Jordan Harshman Faculty Annual Review
Assistant Professor, Discipline-Based Education Research
Department of Chemistry and Biochemistry

A. STANDARD BIOGRAPHICAL DATA SHEET

Name: Jordan Harshman
Department: Chemistry and Biochemistry
College: Science and Mathematics
Present Rank: Assistant Professor
Years Completed in Present Rank: 3
Years in Faculty Service at AU: 3
Years in Faculty Service Elsewhere: 1
Type of Current Appointment: ____ Tenured __X__ Untenured ____ Non-Tenure Track (NTTF)
Pay Basis: __X__ 9 mo. ____ 12 mo.
Graduate Faculty Status: __X__ Member ____ None
Date Awarded: 01-18-2018

Education (list most recent first)

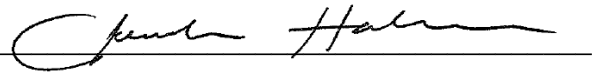
Institution	Degree	Major	Date Awarded
Miami University	PhD	Chemistry Education Research	08-2015
University of Wisconsin – River Falls	BS	Chemistry Secondary Education	05-2011

Professional Experience (include AU experience, list most recent first)

Institution	Rank	Period
Auburn University	Assistant Professor	07/2017 – current
University of Nebraska-Lincoln	Postdoctoral Researcher	06/2016 – 06/2017
University of Iowa	Postdoctoral Research / Visiting Assistant Professor	08/2015 – 05/2016

Other Credentials (if applicable): Certificate in Applied Statistics, Miami University, 2014

I have reviewed (except letters) the contents submitted in the attached dossier:

Signature:  Date: August 26, 2020

B. ALLOCATION OF EFFORT

Research ~ 65%
Teaching ~ 30%
Service ~ 5%

C. HONORS AND AWARDS

2018-2020 Chairman of Younger Chemistry Education Scholars (YCES)
2019 Secretary of the Auburn Local Section of the ACS

D. SCHOLARLY CONTRIBUTIONS

1. SCHOLARLY CONTRIBUTIONS TO TEACHING

a. Courses taught

2020	Fall	CHEM 1110: General Chemistry I	3 Hrs	128 students
2020	Spring	CHEM 5450/6450: Foundations of R for DBER	3 Hrs	14 students
2019	Fall	CHEM 1110: General Chemistry I	3 Hrs	126 students
2019	Spring	CHEM 7410: A DBER Approach to Teaching and Learning in Chemistry	3 Hrs	12 students
2018	Fall	CHEM 1110: General Chemistry I	3 Hrs	133 students
2017	Fall	CHEM 1030 EA1-3: Fundamentals of Chemistry I	3 Hrs	137 students
2016	Spring	CHEM 1120: Principles of Chemistry II (University of Iowa)	3 Hrs	~ 400 students
2015	Fall	CHEM 1120: Principles of Chemistry II	3 Hrs	~ 600 students

b. Graduate students (completed)

N/A

c. Graduate students (current)

Primary Professor

Qi Cui *4th Yr, Ph.D.*	Research focused on abstracting knowledge and skills required by professional chemists. Passed preliminary exams, about to administer full scale survey in collaboration with ACS.
Tinting Qu *3rd Yr. Ph.D.*	Research focused on abstracting knowledge and skills required by current graduate students. Developed and conducted own interview protocol.

