

OPEN PEDAGOGICAL PRACTICES TO TRAIN UNDERGRADUATE STUDENTS IN THE RESEARCH PROCESS

*A CASE STUDY IN COURSE DESIGN AND
CO-TEACHING STRATEGIES*



UNIVERSITY LIBRARIES
VIRGINIA TECH.



Photo credit: Michelle Fleury, Honors College, VT



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INSTITUTIONAL BACKGROUND

VIRGINIA TECH - GO HOKIES!

- Research intensive (R1) institution
- Emphasis on undergraduate research
- Current QEP focuses on experiential learning
- **Question to consider:**
 - How can an institution be deliberate in how it trains and engages students in the research process?



COMMON THEMES FOR PERCEPTION OF LEARNING GAINS

- Higher-level research training is needed early in careers
- First year students can engage in this material
- Builds solid foundation and scaffolds the process of entering and performing research
- Iterate best practices early and often
- **Need to address:**
 - **How can we structure an entry-level course for all majors to each applied research literacy ?**

WHY AN OPEN COURSE?

OPENNESS FOSTERS GROWTH IN EVERYTHING

- Open pedagogy
 - Open learning outcomes
 - Open-ended problem exploration
 - Increased openness in higher education
- Open to enrollment of students of all majors
- Open resources
 - University Libraries' digital repositories, VTechWorks and Odyssey
 - Openly accessible digital learning objects
 - Openly accessible final projects

THEORETICAL FRAMEWORK

PEDAGOGICAL UNDERPINNINGS

Course:

- [Entering Research Curriculum](#)
 - Elements from this for training students in research were included
- Updated Bloom's Taxonomy
 - Students walk progressively through independent stages of the learning process
- Inquiry-based Learning (IBL)
 - Students exploring their own questions
- Problem-based Learning (PBL)
 - Open-ended problem exploration

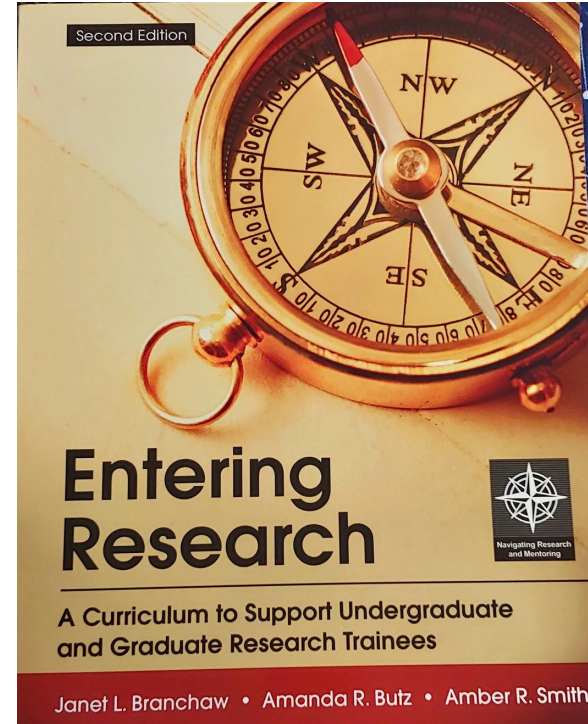




Photo by [Robin Schreiner](#) on [Unsplash](#)

PEDAGOGICAL UNDERPINNINGS

Digital Learning Objects:

- Kolb's Cycle of Experiential Learning (1984)
 - From "concrete experience" through "active experimentation"
- Programmatic and workshop alignment
 - Enables smooth integration in parts or as a whole

Kolb, D.A. 1984. Experiential learning: Experience as the source of learning and development. Prentice-Hall.

OVERVIEW OF COURSE

OVERVIEW OF COURSE STRUCTURE

- 3 credit-hour, 1 semester course
- Open to undergraduate students of all majors and levels
 - Designed for first- and second-year students
 - Assumed equal knowledge base upon entry
- Offered in Honors and non-Honors sections
 - 98 students have taken the course; 35 completed the survey



Course Goals:

- Create a community of practice where students learn the process of executing a research project.
- Understand best practices for engaging in undergraduate research.

Why should I enroll in this course?

