Internationalizing Writing in the STEM Disciplines

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Abstract: Given that STEM professionals must regularly engage in transnational and cross-cultural communication, learning to write in their academic disciplines and professions means learning to navigate World Englishes, employ diverse sociolinguistic and rhetorical resources, and negotiate meaning across linguistic and sociocultural borders. Analyzing interviews conducted by using a Grounded Theory method among engineering faculty members and their graduate students at a large public university in the US, this article first discusses a few stated beliefs about language and writing that don't reflect realities about communication in the STEM fields. Drawing on the participants' description of teaching/learning and communication practices in follow-up interviews, the article then offers recommendations to promote the acceptance of complexity and rhetoricity of scientific communication in place of dominant perception that the sciences only use a transparent and universal code of standard English. Further, it recommends specific ways for writing scholars to shift focus from ideology to practice, arguing that doing so can aid research, program, and pedagogy of writing in the disciplines (WID) and writing across the curriculum (WAC), thereby helping promote cross-cultural and transnational communication skills in the STEM fields.

Introduction

In the STEM fields, the dominant belief about writing is that it should generally use a simple, clear, and universal standard English. Such a "monolingual" view of language and writing (Horner & Trimbur, 2002; Canagarajah, 2006, 2009; Lu & Horner, 2016) fails to account for what happens in many communicative contexts within those fields, such as at academic conferences, in academic-industry partnerships, when communicating science to the local public, in emerging modes of electronic communication that are open to global audiences, and in transnational academic and professional communication. Aside from certain genres like the technical manual and the journal article in conventional venues, STEM professionals regularly and productively use different World Englishes, employ diverse sociolinguistic and rhetorical resources to engage different stakeholders in different contexts and for different purposes, and negotiate meaning in process and across contexts. The co-construction of meaning in process (Canagarajah, 2009) involves different languages or varieties of English and sociolinguistic/semantic resources in them—especially when discourse participants are from different cultural and national backgrounds—rather than being limited to a supposedly universal "technical" code. As such, writing education for students in these fields needs to counter the dominant discourses that are reductive and monolingualist in order to help promote the understanding that like all discourse, scientific communication is rhetorically contingent on different contextual factors, as well as linguistically varied across societies and cultures. Part of the intervention can begin by studying writing and communication in the sciences that—in spite of persisting arguments—in practice does respond to the increasingly diverse and internationalized world of science and technology.

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Traditionally, writing scholars have focused more on "beliefs" and "discourses" about language and writing among members of other disciplines than on their "practices," thereby producing more scholarship in the former area (Anson, 2008, p. 32). For this reason, shifting our focus from what scientists say "about" language and writing to how they "use" them can help us recognize how scientific communication is practically broadening and complicating the use of language and writing as it happens increasingly across national and cultural borders. Such a shift can also help writing researchers identify teaching and learning practices that already respond to internationalization of scientific writing and communication and find ways to help STEM students and faculty treat writing as both product and process, content and rhetoric, text and communication. The shift could also prompt scientists to engage issues of language variation, rhetorical complexity, and international/cross-cultural communication, regardless of the metalanguage that they use. In short, when writing researchers go beyond what STEM professionals believe and state about writing to current realities and practices, multilingual and translingual communicative practices become more visible, allowing them to find new pathways for better conversation and understanding toward countering roadblocks created by reductive monolingual discourses and ideologies about language and writing that continue to persist in spite of change in practice.

This article aims to illustrate that the monolingual orientation of STEM disciplines is both the product of the disciplines' ideologies regarding language and a construct created by writing scholars' focus on beliefs (instead of practices). Discussing the findings of an interview-based study among engineering faculty and students at a public university in the US, I argue that shifting the focus to practice can help the research, programming, and pedagogy of writing in the disciplines (WID) and writing across the curriculum (WAC) facilitate the "internationalization" of writing (as defined below) in STEM fields. Consequently, the article shows how exploring the productive tensions between prevalent ideologies on the one hand and emerging realities and communicative practices on the other can help writing scholars theorize and develop effective interventions with writing programs and pedagogies that foster writing and communication abilities for an increasingly diversified and globalized world that STEM students face in academia and the professions outside.

As noted in the call for papers for this special issue, the broader context behind this article is that of higher education where "international experience and international competence in terms of communication and cultural understanding have become extraordinarily important to the newest generations of undergraduate students." As the call further indicated, universities in the US and around the world are actively seeking to internationalize their curricula, in the sense of integrating knowledge, skills, and perspectives from more than local and national contexts so that students are able to work and succeed in an increasingly globalized world. Higher education today seeks to inculcate in students "global competencies" and a sense of global citizenship so that students are more capable of engaging with people, challenges, and opportunities beyond the borders of their local language, their nation state, and their culture.

In the context of WAC/WID pedagogy and programs, these educational objectives can be achieved by promoting knowledge, skills, and disposition in favor of communication across borders. In this context, internationalization involves teaching/learning about global/international issues (content knowledge), cultivating an interest for addressing globally shared challenges (disposition), and developing skills for communicating and working with people and social institutions across national/geopolitical and cultural borders. The last of these goals is clearly within the professional domain for writing teachers and scholars given how they can contribute to the broader goal of internationalizing higher education by defining "global competencies" in terms of multilingual and translingual skills. Writing teachers can contribute to STEM education by addressing the particular tension between, on the one hand, a persistent monolingual, universalist ideology described above, and on the other, the fact that these fields are also quite diverse and are globally connected both in academia and the professions.

Methodology

This article is based on the analysis of data gathered for a larger interview-based study that examined the effects of apparently reductive ideologies about language and writing on teaching and learning of academic/professional writing among a group of engineering scholars and their graduate students. Contextualizing some of the key findings of that study against the emerging discourse about internationalization of higher education, this article analyzes the data set with the focused objective of illustrating the influence of language ideologies in the STEM fields, the tension between belief and practice about language and writing in them, and the prospects of using writing education to promote communication practices in those fields in an increasingly globalized world.

