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All Scientists Should Write Poetry: Creative Writing as Essential Academic Practice

Mariya Deykute
Nazabayev University, Kazakhstan, m.deykute@gmail.com

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Abstract: *Creative writing in undergraduate academia has often been regarded as an elective practice that has benefits primarily for students who plan to pursue creative or literary majors. However, poetic inquiry specifically offers crucial benefits to STEM students, owing both to the transformative nature of poetic process and to the way poetic inquiry can stimulate innovative, ethical, multilingual and interdisciplinary growth. The author frames the issue through individual experience of teaching poetry to STEM undergraduates in the context of a rich multilingual environment, in which many students are fluent or proficient in several languages. The author argues that due to the commonalities poetry writing shares with the scientific process, as well as the essential skills it requires of the practitioners, poetry writing is an essential techne in academia rather than a "quirky elective."*

Creative Writing in Academia: Past and Future Revolutions

Creative writing in academia has a relatively recent history. That is, of course, if one is to consider such history from the perspective of official course offerings and departmental recognition rather than student writers' clubs, journals, and creative writing in the university community, which doubtlessly existed prior to creative writing's official entry into the academic purview. Sources differ on when this entry occurred, but even if one were to take the early date of the 1880s (Myers 278-279) rather than the 1910s, (Radavich 109) one can argue that creative writing in academia is still among the nascent disciplines—as much change as it underwent after the first writer's workshop opened in Iowa in the 1950s (Radavich 110). Initially, creative writing courses were introduced as an attempt to revolutionize the study of literature: to show the benefit of the living process of creating poetry and fiction, rather than reserve the scope of literary studies to only the final product, the published text (Myers 279). And while the current state of creative writing courses and programs and their continual growth has long surpassed this initial aim, the revolutionary potential of creative writing education for the academic community, I would argue, is yet to be fully actualized.

This is unfortunate. Creative writing education is capable of producing a generative paradigm shift, a fundamental change in how we think about arts education and education in general. I will focus here on one aspect of all such possible revolutions: establishing creative writing, specifically poetic inquiry, as a routine companion and collaborator to the sciences and STEM education, particularly in the context of a multilingual student body. I review literature on the false dichotomy between creative writing practice and research as well as the complementary and often parallel natures of poetic and scientific inquiry. In addition, I discuss my experience of teaching a rigorous poetry and

research seminar at a STEM university in the Republic of Kazakhstan to establish poetic inquiry as beneficial practice in STEM contexts.

My argument owes much to the commonalities creative writing shares with the scientific process and the neurobiology of inquiry. Creative writing, with its ability to "explore the interconnections between the world of ideas and the world of our lived experience" is truly a natural companion to the sciences (Watkins and Tehrani 33). The skills required of practitioners (namely, in the form of accessing difficult questions; persevering through adversity and the unknown; synthesizing knowledge from a variety of disciplines; and establishing a personal, ethical and integral relationship to the product of one's own scholarship) further establish poetry writing as an essential practice rather than the dilettante's prerogative. While undoubtedly beneficial for humanities students, poetry writing also forms a way for those outside the humanities to establish a holistic, intentional, and integrated relationship with their language(s), which will inevitably serve to inform their work as scientists, engineers, computer programmers and mathematicians. Here I will also argue that in order to accomplish these goals and fully capitalize on these benefits, poetry courses that seek to bridge the perceived gap between the fine arts and the concrete disciplines must involve not only individual work or poetic craft, but also research, collaboration, and frequent in-depth exposure to the languages of others through reading and writing multilingual poetry, translation, in-depth peer workshop, and peer editing.

The Poet or the Scientist: The False Dichotomy

As someone who has been involved with creative writing in academic settings for more than a dozen years—as a student, a secondary school teacher, a university instructor, a program coordinator—I have been continuously surprised by very distinct aspects of the practice as it currently appears in academia. Some benefits students derive from creative writing are well-documented, such as developing a deeper connection to language and expression that can support marginalized or disadvantaged voices (Kinloch 96); creating meaning, finding relevance, power and authentic self-expression in the midst of their educational experience (Ostrom 81; Hunt 75, 83); forging a cross-disciplinary community and thus maintaining resilience, engagement with scholarship, and a closer tie to school or university (Philip, Doolan, and Wilson 2-3).

However, some of the other benefits are perhaps not quite so obvious or well-researched and may even seem of dubious value in a course that is supposed to impart some kind of certainty onto the student-scholar. I am speaking here of the ability to embrace what the poet John Keats termed "negative capability," namely, "when a man is capable of being in uncertainties, Mysteries, doubts, without any irritable reaching after fact and reason" (Hebron). While Keats was frustratingly brief in his exploration of this term, in undergraduate creative writing students this essential negative capability manifests as the ability to live with, interrogate, and find joy in exploring difficult questions, ambiguities, the undiscovered; to pursue with intellectual rigor queries and obsessions that originate within themselves and that perhaps do not find a quick wrap-up by the end of the semester but instead continue to generate ever more questions and instigate a journey that lasts through their years at university and beyond.