As innovation continues to thrive in the space between disciplines, there is an increasing need to pursue interdisciplinary research and collaborative work. This is an opportunity to apply problem solving skills in a diverse group setting. In addition to the regular meeting of the course, we will use a workshop model once a week to engage students in understanding and discussion of concepts of literature review, presentation and writing skills, and best practices to becoming a collaborative interdisciplinary researcher.

What will I gain from this course?

- Present research to faculty and peers in a formal setting (resume building)
- Competitive edge for undergraduate research opportunities



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UNIVERSITY LIBRARIES
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COURSE LEARNING OBJECTIVES

By the end of this course, students will be able to:

1. Pose questions in relevant field of study and explore routes for novel inquiry
2. Identify common approaches for solving questions using scholarly resources
3. Consider all phases of the research lifecycle for a research project
4. Conduct a literature review regarding a current research topic
5. Describe small, medium, and large implications related to a research topic
6. Explore ethical concerns regarding a research topic
7. Explore grant funding opportunities and data management practices regarding a current research topic
8. Explain limitations regarding a current research project
9. Produce a research proposal and poster based on a topic or question of group interest

COURSE SCHEDULE

Agenda:

Week	Date	Agenda	Task Assigned	Assignment Due
1	19-Jan	Introduction to Course, Becoming a Researcher, thinking about research topics of interest	Literature review proposal, poster presentation (final semester deliverables)	Questionnaire (individual – in-class assignment)
	21-Jan	Developing a Topic IS Research		
2	26-Jan	Working on interdisciplinary teams & Defining areas of research interest		
	28-Jan	Finding Scholarly Literature	Citation list (group)	

CONNECTION TO RESEARCH DEVELOPMENT THROUGH ASSIGNMENTS

- Role of ethics in research and in general data utilization
- Introduction to human/animal subjects research
- Remote work skills
- Predicting and troubleshooting problems
 - Thinking about data management and storage
 - Techniques, limitations and data output
 - How much things cost!

OVERVIEW OF ASSIGNMENTS

- Order of instructional content and assignments is based on the research lifecycle and flowing for idea to dissemination
- Types of assignments:
 - Research topic and question
 - Citation list
 - Annotated bibliography
 - Abstract
 - Ethical issues to consider prompt
 - Proposal
 - Poster

PROGRESSION OF CONCEPTS THROUGHOUT THE COURSE

- Culminating assignments were group research proposals and posters, individual reflections
- Research and Data literacy key foundational skills:
 - Developing authentic topics
 - Conducting literature reviews
 - Using citation managers
 - Managing and organizing data
 - Joining the scholarly conversation

EXAMPLES OF STUDENT WORKS



The Impact of Microplastic Ingestion on the Bivalve Filtration Efficiency of the Hooked Mussel (*Ischadium recurvum*) from the Chesapeake Bay



Matthew Betsill (CS), Juan Gonzalez (HORT), Allison Woods (CMDA)

Introduction

- Global plastic production has increased to ~250 million tons/year
- Mass production of plastic led to plastic pollution infiltrating marine environments
- Microplastic pollution can block intestinal function and cause physical damage
- I. recurvum* (Hooked Mussel) Has a key role in purifying the water of the Chesapeake Bay
- Microplastics are plastic particles ranging in size from 5 nm to 10 nm
- Hooked Mussel utilizes a bivalve system allowing it to filter toxins out of the water by intaking seawater through an inhalant siphon
- Water is then filtered through the gills to separate water, toxins such as bacterias, and food items
- It is possible that microplastic ingestion could cause negative implications on the filtration capabilities of *I. recurvum*

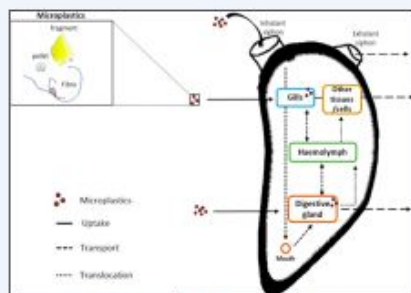


Figure 1: Routes of Microplastic in Bivalves

Research Question

Does an accumulation of microplastics affect the filter efficiency in mussels?

