STEM and WAC/WID: Co-Navigating Our Shifting Currents

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Since its emergence in the late 1970s in the United States as a coherent scholarly and programmatic enterprise, writing across the curriculum/writing in the disciplines (WAC/WID) has been invested in shaping how writing is taught and used as a tool for teaching and learning in STEM (science, technology, engineering, mathematics) (Russell, 2002). Through this evolving relationship, WAC/WID has gone from informing the design, implementation and assessment of individual writing assignments in the STEM classroom (Bean, 2011) to entire programs in quantitative reasoning (Condon & Rutz, 2012), and through a paradigm that increasingly foregrounds not just faculty development but the student learning experience (Nicholes, 2018). Meanwhile, both WAC/WID and STEM education are separately evolving in response to shifting currents in and beyond higher education, including deeper consideration of students' racial and linguistic identities (Perez-Felkner & Gayles, 2018; Poe, 2013) and deeper skepticism toward conceptions of disciplinarity that have for decades defined both STEM and WAC/WID and the relationships between them (Gere, et al., 2015; Hawkins, et al., 2018; Rademaekers, 2015).

With the understanding that such shifts warrant a constant revisiting of how STEM and WAC/WID can continue to learn from and contribute to one another's advances in teaching and learning, this special issue of *Across the Disciplines* seeks to address a range of concerns that remain in need of systematic exploration:

- WAC/WID as both an original and evolving high-impact practice (Boquet & Lerner, 2016) that speaks to advances in STEM around student engagement, success, persistence, and retention (e.g., Hanauer, et al., 2016; Elrod & Kezar, 2016);

- Where threshold concepts in writing, WAC/WID, and STEM connect, diverge, or conflict (Anson, 2015; Thornton, 2020);

- How WAC/WID encourages us to think of STEM as a broader set of literacy and critical thinking skills and not through an overly narrow disciplinary lens, and vice versa (e.g., Bruce, et al., 2016; Gere, Knutson, et al., 2018; Roozen & Erickson, 2017);

- Supporting teaching and learning in STEM in different programmatic spaces (e.g., co- and extracurriculum, learning centers, graduate education) and institution types (e.g., Minority Serving Institutions, polytechnics, two-year colleges)

- Advancing equity, inclusion, and belonging, and becoming more responsive to the needs of a fuller range of STEM learners (e.g., Chen, Hand, et al., 2013; Chen, Mejia, et al., 2019; Emerson, 2016; 2019; Hendrickson, 2016; Knight, et al., 2008; Mallette, 2017; Pugalee, 2001; Simpson, et al., 2015; Stroumbakis, et al, 2015).

The Contributions

Advancing WAC/WID's continued search for more equitable ways to support multilingual writers in higher education, Keira Hambrick and Genie Nicole Giaimo kick off this special issue with "Understanding the Challenges and Needs of International STEM Graduate Students: Implications for Writing Center Writing Groups." In their multi-year, mixed-methods survey analysis with a large sample size, Hambrick and Giaimo report quantitative results suggesting noteworthy differences between what domestic and international STEM graduate students want from writing groups, pointing to a need for more classroom-based instructional support in order for STEM students more generally and international students especially to make the most out of writing center support services like writing groups.

In the next contribution, "Sustainable Writing Support in a Second Year Pharmacy Course," Cristina Hanganu-Brexsch, Justin Everett, Trisha Egbert, Lisa Charneski, and Gary Sloskey study the kind of classroom-based intervention that Hambrick and Giaimo's findings suggest STEM students might need more of. Their multi-year integration of writing instruction into a second-year course at a pharmacy college focused on supporting writers' acquisition of health science reasoning skills and writing knowledge. The authors' analysis of student assignment scores and survey results indicates statistically significant increases in writing scores year after year during the collaborative effort between writing and pharmacy faculty.

At a different STEM-focused institution, Meghan Velez's "Like Speaking a Blueprint: STEM Writing Tutors' Disciplinary and Writing Identities" explores the benefits of providing peer-to-peer writing support in the writing center not just for the STEM writing student, but the STEM writing tutor as well. Upon analyzing consultation observations and tutor interviews and bios, Velez concludes that writing centers provide spaces for STEM writing tutors to leverage rhetorical knowledge and the activity of peer tutoring toward the co-construction of disciplinary identity in ways that STEM majors (as opposed to humanities majors) are uniquely positioned to do.

Further exploring disciplinary enculturation, Bruce Kovanen, Nicole Turnipseed, Megan Mericle, and Kevin Roozen trouble the boundaries of disciplinary identity and literate activity in "Tracing Literate Activity across Physics and Chemistry: Toward Embodied Histories of Disciplinary Knowing, Writing, and Becoming." Synthesizing findings from two distinct but complementary case studies of STEM students conducted at two separate R1 institutions—analyzing a range of data, including texts, talk, gestures, and images—the authors spotlight the embodied, culturally enmeshed, and sociohistorically distributed nature of literate activity and identity development in STEM, as well as the need teach writing in STEM in ways that embrace these more complex conceptualizations.