In the larger study, five foreign-born and nonnative English speaking (NNES) faculty members from across a school of engineering at a large public university in southern United States and one each of their graduate students (also NNES and international) were recruited through email-based solicitation following a preliminary survey and snowballing of contacts. The central research question of the study was whether international faculty members and graduate students within STEM fields, whose numbers have rapidly increased in the past few decades in the United States (IIE, 2016), are more tolerant of language variation (specifically "non-standard" English) and more savvy about rhetoricity of language and writing in their disciplines. The study was designed by using Grounded Theory (Corbin & Strauss, 1990; Charmaz, 2006) methodology for data collection and analysis. As such, data gathering and analysis were allowed to gradually shift focus from the participants' beliefs and arguments about language and writing toward intriguing gaps between what they said "about" language and writing (especially their variability, rhetoricity, and complexity) in early interviews and how they described their own language use and writing practices in the more in-depth follow-up discussions. The potential of Grounded Theory approach for unraveling such layers of findings is documented by Sophie Soklaridis (2009). Complicating initial responses, more in-depth discussions based on samples of participants' own writing revealed rich practices of language use and writing. Discussion of the samples also changed researcher-participant relationship and created more room for conversations about writing processes, stylistic choices and variations, and issues of audience and crossing borders (See Kirsch, 1992; p. 261). For instance, contrary to my assumptions regarding the participants as multilingual individuals with transnational/cross-cultural experiences in life and education, the participants embraced what writing scholars have described as "monolingual" views about language (e.g., Horner & Trimbur, 2002); their stated beliefs about language and writing were shaped largely by what writing scholars have described as prevalent "myths" (Russell, 2002) in their academic disciplines. However, the practices that they described in more in-depth and less formal later interviews revealed tensions between stated belief/discourse and described practice. This article specifically explores how the practices and experiences of using language and writing as tools of communication as described by the participants interacted with the dominant discourses and ideologies about these tools in their disciplines.

In the early interviews with all of the faculty and students, there were also considerable amounts of resistance, gaps, and tensions in their stated beliefs. They often told me that their view of writing is different from "you English people" (in the words of one of the faculty members). The attempt to define language and writing in contrast to how they believed I defined them may have contributed to simplifications and ideological overtones about language and writing in scientific communication. Similarly, participants often described what they considered good practices instead of their actual practices of teaching or learning to write (See Yin, 2011; esp. p. 134). To counter these challenges, I tried to build some rapport through additional, less formal meetings, including some off the record. I also started second and subsequent rounds of interviews by asking the participants to focus on (and, where possible, to show materials about) how they taught or learned writing and the language/discourse of engineering. These strategies further helped to shift the attention from belief to experience, from ideology

to practice. After establishing rapport with participants (See King & Horrocks, 2010), "cultural gaps" regarding disciplinary differences were brought up during later interviews when I asked the participants to "help me understand" those gaps. I also asked participants to "tell me what you would recommend" as solutions to problems that would be addressed within the context, priorities, and limitations of their discipline. Assuming a participant-observer role, rather than taking a detached observer's approach, was useful in making the data from later interviews and informal discussions richer and more reliable.

This article uses the same data analysis method as the larger study, particularly focusing on the "constructivist grounded theory" method for coding, finding patterns, and theming the data as described by Kathy Charmaz (2006). For this work, I have focused most on the method's "constant comparison" of codes as they emerged in multiple iterations of coding, starting with in-vivo codes (or words used by the interviewees), then developing axial codes (interpretive terms that helped me compare initial codes toward developing specific themes), then creating emergent codes for theming the data and developing the theory (or the arguments drawn from data analysis). Grounded theory analysis was particularly productive in exploring the tension between how the engineering faculty and students described language and writing (as transparent tools of communication) versus how their discussion of practice (communicative use, teaching, and learning) treated language and writing. As I more fully explored that tension in the context of increasing internationalization of higher education in general and the STEM fields in particular, this approach to data analysis also allowed me to consider the implications of that tension through the lens of emerging discourses on translingualism and internationalization of writing education.

Beliefs and Blind Spots

Describing the history of writing in the academic disciplines in the US between 1870 and 1990, David Russell (2002) highlights two "myths" (or problematic beliefs) that have become prevalent across many disciplines. When generally describing language and writing as a means of scientific communication, the majority of participants in my study essentially argued, especially in earlier interviews, that they are transparent mediums for encoding ideas that can be learned before and outside of advanced disciplinary and professional communication. Their terms for conveying this idea included: clear, simple, straightforward, logical, and "like it is." They generally denied that scientific communication often demands flexibility in language and complex rhetoric, creating tensions between both belief and reality, and ideology and practice. This section describes several dominant discourses about language and writing that were present among the participants based on initial interviews and then discusses how these discourses represent a belief system and ideologies in the discipline, rather than its communicative and teaching/learning practices.

The Myth of Transparency

The most prominent belief about language and writing that the engineering professors and their students expressed is what writing scholars call the "myth of transparency," a term that David Russell credits to Susan Miller. This view of writing, as Russell (2002) demonstrates, developed from changes within higher education since the establishment of universities, especially with the emergence of disciplines and specializations based on similar models in industry. Even though writing has changed from a supposedly "single, generalizable skill learned once and for all" to a "complex and continuously developing response to specialized text-based discourse communities" (p. 5), members of the academic disciplines continue to consider writing as "transcribed speech," giving rise to "a conceptual split" between content and expression. Both the professors and their graduate students in this study generally defined language and writing as transparent mediums, arguing that scientific writing must avoid rhetorical complexity and

linguistic variations. In a comment that is fairly representative of how all the participants defined language, a mechanical engineering professor said:

> … journal papers that are published [in our field], they have some basic standards for writing. As long as you meet those basic standards, as long as it looks good, you basically think that it is publishable. Mainly the content is the most important.

The professor's emphasis on "basic" and "standards" underscores the belief that language and writing need to be simple and straightforward so they don't complicate scientific communication. Because "content" is distinct from language in this view, writing becomes a matter of form that must "look good" (meaning simple).

One student took the idea of "transparency" of language in scientific writing further when he said that engineers should try to convey as much information as possible through images: he argued that images convey messages without complicating reality like words do. Dorothy Winsor (2003) discusses similar accounts of writing among engineering students who considered it as a tool for conveying data simply and describing reality objectively; she notes that this is how the tenets of their disciplines have shaped their understanding of the function of writing. Other scholars have also discussed the prevalence of reductive views about language and writing in the sciences (e.g., Haas & Witte, 2001; Herrington, 1985; Jenkins et al., 1993; Jordan & Kedrowicz, 2011; Reave, 2004; Turner, 1999; Winsor, 1996; Zhu, 2004). The advisor of the student who referenced transparency similarly emphasized "clarity" as a prime quality of effective writing in engineering:

> I would tell my students … [to] make it as *clear* as possible, as concise as possible. . . . I think good writing in my discipline would be, in my opinion, written very *clearly*, short sentence, simple way, simple writing, and concise. (emphasis added).

The idea that all scientific writing must be clear and simple becomes problematic when we consider that today, academic and professional communication occurs in increasingly globalized, multilingual, and cross-cultural contexts. Firstly, scientists and engineers work across national and cultural borders (perhaps more than professionals in the humanities and social sciences); this requires an understanding of the material, social, and even cultural contexts of fellow professionals as well as other audiences and stakeholders. Transnational communication introduces linguistic variations, ambiguity, and complexity that one must learn to navigate rather than trying to avoid. Secondly, academic and professional writing by STEM professionals increasingly demands translingual understanding and competence because of the increasingly diverse membership of these professions, a diversity amplified by globalization, differing World Englishes, and increasing demands for virtual collaboration. Thirdly, because of the shifting distribution of geopolitical powers on a global scale, transnational and cross-cultural communication may be different in terms of whose language, culture, context, and perspectives are considered the norm.