Committee Member

Elijah Johnson	Ph.D.	Geoscience Education Research	Prof. Karen McNeal
Tyler Smith	Ph.D.	Geoscience Education	Prof. Karen McNeal
Emily Dreissen	Ph.D.	Biology Education Research	Prof. Cissy Ballen
Ben Jackson	Ph.D.	Computational Chemistry	Prof. Evangelos Miliordos
Mark Brenneman	Ph.D.	Science Education	Prof. Chris Schnittka
Daniel (Ryan) McMullan	Ph.D.	Physical Chemistry	Prof. Rik Blumenthal
Dianna Forbes	Masters	Science Education	Prof. Chris Schnittka

d. Courses and curricula developed

CHEM 7410 (A DBER Approach to Teaching and Learning in Chemistry), proposed novel course to introduce evidence-based teaching strategies in chemistry, teaching as research framework, and introduction to discipline-based education research for chemists. This course is part of a growing effort to both communicate the robustness of the science behind teaching and learning and to better prepare graduate students for the teaching aspects of their careers as faculty members, should they choose this career path.

CHEM 5405/6450 (Foundations of R for DBER): Developed this course in communication with Statistics Department to offer sole course on campus that teaches computational programming for applications in a variety of research disciplines. The goal of the course is to not just teach what/how to program, but why researchers would and should want to implement certain aspects of code.

e. Teaching grants

N/A

f. Teaching publications

Jackson, B., **Harshman, J.,** & Milordos, E. (ASAP). Addressing the Hypervalent Model: A Straightforward Explanation of Traditionally Hypervalent Molecules. *J. Chem. Educ.*

g. Other teaching contributions

- Developed two original active learning activities for CHEM 1030 EA series
- Coded online application to automatically provide feedback to instructors based on data collected from COPUS (Classroom Observation Protocol for Undergraduate Science)
- Wrote 7 recommendation letters for students and 3 for faculty
- Substitute taught for Prof. Konrad Patkowski for a total of three class periods while he was away at a conference.

Undergraduate Students

Research Advising

Sarah Friday (biochemistry)
Whee Nguyen (biomedical science)
Marie Harris (pre-medical sciences)
Isabella Lopez (psychology / pre-medical sciences)
Natalie Usher (biomedical sciences)
Allison Epperson (chemistry education)
Emily Kable (chemistry)

Postdoctoral Researchers

Brittany Busby

h. Statement of teaching philosophy and self-evaluation

I believe that how students learn and the best instructional methods to facilitate that learning have been well established in the literature. Generally speaking, students will not engage in deep learning if they are passive recipients of knowledge and instead should be actively engaging in the content. This is based in fundamentals of learning theory that describe the process of learning as assimilating and accommodating new information into existing mental schema. In the contexts of undergraduate chemistry, this means that students should be given many opportunities to independently come to conclusions and be made aware of the way they think about topics prior to instruction. It also means that students should be allowed to reason through chemistry concepts by examining real-life phenomena. I also believe that chemistry is not fully understood until the translation between macro, symbolic, and sub-microscopic domains are experienced by students. It is often between these domains that the explanatory nature of chemistry exists and those explanations are the best evidence of students' understanding.

In reflecting on this year of teaching, I taught a fundamentals of R for DBER course in which I have adequate content knowledge but very limited pedagogical content knowledge (knowledge of how to effectively teach the subject). I felt as though I designed the course with a novice learner in mind, but in hindsight realize that even my attempts to slowly introduce students to the statistical programming language were generally not within the zone of proximal development and I did not feel that I included enough scaffolds for the majority of the students. In teaching this course again, I will place an even greater emphasis on the fundamental concepts of programming in R and inclusion of much more practice. I generally avoid exercises that revolve around lower cognitive demand, but in this case where the course is predominantly a language, a greater extent of reiteration and practice will be necessary. I also created homework sets that were too challenging for the level my students were at. As a result, they were not properly scaffolded and I don't believe the learning outcomes were as tangibly met.

For the general chemistry sequence, I have begun my third semester teaching this course designed for the chemistry and chemical engineering majors. Each year, I have tried to reform a chapter to include more real-life contexts and callouts to careers in chemistry. My hope is that this class will serve as an introduction not just into the content of chemistry, but also what possibilities are open to being a chemist. I received an overwhelming amount of feedback last year criticizing my choice in exam questions, many of which were warranted. I felt as though, like in the graduate level course, I lost sight of proper scaffolding and tried to be too creative with the questions I made for the exam. This caused (just) frustration in the students and I will strive to select questions that are not algorithmic, but more commonly observed in the traditional cannon of chemistry assessments. I continue to be proud of the very conceptual focus I place on class and am working to better align the online homework with the things I'm emphasizing in class.