This ability to tolerate and illuminate the unknown and the unresolved (Peary 68) and the ability to constantly generate new questions are also ones that find relevance not only in writing or the pondering of philosophical or humanitarian questions, but in biology, computer science, engineering, linguistics and fine art classrooms (Watkins and Tehrani 33). The capacity to tolerate the unknown is recognized by social constructivist pedagogical theories as one of the necessary steps in the epistemological and personal development of an undergraduate student and scientist. In particular, Baxter Magolda's "epistemological reflection" (ER) model is not only closely tied to the development of young adult identity but also shows a progression between "absolute knowledge" and "transitional," "independent," and "contextual" knowledge (Hunter, Laursen and Seymour 38). Each successive step in epistemological development necessary to conceive of oneself—and become—a successful scientist is impossible without developing tolerance and appreciation of ambiguity, the unknown, and the unresolved. This faculty—to remain curious and persistently open in the face of staggering, failing drafts and no clear directions or instructions—often sets apart those students who go on to become innovators, inventors, the meaning-makers in STEM disciplines (Edwards and Ashkanasy 168; Alexander, Berthod, Kunert, Salge, and Washington 84; Root-Bernstein 267-268; Webb and Lee 193). And this is where the revolutionary potential of creative writing instruction fully emerges, not only for the field of literary study but for cross-disciplinary academic environments, an idea I will return to.

The less pleasant surprise that I encountered as a creative writer and an academic was how often the general university environment perceived creative writing courses as fashionable but niche (McVey 290), optional, or "easy": in other words, an elective that conveyed some benefits but was certainly less "rigorous" or "academic" for students of practical disciplines like the sciences. And even within English and creative writing departments housing the burgeoning MFA, major and minor programs, the backlash against the "MFA factory" and the increasingly impractical creative writing degrees meant that creative writing courses, according to David Radavich, were more and more seen as an investment in personal rather than professional development (110-111). While Radavich is optimistic about the direction of creative writing studies, in our present climate of increased budget cuts and elimination of humanities departments, creative writing courses yet again occupy a precarious position.

This issue is prevalent not only in the U.S. or the broadly-termed "Western World," but within international Western-style STEM universities. In my own institution in the Republic of Kazakhstan, writing across the curriculum, and specifically creative writing across the curriculum, is viewed by most STEM educators and students as a fairly useless concept. However, in the context of a multilingual, multicultural university in which students must navigate additional layers of identity formation in order to conceive of themselves as scientists, scholars, writers (especially in English), creative writing and poetry writing is even more crucial in developing what Leonardo Da Vinci called "a complete mind," the creation of a scholarly identity steeped in connections among disciplines, between ideas and work and lived experience (Watkins and Tehrani 30).

Ultimately, the view of creative writing courses as an elective practice is as pervasive as it is mistaken—and falls out of line with the scientific community's finding that creative writing (among other arts) is not only aesthetically pleasing but also intellectu-

ally stimulating. More and more, creative writing is recognized as a valuable tool in the greater scientific and technological communities as well as in pioneering pedagogy—as a way to encourage creative thinking (Charon, Hermann, and Devlin 346); to raise levels of engagement with content (Krom and Williams 235); to communicate complex ideas to the public (Januchowski-Hartley, Sopinka, Merkle, Luz, Zivian, Goff and Oester 905); to encourage scientists, engineers, and doctors to consider ethical, humanistic, and cross-disciplinary effects of their work (Atkinson 33). Stephanie Januchowski-Hartley et al. begin their exploration of the use of poetic inquiry in conservation studies by citing diverse examples of the way science is communicated through art, such as the 2018 Linwood Pendleton's plenary, "Rethinking marine conservation science in three acts," that brought together poems, music, video, and dance to demonstrate how creative approaches can help to achieve and celebrate breakthroughs in marine conservation science (905-906). Robert Root-Bernstein in his chapter on creativity, polymaths, and innovation cites numerous examples of scientists, engineers, mathematicians (such as Jonathan Kingdon, Robert Bakker, Kack Coulehan, Santiago Ramon y Cajal, Rorscharch, Alexander Graham Bell, Desmond Morris, Kenneth Clark) who were or are also accomplished artists (and while it is important to note that the majority are visual or musical artists quite a few are novelists and poets) (268-272). Root-Bernstein further asserts that proficiency in an artistic or literary pursuit is a significant and reliable predictor of scientific productivity, interdisciplinary thinking, and innovation (267).

Of course, some academic contexts have also recognized this—from courses that engage accounting students in writing fairy tales (Krom and Williams 238) to undergraduate chemistry students writing horror stories (Nicholes) to professors using haikus and creative nonfiction to stimulate greater engagement and understanding of their content across disciplines (Januchowski-Hartley et al. 906-907). However, as Root-Bernstein notes, the general educational trend is still to propagate the rift between the arts and the sciences, to separate rather than to merge, and concludes that "we need a new kind of education that fosters interaction between disciplines rather than divisions between them.... [T]he future of innovation will reside, as it has always resided, in the minds of multiply talented people who transcend disciplinary boundaries and methods.... [W]e ignore this profound truth at our own peril" (276). Root-Bernstein's new kind of education that normalizes and establishes creative writing as an essential academic practice is exactly the kind of education that would allow CW to transcend its niche, trendy status and fully bestow its benefits upon the interdisciplinary student collective.