As Ian Barnard (2010) notes, the insistence on clarity raises the question as to "[w]hat travels under the sign of 'clarity'…? What is foreclosed by the insistence on parochial standards of transparency as requisite for all communication? What does 'transparency' keep obscure?" (441). This is problematic when scientists engage in complex rhetorical acts across linguistic and sociocultural borders while telling their students that scientific communication must avoid linguistic and rhetorical complexity. For instance, if a scientific grant project is funded by a Chinese university, a planning meeting is happening over Skype, and an Indian professor is principal investigator leading a team of mostly Americans, the dynamics of language use and translation, context and culture, power and privilege in that team's internal communication would be different from communication in an imagined monolingual context where everyone uses standard English and similarly understands issues in the project. In fact, complicated communicative dynamics are increasingly becoming the norm rather than exception even within US

academia and the professions, particularly in the STEM fields. To quote a scientist who highlights the importance of rhetoric in scientific communication, "the decision [of the scientific community] to commit public resources [for engaging the public] is attributed to numerous goals including a need to improve teaching, training, and learning, a desire to diversify the scientific workforce and an aspiration to increase public understanding of science" (Vernon, 2014; p. 3). As Vernon suggests, acknowledging and exploiting the value of language and rhetoric can help scientists convey information and help achieve these goals. Writing education that promotes these values can be enhanced by drawing on and describing the communicative practices of scientists themselves and revealing the shortcomings of the dominant discourse.

The Myth of Simplicity

An extension of the myth of transparency is what I call the myth of simplicity. A belief that conflates clarity with simplicity, this notion also undermines the internationalization of academic literacies in the STEM fields by urging writers to seek a rigid universal medium. Ranging from a new Chinese international student who had limited experience writing in English to a professor who had come to the US at the age of seventeen almost forty years ago, most participants in my study used "simplicity" and "clarity" synonymously. One of the more advanced doctoral students said: "I would say, like, language is not the most difficult part; the difficult part is probably the logic and how to explain a complicated system very concisely and very clearly." He argued that scientists communicate most effectively when they avoid complexity in language. In reality, while clarity of writing does come from clarity of thought, simply avoiding complex language is not possible in all instances of communicating complex scientific ideas. Most of the professors and their students, however, separated language from content, deprioritizing language and rhetoric vis à vis content and logic. For instance, a professor emphasized simplicity thus: "Yeah, I tell [students] to keep their writing very, uh, simple, because they need to be able to convey their ideas in a very succinct manner, but also keep it simple, just say it like what it is." His argument was also that clarity and conciseness of language came not from a writer's ability to effectively handle complex content but from avoiding complexity altogether. Most participants argued that if a writer focuses on the content, keeping language simple, writing always becomes effective.

These beliefs about simplicity and clarity are an ideological construct of the sciences and are problematic for communication in globalized contexts. In terms of how power and politics shape beliefs and discourses, this construct favors the language variety of a dominant group of English speakers and helps maintain a hegemonic belief system thus limiting access and awarding privilege to those who have a greater facility with the standard variety of the language. Writing scholars have explored various problems regarding this expression of monolingualism recently (e.g., Canagarajah, 2002, 2009; Horner & Trimbur, 2002; Prendergast, 2013; Lillis & Curry, 2010). Promoting views about language that are more amenable to global communicative competencies will require creating more equitable communicative conditions between users of different World Englishes, fostering respect for different rhetorical practices, and educating students in one country and context to better understand academic and professional communication in others.

In the context of WAC/WID programs and pedagogy, the idea that all scientific writing needs to be simple adversely affects teaching and learning practices; if effective writing is to just "keep it simple," then there is no need to teach complex language for complex scientific communication. As Rude (1992) pointed out, this ideology of clarity is generally used for defending science against the muddy rhetoric of the humanities. This defense of the objectivity of science against the vagaries of language was manifest in responses to a variety of questions when the participants directly or indirectly defined language used in engineering writing. Faculty members shared more complicated responses to other issues during subsequent interviews, but when it came to good writing, their responses boiled down to the fundamental notion of "clarity." While the writing practices that the participants described in later interviews were

evidently more than simple reporting of facts and information, the beliefs and arguments about language and writing did seem to impede the teaching and learning of writing.

The demand for simple-only writing assumes that there is a homogenous global norm that readers and writers across the world must use. This demand, based on the belief that "scientific" language can and must be universally standardized, belies the variation and complexity of its use in the real world in which STEM professionals work and communicate, within and across national borders. Students only benefit when they become aware of the complexity and fluidity, of language as disciplinary knowledge is shaped by and travels across sociocultural contexts. Today's students need the ability to navigate complex dynamics of language and communication even within scientific communication in academia and professions beyond.

The Myth of Transience

The third belief that prevails in the STEM fields is what Russell (2002) calls the "myth of transience," borrowing from Mike Rose (1985), who described it as the belief that writing is learned once, ideally before entering higher education in order to learn the content of particular disciplines. Most participants generally echoed the prevalent belief that if a student hasn't already learned enough "writing," he or she will gradually get there (writing will "happen"). They seemed to assume that writing is a generalizable skill that can be mastered independent of specific contexts of advanced disciplinary discourse. What Russell and Rose called the myth of transience manifested in the following ways in the NNES scholars' response to my question about how NNES students learn to write: (i) If students focus on the "logic" and content of the discipline, the challenges with writing will gradually but automatically disappear; (ii) Proficiency for all scientific communication is gained once clear and standardized writing skills are achieved; and (iii) NNES students can overcome their challenges with writing in their disciplines by eliminating language variations as well as errors.

Beliefs about clarity and simplicity extended into the idea of transience in that once engineering students acquired sufficient "simple" language, it was believed that they were able to write well. In fact, they would also be able to avoid language variations and errors once they learned the simple and clear universal code of standard English for all scientific communication. For example, a chemical engineering professor argued that she learned to write well after being in an English speaking academic community and society for a certain period of time:

> I think [language problems hindering effective writing] can be overcome probably within five years, assuming that five years is their PhD training. [In my home language], we don't use articles as much as … Americans do. . . . It's just by, you know, by staying in America... using this language forever, you just automatically know about it.

She suggested that once she eliminated deviations from standard English, which she seemed to conflate with "errors," effective (meaning error-free) writing began to happen. When students discussed their struggles with writing, they too described having "not yet" learned general writing skills rather than recognizing that they must continue learning increasingly advanced and specific rhetorical skills throughout their careers in science.