2. RESEARCH/CREATIVE WORKS

a. Publications - books

N/A

b. Article-length Publications

Refereed Journal Articles

From Research at Auburn University

(16) Harshman, J. (minor revisions). "A Review of the Challenges that Face Doctoral Education in Chemistry." *J. Chem. Educ.*

(15) Busby, B. & **Harshman, J.** (second revision). "Program elements' impact on chemistry doctoral students' professional development: A longitudinal study." *Chem. Educ. Res. & Pract.*

(14) Jackson, B., **Harshman, J.,** & Milordos, E. (ASAP). "Addressing the Hypervalent Model: A Straightforward Explanation of Traditionally Hypervalent Molecules." *J. Chem. Educ.*

(13) Hebert, S., Berk, S., Brunelli, R., Creech, C., Drake, A.G. Fagbodun, S., Garcia-Ojeda, M., Hall, C., **Harshman, J.,** Lamb, T., Robnett, R., Shuster, M., Cotner, S., & Ballen, C. (ASAP). "A call for data-driven networks to address equity in the context of undergraduate biology." *Cell Bio. Educ. – Life Sci. Educ.*

(12) Cui, Q. & **Harshman, J.** (2020). "Qualitative Investigation to Identify the Knowledge and Skills That U.S.-Trained Doctoral Chemists Require in Typical Chemistry Positions." *J. Chem. Educ. 97*(5), 1247–1255.

(11) Popova, M., Shi, L., **Harshman, J.,** Kraft, A., & Stains, M. (2019) "Untangling a complex relationship: teaching beliefs and instructional practices of assistant chemistry faculty at research-intensive institutions." *Chem. Educ. Res. Pract*. 21(2), 513-527.

(10) Stanbury, D. & **Harshman, J.** (2019). "Large-Scale Models of Radiation Chemistry and the Principle of Detailed Balancing." *J. Phys. Chem A.* 123(*47*), 10240-10245.

(9) Stains, M., **Harshman, J.**, Barker, M.K., *et al*. (2018). Anatomy of STEM Teaching in American Universities. *Science*. 359(6383), 1468-1470.

From Research Prior to Auburn University

(8) Harshman, J., & Stains, M. (2017). A review and evaluation of the internal structure and consistency of the Approaches to Teaching Inventory" *Int. J. Sci. Educ. 39*(7), 918-936.

(7) Husting, C., **Harshman, J.**, Yezierski, E. (2017). Using teacher action research in high school chemistry to develop novel assessment tools. *J. Teach. Action Res. 3*(2), 14-29.

(6) Harshman, J. & Yezierski, E. (2016). Assessment data-driven inquiry: A review of how to use assessment results to inform chemistry teaching. *Sci. Educ.*, *25*(2), 97-107.

(5) Harshman, J. & Yezierski, E. (2016). Characterizing High School Chemistry Teachers' Use of Assessment Data via Latent Class Analysis. *Chem. Educ. Res. Pract*. 17, 296-308.

(4) Harshman, J. & Yezierski, E. (2016). Test-Retest Reliability of the Adaptive Chemistry Assessment Survey for Teachers: Measurement Error and Alternatives to Correlation. *J. Chem. Educ*. *93*(2), 239-247.

(3) Sandlin, B., **Harshman, J.,** & Yezierski, E. (2015). Formative Assessment in High School Chemistry Teaching: Investigating the Alignment of Teachers' Goals with Their Items. *J. Chem. Educ*. *92*(10), 1619-1625.