- It is hypothesized that micro-plastics will reduce the efficiency of the Hooked mussel and affect its ability to filter toxins that are deteriorating water quality

Methods

Collection

- Dozen mussels will be collected for each trial
- Mussels will be transported to a refrigerated container at 4°C



Mussel Examination

- Before the acclimatization period, all mussels will be scrubbed to remove epiphytes from the valves
- Externalities will contaminate the water source for experimentation and alter the results of algae filtration

Control and Test Scenario

- Mussels placed in the 10-gallon water sample with a set amount of algae concentration
- One hour to filter the water
- Water quality test before and after the filtration period for comparative results
- Same mussels will be placed into the same conditions with 10-micrometer diameter tan spherical microplastics for easy ingestion

Water Filtration

Mussels No Mussels

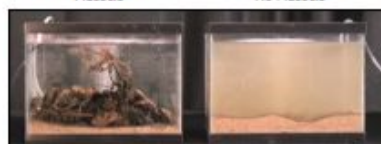


Figure 2: Filtration Comparison

Four Contributions to Results



Expected Outcomes

Microplastics No Microplastics



Figure 3: Microplastic vs. Control Filtration Visualization

- Rate of control versus the filtration rate of the test group will likely diverge after a certain amount of time due to the buildup of microplastic in digestive tract
- Blockage will lessen cellular respiration capabilities, which disrupts ability to filter water
- Mussels are expected to filter the water at rate of about 75% of the mussels without microplastic, with the rate decreasing near the end due to microplastic accumulation

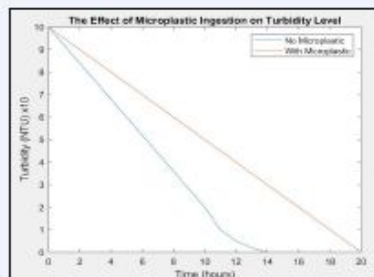


Figure 4: Expected Filtration Rate Change from Microplastic to No Microplastic Ingestion

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Mental Health Treatment in United States Prison Systems: The Influence of Varying Treatment Methods on Inmates with Schizophrenia

Corinne Marr (PR), Jill Morris (MMU), Kathryn Francis (HD), & Mattie Schmidt (PSCI)

Abstract

Schizophrenia is a psychological disorder that produces symptoms commonly of hallucinations, delusions, movement disorders, and confused thought or speech. Americans diagnosed with schizophrenia are three times more likely to be imprisoned than hospitalized for their symptom expression, thus necessitating prison reform to treat individuals and reduce repeat offenses.

In order to conduct the research, surveys will be distributed to IWS in 100 prisons across the United State. Changes in symptoms will be analyzed over the six-month period to observe how medications and other forms of treatment affect symptoms of IWS.

Federal prisons fail to classify serious mental illnesses in prisoners and only require treatment in 3% of inmates. In comparison, California prisons classified over 30% of inmates in need of regular treatment for serious mental illness.

Lack of treatment causes many IWS to experience heightened negative symptoms which, without treatment, drove some inmates to attempt suicide. Administering antipsychotic drugs to people with schizophrenia reduces their negative symptoms, which would help current inmates, and keep non-incarcerated people with schizophrenia out of prison.

The United States, compared to other countries, lacks in treating IWS, thus reform is needed to fix this problem.

Background Information

2.8 million Americans have Schizophrenia and 383,000 inmates in the US have been diagnosed with it.

Federal prisons only found to require serious mental illness treatment for 3% of inmates whereas CA prisons classified of 30% of inmates in need of treatment.

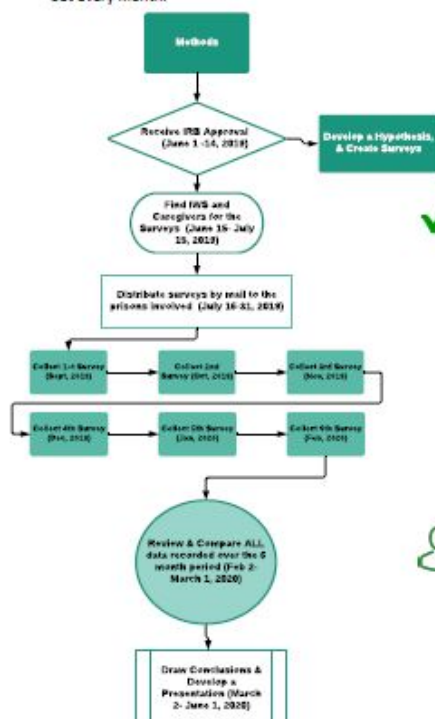


This map shows the global effect of anxiety disorders; schizophrenia is a type of anxiety disorder. We chose this map to show focus on the intensity of disorders in the United States vs. around the world. We chose to focus on the United States and compare it to other countries to show that prison treatments in the United States need reform.

