding of the basic principles underlying isolation and identification of microorganisms
- Identify and assess primary literature relevant to a specific question or topic
- Effectively communicate laboratory results both orally and in writing
- Design, implement and share plans and findings from the CURE
- Engage, individually and as members of a group, in community efforts to make visible, and address issues affecting Rochester, MN environmental and community health

CURE Design Elements

Skill Acquisition *to become familiar and proficient with experimental techniques and existing literature.*

Develop *a research plan to address the hypothesis. Iterate and synthesize course concepts.*

Implement *the research plan. Work with community members, collect and analyze data.*

Disseminate *results to classmates, faculty and community members via scholarly conversation.*

Methods

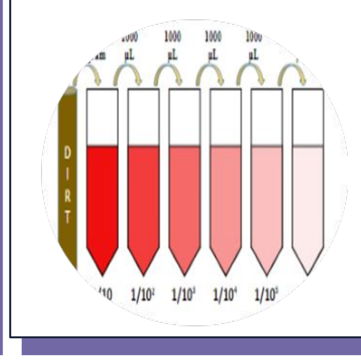
Study sites

- Prairie n=3
- Soil with jumping worms n=3
- Soil without jumping worms n=3

Olmsted Co, MN

Bacterial isolation

- Serial dilution
- Plating

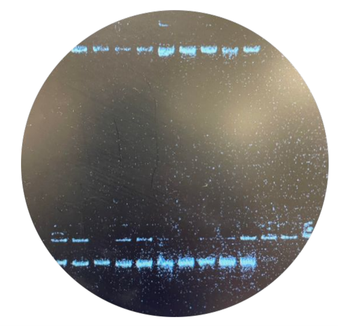


16S amplification

- Primers 27F & 1492R

Verification of amplification

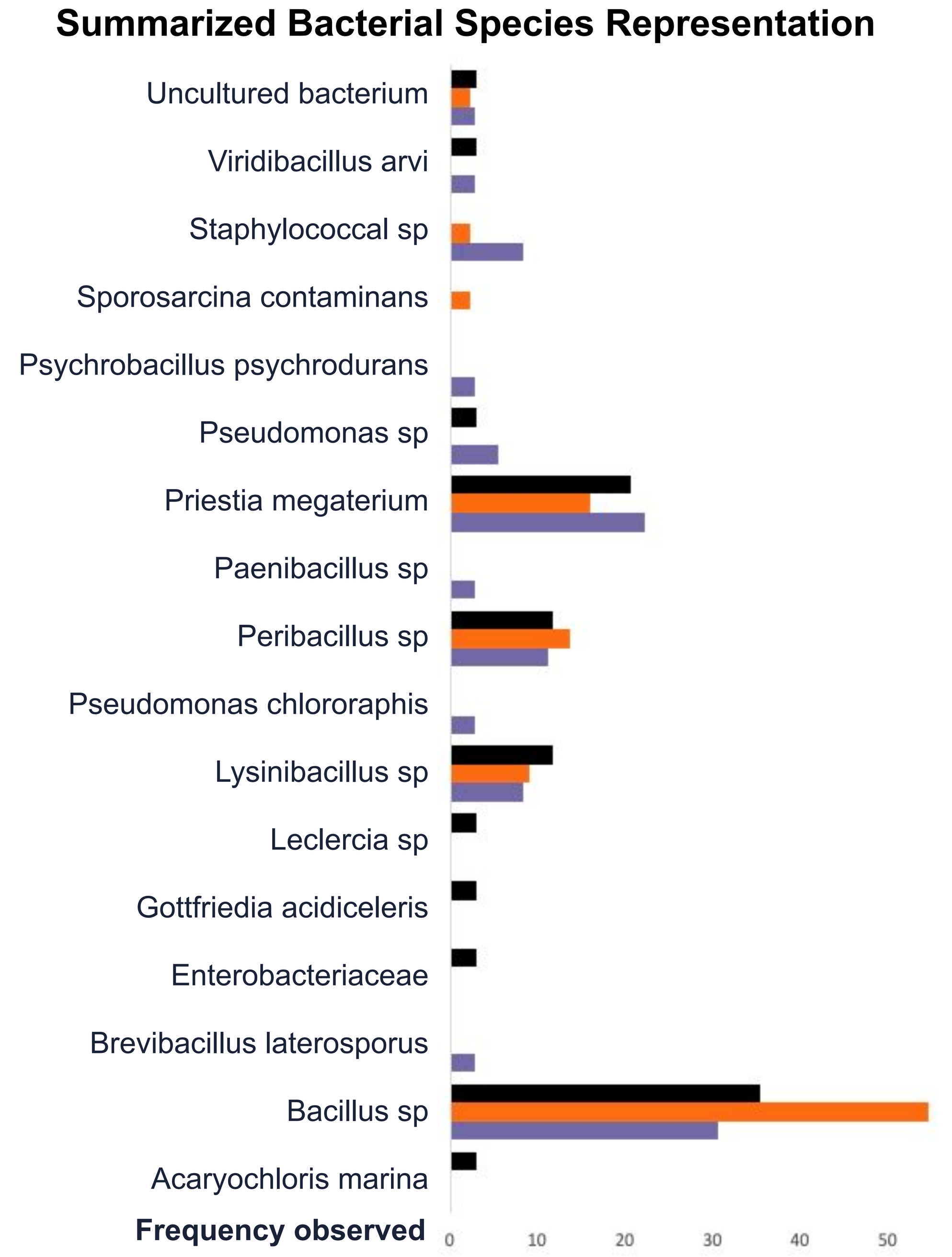
- Gel electrophoresis



Analysis

- Bacterial density
- Species composition

Results



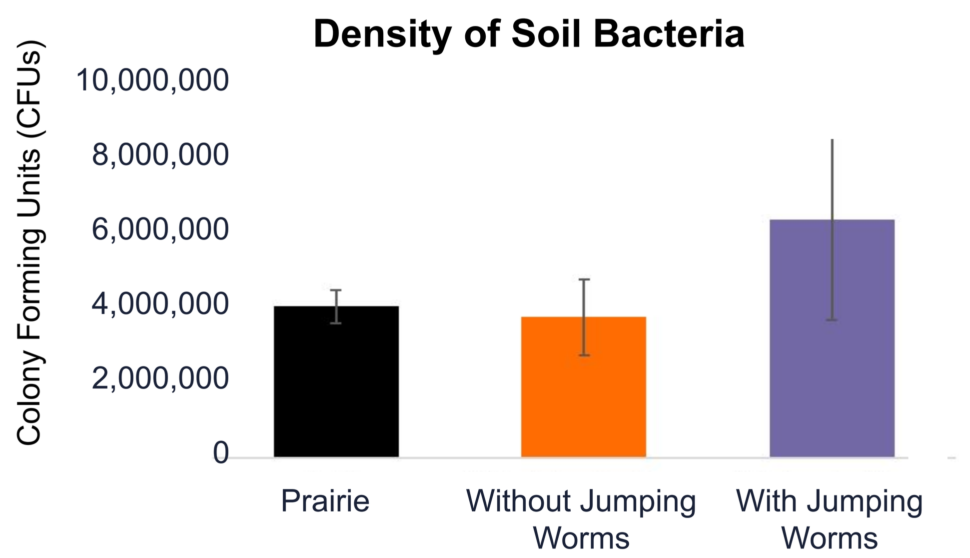
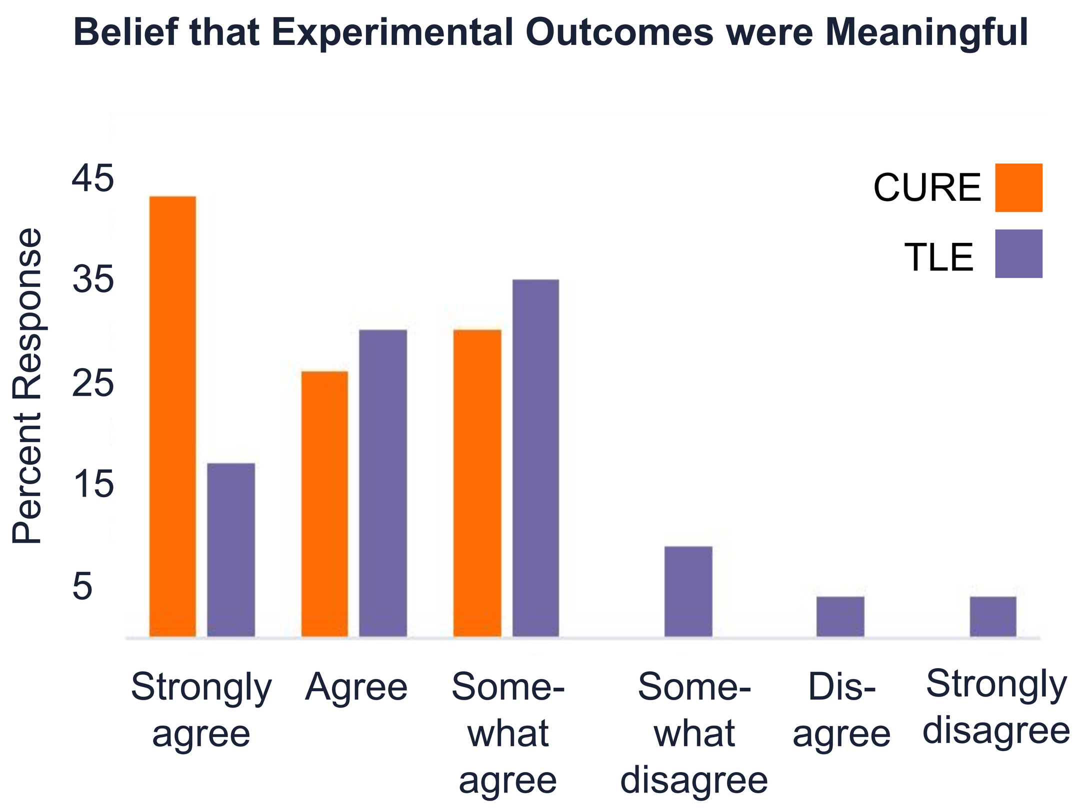