Poetry in particular has long been recognized as useful in developing empathetic, reflective, and innovative skills in research and inquiry, particularly in qualitative research (Brown, Kelly, and Finn 258). However, the specific usefulness of poetry in the case of reconciling various linguistic realities and what this means for a STEM student is not as widely explored. In this sense, the poetry course that I taught at Nazarbayev University worked most urgently through multilingualism and the meticulousness of poetic language with the dual developments of an epistemological and personal identity of the writers, what Anne-Barrie Hunter, Sandra L. Laursen, and Elaine Seymour call the self-authorship (38) necessary for the conception of oneself as a scholar, a scientist, a thinker. However, STEM students were reluctant to recognize themselves as poets—to

own and author as meaning-makers and language-shapers rather than spectators—and to align their lived experiences with epistemological inquiry. Added to the existing rifts between their private languages and their public, professional language was the often greater rifts among their identities as scientists, scholars, and human beings.

Alas, what lies at the core of this rift are false dichotomies: the opposition of theory with research and practice (Webb and Lee 190) and of the arts and sciences (Snow 4-5). These false dichotomies have long plagued academia in addition to the lack of recognition of the necessary interplay and the similarities that may very well exist between the neurocognitive processes of engaging in creative writing and the neurocognitive processes involved in scientific research (Liu, Erkkinen, Healey, Xu, Swett, Chow, and Braun 3361). Researchers remark that, whether in their scholarship or through their own experience as students and educators, educational systems continue to support artificial divisions of knowledge, neither serving the learner nor the educator particularly well (Petersen). Taken further, the continual adherence to this false dichotomy is a failure to recognize the unique skill transference that takes place when students of creative writing (in the case of this article, poetry) engage in other disciplines that require critical thinking. As Maria Fernandez-Gimenez, Louise B. Jennings, and Hailey Wilmer note, when describing the advantages and applications of Arts Based Research (ABR) using poetic inquiry to interrogate and find solutions to natural resource issues, ABR in general and poetic inquiry in particular possess distinct advantages, including provoking new insight and learning; forging micro-macro connections; raising critical consciousness; elevating marginalized voices; challenging dominant ideologies; promoting dialogue as well as participatory research and advancing public scholarship (1082).

Such skills and dispositions may be even more essential for the scientific disciplines than the humanities, in part due to the ever-increasing pace of technological innovation (Berman and Dorrier) and the continual difficulty scientists encounter in both finding ways to connect their research holistically and communicate this research to the general public (Retzbach and Maier 430-432; Blythe, Grabill, and Riley 290-293). While the kind of thinking creative writing embodies does not offer solutions or clear-cut avenues of research, or even readily accessible and generalizable knowledge, it nonetheless "directs attention to questions that need to be asked, and understandings that need to be formulated" (Webb and Brien 192) which lie at the heart of scientific inquiry. As novelist and scientist Richard Mueller writes, "art may be a necessary condition for constructing the new consciousness from which future science gets its structural realities" (320). While Mueller's book *The Science of Art* was first published more than 50 years ago, his sentiments are perhaps even more applicable to our contemporary realities.

Establishing Context: Teaching Poetry in a Multilingual STEM University

The focus of my article is not on the broad discipline of creative writing in general, but specifically on the teaching of a strenuous elective course (300-level) in poetry writing at Nazarbayev University (NU), the leading English-language STEM university in the Republic of Kazakhstan. The student body, while largely Kazakhstani, includes students from a wide range of cultural, socioeconomic, and linguistic backgrounds. The latter, of

course, is of crucial importance to the teaching of creative writing and requires elaboration. While the English-language creative writing courses in the US (and in the UK, Australia, and New Zealand) certainly contain a sizeable number of students who are bi- tri- or multilingual (and, as I will later argue, all contain students who speak multiple Englishes), the students at Nazarbayev University are unique in that none of them are monolingual. English for many is a third language, if not a fourth or a fifth. Most grew up speaking Russian and Kazakh; many know Turkish, Chinese, Arabic or Uighur; others learned French, German, Italian and Polish at school before coming to university. As such, their studies at Nazarbayev University are a near-constant navigation of linguistic contexts and translations with students code-switching constantly as they move among the university classroom, their social life, their family lives, and the private language of their own thoughts and creativity.

Over the course of designing and teaching this course, I was fortunate to teach students with a diversity of future aspirations: engineers, biologists, geologists, historians, computer programmers, robotics and neuroscience scholars as well as economists, anthropologists, and literature majors. As the course has no prerequisite requirements save for an application and a portfolio, students self-selected by interest, but also formed a more diverse cohort than in other, more traditionally integrated humanities courses. In creating this course, I was confronted with its status as an interdisciplinary outlier. I wanted to focus on the production of creative writing through a lens of rigorous research and systematic inquiry as well as systematic practice. After all, poetic inquiry, as mentioned above, is uniquely fitted to provide the necessary skill transference in STEM fields. Thus, while the observations made do apply to other branches of creative writing (based on my prior experience teaching fiction and memoir), the scope of this paper will be limited to discussing the specific benefits and influences of poetry specifically, including poetry written in English, a non-native language to the vast majority of this student population.