(2) Harshman, J. & Yezierski, E. (2015). Guiding teaching with assessments: High school chemistry teachers' use of data-driven inquiry. *Chem. Educ. Res. Pract*. 16, 93-103.

(1) Harshman, J., Bretz, S.L., & Yezierski, E. (2013). Seeing chemistry through the eyes of the blind: A case study examining information processing of multiple gas law representations. *J. Chem. Educ*. *90*(6), 710-716.

Book Chapters

(1) Harshman, J., Nielsen, S., Yezierski, E. (2016). Putting the R in CER: How the Statistical Program R Transforms Research Capabilities. In Gupta, T., Mehta, A., and Cartrette, D Computer-Aided Data Analysis in Chemical Education Research (CADACER): Advances and Avenues. American Chemical Society Symposium Series, American Chemical Society, Washington, DC.

c. Posters and lectures

From Research at Auburn University

Invited Lectures

(35) *Characterizing instructional practices with cluster analysis: An exercise in reducing uncertainty,* National Meeting of the Geological Society of America, October, 26-30, 2020

(34) *A little bit of everything: Classroom observation, cluster analysis, and effective graduate education,* Auburn University Physics Department, September 13, 2019

(33) *R Workshop at MTSU,* Middle Tennessee State University, October 24, 2019

(32) *Instructional Profiles of STEM Instructors and Optimization of Cluster Analysis Techniques,* Middle Tennessee State University, October 24, 2019

(31) *R Workshop at SEER 2019,* Scientists Engaged in Education Research Conference, University of Georgia, April 25-26, 2019

(30) *Instructional Profiles of STEM Instructors and Optimization of Cluster Analysis Techniques,* Scientists Engaged in Education Research Conference, University of Georgia, April 25-26, 2019

(29) *Instructional Profiles of STEM Instructors and Optimization of Cluster Analysis Techniques,* Kennesaw State University, Kennesaw, GA, January 22, 2019

(28) *STEM Teaching in American Universities: Trends, Research, and Preparing the Next Generation of Chemists*, Wake Forest University, Winston-Salem, NC, February 13, 2019

(27) *Characterizing teacher and student behaviors in over 2,000 classes: A journey into mixed-model clustering,* Auburn University, Department of Statistics, Auburn, AL, November 3, 2017

Contributed Lectures

(26) Harshman, J. *Opportunities in the academy: Discipline-Based Education Research*, 257th Meeting, Orlando, FL April 2019

(25) Harshman, J. & Stains, M. *The instructional profiles of undergraduate science classes: Characterizing teacher and student behaviors in over 2,000 classes*, 255th Meeting, New Orleans, LA, 2018

(24) Harshman, J. *Data Science in R Workshop,* Society for the Advancement of Biology Education Research National Meeting, Minneapolis, MN, 2018

(23) Harshman, J. *There are ___ types of people in this world: Providing the empirical evidence for groups of people through cluster analysis*, Biennial Conference of Chemical Education, Notre Dame, IN, 2018

(22) Harshman, J. *Determining Empirically-Based Groupings in Education Research: A Cluster Analysis Simulation*, Inorganic Seminar, September 17, 2018

(21) Cui, Q., **Harshman, J.** *Identifying the knowledge and skills that chemists require in workplace*, Biennial Conference of Chemical Education, Notre Dame, IN, 2018

Posters

(20) Harshman, J. *Effective Graduate Education in Chemistry: The Century-Old Problem*, Gordon Research Conference: Using Education Research to Foster Meaningful Chemistry Learning. Lewiston, ME, June, 2019

(19) Harshman, J. *Attempting to find the most accurate clustering method for chemistry education research: Simulating 3.6 million cluster analyses.* 257th Meeting, Orlando, FL April 2019

(18) Harshman, J. *Research-grade evidence for assessments for measuring chemists' knowledge and skills*, Graduate Student Invitational, Auburn University, AL, 2018

