Formalized Assessment of Written Communication of Scientific Information

Denyce K. Wicht
Associate Professor
Suffolk University
Department of Chemistry and Biochemistry
20 Somerset Street
Boston, MA 02108
dwicht@suffolk.edu

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SUFFOLK
UNIVERSITY
BOSTON

CHED SYMPOSIUM NAME: Developing & Assessing
More than Content Knowledge

Slide 2 text:

Suffolk University is a private, urban university; the College of Arts and Sciences (CAS) is accredited by the New England Association of Schools and Colleges and the Department of Chemistry and Biochemistry is accredited by the American Chemical Society (ACS). Since 2013, on average, the Department graduates 10 majors per year. The Department of Chemistry and Biochemistry has four tenured or tenure-track professors and three full-time instructors.

CAS at Suffolk University is primarily an undergraduate institution; there is one graduate program in the sciences, a MS clinical program in Medical Dosimetry offered out of the Department of Biology. The teaching load for a full-time, tenure-track faculty member in the Department of Chemistry and Biochemistry is three/two, where a laboratory course carries equal teaching weight to a lecture course. Typically, tenure-track and tenured faculty members in the Division of Physical Science (Department of Chemistry and Biochemistry and Department of Physics) teach a minimum of two laboratory courses a year. Because the Department does not support a graduate program, all research is conducted with undergraduate students.

The average overall class size is currently 20 students per faculty member. Our small class size allows faculty members to build strong relationships with students. Faculty in CAS are teacher-scholars who build important mentoring relationships with undergraduates, giving students the tools they need to transition from college to career. Nearly 50% of the undergraduate students majoring in chemistry or biochemistry at Suffolk University are hired as technicians or entry-level research assistants at local research hospitals, academic institutions, or pharma/biotech companies upon graduation.

Research at Undergraduate Institutions: Biophysical characterization of reduced flavin-dependent two component monooxygenase sulfur assimilation enzymes: SfnG, MsuC, and MsuD

Daniel P. Dowling
UMass—Boston

The Dowling Lab

Andrew Gnann
Jeremy Liew
Courtney Truong
Reyaz Gonzalez
Jess Soule
Chris Kim

Award 1807480

National Science Foundation
Funded Summer 2019 Research
Assistants (RAs)

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With this award, the Chemistry of Life Processes program is funding Dr. Denyce K. Wicht at Suffolk University and Dr. Daniel P. Dowling at UMass-Boston to research proteins involved in extracting sulfur from naturally occurring organic molecules. The microbial cycling of sulfur-containing substrates is important to understanding how living organisms (including humans) play a role in moving this specific element between earth's water, atmosphere, and terrestrial components. The biochemical interconversions of compounds containing carbon–sulfur bonds and sulfur–oxygen bonds are observed across a range of microorganisms, but the order in which the chemistry proceeds only recently has been discovered. Therefore, these chemical transformations remain largely unexplored. This research entails a collaborative effort by Dr. Wicht and Dr. Dowling to perform fundamental biochemical analyses and obtain structural information for how these biochemical systems function. Research assistants at the undergraduate and graduate level gain experience with enzymology, biochemistry, and protein crystallography. Additionally, participants engage in outreach activities with middle school students and receive specific feedback on lifelong learning skills important to the production of a modern STEM workforce. Strong scientific mentorship provided by PI Wicht and co-PI Dowling contribute to the development of a diverse, globally competitive STEM workforce.

PI Wicht's responsibilities include recruiting, interviewing, and hiring the undergraduate research assistants (RAs), serving as the direct supervisor of the RAs, and managing the experimental results generated at Suffolk University. In March 2019, Wicht and co-PI Dowling identified, interviewed, and hired five undergraduate RAs for full-time employment at Suffolk University for ten summer weeks under the direct supervision of PI Wicht. The five funded RAs (three from Suffolk University and two from UMass–Boston) worked up to 40 hours per week in Suffolk University research laboratories. The main task of the RAs was to produce, purify, and quantify recombinant proteins.