Figure 2. Bacterial species representations (summarized) and bacterial density between soil collected from prairie, without jumping worms and with jumping worms.

Course Overview

Microbiology at University of Minnesota Rochester, examines the evolution, structure, physiology, metabolism and genetics of microorganisms with an emphasis on bacteria and viruses. Students also examine the dynamic impact of microbes on humans and the role of microbes in the environment. This course is taught using student-centered, active learning and writing integrated approaches. Students apply these concepts to problem solving within the field, while also gaining confidence in his/her communication of microbiology through collaborative, team-based assignments. In the accompanying laboratory, students gain exposure to and develop a variety of current microbiology techniques. The accompany laboratory consists of a **Traditional Laboratory Experience (TLE)** where "canned" experiments conclude with expected results. These TLEs provide students with opportunities to gain necessary microbiological laboratory skills. During the summer of 2022 we also implemented a **CURE** in collaboration with Angela Gupta and Olmsted County Master Gardeners.

Student Perceptions of CURE



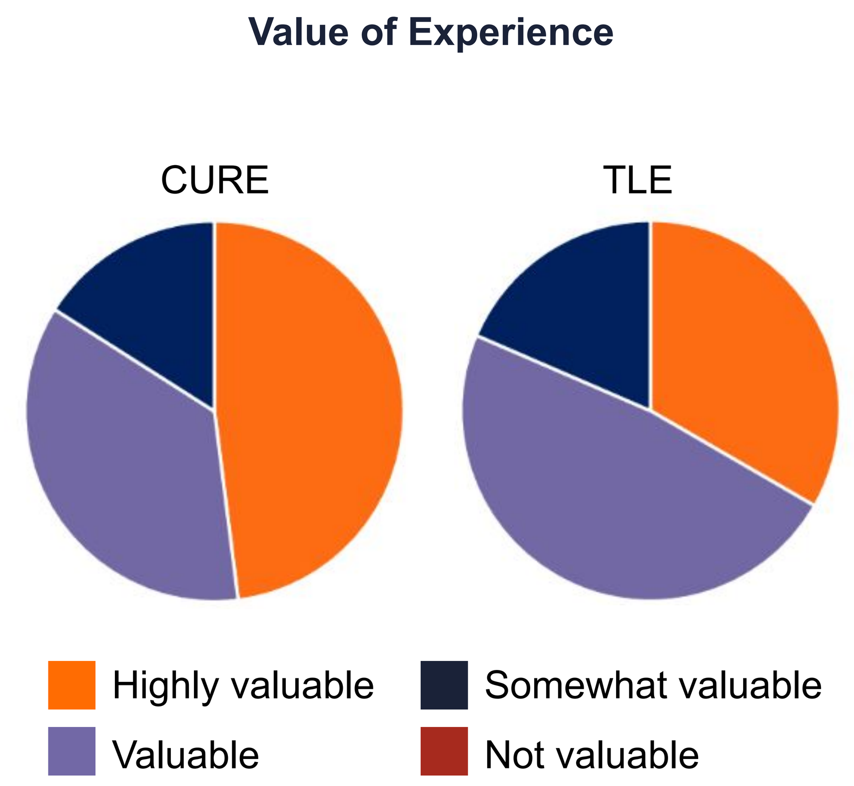


Figure 1. Student responses to the question of, "My research will help solve a problem in the world" (left). Student responses to the question of, "How VALUABLE did you find this experience?" (right). Course-Based Research Experience (CURE) compared to traditional laboratory experience (TLE), n=23.

Conclusions

- Students perception of skill and learning artifact acquisition was greater with CURE compared to TLE.
- A metagenomic approach most likely would have produced better results, but this approach would have deviated from course learning objectives.
- Students observed a greater number of bacterial colony forming units in soil with jumping worms.
- Community members allowed soil collection on their properties and expressed enthusiasm to help grow the science around this troublesome pest.

References

1. Werth et al., 2022 Phys Rev Phys Educ Res
2. Johnson et al., 2021 Int J Allied Health Sci & Prac
3. Jang et al., 2022 Soil Biol & Biochem

Visit the QR code for a detailed slideset