Russell (2002) relates this belief to the historical development of general education writing programs: "In the rush to find a single comprehensive solution, academia never systematically examined the nature of writing or its potential for improving learning" (p. 9). Because writing programs came to be seen as a specialized place for fixing writing, the programs are expected to inoculate all students against errors and unnecessary complexity. Other WID scholars have highlighted this belief in relation to the low priority accorded to the teaching and learning of writing in the academic disciplines as a result of reductive

understanding of the role and nature of writing (e.g., Carson et al., 2000; Jordan & Kedrowicz, 2011; Krase, 2007; Kranov, 2009; Leydens, 2008; Winsor, 1996, 2003; Zhu, 2004). As Winsor (2003) pointed out, engineering scholars, for instance, claim that their writing does not rely on the interpretation of facts, use of arguments to persuade others, or use of language to represent reality in ways that are shaped by context-specific discourses and perspectives. Based on the "epistemologies and ideologies of their disciplinary community" (p. 7), they view writing as a rather straightforward recording of thought. Richard Burnett (1996) described how simplistic views about writing affected teamwork among engineering students: their project gradually became dysfunctional because they did not consider writing as necessary or useful in helping them explore, consolidate, and represent their learning until there was a crisis in the collaboration and project completion.

When viewed in the context of cross-cultural and transnational communication, the myth of transience can adversely affect students' development of fundamental communicative skills. If our engineers and scientists believe that it only takes one course or one stage of development to become successful academic and professional communicators in a globalized world, they will seem unaware and insensitive about language use in different contexts when they move on to new workplaces beyond their local contexts and cultures. Scientific ideas and methods may be universal, but their social and professional applications are contingent upon local realities and perceptions, value systems and interests. Today's scientists must also understand global issues and contexts in order to be able to engage in academic and professional communication across national, geopolitical, and cultural borders. International collaboration critically depends on successful cross-cultural communication, which cannot be learned once and for all in a single course or degree. The ability to analyze scientific problems by using different perspectives, skills for adjusting writing for different audiences and interests, and even a facility with different languages (or language varieties) are becoming increasingly necessary for successful careers in science and technology, as well as business and social sciences. A sense of global citizenship, undergirded by the ability for cross-border communication, can greatly enhance the success of science professionals on the global stage. As this sensibility is evidently becoming more important and advantageous for students here in the US, writing programs and pedagogies are needed to foster associated skills among students in all disciplines, including the STEM fields.

The Myth of Universality

The participants also shared a fourth belief about language and writing that seemed to further undermine the promotion of cross-cultural and transnational communicative competencies. During the final round of interviews, I explicitly asked them why, even as multilingual scholars, they believed in and demanded a universal English standard. Their explanations were straightforward: English is a universal language of science and there is a clear and concise version of standardized "technical" English that best serves the purpose of scientific communication. One chemical engineering professor argued that a universal standard is just a logical need for science:

> So, yeah, you want to gravitate towards one linguistic style, because it is simple and everybody can understand that. . . . I mean everybody understands and everybody is forced to gravitate towards [standard] English. Yes, of course, you can have someone from Thailand, or from South America, have their own linguistic practices. But their work is not going to be accepted because … they have not actually presented their ideas in [standard] English. . . .

Other participants implied that there is (or must be) a certain standard English as a "global" language for scientific communication. At first, the responses were surprising to me because the participants were scholars and students who used recognized varieties of world Englishes, including Indian English, Chinese English, and Chicano English. Some of them acknowledged that NNES writers bring different writing

styles and varieties of English into scientific communication. But they still insisted that variations should be ultimately eradicated. As one of the professors argued, engineering and technical writing cannot accommodate variation because it "has to be concise, accurate, straightforward. So, writing is not about, to me, it's not about English. … It's more about the thought process." By shifting the focus from language to "thought process," she denied language variation a place in engineering writing.

From the perspective of the politics of language that writing scholars have developed especially in the past two decades, the multilingual scholars' enforcement of monolingual standard of academic English is a perfect example of hegemony where marginalized groups seek to exert their agency by accepting and enforcing the dominant hierarchy of power. One of the professors, in fact, stated that a unified global norm is necessary and desirable: "So, it's this argument between melting pot and a mosaic, right, about culture. . . . you can't have a mosaic in writing. You just wouldn't-- maybe there is instead a melting pot, [even though] the pot changes ever so slowly." Asked whether different varieties of English—such as British, American, Indian, and Chinese—have failed to coexist in the world of scientific communication, he said, "Not in writing, I don't think." The argument reflects the privilege that successful multilingual scientists have as members of a global academic and professional community. While describing a reality and expressing a legitimate desire to keep scientific communication universally consistent, this also embodies a language ideology that seems innocuous in itself. It demands a condition that is not realistically achievable without exacerbating unequal access to publication and other contributions to the advancement of science across national and social borders.

The demand for a rigid universal set of norms only discourages and excludes many from contributing to science in the first place (See Huang, 2010, for a review of scholarship on this issue). Beyond describing the denotative function of language, this demand rejects the possibility of glosso-diversity, or the enriching of meaning brought about by diversified language standards. Successful professional writing from different linguistic and sociocultural backgrounds cannot, in reality, be limited to monolithic and universalist terms because this will also fail to engage different audiences, work in different contexts, and serve the different rhetorical purposes of scientific communication. "Scientific English" is not just the standardized and edited English of research articles in journals but also the language of emails and reports written across world regions. American scientists need to be able to understand papers and presentations of Indian and Japanese scientists when attending academic conferences in Turkey or collaborating with fellow scientists in Brazil. As such, the belief that scientific writing follows a simple, universal code not only encourages multilingual STEM students to try to eliminate linguistic variation, it also undermines all their efforts at learning about the increasingly complex modes of today's scientific communication.

Why the "Myths" Matter

In spite of their justifications in the name of universality of scientific discourse, these language myths are less and less able to describe the reality of professional and academic communication among scientists today. For instance, Katehi (2005) states that in the span of a few years, the US engineering workforce has experienced trends that could not have been anticipated ten or twenty years earlier: "the outsourcing of mainstream engineering jobs; increasing reliance on foreign-born Ph.D. graduates; and the need for retraining engineers to enable them to change careers a number of times before retirement" (p. 151). Another emerging possibility is that "[i]n 20 to 30 years, the most popular language will not be English," meaning that multilingual and translingual skills are likely to become highly beneficial if not necessary in the future. Katehi goes on to add that US engineers of the near future may need to be based abroad and travel around the world (both physically and virtually), "will have to converse proficiently in more than one language," and because they are already outnumbered and outpaced on many fronts, they "will have to be open to different ways of thinking, and different social values. . . . U.S. engineers must become global engineers" (p. 151).

