Fostering Career Development through Research Learning Experiences

Organizers:
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Presenters:
• Mauricio Pereira Da Cunha, Professor, Director of the Microwave Acoustic Lab
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• Melissa Maginnis, PhD, Associate Professor, Associate Director of CUGR
OUTLINE

I. Current Techniques used to create Undergraduate Awareness and Engagement in Research & Scholarship (R&S)

II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Examples:
- Fields and Waves (required)
- Microwave Engineering (elective)
- Sensor Technology and Instrumentation (elective)

III. New Initiatives under Discussion & Implementation @ UMaine
- Research & Scholarship exposure at 100 level course campus wide
- Single area / Multidisciplinary Undergraduate R&S
- Acknowledgement of student’s activities: mention in end of course graduation
I. Techniques used to create Undergraduate Awareness and Engagement in Research & Scholarship (R&S)

I. Basic courses → Initial exposure to R&S
- 101 courses: Motivational R&S talks & activities
  - Hands on circuits, robotics, Legos, challenges
- Support: Profs. & Lectures → fostering interest & interactions to discovery

II. Undergraduate R&S Engagement
- NSF/REU: Summer program on Sensors (others on campus)
- R&S continuation after summer → During academic year
  - Work close with Grad. Students & Research Associates
- Presentations in
  - Project Group Meetings
  - UMaine Student Symp. & Professional conferences
- Path for Critical thinking & Graduate Studies
II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Basic course → Example: 351 Fields & Waves (2nd Year EE / required)

- Course traditional format → Lecture → Hybrid alternatives sought
- Interactive software → student engage in creative & exploratory activities
- Prep: myself / colleagues / www / textbook

- Hands on Demo. (8 / prep. By UG R students)
- Prof. & my grad. & undergrad. Research students → TAs → 3h office h advising
II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Elective Course → Example: 453 Microwave Engineering (Junior / Senior / Grad)

- Lecture / Lab / Project → Entire spectrum from orienting to engaging
- Project Course Activity ➔ START: 1st Month → FINISH: end of period
  1. Research Topic → Group activity (Guided)
  2. Select Topic (Guided)
  3. Defend topic to class → Technical and feasibility
  4. Industry Grade Radio Frequency Software Simulations
  5. Design & fab. at UMaine / Research grade & equip. facilities
  6. Testing & comparison with previously simulated results
  7. Final presentation to class & professional level report
- Research oriented activities:
  - Literature search & awareness / critical thinking / Individual & group initiative & work
  - Technical & professional writing
II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Elective Course ➔ Ex.: 466 Sensor Tech. and Instrumentation (Jr. / Senior / Grad)

- Lab / Lec. / Project → Hands on multiple (eight) sensor topics
- Project Course Activity ➔ Distributed along the semester
  i. Topic search → Individual activity (Guided)
  ii. Proposal prep. → basics / soundness / materials / BUDGET
  iii. Defense to peers (class)
  iv. Discussion / Vote / Selection of best proposals
  v. Implementation of the best proposals by the groups
  vi. Final presentation to class & professional level report

- Research oriented activities:
  - Literature search & awareness / critical thinking / Individual & group initiative & work
  - Technical & professional writing
II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

IMPACT FOR UNDERGRADUATE STUDENTS

✓ “This course helped me land my job in RF: project design, fabrication, testing provided hands on experience that impressed (hiring) engineers.”
✓ “453 was most impactful and I enjoyed the most … made me decide that I wanted to apply to the PhD program here at UMaine.”
✓ “It was very interesting to go through the entire creation, design & fabrication process of a microstrip circuit.”
✓ “We actually did real “industry” work in 453.”
✓ “Latest real-life sensor in lab & understanding sensor concepts. Huge impact in my interest in this area.”
✓ “I use sensors in my work, and this lab helped me understand them.”
✓ “Perfect balance of getting you to figure stuff out vs. telling you how to solve a problem.”
III. New Initiatives under Discussion & Implementation @ UMaine

U. of Maine → Wider Student Population Targeted Initiative

- Visits & presentation to high school students
- Incentive from President Joan Ferrini-Mundy
- Univ. of Maine Senate Committees currently involved:
  - Academic Affairs / Research & Scholarship / Finance and Institutional Planning