Multilingualism and translation are important to this approach of teaching poetry in a research-based, upper-level course. While some creative writing courses in monolingual contexts do introduce some aspects of multilingualism or translation into their syllabi, in an English-medium university in an officially trilingual country (and, as shown above, with students speaking a wide variety of language), there is an even greater urgency to give students the necessary tools to intimately connect to their languages, their stories and their unanswered questions, as well as create a relationship to English and their scholarship that goes beyond the performative or merely pragmatic. NU students are navigating multiple linguistic realities, certainly, but also shifting sociopolitical and semiotic contexts that are uniquely tied to language—from changing street and city names, to the weight and prestige put on one language over another, such as the decolonization campaigns to reclaim Kazakh as the national language in an effort to subvert Russian language hegemony in the post-Soviet era. Of course, the real language politics and linguistic experiences are not quite so clear-cut.

Poetry writing gives these students the ability to reconcile, or at the very least get to know and accept, their many languages—and develop and strengthen their private language, a semiotic expression that is uniquely their own, populated with symbols and linguistic choices distinct from the social/public languages surrounding them. This move

supports not only their academic education, but their mental health, their individuated meaning-making, and their ability to be aware local and global citizens. Of course, these pursuits and needs are not unique to students in Kazakhstan: one could say they form a pervasive universal, even in so-called monolingual contexts. In fact, this capacity of poetry to foster communication across and build awareness of different linguistic landscapes is not one that is unique to a multilingual environment. I argue that any environment is by its nature multilingual, as students even within a monolingual environment have to navigate a variety of socioeconomic, political, and usage differences that make awareness of the many languages we speak essential (Marshall, Hayashi, and Yeung 33; Piller 26). The poet Oana Avasilichioaei writes about this fact, exposing monolingualism as a myth, and speaking about her English, which "revels in its bastard status because [its] context has never been and will never be monolingual." She further postulates that any language is "an ecosystem, complex, alive, unstable, and struggling in a fraught environment" and less static than we believe.

Scientific communication largely utilizes formal, academic English, and an important dimension of future scientific practice will be the translation of scientific knowledge into existing monolingual or multilingual communities and the promotion of scholarship in minority languages (Ludi 214-215). Regardless of one's language background, fluency occurs with the knowledge of how language shapes meaning; the attention to detail that poetry invites highlights the subtle, crucial shifts that mark this function. Fluency is achieved precisely through mending the rifts between the false split of research and practice; between the creative and the scientific; the personal and the academic. The fact that monolingualism is, perhaps, a myth, does not mean there are not important contextual differences between the multilinguistic context of NU and a traditionally conceived monolingual classroom. The students arriving in my poetry classroom arrive with complex relationships with their language that are often already recognized, even formulated. Such relationships are not theoretical but derived from lived experiences that create firm divisions in the student's understanding of themselves, the world around them, and the future's possibilities. The language of childhood (for many, Russian or Kazakh), the language of interpersonal relationships and daily life (often, Russian), and the language of achievement and the future as they report it (English) are compartmentalized and shared among students. Thus these preconceived divisions become important starting points for the revolution that multilingual poetry can create in a shift towards integration rather than separation of their multiple literacies. This cohesiveness may facilitate the development of advanced empathy for others through attention to language, as well as deepen their self-knowledge, reflective practice, and meaning-making. This kind of linguistic cohesion contributes to personal as well as epistemological growth, shown as inextricably linked in undergraduate learners (Hunter, Laursen, and Seymour 39). And while students everywhere confront this process, the students who entered my poetry classroom faced a unique set of challenges and opportunities due to the fact that their personal and professional identities resided on separate linguistic isles. The recognition of English as a potential private language, not just as the language of their professional disciplines, facilitated necessary personal and epistemological growth.

When students entered my course, I asked them whether they thought of themselves as poets and, if so, what role poetry occupied in their scholarship—whether they came from a humanities background or a STEM background. Many found both questions perplexing. Certainly, they all submitted a portfolio to be considered for the course; however, few considered themselves "poets" and even fewer saw any connection between their impassioned verses and the experiments they conducted in the lab, the code they wrote in Python, or the historical inquiries they conducted into Russian Imperial interaction with the Kazakh tribes. They generally agreed that there are criteria to be considered a poet—seriousness of pursuit, inborn talent, a kind of manic dedication to poetry—and that there are criteria to be considered a professional in their fields, including seriousness of pursuit, inborn curiosity, a kind of manic dedication to inquiry and the production of knowledge. While some of these commonalities were not lost on them, even students who did consider themselves poets viewed their poetic self as wholly and necessarily separate from their scholarly self: two reluctant roommates, as it were, working opposing shift schedules, never truly meeting, let alone considering combining their efforts and learning from each other.

At the root of this individual divide lies the same aforementioned dichotomy that even creative writers adopt in academia when discussing creativity in relation to their own poetic work and the creativity involved in their research (Webb and Brien 190). Dominique Hecq outlines in *Towards a Poetics of Creative Writing* that research in creative writing has been considered by many to be highly problematic, fraught with unanswered fundamental questions and lacking in any clear models and concepts. The greatest impediments for conceptualizing creative writing practice and research may be the epistemological character of the research itself, as by nature subjective and grounded in individual practice rather than verifiable patterns and shared methods and patterns. This is coupled with a resistance in academia to theorizing creative writing within the constraints of a traditional model of theory formation, expansion, and diversification. This resistance has compounded creative writing's inferior status as a discipline, relegating it in the romantic binary to the wild, unknowable feminine epitomized in Nigel Krauth and Tess Brady's figure of the rude girl who "sits in the senate…out of place amongst all that beige and grey" (qtd. in Sparrow 78). For some, the problem stems from the mode of production of creative research and the indivisible link to the subjectivity of the researcher, thus bringing the "objective" aspect of research into question (Sparrow 2).