From Research Prior to Auburn University

Invited Presentations

(17) Pentecost, T., Komperda, R., **Harshman, J.** *CheapeR, PrettieR, and ShaReable: Introduction to R for Chemistry Education*. Workshop for the Biennial Conference on Chemical Education, Greeley, CO, August, 2016

(16) Harshman, J. & Yezierski, E. *Characterizing High School Teachers' Assessment Practices via the Adaptive Chemistry Assessment Survey for Teachers*. Gordon Research Conference: Chemistry Education Research and Practice, Lewiston, ME, July, 2015

(15) Supalo, C., **Harshman, J.** *The revolutionary shift of the educational paradigms towards the blind in science.* 200th Conference of the Two Year College Chemistry Consortium, New Orleans, LA, April, 2013

(14) Harshman, J., Bretz, S.L., Yezierski, E. *Practical, implementable suggestions and considerations for undergraduate chemistry instructors in their task of accommodating blind students.* Presentation for the 2012 Independent Science: Learning in a New Direction (ISLAND) Conference. West Lafayette, IN, November, 2012

Contributed Presentations

(13) Harshman, J., Nielsen, S., Yezierski, E., & Becker, N. New approach to data mining and visual communication of data via R. 251st Meeting, San Diego, CA, April 2016

(12) Harshman, J. & Becker, N. Characterizing students' reasoning about graphical models of reaction rate. 251st Meeting, San Diego, CA, April, 2016

(11) Harshman, J. & Yezierski, E. Using the ACAST to characterize high school chemistry teachers' data-driven inquiry practices. 249th Meeting, Denver, CO, April, 2015

(10) Bancroft, S., Carmel, J., **Harshman, J.,** Yezierski, E., & Herrington, D. (2015). Describing and characterizing the affective domain in middle and high school science students. 249th Meeting, Denver, CO, April, 2015

(9) Carmel, J., **Harshman, J.,** & Yezierski, E. Target Inquiry at Miami University (TIMU): Uncovering novel relationships among affective and cognitive measures of high school chemistry students. 249th Meeting, Denver, CO, April, 2015

(8) Harshman, J. & Yezierski, E. Data-Driven Inquiry: High school chemistry teachers' use of classroom assessments. 2015 NARST Annual International Conference, Chicago, IL, April, 2015

(7) Harshman, J., Yezierski, E. Teachers' use of assessment results in high school chemistry classrooms: The practice of data-driven inquiry. 2014 Biennial Conference on Chemical Education. Allendale, MI, August, 2014

(6) Harshman, J., Yezierski, E. Developing a survey to measure how high school chemistry teachers use data generated by formative assessment to guide their practice. 247th Meeting, Dallas, TX, March, 2014

(5) Harshman, J., Yezierski, E. Interpreting formative assessment to meaningfully guide chemistry teaching. 246th Meeting, Indianapolis, IN, September, 2013

(4) Harshman, J., Yezierski, E. The Process of Assessment Interpretation to Enhance Chemistry Teachers' Practice: Assessment as Scientific Inquiry. 245th Meeting, New Orleans, LA, March, 2013

(3) Harshman, J., Herrington, D., Yezierski, E. Determining the effect of the Target Inquiry professional development program: A multilevel analysis of student achievement. 243rd Meeting, San Diego, CA, March, 2012

(2) Harshman, J., Bretz, S.L., Yezierski, E. (2012). Seeing chemistry through the eyes of the blind: A case study following one blind student through the math and concepts of gas laws. 2012 Biennial Conference on Chemical Education. University Park, PA, July, 2012

(1) Harshman, J., Schneider, J. (2011). Immediate versus delayed feedback in chemistry assessment. 25th National Conference on Undergraduate Research (NCUR). Ithaca, NY, April, 2011

d. Exhibitions

N/A

e. Performances

N/A

f. Patents and inventions

N/A

g. Other research contributions

I attended a workshop in Madison, WI for the Entering Research Workshop to improve my skills as a mentor as well as bring back resources to share with the rest of the faculty for their own improvement of mentoring skills.