Americans diagnosed with schizophrenia are three times more likely to be imprisoned than hospitalized.

Methods

The symptoms we analyze will be hallucinations, delusions, movement disorders, suicidal thoughts, and confused thought or speech. Out of all IWS in a given prison, a random sample of 45 IWS and five caregivers will be provided with six self-reporting written surveys on expressed negative schizophrenic symptoms over a six-month period, filling one out every month.



Anticipated Outcomes

1. Prisoners experiencing an increase in their symptoms with schizophrenia due to long term exposure to a prison environment. This includes looking into the treatments performed globally and comparing it to the United States.
2. We are looking into Violent vs. Nonviolent crimes and the anticipated outcome is schizophrenic rates in a prison are much higher within prisoners convicted of violent crimes.

Treatment Variable	% of state prison inmates with a mental illness	% of federal inmates with a mental illness
Lifetime use of medication for a mental condition	12%	24%
Received medication while incarcerated	52%	42%
Ever seen a counselor during lifetime	87%	78%
Ever a counselor in prison	46%	67%
Used self-help group or peer group in prison	21%	19%

A table of prison statistics taken from a group of 10,000 inmates regarding the best of mental health services state and federal prisons provide in the United States (Bergin, Gendler, and Carroll n.p.)

Conclusion

The economic values associated with different therapeutic methods and treatment reforms for inmates with schizophrenia are important to note. The goal of implementing these programs are to reduce recidivism rates and violent outbursts of inmates with schizophrenia, and there are many cost benefits to this.

Inmate with mental illness → \$130
Inmate without mental illness → \$80

Therefore, the implementation of these solutions could lead to reduced recidivism rates. Ultimately, reduced recidivism rates will keep more people with schizophrenia out of prison and reduce the total costs of housing mentally ill inmates.

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Minick, Hannah, and Max Rosen. "Mental Health." Our World in Data, Jan. 2018. <https://ourworldindata.org/mental-health>.

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ABSTRACT

Pseudoscience, or scientific research presented with manipulated data or conducted with flawed methods, has measurable and potentially dangerous impacts on society. With increasing media focus on pseudoscientific data, learning how to identify pseudoscience is vital to the modern public. As such, this research project seeks to assess if the average person can distinguish pseudoscience from peer-reviewed science based on context cues within the writings, such as experimental methods, tone, and organization of the paper. A critical reading workshop will be implemented to train individuals to recognize pseudoscience so that they may base important, life-altering decisions on reliable sources.

Individuals in six different age groups will be presented with two medical research articles, one peer-reviewed and one pseudoscientific, and will be asked to label which is which and explain their answers. Afterwards, we will lead a short language workshop designed to develop critical reading skills. Next, we will survey the age groups again. We expect to find those to half of each age group in the sample will be unable to determine the pseudoscientific article from the initial survey. Our estimates may increase for specific age groups based on prior research. After completing our workshop, we expect meaningfully larger portions of individuals will be able to recognize falsified work. In summary, the workshop strategy suggests that workshops should be implemented into educational systems so that the public is better prepared to analyze scientific research when making important decisions for themselves and their children.



QUESTION AND BACKGROUND

Can the average person from a given age range be trained to distinguish pseudoscientific research from peer-reviewed research using a workshop?

METHODS (6 age groups, 100 individuals each)

- Individuals will be given two articles (1 pseudoscientific & 1 peer-reviewed)
- They will be asked to distinguish the pseudoscientific article from the peer-reviewed article
- We will then hold 15 min critical thinking workshop to train our sample in recognizing pseudoscience
- We will then readminister the same survey without having revealed the answers
- Our data will be sorted by various age ranges

Small sample size and no controls

Real: lymphoid nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children
Wassilak et al.