Few students have been invited to see their poetic creativity as anything other than a private fancy; almost none of them saw the "rude girl" of their creative craft having bearing on their scientific research, despite the fact that, as Meg Petersen writes, "good scientific writing…draws on a wealth of details and specific language. Meticulous distinctions… require precise language" (98) in the same manner as attention to poetic language does. These convictions, then, obscure the opportunities of integrated multilingualism that are potentially so valuable for students. As mentioned earlier, students' relationship to language is often fragmented with regard to sense of self and authorship. The academic environment appears as its own linguistic landscape in which students feel compelled to cast aside languages and speech patterns from previous studies or daily life in order to fully commit to the conventions and mores of academic English. For my students, their rich multilingualism mentioned previously is often set aside and sacrificed

to that false dichotomy separating the personal and the academic/public worlds. Poetry here is a dangerous, transgressive interloper, a rebel matchmaker that, if not bound to a specific paddock by the instructor, will run wild, much like Jen Webb and Donna Brien Lee's bowerbird (198) that takes material promiscuously to create its unique nest. This, in truth, is poetry's ontological power, to seek that which it needs in order to create new meaning irrespective of disciplinary boundaries. Students see this power when they incorporate research into their poetry writing; when they use poetry to illuminate research, theoretical concepts, and to create new paths of meaning in the STEM fields. This is poetry's great gift—that of creation and connection, making bridges among the human researcher, the research itself, and then, loftily, the greater humanity that can benefit not merely from the fruits of that research but by understanding it as well.

The Unique Power of Poetry in the Context of Scientific Innovation

Poetry, more than any other genre, is at its core a reimagining and remaking of a private language. In the case of this course, it's the creation of one's own English, even as it works in conjunction with "public" or "commonly accepted" English. Poetry is not private. As the poet Ilya Kaminsky writes, "In his or her privacy [a] poet creates a language in which he or she is able to speak, privately, to many people at the same time." This creation of the private-public language is a way of reimagining symbolic reality in much the way the scientific disciplines must imagine alternative futures, solutions, pathways of meaning, and knowledge creation. And much like scientists who must translate their discoveries into meaning outside of the immediate scientific community, poets plant new symbolic roots and establish new linguistic connections: creating, thus, new ways that dialectically inform the private and public languages (as suggested in the currently understood less deterministic version of the Sapir-Whorf hypothesis where spoken language influences thought and cognitive processes) (Ottenheimer 8). Poetry, "not an argument but a way of seeing," just like science, creates new modes of thought and perception, deriving from "a hypothesis about experiential reality" (Webb and Brien 191).

A significant number of scientists and science educators use poetry in their work, sometimes writing their own or leveraging poems to illustrate connections, teach content, and create engagement for their students (Atkinson 35; Fernandez-Gimenez et al. 1080-1083; Charon et al. 348). Likewise, when my students drew on their primary disciplines to create and analyze poetry, they found ways in which their poetic language—and thus, their integrated, personal, private language—was enriched by the concepts hitherto siloed in their professional worlds. Thus, one student finds his voice through writing poem-programs in Python; another subverts her essay on the Communist Manifesto and gains new understanding of her own language and her own material through remaking it into a black-out poem; another takes a leaf out of Amy Catanzano's *Quantum Poetics* and considers through their work the "question of what defines the present and the parameters of language, spacetime, and reality" (6). In time, the false dichotomy falls away to reveal, as Octavio Paz claims, that "poetry is a form of knowledge, of experimental knowledge" that, despite its subjective nature, similar to science holds "a respect for the autonomy of the phenomenon being investigated."

Beyond the structural similarities of poetic and scientific inquiries, poetic language remaking has tangible benefits for the scientific community, such as fostering resilience, communication, innovation, interdisciplinary connections, ethical integrity, as well as the ability to view and accept the world as messy, multidimensional, and multivocal. For example, the earlier mentioned negative capability of Keats highlights the remarkable resilience that the intentional, rigorous practice of poetry can ingrain in the practitioner who dwells with questions rather than immediate answers through desire and drive to produce the worthwhile, something true to the poet's hypothesis of reality. Poetry is always and inevitably an act of translation; and translation always and inevitably is as frustrating as it can be surprising and gratifying. The translation that happens is, of course, from the aforementioned private language or nonverbal image into a language whose truth reaches a reader. The process of such a translation, from the vague notion of hypothetical ideas; to the bowerbird-like gathering of materials in order to express a complex synthesis of ideas; to the numerous experiments that need to be conducted, scrapped, reflected on, tried again; to the final presentation of an often surprising product (and sometimes, too often, an admittance of failure—that no matter the drafts, the hypothesis, the approach was simply not sufficient) imparts the kind of resilience that is personal, passionate— not unlike that of an impassioned scientist (Webb and Brien 199)— revealing the "self to the self" (Hunt 17). This journey provides practice in confronting that with which all risk-takers must routinely contend: failure (Fernandez-Gimenez et al. 1083; Hunt 100) and familiarity with the uncertainty humans tend to find threatening (Stillman and Baumeister 249-250).

