Mentorship for Developing course-based undergraduate research experiences (CUREs): The CUR Mentorship for Integrating Research Into the Classroom (MIRIC) program

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Abstract

The life science education community has responded to the recommendations of the American Association for the Advancement of Science (AAAS) Vision and Change document with several initiatives designed to improve the way in which undergraduates learn science. These initiatives have often taken the form of one-time workshops that generate awareness of and interest in developing authentic research experiences for undergraduate STEM classrooms. However, they have been less successful with respect to generating the sustainable change necessary to bring real reform to undergraduate science education. To create sustainable change, long-term faculty development initiatives focused on mentorship are needed so that instructors seasoned in developing and implementing course-based undergraduate research experiences (CUREs) can convey their experiences to mentees interested in using these pedagogical techniques as the centerpiece of their own teaching. The Council on Undergraduate Research (CUR) Biology Division has created the Mentorship for Integrating Research Into the Classroom (MIRIC) program to provide a means for members with an interest in developing improved and sustainable active learning techniques to gain experience in this style of teaching through close, long-term interaction with a veteran teaching mentor. MIRIC focuses on the development of instructors who wish to develop a dynamic CURE. Current and future life science instructors pair themselves up with seasoned veterans of CURE development and work with them and their students over the course of a semester or longer to develop a CURE that will allow the mentee to bring authentic research into his or her classes. In our pilot studies, we collected qualitative and quantitative data based on participant interviews and coding videos of student and instructor actions during classroom activity (Smith *et al.*, 2013), respectively, that suggest that MIRIC mentorships have made positive gains in promoting sustainable active learning techniques among participants. Going forward, we wish to use instruments like the Laboratory Course Assessment Survey (Corwin et al., 2015) and Experimental Design Ability Test (Sirum and Humburg 2011) to assess the effectiveness of the MIRIC laboratory intervention.

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MIRIC in Action

Establishing a mentor/mentee relationship:

- Mentees can be anyone from seasoned veteran faculty looking to integrate active learning techniques into their teaching to graduate students looking for a significant independent professional development experience in teaching.
- Mentors and mentees work together to decide how to best design a mutually beneficial mentorship experience.

Active learning instructional skill development:

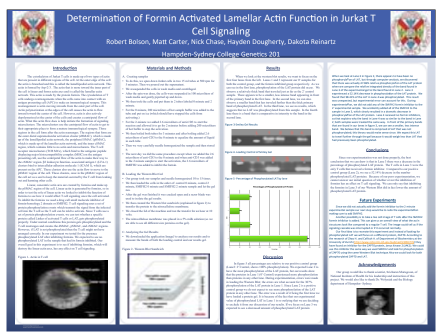
- Mentors share effective active learning strategies that the mentee can sustainably integrate into his/her own teaching .

New teaching ideas that bring active learning to new student audiences:

- Authentic research and primary literature critique of actin filament formation in an intermediate-level Genetics and Cell Biology course (Hampden-Sydney College)
- New senior-level Cancer Biology course focused on close analysis of techniques used in cancer research (Brescia University)
- Collaborative laboratory module in teaching genetics via analysis of epistasis in budding yeast (Quinnipiac University)

*Using creative tools to learn complex concepts. **LEFT:** A "method cartoon" used by students to illustrate experimental techniques from the primary literature in a cancer biology course. **ABOVE:** Illustrating organismal systems for a nutrition class. These techniques were integrated by Dr. Jacob Adler of Brescia University after seeing its use in his mentorship with Dr. Alison Crowe of the University of Washington.*

Mentee interactions with students and classroom products



ABOVE LEFT: *Mentee Dr. Glenn Simmons (UT-Southwestern Medical Center, Dallas) leads a student debate in mentor Dr. Amy Prunuske's (Univ. Minnesota-Duluth) classroom.*

ABOVE RIGHT: *Mentees Drs. Bryan Leland and Sarah Schreiner (Yale Univ.) analyze epistasis data with students in mentor Dr. Lani Keller's (Quinnipiac Univ.) classroom.*

LEFT: *Research poster resulting from mentee Dr. Sricharan Murugesan's (NIH) classroom and laboratory module developed with mentor Dr. Michael Wolyniak's (Hampden-Sydney College).*

ASSESSING THE PROGRAM: How likely are mentees to develop a more active learning based teaching philosophy?