National Science Foundation funded summer 2019 research assistants

Jonathan Ottinger
University of Massachusetts—Boston
Biology 2020

Son Nguyen
Suffolk University
Biochemistry 2020

Chaim Wigder
Suffolk University
Psychology 2020
Chemistry minor

Ngan Phan
University of Massachusetts—Boston
Biochemistry 2020

Kylie McKenna
Suffolk University
Biochemistry 2020
Forensic Science minor

The application deadline for these positions was March 1, 2019 and the applicant pool was **competitive**. What did the **professional references** say about each applicant?

“Jonathan’s **academic performance** is exceptional. He will make **a good asset** to your lab.”

“Ngan is pleasant, polite and has a **great attitude**. She **works very hard to improve** her skill set.”

“Son is a **diligent and detail-oriented** student in lab. Her notes are always **organized**.”

“Kylie shows **maturity** and **a high level of commitment** to finishing the job that she started.”

“Chaim possesses **a strong work ethic** and is a great **dialogue partner**.”

Through a rigorously vetted assessment platform (the Enhancing Learning by Improving Process Skills in STEM (ELIPSS) project), the RAs were provided with feedback from assessment experts on the written communication of scientific information pre and post funding period

Assessment Experts:

Meaghan Fallano
Digital Content Developer at Pearson
Adjunct Laboratory Instructor at Suffolk University
B.S., Chemistry
Ph.D., Chemistry

Nicole Reder
Program Manager at the Center for Learning & Academic Success
Suffolk University
B.S., Chemistry and English Literature
M.A., International Education

Ellane J. Park
Rollins College
Assistant Professor of Chemistry
B.S., Chemistry
Ph.D. Chemistry

Student Name:

Written Communication	Conveying information and understanding to an intended audience through written materials
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Rubric Version: WC_prod_Jan10_2017

Category	0	1	2	3	4	5
Audience (Language)		Ignores intended audience or uses unsuitable language for the audience		Considers intended audience, but uses some unsuitable language for the audience		Considers audience and uses clear and suitable language for that audience
Audience (Relevance)		Poorly conveys the topic's relevance or importance to the audience		Adequately conveys the topic's relevance or importance to the audience		Effectively conveys the topic's relevance or importance to the audience
Organization/ Cohesion		Uses disjointed sequence of ideas		Uses logical sequence of ideas		Uses logical and effective sequence of ideas
Subject Area Conventions		Uses language that is inconsistent with the norms, formal rules, and informal rules of the subject area		Uses language that is somewhat consistent with the norms, formal rules, and informal rules of the subject area		Uses language that is completely consistent with the norms, formal rules, and informal rules of the subject area
Visual Representations		Constructs and uses visual representations ineffectively and inappropriately		Constructs and uses visual representations somewhat effectively		Constructs and uses visual representations effectively and appropriately
Presentation/ Formatting		Format and appearance impede readability		Format and appearance support readability		Format and appearance enhance readability
Writing Mechanics		Uses poor sentence/paragraph structures; contains many errors in spelling, grammar, or word usage		Uses some poor sentence/paragraph structures; contains some errors in spelling, grammar, or word usage		Uses effective sentence/paragraph structures; contains correct spelling, grammar, or word usage
Purpose		Does not clearly convey the writing's purpose		Clearly conveys the purpose, but the purpose and content are not well-aligned		Clearly conveys the purpose, and the purpose and content are well-aligned

Slide 5 text:

The five undergraduate RAs hired to work summer 2019 were provided with specific feedback on the lifelong learning skill of written communication, a skill also important to the production of a modern STEM workforce. Specifically, assessment consultants with chemistry expertise applied a vigorously vetted rubric generated via The ELIPSS (Enhancing Learning by Improving Process Skills in STEM) Project (<http://www.elipss.com/>) to RA writing samples from 300-level undergraduate courses in either analytical chemistry or biochemistry collected during the RA application process. Assessment consultants were compensated for their time and expertise; the compensation was budgeted for in the NSF grant.