While teaching multilingual poetry and encouraging students to engage with numerous multilingual poets (Anuar Duisenbinov, Eugene Jolas, Anne Tardos, Rhina Espaillat, Kaveh Akbar, to name a few), I pushed back against the rigidity they were taught and emphasized a different ethos: they should aim not for separation of their languages but rather unity among them, the kind that, as poet Antoine Cassar, author of the multilingual book *Muszajk,* notes "allows mutually distinct voices to coexist in harmony and interact to different degrees" (3). Cassar insists that writing in multiple languages "allows [him] to listen to the voices within and around…without the pressing need to translate all thoughts, ideas and emotions into a single tongue" (4-5).

My students produced work that not only synthesized their own languages but also explored the languages of others through collaboration, translation, extensive peer workshops and collaborative editing. In order to foster the kind of resilience and comfort with the unknown and the "other" that I believe is essential in any kind of education, my course relied far more than is usual on the practices of multilingual writing, translation, and collaboration. This challenged my students perhaps more than simply creating their own work would have (collaboration is difficult even for seasoned poets), but it also allowed them to demystify the process of writing early on; to disengage from the particular draft as "truth" (as one must disengage from a particular experiment as "the only possible experiment") and instead work with the greater truth of intention, of articulating both their private language and understanding the language of their peers and, ultimately, to gain the resilience necessary to embrace this process as a whole.

This process of community practice increased their ownership of their epistemological journey and increased their confidence in themselves as poets as well as knowledge-

creators and thinkers, whether that practice was scientific or creative (Hunter, Laursen, and Seymour 38). One of the exercises ended up being a telling celebration of the private language of each multilingual individual. The exercise was two-fold. The students wrote down seven words that held deep emotional and semiotic significance for them in one or more of their first (or second or third languages). Then they wrote an English-language poem that would incorporate and give further elaboration, context, rhythmic, or tonal interplay to the words. The students had the option of revising the poem into one of the established forms we practiced in class, or into a traditional form in either Kazakh or Slavic poetry. What emerged, especially in cases where students chose to house their language in formal structures, whether Western or Eastern, was that their poems were much better than poems written only in English – and not only because of the exotic incrustations of Kazakh or Turkic or Russian. The English also became more nuanced as they thought about the importance of reaching often into their childhood to choose the seven significant words and of using English to bring out the emotional and personal significance of non-English words while then setting these poems into the beautiful constraints of formal poetry. The fact that the cohesive rather than fragmented linguistic identity can give great benefit to their writing and their thinking was perhaps most obvious when they wrote multilingual poems themselves and entered into the practice of multilingual poetry and a multilingual community of practice. This ability to take and restructure their private language and make it public, make it understandable and accessible to themselves and to others, is something that can inform their work as scholars and scientists as well. Science, like poetry, emerges from the "mind's magic lantern" (Jenkins 1095), the imagination's leap of faith that brings together the disparate parts to create the new.

More than just the imaginative leap that both poetry and science require, the ability to look at all of their languages and consider both their emotional importance and their interplay through initial generative drafts and subsequent revisions contributed to an important skill of stepping away from an emotionally charged or significant problem—what scientists call an incubation period—a period of reflection and gathering that is just as important for the arts as it is for the sciences (Januchowski-Hartley et al. 906). Students found revising poetry very difficult, especially poetry that integrated such deeply held emotional truths as the use of one's childhood language. The labor of revising something in which the creator is deeply self-invested is important not just for the artist but for the scientist, for the engineer, for the mathematician.

I assigned a number of exercises that were aimed at achieving this resilience and cognitive flexibility through several kinds of translation. Students engaged in "classical" translation; the act of taking a text from a language they know well (usually Kazakh or Russian) and translating it into English. Likewise, they tried their hand at translating one of the poems we read during class into Kazakh or Russian. However, the two weeks we spent on translation introduced several variations on this relatively straightforward exercise. The first was aimed at showing how private language of association, imagery, and linguistic nuance shone through the public, or translated language. I asked student working on translation to work on the same poem, and then compare their translations in class, using both free observations and a few guided questions, such as interrogation of specific imagery, form, and word choices. The target poem for one semester

was a difficult one to translate, Elizabeth Bishop's "One Art." Before translation students read excerpts of Bishop's letters about the work and responded extensively to the poem through free writes and their own formal poetic compositions to become familiar with the intricacies of the work. Their translations showed clear evidence of choice and nuance. For example, the synonyms for "loss" showed how those synonyms play with vastly different grammatical structures in Russian and Kazakh (some chose to translate into one language versus the other). Students had to consider the choice of rhyme and the villanelle form and whether rhyme and form were preserved in the translated version, or sacrificed to preserve image and literal meaning. Some students fell away entirely from Bishop's lists ("lost door keys, the hour badly spent") and elected to bring others in their place that seemed more poignant to them in terms of communicating this narrative of snowballing loss. The veracity or skill of the achieved translation is not necessarily of interest here; it is the act of making a linguistic choice that demonstrates how one's own private language and private understanding of language influenced the act of translation.