Even when we situate the argument in the context of day-to-day teaching and learning, the myths deny that both spoken and written communication in science use local idioms and references, situate science in social and cultural contexts, are shaped by contextual contingencies, and demand a range of complex rhetorical functions. Simply ignoring this reality confuses learners and undermines education because global communicative competencies are critical skills that students and scholars need. In "Paths to global competence: Preparing American college students to meet the world," William Brustein (2006) states that such competency includes "the ability to work effectively in international settings; awareness of and adaptability to diverse cultures, perceptions, and approaches; familiarity with the major currents of global change… and the capacity for effective communication across cultural and linguistic boundaries" (p. 23). Similarly, summarizing a roundtable titled "Preparing chemists and chemical engineers for a globally oriented workforce" and organized by the National Academy of Sciences, Donald Burland, Michael Doyle, Michael Rogers, and Tina Masciangiolo (2004) argue that being globally competent engineers and scientists today requires "higher-order" abilities, including "the ability to work on teams, to communicate ideas orally and in writing, and to be flexible in learning new subjects" (p. 3). They add that "[g]lobalization has added the requirement that researchers be culturally sensitive, which includes having language skills" (ibid.). Similarly, in a Brookings Review article, AnnaLee Saxenian (2002) gives the example of how the most successful US scientists and engineers are mobile, multilingual, and able to navigate different communicative cultures and contexts.

> Silicon Valley's Taiwanese engineers, for example, have built a vibrant two-way bridge connecting them with Taiwan's technology community. Their Indian counterparts have become key middlemen linking U.S. businesses to low-cost software expertise in India. These cross- Pacific networks give skilled immigrants a big edge over mainstream competitors who often lack the language skills, cultural know-how, and contacts to build business relationships in Asia. (n.p.)

Indeed, universities around the US have started responding to the demands facing future scientists and engineers in an increasingly globalized (and multilingual, multicultural) world. At Purdue University, for instance, a program named the "Global Engineering Learning Portfolio" "provides opportunities to all engineering students of Purdue through global educational initiatives that empower them to become leaders of engineering discovery, engagement and learning" (n.p.). The initiative includes study abroad, service learning work abroad, research on global issues, and global awareness at home through global-themed courses and guest lectures as well as intercultural knowledge-sharing events on campus.

The myths about language and writing continue to counter the internationalization of writing practices and pedagogies within the STEM fields, as well as creating tensions with writing support that is increasingly shaped by an appreciation of linguistic variation and complexity. As social, economic, political, and educational forces are making more complex views of language and global communicative competencies more necessary, writing programs and pedagogies are best equipped to promote understanding and practice in the STEM fields, thereby fostering translingual and cross-cultural communicative competencies among future STEM professionals.

Toward Internationalized Writing Programs and Pedagogies

Reductive beliefs about language and writing seemed to affect how the participants of my study approached writing and communication; follow-up interviews, however, increasingly revealed important tensions between belief and practice. These tensions are an important subject of study, as well as a basis for writing pedagogies for the STEM fields in the context of globalization and internationalization of higher education and the professions. Current writing scholarship focusing on discourse about language in other academic disciplines indicates the need to counter these beliefs in order to promote writing in

general. If we pay more attention to educational "practices" than to dominant discourse about language and writing among STEM professionals, it seems more productive to not simply educate away the dominant beliefs and discourses.

Writing pedagogies can be developed by looking past problematic discourses that depend on what I call "talking point response" (TPR) and identifying and building upon productive practices instead. Drawing on descriptions of communicative and educational habits by the participants of the study, I argue here that writing teachers and scholars must build on practices in order to foster awareness about linguistic variation and complexity in scientific communication and to promote multilingual, translingual, and cross-cultural communicative competencies in the STEM fields. We can discuss how writing programs and professionals can create new pathways out of the very tensions between reductive discourses and increasingly pluralized communicative demands and practices in the STEM fields. I do so by asking how globalization is affecting education in the STEM fields and what demands of communication skills faculty and students in those fields are most interested in addressing. How can WAC/WID pedagogy and programs best help STEM students to achieve the goals while taking the priorities of STEM faculty into account? What will the teaching of writing and communication skills entail when we give "global competencies" a greater priority than we do now? How can we constructively address curricular and pedagogical roadblocks created by reductive, monolingual views of language and writing? How can we best describe, teach, and promote the written and communicative competencies demanded by internationalization of higher education and the specific demands for STEM professions?

While the study was primarily based on interviews, incidental observations, samples of written work, and discussions during later interviews focused on the practice of teaching and learning and also regularly highlighted that participants actually did what they had theoretically denied in earlier interviews. When asked how they supported students in writing, professors indicated that they groomed their students towards becoming effective professional communicators in their fields in a variety of ways that went beyond simply demanding "clear" or "simple" sentences. Some professors said that they asked their students to write progress reports of their work, while others required them to come to meetings with slide presentations and explanations of their findings. One of them provided extensive feedback on writing and another let his student run meetings and do most communication with contact persons in the industry, providing support in the background. The professors essentially treated writing as involving a set of distinct skills from what oral discussion and presentation of ideas require, allowing students to start early and to gradually improve their language proficiency and understanding of writing conventions. These teaching and learning practices would be even richer without the ideologies that defined language and writing reductively, but the practices were still varied and vigorous as later described by the participants.

It was evident that while responding to the demands and opportunities of professional communication, the students gradually became competent and confident communicators who were able to engage a range of audiences in a variety of contexts and types of communication. In spite of the reductive, monolingual ideologies that they theoretically espoused, the more experienced professors in particular engaged their students in purpose-driven, genre-based teaching and learning, more or less formally and systematically. The demands of the profession, awareness of different audiences, and the need to achieve clarity beyond its conflation with simplicity often led to fairly effective teaching, learning, and doing of writing. The denial of rhetoricity, variability, and complexity often seemed to belong to a different domain altogether, that of what the participants "said" as opposed to what they actually "did." For instance, when asked what helped her "the most between the initial struggle and your current status of liking [writing]?" a student said that "by writing emails, or communicating with people, [I] feel that they are understanding [me], and that's encouraging. . . . My advisor, she let me do a lot of communication with other people. . . ." The practical engagement in writing made up for the lack of explicit writing pedagogy. Email communication situated scientific writing at the "intersection of science and society" (to use a phrase one of the professor

used for defining engineering), requiring more than a simple scientific code for communicating scientific ideas to different audiences in particular sociocultural and professional contexts.