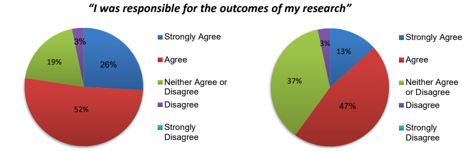
#	Answer	Min Value	Max Value	Average Value	Standard Deviation	Responses
1	Writing learning objectives that reflect the nature of science BEFORE	38.00	100.00	64.50	30.57	4
2	Writing learning objectives that reflect the nature of science AFTER	66.00	100.00	86.00	16.08	4
3	Using active learning exercises to develop critical thinking skills BEFORE	35.00	80.00	52.25	19.50	4
4	Using active learning exercises to develop critical thinking skills AFTER	76.00	90.00	83.75	7.32	4
5	Using assessments to evaluate student learning BEFORE	29.00	80.00	61.33	28.11	3
6	Using assessments to evaluate student learning AFTER	58.00	90.00	77.50	13.70	4
7	Encouraging students to value diverse views in science BEFORE	50.00	81.00	70.33	17.62	3
8	Encouraging students to value diverse views in science AFTER	50.00	100.00	76.67	25.17	3
9	Discussing a teaching challenge with a colleague BEFORE	50.00	80.00	67.67	15.70	3
10	Discussing a teaching challenge with a colleague AFTER	75.00	93.00	86.00	9.64	3

ASSESSMENT OF THE "CURE": Do students show active engagement with the material and development of scientific thinking skills?

RIGHT**: A representative response from the Laboratory Course Assessment Survey (Corwin et al., 2016) as used at Hampden-Sydney College.* ***BELOW: *The Experimental Design Ability Test for examining scientific thinking skills.*

Hops lab experiment — **Traditional lab modules**

"I was responsible for the outcomes of my research"



Experimental Design Ability Test

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Pre-Test: Advertisements for an herbal product, ginseng, claim that it promotes endurance. To determine if the claim is fraudulent and prior to accepting this claim, what type of evidence would you like to see? Provide details of an investigative design.

Post-Test: The claim has been made that women may be able to achieve significant improvements in memory by taking iron supplements. To determine if the claim is fraudulent and prior to accepting this claim, what type of evidence would you like to see? Provide details of an investigative design.

EDAT Scoring Rubric (7/2010)

____ 1. Recognition that an experiment can be done to test the claim (vs. simply reading the product label).
____ 2. Identification of what variable is manipulated (independent variable is ginseng vs. something else).
____ 3. Identification of what variable is measured (dependent variable is endurance vs. something else).
____ 4. Description of how dependent variable is measured (e.g., how far subjects run will be measure of endurance).
____ 5. Realization that there is one other variable that must be held constant (vs. no mention).
____ 6. Understanding of the placebo effect (subjects do not know if they were given ginseng or a sugar pill).
____ 7. Realization that there are many variables that must be held constant (vs. only one or no mention).
____ 8. Understanding that the larger the sample size or # of subjects, the better the data.
____ 9. Understanding that the experiment needs to be repeated.
____ 10. Awareness that one can never prove a hypothesis, that one can never be 100% sure, that there might be another experiment that could be done that would disprove the hypothesis, that there are possible sources of error, that there are limits to generalizing the conclusions (credit for any of these).

MIRIC is undergoing its full launch in 2018!

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References

Corwin LA, Runyon C, Robinson A, and Dolan EL. (2015). The Laboratory Course Assessment Survey: A Tool to Measure Three-Dimensions of Research-Course Design. *CBE-LSE* 14(4): ar37. doi 10.1187/cbe. 15-03-0073.

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Smith MK, Jones FHM, Gilbert SL, and Weiman CE. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): A New Instrument to Characterize University STEM Classroom Practices. *CBE-LSE* 12(4) :618-627.

The University of Minnesota IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR. **Study Number:** 1504E69564