Shifting scope to a 200-participant, mixed-methods study of information literacy among natural, environmental, and health science and pre-pharmacy majors at a private R2 university, Kristin M. Klucevsek, in "Writing with Research: Understanding How Students Perceive Sources in the Sciences," reports a gap between what students know about primary research articles and how effectively they can integrate them into their writing. After analyzing surveys, paper samples, and reflections, Klucevsek identifies several points at which threshold concepts in writing studies, STEM, and information literacy overlap in ways that might be conductive to teaching source use earlier and more effectively to STEM majors.

In "Lecture, Discussion, Group Work, Repeat: Using Aerial Photography and Machine Learning to Study the Use of Writing-Related Pedagogies in STEM Courses and Their Impact on Different Student Subgroups," Julia Voss, Navid Shaghaghi, Andres Mauricio Calle, Kristin Lee, and Liam Abbate bring STEM methods to questions about the impact of writing pedagogies on STEM teaching and student learning, using machine learning to analyze 18,000 aerial classroom photos and student grade/demographic data representing 18 courses across five STEM disciplines at a private liberal arts university without a WAC program. Their study arrives at several insights, including a statistically significant negative association

between the variables of grades and lecture formats for international students while, at the same time, a significant positive association between these same variables for domestic learners.

Suzanne Lane, Atissa Banuazizi, Malcah Effron, Leslie Roldan, Susan Ruff, Jessie Stickgold-Sarah, Michael Trice, and Andreas Karatsolis, in "Mapping the Relationship of Disciplinary and Writing Concepts: Charting a Path to Deeper WAC/WID Integration in STEM," present disciplinary reasoning diagrams as a method for making implicit disciplinary communication knowledge explicit for faculty and students. Drawing upon focus group data collected during the refinement of a materials science and engineering diagram at a large private polytechnic institution, the authors share three additional diagrams developed using the same methodology, as well as evidence in the case of a computer systems diagram for how students used it and perceived its usefulness.

Soyeon Lee and Shuo Zhang's "'We Are What We Eat': Adopting Recipe Writing as a Boundary Object of First-Year Writing and Nutrition Courses" involves a case study of a pilot collaboration between Composition I and Nutrition courses at a community college. Focusing on interviews with and writing samples collected from two international, multilingual students, Lee and Zhang observe how recipe writing afforded these students an opportunity to employ their own cultural and linguistic resources to integrate what they were learning across these two courses.

Finally, Thomas Deans, in "What Can We Learn About WID From Exceptionally High-Achieving STEM Majors?" analyzes 16 interviews with high-achieving undergraduate STEM majors at a public research university, arriving at the observation that these students tended to identify as most meaningful those writing experiences that afforded them greater agency, more feedback, and a novel experience. In closing, Deans extrapolates some recommendations for providing students more meaningful writing experiences in STEM.

Takeaways and Future Directions

This special issue captures only a snapshot of the valuable scholarship proliferating at the intersections of WAC/WID and STEM. To narrow down our scope, we aimed to spotlight research that examined the impacts of various interventions on students, while also taking pains to represent a range of institutional and disciplinary contexts and methodologies. This special issue evidences that while WAC/WID scholars might still be more inclined toward qualitative methods, they are not nearly as predominant as they are sometimes made out to be, especially, perhaps, when involving research on writing in STEM. Instead, this special issue showcases innovative mixed-methods approaches alongside advances in qualitative research that render richer portraits of literate activity and identity development in STEM, hopefully highlighting the value that each methodological orientation offers the other.

Furthermore, the studies presented here tended to represent more organically evolving WAC/WID interventions outside the bounds of institutionalized WAC/WID programs, suggesting that STEM and WAC/WID have a long way to go toward formalizing partnerships within sustainable institutional frameworks that are more capable of supporting the incredible amount of innovation and labor represented by the work collected here. At the same time, our focus in this special issue on impacts on student learning omitted a larger body of scholarship measuring impacts on faculty mindsets and teaching as well as program design, so future collections might more specifically take up these areas for exploration.

Lastly, through rich qualitative description and through large-scale quantitative analyses, the studies included in this collection open pathways for better serving a more racially, culturally, and linguistically diverse spectrum of STEM learners, frequently by calling attention to what we need to better understand and implement. In this respect, we hope this special issue is just the beginning of a more robust conversation about where the aims of WAC/WID and STEM, teaching and learning interventions, and qualitative and

quantitative methodological frameworks might converge with greater consideration toward equity and inclusion.

Acknowledgement

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