University wide UNDERGRADUATE exposure to Research & Scholarship

1. All departments / academic units expected to engage
2. Intro to Research & Scholarship → One or two classes
   - Embedded in 100 level courses
   - Unit major related research OR Multidisciplinary
III. New Initiatives under Discussion & Implementation @ UMaine

Univ. of Maine → Wider Student Population Targeted Initiative

Ø (cont.) University wide UNDERGRADUATE exposure to Research & Scholarship

1. All departments / academic units expected to engage
2. Intro to Research & Scholarship → One or two classes
   ✓ Embedded in 100 level courses
   ✓ Unit major related research OR Multidisciplinary research
3. Invitation for paper / proposal from 1st Year students for UG research
   ✓ Competition → best 100-level course proposals voted / selected by the students
   ✓ If acad. unit related → Course instructor direct to Dept. funded Research projects
   ✓ If multidisciplinary → Course instructor direct to respective Deans / researchers
   ✓ If UG best voted proposal does not find home in Units → consideration for
     Presidential seed support
     • Advised by faculty related to the area or
     • Research independently run by the students
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Univ. of Maine → Wider Student Population Targeted Initiative

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3. Invitation for paper / proposal from 1st Year students for UG research
   ✓ Competition → best 100-level course proposals voted / selected by the students
4. Students who engage in UG research during their time @ UMaine:
   ✓ Should have that activity acknowledge in their end-of-course graduation
Pre-College Programs

- Student Fellowships
- Student Symposium
- Student Travel
- Faculty Support

Research Learning

- Structured Course/Capstone/Honors
- Independent Lab/Studio/Library

Experiential Programs

- Summer Internships NSF, NASA, EPSCoR
- STEM Academy All Year Long
- Tours / Open houses
- Expo / Family nights
- 4H / Coop Ext.
- Expanding Your Horizons
Cultivating Effective Scientific Thinkers

- Knowledge
- Hypothesis
- Experiment
- Analysis
- Reasonable Solution
- Question
- Hypothesis
- Courage
First-year Undergrad

Effective Scientific Thinkers

Knowledge → Reasonable Solution
Analysis
Experiment
Hypothesis
Question
Courage
the capacity for interdependent thinking
the ability to recognize past knowledge and new evidence that becomes relevant in a new scientific problem

doing this will require the ability to persist in the face of challenges, knowing that this kind of courage pays off
Collectively develop a strategy for the challenging learning situation based on students’ own experiences using that skill.

Model it!

Reflect: Students reflect on their understanding of new concept and their experience with learning habit/skill (e.g. solving impossible problems or effective collaboration).

Strategize: Research Problem

Weekly Written Reflections: heightened awareness of conceptual understanding, gaps in knowledge, and the value of specific learning approaches and mindsets.

Da Vinci, L., The notebooks of Leonardo da Vinci

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Let's get warmed up

1. What strategy do you use when faced with a really difficult task or a question to which you do not immediately know the answer?

   The best thing to do is break it down into pieces you know. Circle or highlight words that dictate what the question is looking for specifically. Also, you can look at the basic concepts behind the question to help you understand the bigger, more difficult question.

2. Using an illustration with text labels, describe your understanding of a bacterial promoter.

   A bacterial promoter is a region on bacterial DNA that allows for RNA polymerase to attach, leading to transcription. Promoters are important since they allow transcription to proceed.

   ![Diagram of bacterial promoter and RNA polymerase]
Strategize: Students collectively develop a strategy for the challenging learning situation based on students’ own experiences using that skill.
Experience: Students construct knowledge and apply to research problems.
Reflect: students develop heightened awareness of conceptual understanding, gaps in knowledge, and the value of specific learning approaches and mindsets.
At first glance of assignment 2, question 6 had me all sorts of confused. It was a lot to look at, lots of letters (nucleotide bases). After breaking the question down, I knew that the question was asking me to identify promoter sequences. I then drew back on the information of what a promoter sequence was, and how to identify them in a sequence. When I came across questions that I was unsure of, we all discussed them in our small group, and came up with a collaborative answer that made sense. **At the end of the question, I was surprised that it actually didn’t take me that long to complete, and that I did it with ease.** After I got past the initial shock of a ‘scary and difficult really long question and was able to break it into manageable pieces to tie back to information that I had studied, the problem could be answered in just a couple of steps. I really liked having my group mates to compare answers with, have discussions, and further my understanding on subjects I may had been a little unsure of.
Completing research and solving difficult problems felt really good. I was always so nervous to jump in, but as soon as my toes were wet, I just wanted to swim! The more research we did, and the more I learned about confusing concepts, the more I wanted to tackle difficult questions! There definitely were times that I still was apprehensive about the work I was supposed to complete, but I felt like every time I didn’t think I was capable of completing something, I always came out stronger in the end. The more I finished these “impossible” tasks, the less scared I was for the next one.
Abstract