This translation exercise drives home the similarity of poetic discourse to scientific by bringing attention to the subtleties marking private and public language (Petersen 98). In addition, it continues to promote writing as a transferable, or "travelling" skill, as a "flexible method for communicating knowledge and experience" (Stephens 69). This was particularly valuable in the context of a multilingual classroom, because along with looking at the flexibility of language within translation (and the choices the translator must make), students were able to reconcile with and interrogate the translations they undertook in their own lives—the translations that formed a core of their lived experiences and that necessarily made their way into their learning as well.

The second exercise drew on this. Students were asked to translate one of their own poems from English to another language, or vice versa. This exercise (which students found incredibly difficult) went hand-in-hand with our discussion of the different ways the students viewed themselves in their respective languages. For many, English was the academic respite from the emotional language(s) of childhood. Poetry, in this way, occupied an interesting territory. Many said it was difficult to access poetry in English because they associated poetic language with emotion; and yet others discovered liberation in a language free from emotional or childhood association. The act of translating oneself showed precisely how varied that self can be across linguistic landscapes (and hearkens back to Cassar's argument for multilingualism and simultaneous expression in multiple languages). Certain things, students found, were simply untranslatable, or much more explanation, both for themselves and their peers. The occasional failure to explain the translation; to explicate the "private" language as it turned public; the difficulty in rendering an emotional reality of one language onto another proved useful when discussing with them the diverse and, it would seem, divergent aspects of their lives as poets, scholars, scientists, human beings. It also set the stage for being comfortable with the untranslatable, the liminal, the only privately understood.

The third set of exercises was designed to demonstrate the gulf between the inner, unformed, preverbal language of image and association and the word itself: the translation from the unknown. In class I took a poem from a language none of them knew (most recently, a Lithuanian poem by Salomea Neris, though I have used German

poems by Rainer Rilke and readings of the Old Norse beginning of Beowulf to similar effect) and read it aloud to the students. I then asked them to make a "sound" translation—to create a poem that translated the original simply by virtue of sound. We discussed their translations, commonalities, associations—how at times they were able to grab onto a similar Sanskrit root word like *neshti* in Lithuanian (nesti or, to carry, in Russian) and other times rendered a completely divergent reading of the text by personal associations and sounds. The second part done at home was a "translation" of a dance or a contemporary painting/sculpture. I purposely assigned them images and videos from my own private stores without releasing the author's name or location to prevent them from reading what others had said about the works.

Finally, the students completed an exercise they submitted for a mini-workshop with a group of students specifically selected from other disciplines. I asked them to take a text that was in some way seminal in their discipline (whether a historical document; a C++ manual; a set of laws in Newtonian physics; a logic proof, etc.) and translate it into a poem. We looked at Amy Catanzano's *Quantum Poetics* as an example of taking concepts unique to physics and transforming them into a poetic language or interweaving academese and the text of formulas and textbooks with a language of emotion, connection, and image; ultimately, I left the interpretation of the assignment up to them. Already prepared for the unknown, for strange connections and how they may manifest in their work, the students ended up creating found love poems out of the Communist Manifesto; a computer program that was trying to make the user a poet; a narrative of writing a paper on geologic strata and mourning a breakup; an ode to the word *mother* as seen through the linguistic prism of language families and loan words. Crucially, in the context of this essay, students reported in our reflective sessions gaining not only an increased understanding of poetry and the leaps of faith required to produce a fresh image or a clear connection but also an increased appreciation for their major and a novel way to relate to the concepts they once considered unrelated to their emotional life, private language, or poetic inquiry.

While these last exercises were perhaps not true "translations" but closer to ekphrastic pieces inspired by other art forms or explanations of the viewer/listener experience, this kind of exercise forced students to think in ways that were unconventional, expanding their understanding of what was possible in creative writing and in crossing genre and discipline platforms as well, especially with regard to collaboration. Unfortunately, in my many years as a student in undergraduate and graduate workshops, I have never worked with collaboration, collaborative editing, or translation. My multilingualism, while a feature of my own poetry, was never something beyond an exotic curiosity. However, pushing students to engage in collaborative creative practices not only creates a writing community that is uniquely linked but also prepares students for facing uncertainty generally when working with others. In both poetry and science, the language of passion, the language of criticism and reinvention is crucial—and so is the ability to develop not only one's own vision, but contribute authentically to a larger work, as well as the ability to recognize the value and beauty in the complex, nuanced and often difficult to comprehend languages of others (Avasilichioaei).

This quality goes hand-in-hand with interdisciplinary curiosity and the ability to embrace knowledge creation and academia in its sometimes contradictory, multidimen-

sional incarnations. Interdisciplinary curiosity and collaboration are essential to the sciences (Root-Bernstein 269); my experience suggests that a research-based poetry class that exposes students to investigative poetics, multilingual, experimental, documentary, historical and science-based works is at its core an exercise fostering such interdisciplinarity and engagement not only in one's own field or concern, but in that of others. Students gain admiration for the execution of a well-framed inquiry. At its core, just like the work of a scientist, the work of a poet is that of inquiry (Webb and Brien 190).