"12 children, consecutively referred to the pediatric gastroenterology with a history of a pervasive developmental disorder (diarrhea, abdominal pain, bloating and food intolerance), were investigated...

...he received a dose of measles, mumps, and rubella vaccine at age 4.5 years, the day after which his mother described a striking deterioration in his behavior that she did link with the immunization...

...We took histories, including details of immunizations and exposure to infectious disease, and assessed the children. In 11 cases the history was obtained by the senior clinician (19-6). Neurological and psychiatric assessments were done by consultant staff (19), with DSM-IV criteria. Developmental histories included a review of prospective developmental records from parents, health visitors, and general practitioners. Four children did not undergo psychiatric assessment in hospital; all had been assessed professionally elsewhere, so these assessments were used as the basis for their behavioral diagnosis...

...In eight children, the onset of behavioral problems had been linked either by the parents or by the child's physician, with measles, mumps, and rubella vaccination..."

Other scientists unable to replicate experimental results

Parental bias

Data was not collected blindly

Correlation, not causation

Insufficient explanation for conclusions

EXPECTED OUTCOMES

We speculate that the results from the survey will emulate the data displayed below.

- Individuals in the 21 to 30 age range will achieve the highest initial and final average of correct responses because they have the highest level of education and are most socially active.
- Individuals in the 10 to 15 age range will show the lowest initial and final average of correct responses because they are still too young to understand the context within the articles.
- After 45 yrs, as age increases, the average decreases as individuals are less often exposed to social interactions and are gradually distanced from critical thinking skills.

Our expected rates of improvement are visualized in Figure 1.

Predicted Correct Responses Before and After Workshop

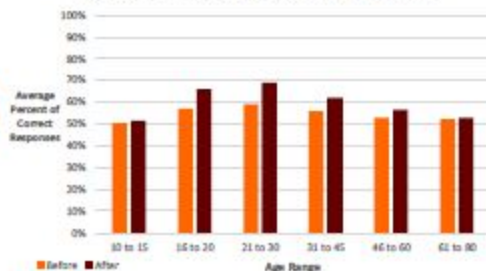


Figure 1. The predicted response differences before and after the workshop by age group.

CONCLUSION

We found critical reading workshops have the potential to meaningfully increase public awareness of pseudoscience. Therefore, more workshops and classes should be implemented into educational systems to better prepare citizens to analyze public information. Given the expected success of our strategy, further research into the ability of the general public to distinguish pseudoscience is clearly supported.

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Comparison of Energy Efficiency, Eco-Friendliness, Cost, and Convenience of Phase-Change and Biosolar Materials in Solar Panels

Clint Vaughan, Kelly Richardson, Jiongzhi Yang

Purpose

The purpose of this study is to conclude whether bio-solar materials or phase change materials are better in terms of energy efficiency, eco-friendliness, and cost and convenience in solar panels. We will explore these factors in a variety of different conditions and designs, for each type of material. To come to the most accurate conclusion, we created a rating system, based on government regulations, industry standards, and common scientific values.

Background Info

Two materials currently being researched for solar panels are phase change materials (PCM) and biosolar materials. PCMs are useful in solar panels since they can hold their shape, are thermally conductive, and are corrosion-resistant (Dwivedi et al., 2016). However, their efficiency can be affected by temperature, they are very expensive, and they need a secondary panel since they cannot generate power directly. Biosolar materials do not need to be used in conjunction with different materials for generating electricity and can form the whole solar cell, but it requires specific species of bacteria and must be cleaned regularly (Reshma et al., 2017).

Experimental Methods

Figure 1. Biosolar Solar Panel Layout.

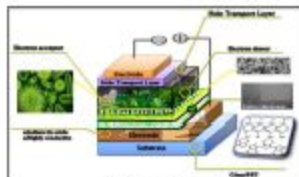
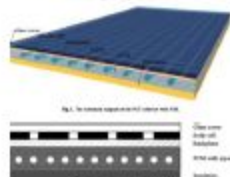


Figure 2. PCM Solar Panel Layout.



Efficiency

- Voltmeters and ammeters will measure voltage and current.
- Measurements in the morning, afternoon, and evening.
- Different test variables, including amount of sunlight exposure, cleanliness, temperature, weather, and more.