The tension between discourse and practice prompted my research to shift focus from discourse to practice, from ideology to action. It revealed a middle ground where writing professionals could create bifocal lenses, viewing writing from the perspectives of students and scholars of other disciplines, as well as that of their own. While discussing how he approached writing, one of the professors, for instance, described a problem-solving loop involving the proverbial duct tape versus WD-40 idiom—"if it's supposed to move but it doesn't, use WD-40; if it isn't supposed to move but it does, use duct tape"—in order to tell me "how engineers think." He argued that most engineering faculty will only solve tangible problems and will adopt the most efficient approach to doing so. That is why, he argued, they let writing take care of itself unless it is necessary and justified to teach it explicitly. Similarly, he said that he would be interested in producing globally competent future scientists if he were convinced that this is a practical need and that efficient solutions can be created. Similarly, a conversation with an advanced graduate student indicated how writing programs and teachers could identify or build pathways in spite of the ideological roadblocks described above. Praising her professor for giving her the opportunity and challenge to develop professional writing skills, she said: "Some professors, probably, they do [the communication] all by themselves; they don't ask students to do that a lot." In contrast, "my adviser let me do it and she let me take a lot of responsibility in the lab, like waste management, and for that you have to communicate with a lot of people." Her professor also took her to meetings with other professors "so I watch how to communicate." The more advanced she became in her discipline, the more conscious she was about the demands of writing for different audiences and purposes as a professional engineer. She was describing an on-the-job approach to learning writing. WAC/WID research has documented cases where STEM students developed rhetorical awareness alongside (and as evidence of) their development of professional voice and identity in their discipline. Christina Haas (1994) presents a case of an undergraduate biology student and John Leydens (2008) describes similar development among engineering students. Leydens found that engineering scholars only slowly began to take a rhetorical view of knowledge after they entered the professional market and become "more immersed in actual professional practice, with its own complex sets of ideologies and epistemologies" (p. 261). WAC/WID programs that seek to promote global competencies in writing and communication can achieve this objective if they focus on professional development while or beyond teaching general academic writing.

The needs and opportunities for promoting translingual, cross-cultural, and transnational awareness and communicative competencies—which STEM professors may recognize from their own unique perspectives—come from a number of realities about the STEM field. While they may not agree that the demand for a simple, clear and universal code in the name of standard or "technical" English is inherently political and ideological, scientists seem to agree that monolithic standards cannot be expected from all professionals in all contexts. They also know that students both need and benefit from the ability to communicate across language and cultural differences. Secondly, as the number of nonnative English speaking faculty and students increase especially in the STEM fields (Katehi, 2005), a shift of focus from language deficits to translingual and cross-cultural communicative skills is likely to gain more traction among STEM professionals. Multilingual students and scholars are adept at negotiating meaning in spite of variation in language and the attendant complexity in their social lives (e.g., Canagarajah, 2006, 2009). Thirdly, increasing numbers of multilingual and transnationally connected STEM professionals are ideally equipped to respond to the increasing internationalization of academia and professions as teachers for their students and partners for writing programs and instructors. Finally, even within the boundaries of nation states, societal changes have led to increased demand for scientists to communicate their specialized knowledge with the world outside their specialties. Technological advancements have both created the conditions (such as the near elimination of "science desks" in newspapers and magazines) and opportunities (such as open-source journals and platforms for professional communication) for scientists

to write and communicate their ideas themselves, rather than through professional mediators. Thus, STEM professionals (among others) write emails to a variety of audiences, present papers and posters for increasingly interdisciplinary and mixed audiences, write grant proposals and reports that increasingly demand layman's language, fulfill more teaching and service demands, engage in administrative and managerial work that requires more types of communication, and contribute to policy discussions and leadership.

In light of the above realities, the rest of this section recommends strategies for promoting translingual and cross-cultural communicative competencies in the STEM fields through writing programs and pedagogy. The recommendations are based on the premise that writing support for the STEM fields is most effective when it is built on the best practices of writing and communication already within them. Whether for promoting general academic writing in the disciplines or for fostering global communicative competencies, it is ideal to begin by assessing how students or faculty in the disciplines perceive and treat writing, what they find necessary and urgent, and where they need support and partnership (See Carson et al., 2000). Pedagogy is most effective when it recognizes the forces that shape persisting views and ideologies about language and writing in the disciplines. Successful programs must also account for curricular priorities and limitations, institutional and professional power structures, and the mechanisms of incentives in the disciplines.

Promote Writing as Getting Things Done

The participants of my study better appreciated the complexity and variability of language and writing in the context of using them for getting things done. Michael Carter's (2007) concept of writing as "doing" essentially appealed to them, whether it was in the context of writing courses, workshops, or one-on-one support for students. As Carter notes in his article "Ways of Knowing, Doing, and Writing," writing programs can best promote writing in the disciplines by considering how the disciplines define themselves in terms of "metagenres" or sets of genres that are broadly valued as "ways of doing" rather than "ways of knowing" things.

Focusing on getting things done can help us explain how to both analyze and write in different genres; it can also provide an approach that bridges the gap of understanding between our discipline and STEM students. As Carter notes,

> The problem for WID professionals is how to bridge the gap between writing in and writing outside the disciplines, the knowing that and the knowing how. This is not a problem that can be solved by reference to our own discipline's understanding of the relationship between writing and knowing. Rather, we need to be able to conceptualize writing in the disciplines in a way that is grounded in the disciplines themselves, a viable alternative to an understanding of writing as universally generalizable. (p. 387)

Using this approach could also help WAC/WID initiatives seeking to promote global competencies among future scientists more easily achieve the objective. For instance, international students who participated in this study found writing most beneficial when it involved communicating with people within the industry but outside the university. Even when they did not write a lot, the opportunity to do so for communicating and working with a variety of audiences, they said, helped them develop advanced writing skills. When asked how she documented the results of her study if she didn't "have to write a lot," one student said, "I don't have to write it down. I consult with [my advisor]. We talk to each other." Putting writing in the larger context of communication seemed to alleviate stress, scaffold the development of her writing skills, and also foster her ability to engage diverse audiences.

Redefine Clarity as Accessibility

As discussed above, STEM scholars tend to conflate clarity with simplicity, considering it a function of a supposedly universal standard "technical" English. Writing professionals should teach and promote clarity as more of a function of accessibility (due to effective organization and presentation of ideas for example) than of simplicity itself. To use a set of words from my own classroom (with the mnemonic "f words") in relatively "clear" writing by experienced scientists, the ideas are more likely to be fleshed out, the writing better framed, the framing devices more often foregrounded than buried or delayed, the work consistently focused on its key objective, the writing flowing well due to strong logical connections, and the draft being given the finishing touches and proper formatting that it needs for its venue and audience. While these could be general features of accessibility in academic and professional writing, they are particularly useful with diverse or mixed audiences in cross-cultural and globalized contexts.

The participants of my study shared a variety of practices that countered the dominant beliefs and discourses about clarity that they had shared in earlier interviews. For example, their focus on images, objects, and actions within or around written communication helped to convey the idea; the emphasis on clarity of organization and connection in scientific writing also provided a similar basis for clarity.

Ultimately, clarity is the result of giving the audience greater access to ideas and perspectives, as well as incentive to read or respond. Writing can be more accessible to diverse audiences across disciplinary and sociocultural borders if we help students focus on clarity of content while also helping them pay attention to language use in and across contexts.