Gordonia phage are incredibly diverse

SallySpecial forms a new cluster, DM, with phage Emperor

SallySpecial's genome represents the minimal genes necessary for lytic and lysogenic infection

Gene product 20 is a CCA-dependent RNA helicase

The AtpP integration site of the repressor protein is located in the repressor protein

References

Acknowledgments

Reaching for more challenge

Fellowships
Internships
Lab positions
Mission: increase, improve, and enhance undergraduate students’ participation and experiences in research, scholarship, and creative activity

Center for Undergraduate Research (CUGR)
Building Capacity for Undergraduate Research Experiences

Faculty-mentored independent research project → Develop a research proposal → Authentic RLEs → Showcase Accomplishments

Reflect
Celebrate

Specific aims
1. Establish whether activation of the ERK signaling pathway is required for JCPyV infection in primary astrocytes.
2. Determine whether DUSP6, a negative regulator of the ERK signaling pathway, influences JCPyV infection in primary astrocytes.

Experimental Plan
Aim 1: Establish whether activation of the ERK signaling pathway is required for JCPyV infection in primary astrocytes. JCPyV infection of SVG-A cells activates the MAPK/ERK pathway and requires ERK activation for infection (REF – DuShane 2018, 2019). However, preliminary studies to determine whether ERK is required for infection of primary astrocytes, suggest that utilization of ERK may not be required for JCPyV infection of primary astrocytes (NHAs) data. Treatment of, has suggested that NHAs with the chemical inhibitor of the ERK pathway, U0126, does not reduce JCPyV infectivity in primary astrocytes like it does in SVG-A cells, suggesting that ERK activation may not be required for JCPyV infection in primary cells. However, chemical inhibitors like U0126 have potential off-target effects on cells, and thus it is necessary to use more specific methods to test the role of ERK in JCPyV infection in NHAs.

Therefore, employment of aRNA targeted towards knockdown expression of ERK, will be used to determine whether ERK expression is reduced in NHAs, and with SVG-A cells will be.
Generating a Culture that Supports Undergraduate Research Experiences

1st Year Phage Genome Discovery Student

Student Presentation Award Winner
Generating a Culture that Supports Undergraduate Research Experiences

- Started in 2010 as UG Showcase
- Merged with Grad Expo in 2016

Student Symposium Participants

- Symposium UG Students
- Symposium Total Participants

Number of participants vs. Year 20xx
CUGR Impacts on Career Development

Ashley Soucy, **CUGR Fellowship Recipient**
- B.S. Biochemistry ‘18
- 6 fellowships, $15,000 in funding
- Best Undergraduate Presentation in Biomedical Sciences (UMSS18)
- Presented at regional and national conferences
- Co-authored publication
- Currently a PhD student in GSBSE Program

Casey Clark, **CUGR Fellowship Recipient**
- Summer internship as HS student
- B.S. ‘14 and M.S. ‘16 in Electrical Engineering
- Presented at national conferences
- Co-authored publications
  - Launched product to international space station
- Currently employed at SpaceX in CA
Recap and Inspire Action

• Pre-college level:
  - Engage with K-12 students
  - Tours, programs, and community engagement
  - Programs to support K-12 educators

• In the classroom:
  - Develop research learning experiences
  - Start pilot programs then build capacity
  - Attract top students

• Institutional-level:
  - Student fellowship opportunities
  - Highlight accomplishments: student research showcase, awards, media
  - Faculty support for undergraduate research
  - Develop centralized programs
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Questions and Discussion

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