Eco-friendliness

- Measure the effects created by each material on natural water and air.
- Comparison of data to current environmental regulations and industry standards.

Cost and Convenience

- Keep track of the materials that we use, how much we use of each material, and how much each material costs.
- Potentially test alternative materials to see if there is a benefit to using more or less expensive materials.
- Look at ease of installation, maintenance, and versatility.

Expected Outcomes

Table 1. Decision Matrix in Comparing Aspects of PCMs and Biosolar Materials.

* Poor +, Average ++, Good +++, Excellent ++++

Category	Phase Change Materials (PCM)	Biosolar Materials
Efficiency	++++	+++
Eco-Friendliness	++	++++
Cost	++	+++
Convenience	+++	++

Future Implications

- We believe that biosolar materials will be the best choice of material, because it will be efficient, eco-friendly, and low cost.
- Future work should focus on the development of biosolar material solar panels.

References

- Dwivedi, V. K., Tiwari, P., & Tiwari, S. (2016). Importance of phase change material (PCM) in solar thermal applications: A review. In 2016 International Conference on Emerging Trends in Electrical Electronics Sustainable Energy Systems (ICEESES2016) (pp. 42-46). <https://doi.org/10.1109/ICEESES2016.7981766>
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COLLABORATION



LIBRARY PARTNERSHIP

- Advanced Research Skills Program (ARS)
 - Workshop series
- Information, data, research, and digital literacy
 - Instruction
 - Consultations
 - Embedded librarianship

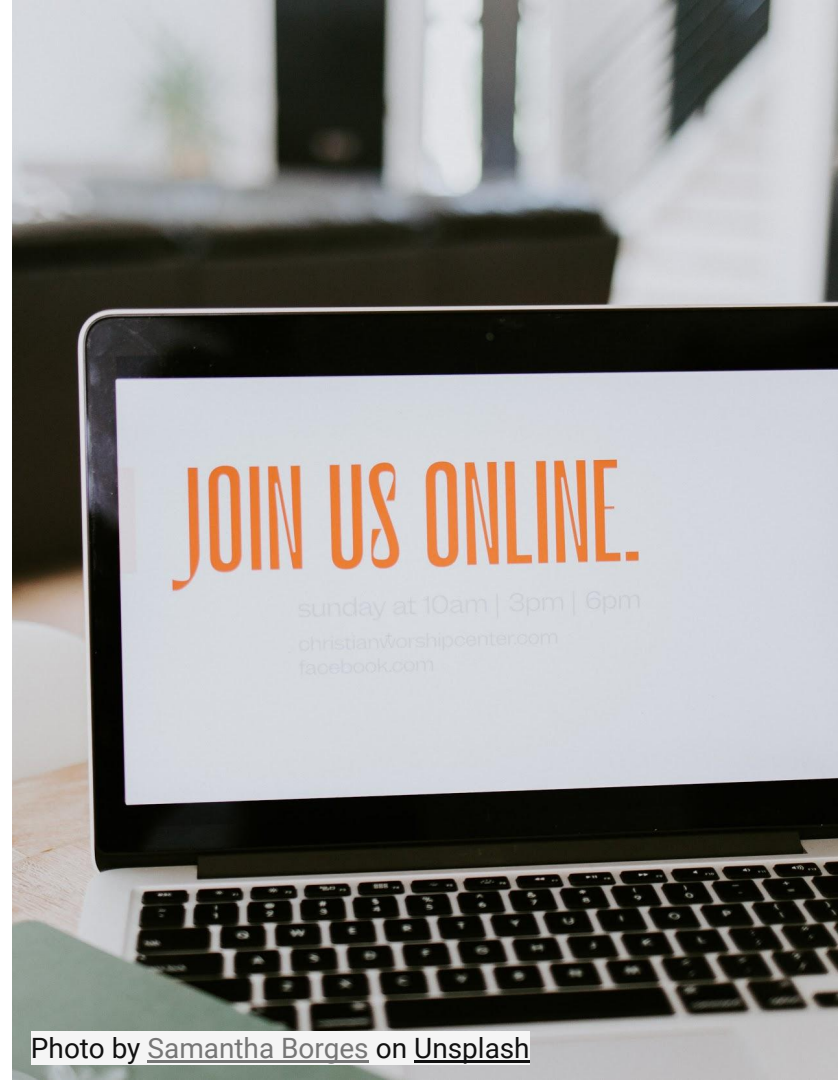
COLLABORATOR ROLES & CONTRIBUTIONS

The instructors possessed distinct educational backgrounds and experiences:

