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Using a Research Catalog and Archive in an Allied Health Professions Microbiology Course

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Abstract

This paper reports on the novel usage of a catalog of research ideas based on certain research themes to provide direction to students in designing experiments. The results of these experiments are continuously compiled into an archive which provides students with a learning resource and a foundation for future research.

Keywords: Course-based undergraduate research; Health professions education; Microbiology education

Introduction

Student independent research (i.e., research conducted by a student outside of a formal course setting) has long been known to be valuable to undergraduate life science education [1]. However, early trends showed that students also respond well to inquiry – based laboratory classes [2], and these early forays into course-based undergraduate research or CUR [3] have exploded into a veritable movement, in which CUR has been assessed and regarded highly by both students and faculty [4-6], even when compared with more traditional apprentice – based research experiences [7,8]. This trend in CUR has not been restricted to just natural science majors but has also been observed in science courses for non-majors, particularly those in health science/allied health [9-14] and nursing [15-18] programs.

Regarding nursing education in particular, microbiology instruction has been found to be most relevant to students when focused on topics relevant to patient care [19]. Involving nursing and allied health students in microbiology CUR has potential for bridging the gap between concept and practice and introducing students to research methods that can help prepare them for possible clinical research studies in their futures [20,21]. This article describes CUR in an ongoing health professions microbiology course. Students select projects from a "catalog" of research ideas based on a few basic "themes" relevant to health care and public health. Over the years results from these student projects have been collected into an online "archive" available to students for future studies.

Themes and Catalog

A list of research themes (Table 1) provides students with relevance and topical boundaries. Within these themes the catalog (Table 2) provides students with both ideas and structure without giving them specific research questions, hypotheses, experimental designs or procedural details (which are left to the students to figure out guided by the instructor). The catalog provides students with experimental boundaries needed to design projects doable within the milieu and limitations of an introductory sophomore – level microbiology lab course for health professions majors (with mostly, but not exclusively, nursing students). For example, regarding Catalog Items 1 & 2 (Microbial Geography & Novel Diagnostic Methods, respectively), students collect samples from a variety of locations and perform quantitative analyses and/or presumptive bacterial identifications or determinations of antibiotic resistance/virulence factors, activities that relate to microbial monitoring in healthcare facilities and in public health. Similarly, Catalog Items 3 – 6 involve testing physical and chemical agents on the growth of bacterial and eukaryotic cells, activities that relate to materials and equipment used by healthcare personnel & public health researchers involved in hygiene and infection control.

• Discovering the factors (temporal, seasonal, environmental, and/or anthropogenic) that affect or correlate with the geographic distribution of specific microbes
• Discovering the factors (as above) that affect or correlate with the geographic distribution of resistance to specific antibiotics
• Discovering the factors (as above) that affect or correlate with the geographic distribution of specific virulence traits
• Developing or optimizing diagnostic techniques to more cheaply and quickly analyze samples for specific microbes
• Developing or optimizing cheaper and/or safer anti-microbial agents

Table 1: Microbiology lab research themes.

1. Microbial Geography (analysis of environmental microbes)
A. Indoor (Building) Microbiomes
(1) Air
(2) Surfaces
(3) Plumbing Fixtures
B. Outdoor Microbiomes
(1) Air
(2) Surfaces
C. Water Analysis
(1) Microbial indicators of water quality
(2) Relationship of chemical/physical factors and microbial indicators
D. Soil (land) Analysis – relationship of chemical/physical factors and microbiomes
E. Virulence & Antibiotic Resistance Factors
2. Novel Diagnostic Methods
A. Novel Uses of Traditional Point of Care/Rapid Methods (POCRMs)
B. Developing New POCRMs
C. Developing Screening Assays for Virulence & Antibiotic Resistance Factors
3. Comparative Analysis of Effects of Physical/Environmental Factors on Growth of Different Microbes
A. Testing of Individual Factors
(1) Electromagnetic Radiation
(2) Acoustic Radiation
(3) Temperature
(4) pH
(5) Osmotic Pressure
B. Testing of Factor Combinations
4. Comparative Analysis of Effects of Chemical Agents on Growth of Different Microbes
A. Minimum Inhibitory Concentration Determinations of Individual Chemical Agents
B. Testing of Agent Combinations
C. Testing of Novel Agents
5. Comparative Analysis of Effects of Physical Factors/Chemical Agents Combinations on Growth of Different Microbes
6. Comparative Microbial/Cellular Stress Analysis (comparing bacterial and eukaryotic cells exposed to various physical and chemical agents)

Table 2: Research catalog.