h. Grants

Awarded - $1,209,878 ($304,910 Auburn)

Title: *Collaborative Research: Building Assessment Capacity in Chemistry Education - The CHemistry Instrument Review and Assessment Library (CHIRAL) Project (#1915343)*
Team: Barbera, J., **Harshman, J.,** Komperda, R.
Agency: National Science Foundation, Improving Undergraduate Science Education (IUSE)
Funds: $710,493 ($186,657 Auburn)
Role: PI (Collaborative)
Percent Contribution: 33%
Awarded: June 24, 2019

Title: *RCN-UBE: Equity and Diversity in Undergraduate STEM (EDU-STEM) (#1919462)*
Team: Cotner, S., Fagbodun, S., Ballen, M., **Harshman, J.**, Hall, C.
Agency: National Science Foundation, Research Coordinated Networks (RCN)
Funds: $499,385 ($118,253 Auburn)
Role: Co-PI (Collaborative)
Percent Contribution: 10%
Awarded: July 19, 2019

Pending

Title: *CAREER: Defining a Model of Doctoral Education in Chemistry and Uncovering Faculty Beliefs and Values (#2045228,* ***Resubmission****)*
Team: Harshman, J.

Agency: National Science Foundation, Faculty Early Career Development Program (CAREER), EHR Core Research (ECR)
Amount Requested: $770,959
Role: PI
Percent Contribution: 100%
Submitted: August 6, 2020

Declined

Title: *Collaborative Research: ECR DBER DCL: Mind the Gap: Identifying the Knowledge and Skills that Chemists Use and Graduate Students Possess (#2000630,* ***Resubmission****)*
Team: Harshman, J. & Schultz, G.
Agency: National Science Foundation, EHR Core Research (ECR)
Amount Requested: $499,613 ($176,806 Auburn)
Role: PI (Collaborative)
Percent Contribution: 70%
Submitted: October 3, 2019

Title: *CAREER: Defining a Model of Doctoral Education in Chemistry and Uncovering Faculty Beliefs and Values (#2045228)*
Team: Harshman, J.
Agency: National Science Foundation, Faculty Early Career Development Program (CAREER), EHR Core Research (ECR)
Amount Requested: $770,959
Role: PI
Percent Contribution: 100%
Submitted: July 16, 2019

Title: *Development, implementation, and evaluation of an innovative learning platform using interactive videos (#1922482)*
Team: Harshman, J. & Vonk, M.
Agency: National Science Foundation, Improving Undergraduate Science Education (IUSE)
Amount Requested: $284,930 ($176,994 Auburn)
Role: PI (Collaborative)
Percent Contribution: 70%
Submission Deadline: February 5, 2019

Title: *IUSE: EHR: Instructional Design for Enhancing Active Learning in STEM Program (IDEALS) (#1915006,* ***Resubmission****)*
Team: McNeal, K., **Harshman, J.,** Boyd, D., & Doukopoulos, L.
Agency: National Science Foundation, Improving Undergraduate Science Education (IUSE)
Requested Funds: $2,975,637
Role: Co-PI
Percent Contribution: 40%
Submitted: December 10, 2018

Title: *Collaborative Research: Mind the Gap: Identifying the Knowledge and Skills that Chemists Use and Graduate Students Possess (#1919119)*
Team: Harshman, J. & Schultz, G.
Agency: National Science Foundation, EHR Core Research (ECR)
Amount Requested: $499,613 ($180,597 Auburn)
Role: PI (Collaborative)
Percent Contribution: 70%
Submitted: January 17, 2019

Title: *Preparing Chemistry Graduate Students for Careers in Industry*
Team: Harshman, J.
Agency: Auburn Intramural Grants Program – Faculty Research Initiation Grant
Amount Requested: $19,460
Role: PI
Percent Contribution: 100%
Submitted: October 24, 2018