Respect Diversity of Perspectives about Writing

To better engage STEM scholars in writing programs that seek to promote internationalization, writing professionals should value different views about writing and communication. During the initial interviews, the participants of my study defined writing by contrasting their view with what they thought I believed writing to be—full of literary and rhetorical flourish and overly complicated. To me, their views seemed to reflect a complete lack of teaching and learning practices. This wasn't, however, the case: they embraced different views but also engaged in the teaching and learning of writing while using different terms. To use LuMing Mao's (2003) idea of research as "reflective encounter," I learned that I bought into the discourses and ideologies about language and writing that shaped my discipline as much as they did theirs. As Catherine Prendergast (2013) notes in her critique of "writing to learn" discourse, writing teachers and programs often promote and teach writing by using perspectives that may seem to be an oversell to members of other disciplines. Using her findings from a qualitative study of undergraduate students and their faculty in an NSF-funded "Research Experience for Undergraduates" program, Prendergast argues that writing teachers should be willing to reassess the role of writing vis-a-vis the "ever-developing understanding of the complexity of learning" (p. 5). Showing how students' in an observed lab used language in a variety of ways, she concluded that "[i]t should not threaten the progress of writing programs in universities nor the research program of WTL if, when faced with questions from scientists about the centrality of writing to scientific practice, we consider that 'they' might be right." Writing instruction "might not be as necessary to the development of the next generation of scientists as time spent in developing physical knowledge, or manual dexterity, or visual acuity in the lab" (ibid.). Robert Ochsner and Judy Fowler (2004) have also similarly cautioned writing teachers against the discipline's favorite definitions and selling points about writing: writing to learn.

The same is also true when it comes to the terms on which we seek to promote or cross-cultural communicative competencies in writing. For instance, for students working in groups, oral communication skills may be more beneficial than writing skills alone. Similarly, writing support may need to split focus to cover the effective use of images and data alongside words. In some contexts, writing support may need to focus on communicative components surrounding writing, such as reading and

discussion or attending to the affective aspects of the writing process. Particularly for students who are adapting to a new academic culture, a broader and more flexible approach to writing support can help them build the confidence to learn to write in new ways.

Meet Scientists and Their Students Half Way

Many STEM scholars do not share the same concerns, perspectives, and priorities about writing as writing teachers and programs. For instance, professors who demanded clarity in writing wanted the writing center to help their students avoid complexity in language; it would be effective for writing tutors to use that demand as an entry point for helping the professors' students address more complex and higher-order writing skills. Starting with problematic syntax or unclear wording, for example, can lead the discussion to sociocultural issues and highlight how internationalization of the profession demands additional rhetorical awareness. Ultimately addressing, rather than challenging, the demands of STEM professors and their students can also help students redefine clarity as accessibility for different audiences in different contexts and societies.

Effective analysis and use of data and visual elements of scientific communication can be another point of entry for addressing challenges that STEM students may face when readers from different societies and cultures interpret those visual elements differently. For example, the international student who wants to maximize the use of images could be best supported by helping him to interpret and write about those images. Or the student who believes it is enough to talk to her professor could be helped with note-taking, a skill that is worthwhile but often overlooked. More generally, promoting and delivering writing courses and services by using the terminology that faculty and students use for defining effective writing can help facilitate understanding among students and their faculty advisors, and improve student engagement in writing courses and programs. It is important to meet STEM faculty and students halfway because seemingly problematic views about language and writing may be justified in their contexts. Similarly, recognizing the reasons and incentives from their perspectives can help us identify the contexts and perspectives in which they will adopt different views and practices.

Shift Focus to Higher Order Concerns of Writing

Writing programs and writing centers constantly face demands to address lower-order concerns, especially from nonnative users of English; issues of cross-cultural communication are even more neglected than important higher-order rhetorical concerns such as organization, genre conventions, and tone. Solely addressing these demands can perpetuate reductive, monolingual views about writing, shifting the focus from the multilingual realities of scientific communication back to the monolingual imaginaries of academia. In a graduate-level course at my institution, STEM students in particular demand that the class focus on "remediation" of basic writing skills; instructors report that it takes some time and effort to educate the students about the complex social, professional, and geopolitical dynamics that shape and influence the language and writing that they must use in their professions.

Like all students, STEM students enter increasingly diversified and internationalized workforces, and they need to communicate internationally and cross-culturally. To help them communicate across societies and cultures, writing teachers and tutors should also incorporate support for navigating the dynamics of language and communication across borders. This support needs to be an extension from lower- to higher- order concerns of language and rhetoric.

Transcend Academic Contexts

Perhaps the most appealing contexts in which STEM faculty and students value writing education is the professional development of students, such as communicating science to the public, writing for

international collaboration, attending and presenting at international conferences, and pursuing research funding and professional development opportunities internationally. While most STEM faculty tend to use academic lenses to assess students' writing skills, many also appreciate cross-cultural communication in the context of professional development. Communicative contexts beyond academia demand better responses to the complexity and variability of language. They also demand cross-cultural perspectives, reward multilingual and translingual skills, and often require a sense of global citizenship for professional success.

Both writing instructors and faculty advisors in the disciplines can thus assign students small but practical writing tasks that fulfill a variety of purposes beyond purely academic ones. As participants in my study mentioned, such writing tasks could involve communicating with vendors, projects partners, and professors; floating agendas for and taking minutes during meetings; preparing summaries and notes for class presentations; and developing conference papers and posters. Using cross-cultural and international communicative situations as writing prompts can help students hone their communication skills for an increasingly globalized world. In fact, this can also be done by asking students to borrow samples of their professors' writing for analysis and discussion because their professors' writing often engages in international academic and professional communication. With help from writing and disciplinary instructors, rhetorical analysis of different genres of professional correspondence can help students see that scientific communication goes beyond a singular code and requires an understanding of complex social and rhetorical contexts.

Situate Science in the World

Writing teachers can include activities that involve communicative tasks envisioning transnational and cross-cultural contexts, especially tasks where scientific problems are shaped or influenced by unique sociopolitical and economic forces. For instance, analyzing and writing emails for specific or mixed audiences in different contexts, societies, and cultures can begin to nudge students in the right direction. Indeed, "email writing" has become a popular topic of writing workshops especially for international students across the US; Google search brings up numerous such programs in all kinds of institutions. Analyzing and discussing poorly written grant proposals or other genres (which one of the professors said she did with her students), as well as communicating specialized knowledge to non-specialized or mixed international audiences outside the discipline can also achieve this goal.

For disciplines like engineering, essentially situated at the intersection of academic science and society, such activities are not only useful but also necessary to prepare students for the workplace. Increasingly, professions in other STEM fields are also demanding the ability to write for a range of audiences using a variety of genres, modes, and mediums. More generally, helping STEM scholars use writing across different contexts—such as professional communication among diverse audiences, projects involving cross-cultural teams, and pursuing global funding opportunities—can make translingual and cross-cultural communication more appealing to them.