Year 2017 – Spring
1. Aerosol-Transmitted Bacteria Across Campus
2. An Analysis of Pond Water from the Trustee Pond for Microbial Growth & Fecal Contamination
3. Effectiveness of Well-Water at Filtering Microbes Versus City Water Treatment
4. Growth of Microorganisms on Vending Machine
5. Chemical Control of Microbial Growth
Year 2017 – Summer
1. Rainwater Analysis
2. An Investigation of Bacterial Growth in Campus Drinking Water Fountains
Year 2017 – Fall
1. Microbial Analysis of UNG's Water Fountains
2. An Investigation of Disinfectants Against Bacterial Growth of *E. coli*
3. The Effect of Treating Water on the Presence of Coliforms
4. The Effects of Hand Soaps, Hand Sanitizers, and Essential Oils on the Growth of *Bacillus megaterium*, *Escherichia coli*, and *Staphylococcus aureus*
Year 2018 – Fall
Comparison of Microbial Growth in Lakes and Creeks
Year 2019 – Fall
1. Hand Washing vs Hand Sanitizer: Which is more effective?
2. The effect of Antibacterial and Non-antibacterial Soaps on the growth of *E. coli* and *S. aureus*
3. The Effects of Acne Products on Staphylococcus Aureus

4. The Influence of Time on Microbial Growth
5. How Clean is Clean?
6. The Effectiveness of Antiseptics and Disinfectants in Elimination of Microorganisms on Door Handles
7. What Kind of Microorganisms Are Found on the Staircase Railings at UNG?
8. The Effectiveness of Disinfecting Wipes in the Elimination of Surface Bacteria
9. Standard Water Analysis on Creek Water, Well Water, and Fountain Water
10. The Effectiveness of Disinfecting Wipes in the Elimination of Surface Bacteria
11. Microbial Growth Analysis of Lake Lanier Water
12. The Effectiveness of Eliminating Bacteria on Smartphones using Disinfectant Wipes
Year 2020 – Spring
1. The Effectiveness of Antibacterial soap VS "normal" soap and hand sanitizer.
2. Effect of "Green" Cleaners vs. Disinfectants on the growth of Escherichia coli, *Staphylococcus aureus*, and *Bacillus cereus*
3. Microbial Contamination of Surfaces via Human Contact
4. The Effectiveness of disinfectants Marketed to "Kill 99.9% of Germs" against, Escherichia coli, Bacillus cereus, and Staphylococcus aureus
5. Effectiveness of different disinfectant cloths on the removal of *E. coli* and *S. aureus*
Year 2021 – Fall
1. Determining The Geographical Distribution of Microbes in the Air at Given Locations in a Room
2. Microbial Growth in Air Samples from a Building Interior
3. Microbial Growth in Occupied Classroom: Is Air Ventilation the Problem?
4. Microbial Growth Patterns at Different Height Levels
5. Bacterial Growth in Unventilated Conditions & Human Health
Year 2022 – Spring
The Distribution of Bioaerosols Near Exterior Door
Year 2022 – Summer
1. Aerosol-Transmitted Bacteria Across UNG Campus
2. Does high-volume traffic system promote the growth of microorganisms?
3. The Geographical Distribution of Microbes at the University of North Georgia
Year 2022 – Fall
1. Microbial Contamination from Bathroom Hand Dryers
2. Microbes in the Air (Multiple Environments Including Home vs. Outside vs. Work Area)
3. An In-Depth Analysis of UNG Gainesville's Water Fountains and Ponds
4. The Analysis of Well Water Locations at Dahlonega, Georgia and Gainesville, Georgia
Year 2023 – Spring
1. Microbes in the Air Versus on Surfaces
2. Drinking Safety of Natural Spring "Spicket" Water when Compared to Tap Water and U.S. Drinking Water Regulations
3. Microbial Analysis of Stagnant and Running Water
4. Bacterial contamination on Door Handles in The Science Building
5. Comparison of Recreational Lakes in Lake Lanier and Their Effects on Microbial Growth
Year 2023 – Summer
1. Analysis of the Effects of Various Levels of Stagnant Water on Microbial Growth
2. Microbial Growth in Outdoor Environments
Year 2024 – Spring
1. Microbial Growth in Indoor Environments Around the Science Building
2. Handwashing and Bathroom Cleanliness
3. What Microbes are in Our Air?
4. Effect of Commercial Probiotics
5. Testing Microbial Air and Surface Colony Growth of Highly Populated or Frequently Trafficked Areas at the University of North Georgia
6. Assessment of Airborne Microbial Growth Throughout Common Indoor Campus Locations
7. Microbial Geography: Bacterial Colonies on Common Surfaces

Table 3: Microbiology lab projects archive table of contents.

Archive of Student Projects

Although collecting course-based undergraduate research results into an online platform has been done previously [22], our online archive is in a password protected platform accessible only by University of North Georgia faculty, staff and students. Student project papers have been compiled since 2017. The Table of Contents (Table 3) lists only the project titles (student author names have not been included for this article), but it shows the depth and breadth of the research projects that students have been conducting in the course.

Conclusion

Allied health and nursing students acquire real original research opportunities in the course that might otherwise be unavailable to them. Having an archive of past research projects provides students not only with examples to follow but also a foundation upon which to either repeat or confirm earlier results or to branch out into entirely new directions but still stay within the confines of the research themes and catalog.

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