- A faculty member from University Libraries holding a doctoral degree in biochemistry, who manages a large undergraduate research lab.
- A teaching faculty member for the Honors College holding a doctoral degree in genetics, bioinformatics, and computational biology with pedagogical theory and curriculum development training.
- A librarian from University Libraries holding two master's degrees in English Studies and Library Science.

RESOURCE INTEGRATION

- Advanced Research Skills program -- high student engagement
- ARS transition from in-person to online enabled easy integration into the course
 - Implemented digital credentialing
 - Created online modules
 - Developed openly accessible resources



ADVANCED RESEARCH SKILLS (ARS)

- A 7-week, 6 workshop, comprehensive online undergraduate research series
- Students practice high-level research skills
- Program was designed with the research lifecycle in mind



ARS WORKSHOPS



Advanced Research Skills Program
Every Undergraduate Student Can Find Success in their Research Journey

> What is the program?
A 7-week, 8-workshop, comprehensive online undergraduate research series where students will practice high-level research skills, such as applying for grants and designing effective research posters, and build confidence as they approach or conduct research.

How will it benefit the student?

- Increase awareness of undergraduate research and opportunities on campus
- Build a network of like-minded peers and faculty/staff from the University Libraries and the Office of Undergraduate Research
- Develop transferable skills that transcend disciplines and appeal to research mentors and employers

What will the program include?

- Multimedia content and online modules on undergraduate research and the research lifecycle, which cover topics such as Using Data & Information Ethically and Writing Successful Proposals
- Interactive activities and relevant assignments that can be used beyond the program (we how to write a letter to a faculty member can be used right away to reach out to find your first research position)
- Direct access to the Coordinators of the Office of Undergraduate Research and the Advanced Research Skills series

What are the takeaways that lead to success?

At the end of the series, students will:

- Identify potential faculty mentors and practice drafting emails to find a research position
- Design an effective poster highlighting newly developed skills from the series
- Build an ePortfolio to showcase their poster, reflect on the series, and share with potential research mentors or employers

Sign-up at libguides.library.vt.edu/ars
Begin January 14, 2025
All program materials at <https://guides.library.vt.edu/ars>
For questions contact Ann Davis, Head of ann.davis@lib.vt.edu

These University Libraries and order led by the Office of Undergraduate Research

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PROGRAM 2025

Workshops included:

- Using Data Ethically
- Managing & Organizing Data
- Managing & Organizing Information
- Writing Successful Proposals
- Sharing Your Research
- Becoming A Researcher

ARS DIGITAL CREDENTIALS



LEARNING OBJECT REPOSITORY: odyssey.vt.edu



Designing Your Poster

This video covers Williams' Design Principles, which include proximity, alignment, repetition, contrast, and balance (1994). It was created for the Advanced Research Skills Program and included in the module

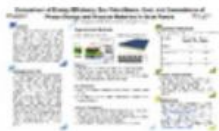


Writing More Effective Abstracts

This video defines abstracts, discusses their purpose, and identifies strategies for writing effective abstracts. This video was created for the Advanced Research Skills Program and included in the module

SCHOLARLY REPOSITORY: vtechworks.lib.vt.edu

Recent Submissions



Comparison of Energy Efficiency, Eco-Friendliness, Cost, and Convenience of Phase-Change and Biosolar Materials in Solar Panels

Vaughan, Clint; Richardson, Kelly; Yang, Jiongzhi (2019-05-08)

Solar energy is a clean, renewable energy source that is a good alternative to nonrenewable energy sources. Currently, the two major materials utilized in solar panels are phase change materials (PCMs) and biosolar materials. ...



The Effect of Reading Workshops on Ability to Identify Pseudoscience

Lou, Lan; McCartney, Abby; Makwana, Sunny (2019-05-08)

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