In order to serve as an assessment consultant, interested consultants were asked to provide a brief paragraph describing their assessment and/or Chemical Education Research (CER) experience, their interest in participating in this specific project, and their research/teaching interests. Their participation required:

- Reading five writing samples from 300-level undergraduate courses in either analytical chemistry or biochemistry
- Applying the rubric to assess each writing sample. The assessment was accompanied by a written explanation citing specific examples from the writing sample to justify the 0-5 assignment for each category (there are 8 categories). Each written assessment was typed; assessment consultants were instructed to anticipate minimally a one-page word document for each writing sample (reminder, there were five summer RAs 2019)
- Submitting an updated CV/resume with their completed assessment materials

Pre-funding assessment data, each category is an average of the data provided from the assessment experts

Category	RA 1	RA 2	RA 3	RA 4	RA 5
Audience (language)	5	3.75	4.75	2.5	5
Audience (relevance)	4.25	2.5	5	2.25	4.75
Organization/ cohesion	5	3.25	4.25	2.5	4.5
Subject area conventions	4.5	2.75	4.75	3	4.5
Visual representations	3.75	3.25	4.25	2.75	4.75
Presentation / formatting	4.25	3	4	3	4.75
Writing mechanics	4.25	2.25	3.75	1.5	4.25
Purpose	5	3.25	4	2.75	4.5
Overall Average	4.5	3	4.3	2.5	4.6

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In addition to the numerical averages above, each RA received the written feedback from each assessment consultant specific to each category.

The 2019 RAs were provided with assessment data on their written communication skills *before* they began working summer 2019. Based on these data, the assessment experts hired to consult on this project and co-PI Wicht concluded that two funded RAs would benefit from Suffolk University's Center for Learning and Academic Success (CLAS) services; they were assessed at 2.5 and 3.0, respectively, on a 5.0 scale in "written communication" based on the rubric. Both RAs attended a conversation workshop and a grammar workshop every week (two separate workshops). Importantly, their attendance at CLAS was a *compensated* activity for both RAs. In other words, the time they spent with CLAS staff was covered by their hourly RA salary as a *professional development component* of their RA position. In general, the assessment experts and co-PI Wicht agreed that three of the five RAs came into the RA position with fairly high-functioning written communication skills, based on the assessment data; overall, they were assessed at 4.3, 4.5 and 4.6, respectively, on a 5.0 scale. They were given specific feedback on some areas on which to pay particular attention, but were informed that no immediate remediation seemed necessary with respect to the professional development of their written communication.

RAs received training in protein production, purification, and quantitation, as well as assay development and the collection of rate data

The proposed activities are motivated by **specific research questions**:

- 1) *What are the catalytic efficiencies (k_{cat}/K_m) of the reduced flavin-dependent two component enzymes SfnG, MsuC, and MsuD? Does the reductase component exhibit higher affinity for oxidized flavin relative to the monooxygenases?*
- 2) *How broad is the range of S-CH₃ containing (C₁) substrates that can be converted to product by SfnG, MsuC, and MsuD?*
- 3) *What structural motif(s) do SfnG, MsuC, and MsuD adopt? In crystal structures solved with substrate/product bound, what amino acids map the active site(s)?*

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The research activities were motivated by specific research questions relevant to three enzymes involved in the conversion of dimethylsulfone to inorganic sulfite.

Importantly, each RA was assigned a unique research goal designed specifically around her/his skill set and was required to produce, purify, and quantify their proteins of interest.

The NSF-funded project provided summer salaries, paid in the form of hourly wages, to the RAs to work in Suffolk University research labs. The RA positions were structured as a job to provide the RAs with lifelong learning skills important to the production of a modern STEM workforce, such as time management and professional accountability.

PI Wicht periodically collected the duplicate pages of the RAs laboratory notebooks to ensure the entries conform to commonly accepted standards for the documentation of scientific data (Kanare, H. M., *Writing the Laboratory Notebook*, American Chemical Society, Washington, DC, 1985). In addition, RAs were given firm deadlines for ongoing drafts of their final reports and PI Wicht provided detailed feedback to each RA. Importantly, their “writing time” was a *compensated* activity. In other words, the time they spent writing was covered by their hourly RA salary as a *professional development component* of their RA position.

The Function of the Enzymes SfnG and MsuE

Ngan Phan
University of Massachusetts—
Boston
Biochemistry 2020

"Ngan is pleasant, polite and has a **great attitude**. She **works very hard to improve** her skill set."

ultraviolet-visible spectroscopy data demonstrating both protein purity and concentration determination via $A_{280\text{nm}}$

"Chaim possesses a **strong work ethic** and is a great **dialogue partner**."