Ethics and Prophetic Technocreativity: Using Poetry Writing to Shape the Future

The main concern of this essay is the idea that teaching poetry in higher education, especially in STEM contexts, is an essential rather than elective practice. With regard to the former, I would like to draw attention to the orientation of progress and innovation in the sciences: namely, the often one-way, rapid-fire launch towards the future that typifies the trajectory of technological progress and the increasing pace of technological and scientific advancement (Berman and Dorrier). The students who are becoming scientists, engineers, innovators today are not simply working within established parameters that change comfortably. The speed with which industry develops is sometimes deeply uncomfortable, both for the practitioners and the bystanders, leaving little room for reflection or course correction or consideration of implications (Alexander et al. 6). Of course, this is not new, as reflection on and recognition of technology's place in the human world has often lagged behind its implementation. But I would argue that as the world grows and becomes ever more interconnected and these advances increase in speed, the ability of the innovators at the helm to connect to their work holistically, with the questions of larger humanity and ethics in mind, is not only essential, it is imperative (Atkinson 33).

This, then, is where the crucial piece of the puzzle emerges: the ability of poetry to foster the exact kind of self-reflection that works with difficult questions of new meanings, new realities, and how this may impact the collective as well as the individual (Lehmann and Gaskins 4). The speed of technological change inevitably brings to the forefront a need for scientists and innovators not only to be aware of their role as meaning-makers, but to ask difficult questions of the technology itself. We can use poetry and creative writing to help us navigate the ethics and the personal in the processes of invention and innovation, rather than compartmentalize such questions or leave them in the hands of philosophers or scholars of scientific history. Who we are as human beings is at the core of poetry and indeed, I would argue, should be at the core of scientific progress and innovation. In fact, this concern with our shared humanity lies at the heart of understanding science and technology, a task all the more important as distrust in scientific thought is at a high point (Iyengar and Massey 7656) and as we face new global challenges. We make and remake meaning through language; our symbolic worlds are shaped in how we use, perceive, and manipulate language. It is thus essential that this awareness of meaning-making through language is central to the innovation and progress of science and technology: for therein lies the ability to bridge the gap between the scientist and the layman; the mind and the heart; the future and the present.

The pathetic appeal of poetry is not, contrary to how it may be perceived, a weakness and should not be excluded from our understanding of science and its communication. As cognitive scientist Theodore Rees-Cheney notes, "even the most conscientious and intelligent reader may soon forget the factual content of a piece if material [has] entered the brain with little emotion wrapped around it [and] humans remember best what enters the brain in an envelope of emotion" (qtd. in Webb and Brien 36–7, 197). This means that learning is enhanced when the content is connected to the emotional human core of the learner and that the objectivity of scientific communication or thought can benefit from consideration of the emotional core forming human associations with facts and discoveries.

Finally, it is important to say something about creativity itself. Excellent research has already been done to show that the intersection between the arts and the science leads to transformative creativity fostering innovation (Root-Bernstein 283; Lehmann and Gaskins 2-3; Januchowski-Hartley et al. 906-907). But looking forward, I want to mention an exceptional feature of poetry, namely, what Roland Barthes terms "prophetic technocreativity" (qtd. in Webb and Brien 67, 192). As Webb and Brien describe it, prophetic technocreativity refers to the idea that "knowledge innovations emerge first in art works, and only subsequently emerge in philosophy" (192). This sentiment is echoed by Paul Magee who postulates that "a modern poem is not a knowledge-report, nor even a mode of self-expression, so much as a device for generating creative desire—the desire for meaning, for resolution, for further aesthetic experience, for an infinite number of things—in others" (qtd. In Webb and Brien 192). This creative desire, this need to formulate questions, synthesize disparate approaches, remake language, meaning, and embrace divergent theories and understandings is the great contributor to creativity in STEM that poetry can offer.

Of course, some recognition of this approach already exists: many universities like Stanford and MIT have courses and interdisciplinary pathways of study that combine science and the arts; a number of initiatives (like the recent Science, Technology and the Arts program in Europe) dedicate their efforts and resources to establishing an exchange of ideas and methodologies between artists and scientists. However, the kind of institutional recognition I argue for in the future would be routine rather than exceptional; an intuitive conflation rather than a rare experimental approach—the establishment of poetry writing (and creative writing at large) as a necessary companion to the world of technological and scientific innovation at the undergraduate level and beyond. Because, in truth, and selfishly, not only science stands to benefit from this companionship. For the maintenance of the false dichotomy is often mutual; creative writers often see their worlds as woven from different cloths than their science/techno colleagues. But the benefits to poetry are enormous if the connection between the rigor of scientific inquiry and the rigor of poetic inquiry and research are stressed in creative writing classes; if negative capability is truly embraced rather than just talked about; if the languages of others and the kind of knowledge and questions that come from multidisciplinary inquiry gain a central rather than peripheral place in the creative writing classroom. This can allow students to explore new subjects as well as eliminate many of the unhelpful and damaging biases/blocks that exist in the mind of a creative writing student, such as the bias/block against multilingualism; or the reluctance of a creative writer to undertake

research as an integrated academic rather than one who must be "two-headed" (Webb and Brien 188) and necessarily separate practice from research in a ghostly echo of New Criticism. Breaking down these self-imposed barriers pushes poetry to continue to do its vital work of shaping language and transforming the private language of individuals into the public language of human ethics, consciousness, and empathy.

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