Engage the Broader Community

A particularly important strategy for promoting global competency in writing among STEM students is to hold institution-wide conversations designed to shift curricular and pedagogical focus away from beliefs about transparency and transience of writing and the regime of monolingual and universal standards toward developing the ability to communicate with different audiences in different contexts and cultures. As one of the professors suggested, engineering faculty in her department did not teach or require writing unless they had to because the institution did not reward it. This means that writing programs may need to go beyond solely supporting faculty and students and promote writing practices among academic units, institutions, and their leaders.

In order to be successful, STEM professionals need to be aware of the complexities and challenges to higher education caused by increasingly diverse demographics and the increasingly globalized nature of STEM communities; they must also accept the inevitability of language variation in these communities. Writing teachers and programs can best educate tomorrow's STEM professionals by teaching them how to communicate successfully across the increasingly porous borders of discourses and discourse communities.

Ultimately, it is by understanding and building upon common grounds of educational objectives and priorities that we can overcome the hurdles in internationalizing the curriculum of the STEM fields and across the disciplines.

Complicate the Idea of the "General" Public

One of the ways in which more complex and realistic views about language and writing could be promoted in the STEM fields is by countering dichotomies between scientists and non-scientists, as well as between writing for "the general public" as opposed to "academic" audiences. The participants of my study embraced the idea that the academic audience, especially in the sciences, is monolithic; but when they discussed communication with people in the industry and the community, they adopted a more complex view of writing. This shift helped to envision the "public" as complex and overlapping groups of people with varying levels of knowledge and interest in scientific knowledge and projects, rather than a generalizable, singular audience. As Roger Silverstone (1991) notes,

> There is no such thing as the public. There are many publics for science: the specialist and the lay, the interested and the disinterested, the powerful and the powerless; young and old; male and female. While these publics will share much, they will also understand or misunderstand, remember or forget, in different ways. (p. 106)

Furthermore, the boundaries of most groups that Silverstone mentions above—as well as those of insider and outsider, general and specific, local and global—are also porous. Writing support for STEM students should be designed with the idea that there are mixed and potentially plural "publics" with whom scientists must communicate; the publics may also be multilingual, multicultural, and increasingly transnational.

One way to tackle the challenge of communicating across linguistic and sociocultural borders to different types of audiences within academia and beyond would be to ask students what they want to "do," based on the analysis of the context, audience, medium, and purpose of communication (using the mnemonic "CAMP"). Context may include venue, time, society, and culture, as well as interpersonal, professional, political, and even psychological issues; audience may be internal or external, distinct or general/mixed, with differing levels of knowledge, interest and biases about the topic; a medium is not only the physical channel of communication but also the genre, formality of the discourse, and interactivity with the audience; and purpose may be logical and informative/persuasive, social and goodwill-building, or emotive or entertaining, and so on.

Utilize Emerging Technologies

Finally, as the advent of web technologies is making cross-border communication and collaboration easier, writing instructors and programs have more tools at their disposal for creating, curating, delivering, and promoting writing resources among both faculty and students. Writing teachers can also connect with their peers across national and cultural borders through the web in order to learn about writing and communication across cultures and contexts. Emerging technologies also make it easier to engage students in real-world communication tasks with individuals and groups that we could not have

imagined being connected with before. This enhances student motivation to cross borders, as well as engagement in learning new communicative skills.

The participants of my study were all international (given the focus of the larger study on monolingual discourse and its effects on multilingual scholars and students); but domestic students also need multilingual disposition and skills for communicating across disciplinary and sociocultural borders. Writing instructors, as well as instructors in the disciplines, can use emerging technologies to engage students with the diverse professional community, such as by using videoconferencing, collaborative writing and peer review, and so on. The more STEM students learn to appreciate complex and varied language use in academia and beyond, the more successful they can be in their future professions in a globalized world.

Conclusion

The prevalence of reductive views about language and writing creates blind spots in writing curricula and pedagogy in any academic field. Those who hold such beliefs are more likely to devalue multilingual disposition and transnational communication. They are also likely to refuse to teach or promote cross-cultural communicative competence and to fail to recognize the importance and opportunity of crossing linguistic, national, and cultural borders. These monolingual orientations are uniquely harmful for the STEM fields because scientists are among the first in line to have to cultivate a sense of global citizenship, advance knowledge, and address social challenges on global scales. Curricular and pedagogical blind spots created by monolingual worldviews can create practical challenges when STEM scholars and students are faced with the complexities of conveying specialized knowledge to outside and mixed audiences. They can also undermine academic engagement in cross-cultural and transnational communication as well as obscuring political and socioeconomic issues in academic and professional writing.

The paradox of the STEM field in the US today, however, is that in spite of persistent monolingual ideologies in their fields, faculty and students speak many languages, bring linguistic resources from different cultural and national backgrounds, and must constantly engage in border-crossing communication. Even as they deny the prevalence and significance of translingual practice and transnational/cross-cultural communication, their communicative practices contradict the persistent monolingual and essentially monocultural ideology in the name of the efficiency and universality of science.

Thus, instead of focusing on this ideology, writing programs and professionals should capitalize on STEM's practical responses to the impact of globalization. Focus on practice will help us foster transnational communication and collaboration, as well as understand the challenges created by the redistribution of geopolitical power and material resources and how they may influence Writing Studies. Such a move can aid us in developing rhetorical awareness and translingual skills, thereby promoting intercultural communicative competence through WAC/WID pedagogy and programs. Most fundamentally, problematic beliefs that still permeate the discourses about writing in the sciences can be best countered by building on best practices within them.

This study used interviews as a primary form of data, with those interviews including in-depth discussions about writing practices. More robust investigation into the paradox of what STEM professionals say versus do about language and writing in their academic and professional communication should focus more on practice, through observation of classroom teaching, writing processes, and communication practices across linguistic and cultural/national borders, for example. Writing Studies needs to further explore this tension in order to look beyond ideologies in favor of better recognizing and promoting practice.

Positioned at the crossroads of teaching and learning as agents of institutional change, writing instructors and scholars play critical roles in making our institutional landscapes, classrooms, and assessment practices more attuned to the realities and demands of educating future scientists and engineers. As Jonathan Hall (2009) argues in his article titled "WAC/WID in the Next America: Redefining Professional Identity in the Age of Multilingual Majority," WAC administrators may indeed need to prepare for that new landscape by helping faculty from across the disciplines embrace the realities of the changing demographic landscape of our universities, as well as the interconnectedness of professions, nations, and societies across the world. Writing scholars and teachers are also uniquely equipped to foster translingual and transnational/cross-cultural communicative competencies among students through academic programs, curricula, and pedagogy. We can promote the educational goal of global citizenship for future generations of STEM professionals by studying how the increasingly diversified members of these fields engage in multilingual and transnational communication in practice.

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