Development of A Gas Chromatography Assay for the SfnG-Catalyzed Conversion of Dimethylsulfoxide to Methanesulfinate

Chaim Wigder
Suffolk University
Psychology 2020
Chemistry minor

gas chromatography data demonstrating development of a method appropriate for the resolution of substrate from internal standard (mass spec data not shown)

Jonathan Ottinger
University of
Massachusetts—
Boston
Biology 2020

“Jonathan’s **academic performance** is exceptional. He will make **a good asset** to your lab.”

Purification of a Tagged Recombinant form of the monooxygenase MsuC and Investigation of its Activity on Methanesulfinate

polyacrylamide gel electrophoresis data demonstrating fractions of pure protein consistent with the expected molecular weight

The Effect of Catalase on the MsuC Catalyzed Reaction in *Pseudomonas fluorescens*

Kylie McKenna
Suffolk University
Biochemistry 2020
Forensic Science minor

“Kylie shows **maturity** and **a high level of commitment** to finishing the job that she started.”

nuclear magnetic resonance spectroscopy data demonstrating conversion of substrate to product

"Son is a **diligent and detail-oriented** student in lab. Her notes are always **organized.**"

Analysis of conversion
from dimethylsulfone
to methanesulfinate by
flavin-dependent
monooxygenase
MsuD

Son Nguyen
Suffolk University
Biochemistry 2020

visible spectroscopy data vs. bovine serum albumin
concentration; a standard curve used for
concentration determination of purified proteins

Wicht and Dowling scheduled a group meeting on August 2nd, 2019 to facilitate co-mentorship activities among the funded undergraduate RAs, the funded UMass–Boston graduate students, and all other Dowling research group members. As a requirement of the position, each RA was expected to prepare and deliver a final research presentation at this group meeting and submit a final written research report.

Total Wages Earned by RAs Summer 2019	Total Hours Worked by RAs Summer 2019
\$28,068	1,920

On average, each RA earned ~\$5,600 and worked
~40 hours/week for almost ten weeks

Pre-funding assessment data compared to post-funding assessment (4 RAs)

Category	RA 1 pre	RA 1 post	RA 2 pre	RA 2 post	RA 3 pre	RA 3 post	RA 4 pre	RA 4 post
Audience (language)	5	4.7	3.75	4	4.75	4.3	2.5	3.7
Audience (relevance)	4.25	5	2.5	4	5	4.3	2.25	3.3
Organization/ cohesion	5	4.7	3.25	4.3	4.25	4.7	2.5	2.7
Subject area conventions	4.5	5	2.75	4.3	4.75	4.7	3	3
Visual representations	3.75	4.7	3.25	4	4.25	5	2.75	3.3
Presentation / formatting	4.25	3.7	3	4.7	4	4.3	3	3.7
Writing mechanics	4.25	4.3	2.25	3.7	3.75	4	1.5	2.3
Purpose	5	4.7	3.25	3.7	4	4.3	2.75	2.7
Overall Average	4.5	4.6	3	4.1	4.3	4.5	2.5	3.1

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The 2019 RAs were provided with the post assessment data on their written communication skills based on their final report *after* their summer RA experience but *before* the start of the fall 2019 semester.

All RAs who submitted a final written report demonstrated improvement overall.

The two RAs who attended a conversation workshop and a grammar workshop every week (two separate workshops) sponsored by Suffolk University's Center for Learning and Academic Success exhibited greater improvement overall. Anecdotally, the RAs communicated that they found the workshops to be helpful as opposed to punitive.

Perhaps the most valuable/useful aspect to the pre and post assessment process for the RAs was the detailed written feedback provided by the assessment experts (data not presented here).

Structure and function of the two-component flavin-dependent methanesulfinatase monooxygenase within bacterial sulfur assimilation

Jess Soule ^{a, 1}, Andrew D. Gnann ^a, Reyaz Gonzalez ^a, Mackenzie J. Parker ^{b, 2}, Kylie C. McKenna ^c, Son V. Nguyen ^c, Ngan T. Phan ^{a, c}, Denyce K. Wicht ^c ✉, Daniel P. Dowling ^a ✉

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