Title: *Thinking in 3D: Understanding Spatial Visualization and Cognition for STEM Achievement*
Team: Wolf, L., McNeal, K., Hawkins, J., Gorden, A., **Harshman, J.**, Katz, J., Lakin, J., Schnittka, J., and Bondy, B.
Agency: Auburn Presidential Awards for Interdisciplinary Research
Amount Requested: $300,000
Role: Co-PI
Percent Contribution: 10%
Submitted: February 26, 2018

Title: *Introduction to Statistics, Quality Assurance, and Data Management in Accredited Analytical Laboratories (#1821530)*
Team: Sykes, D., **Harshman, J.**, Doolittle, P.
Agency: National Science Foundation, Improving Undergraduate Science Education (IUSE)
Amount Requested: $298,167 ($89,399 Auburn)
Role: Co-PI (collaborative)
Percent Contribution: 20%
Submitted: December 12, 2017

Title: *IUSE: EHR: Instructional Design for Enhancing Active Learning in STEM (IDEALS) program (#1821690)*
Team: McNeal, K., **Harshman, J.,** Boyd, D., & Doukopoulos, L.
Agency: National Science Foundation, Improving Undergraduate Science Education (IUSE)
Amount Requested: $2,945,525
Role: Co-PI
Percent Contribution: 40%
Submitted: December 12, 2017

Title: *Mind the Gap: Identifying the Knowledge and Skills that Chemists Use and Graduate Students Possess (#1760700)*
Team: Harshman, J.
Agency: National Science Foundation, EHR Core Research (ECR)
Amount Requested: $338,177
Role: PI (collaborative)
Percent Contribution: 100%
Submitted: September 13, 2017

i. Description of research program

The primary area of my research is in studying the effective education of graduate students in the chemical sciences. Numerous national level reports have criticized STEM graduate education based on inadequate preparation for careers outside of academia, developing knowledge and skills in too specific of areas, and a host of other shortcomings of graduate education. As a group, we have conducted or will soon conduct a full literature review, cross-sectional examinations of knowledge and skills required by chemists and obtained by students, and longitudinal case study identifying how students grow in their profession throughout doctoral education.

Our research seems to be pointing us in the direction that the interactions that growth observed in doctoral students is the product of all interactions throughout a graduate program, even to the extent that there exists significant evidence that the advisor is not necessarily the primary driver of growth. This opens new research avenues that question the long-standing assumptions made by cognitive apprenticeship theory and invite many more questions relating to socialization theories of growth in students.

In addition to doctoral education, my research group also has a vested interest in characterizing instructional practices throughout undergraduate STEM instruction. For decades, it has been very difficult to provide causal evidence that instructional style will directly impact learning outcomes. All learning theories predict this, but quantifying and describing the effect is riddled with imperfect measures of both teaching and learning.

In effort to address error in measurement of teaching, we are seeking novel ways to characterize instruction. Originally, we did this by aggregating behaviors across an entire class, but this does not accurately reflect the many short activities that have been theorized and evidenced to increase student performance. Therefore, we are searching for pattern recognition algorithms to identify key patterns as a means to develop new methods for characterizing instruction, which can then be used as independent variables in the ultimate goal of correlating instructional style to performance.

On the learning side of the equation, chemistry education has a long history of producing chemistry concept inventories – tests that most accurately measure students' ideas about chemistry content because they have been robustly studied and examined in qualitative and quantitative studies. However, these inventories are not widely used because they exist throughout multiple journals and require extensive expertise to distinguish a robust inventory

with proper evidence of reliability and validity from one that does not possess such psychometric qualities. To this end, the research group is involved in the service-oriented effort to design a library for these assessments to exist for the public's use. In the process, a number of small-scale studies will be conducted by our group to examine the extent to which a resource like this can shape standards and increase awareness of concept inventories.

3. OUTREACH

My service within the local and national American Chemical Society frequently keeps me engaged with various stakeholders of the research that I do. Additionally, having a formal collaboration with the Committee on Professional Training is now another avenue for my research group to be able to reach out to chemists regarding our important work on graduate education. Finally, I have also established relationships with Dow, Ecolab, and BASF as well as the University Industry Demonstration Partnership (UIDP) in hopes to create a network for Ph.D. chemists to complete summer internships with industry.

4. SERVICE

a. University Service

University-wide

IRB Discussions. I have continued to spend a significant amount of time meeting with a handful of other faculty and administrators to discuss ongoing issues with the IRB, which have marginally improved.

Scientific Reasoning Assessment. I continued serving on ad-hoc committee to revise and implement the scientific reasoning assessment with Dr. Megan Good, Director of Academic Assessment.

New Faculty Scholars Mentor. I served as a mentor for the New Faculty Scholars Program in the Biggio Center.

College of Science and Mathematics

DBER Faculty Search – Physics. Search committee member: helped draft job advertisement and disseminate the opportunity, filtered applicants and participated in video interviews

DBER Faculty Search – Biology. Search committee member: helped draft job advertisement and disseminate the opportunity, filtered applicants and participated in video interviews

Host, Dr. Tim McKay & Charles Hendersen. Hosted DBER speaker for COSAM events. Co-hosts: Karen McNeal & Cissy Ballen.

Department of Chemistry and Biochemistry

Graduate Student Internships at Ecolab. Made contacts with chemical industry (Ecolab) to start up an internship program within the department so students can gain industrial experience throughout graduate studies. In a post-COVID world, I plan to start these again with Dow and BASF as well.

Lecturer search. Participated in seminars and met individually with candidates.

Faculty Search. Participated in seminars with candidates.

Graduate Recruitment Committee. Contacted institutions and organizations to invite them to the invitational where I participated in most events, including presented a small talk and poster for DBER as well as serving as a judge for poster competitions.

Host: Dr. Sonia Underwood & Dr. Scott Lewis. Hosted departmental colloquia speaker.

b. Professional Service

Chairman, Younger Chemistry Education Scholars (YCES). The YCES is a subcommittee of the Division of Chemical Education, itself a division of the American Chemical Society. YCES is among the most active committees in the division and we interface with hundreds of researchers in chemistry education every year through formal networking events. At this year's Biennial Conference in Chemical Education, I spearheaded the organization of a symposium series consisting of three different symposia. This, in addition to the two symposia that we organize every year, means that I was actively a part of organizing approximately 70 research talks at national conferences. We also are actively recruiting undergraduate students into educational research fields, host professional development events at national meetings, and collaborate with the Education Office at the American Chemical Society.

Affiliate Member, Chemistry Education Research Committee (CERC). The CERC is a subcommittee of the Division of Chemical Education, itself a division of the American Chemical Society. CERC and YCES have increasingly grown close and I end up collaborating on many of their projects, requiring me to attend their meetings as well.

Secretary, Auburn Local ACS Section. I have served the Auburn Local American Chemical Society section throughout this year, which includes taking minutes during meetings, interfacing with the membership to organize and dissemination information about key events, and hosting the elections. I was elected to another term for 2019.

Articles Reviewed (34)

Journal of Chemical Education (20); Chemistry Education Research and Practice (9); and International Journal of Science Education (4), Science Advances (1)

Grant Proposals Reviewed (17 full proposal, 4 summaries)

2017 National Science Foundation, Innovations in Graduate Education (IGE) Panel (9 reviewed, 26 on Panel)

2018 National Science Foundation, Innovations in Graduate Education (IGE) Panel (7 reviewed, 19 on Panel)

Auburn Down-select for NSF Advancing Informal STEM Learning (4 proposal summaries)

Red-Team Review (informal review of grant, 1 proposal)