Ethical Engineering Practice through Language: A Case Study Based on the Flint Water Crisis for Teaching Language and Style

Elisa Bravo, University of Michigan

A Ph.D. candidate in Mechanical Engineering studying at the University of Michigan. A maker and engineer who is interested in the incorporation of culture into educational spaces, like makerspaces and the classroom.

Clay Walker, University of Michigan

Dr. Walker is a Lecturer III in the University of Michigan's College of Engineering Technical Communication Program. He regularly teaches first-year, intermediate, and senior writing courses for students in all engineering disciplines, but especially Mechanical Engineering and Computer Science Engineering. His research focuses on the interplay between identity, experience, and agency in language and literacy practices in technical and workplace communication contexts through translingual and linguistic justice frameworks.

Ethical Engineering Practice through Language: A Case Study Based on the Flint Water Crisis for Teaching Language and Style

1 Introduction & Background

This study explores student's perceptions of how to practice being an ethical engineer through language and was spurred by an interest to make the teaching of language diversity meaningful for engineering students. Following Jenna Tonn's work to share primary historical documents with engineering students to help them better understand the socio-technical aspects of engineering, we worked to develop a case study that might center language diversity and the socio-political challenges that can accompany real-world engineering. To do this, students were exposed to a case study developed by the authors about the Flint Water Crisis. This case study was developed to get students to consider the importance of diverse language practices and how they differ across cultures. As instructional content for engineering undergraduate students, the Flint Water Crisis case study incorporated clear ties to technical engineering problems and the social implications of this event. This paper presents our findings to how students answered the following questions related to our case study: "How do you practice being ethical as an engineer through language? What lessons can you learn from the Flint Water Crisis?" In the following section, we provide background information on the Flint Water Crisis that was embedded into the course content.

Engineering is conceptualized in this study as a sociotechnical practice (McGowan & Bell, 2020). This perspective highlights how engineering work impacts and is influenced by society (Rodrigues and Cicek, 2024). According to Mazzurco and Daniel (2020), sociotechnical thinking has three domains: technology, people, and broader context. Within this framework, engineering projects focus not only on the technical aspects but also on the needs, perspectives, and involvement of stakeholders, as well as the socio-material contexts they inhabit. The people-focused dimension of engineering highlights the importance of engaging diverse stakeholders. In this context, writing becomes a critical tool for communication, negotiation, and the translation of technical ideas across social and cultural boundaries.

Writing is fundamental to engineering practice (Paretti, McNair, and Leydens, 2014). Writing in engineering requires authors to contextualize information and construct persuasive arguments that construct identity relationships between the writer and reader within the text (Leydens, 2012; Artemeva, 2009; Windsor, 2003). Prior work in technical communication research suggests that writing is a powerful identity-building tool, allowing authors to present themselves in a way that aligns with a particular Discourse or professional community (Windsor, 2003). In this way, engineering identity can be developed through participation in the professional Discourse. Discourse, as Sfard (2008) describes, encompasses the collection of words, visuals, routines, and narratives through which professionals think and communicate. From this perspective, learning to become an engineer involves more than acquiring technical knowledge—it requires adopting the ways of thinking, valuing, acting, and communicating that are embedded in the engineering community of practice (Sfard, 1998).

Engineering education often assumes that the language practices used by engineers and engineering students is reducible to standard English, or what April Baker-Bell (2020) has called White Mainstream English. As writing studies scholar Assao Innoue (Lerner 2018) explains,

> Very little scholarship directly addresses the ways in which the discourses expected of nurses, business majors, engineers, and others across all fields and professions are quite simply white supremacist (...) I'm getting really tired of hearing colleagues in Nursing of Business or Engineering tell me, or imply, that their students must use a white standard of English if they are going to be communicative and effective in their fields or professions. That's just bullshit. And it hurts students, Black, Latino/a, Asian, Native/Tribal, and White alike. We all lose. Our disciplines lose (p. 115).

Our students come from a range of backgrounds, and they bring with them language and literacy practices rooted in their individual histories learning a language at home, then developing various secondary social Discourses at school, places of worship, and workplaces (Gee, 2015). The diversity of language practices is evident in the ways that students and student teams interact with each other in engineering courses, as they discuss scientific ideas, apply them to problems, conduct experiments, design prototypes, and collaboratively analyze data. Those language practices may include any sort of English dialects, including Midwestern English, African American Vernacular, New England Dialects, Southern English, Californian, etc., as well as various named languages (each of which have their own regional dialects) such as Spanish, Chinese, Hindi, Urdu, etc.,

Language diversity in students' style collapses when we look at the writing and language expected of them by engineering faculty. This fact mirrors the pattern in scientific and engineering scholarly publication. For example, standard edited American English (SEAE) is generally considered the universal language of academic publication in the sciences and engineering (Adúriz-Bravo, 2013; Halliday, 2004; Huttner-Koros, 2015; Hyland and Feng, 2017; Poe et al, 2010). However, not all scientists or engineers are raised speaking a given dialect of English, let alone a dialect closely related to SEAE, such as upper-middle class midwestern white mainstream English in the United States or Received Pronunciation in the United Kingdom. Engineering discourse, which often privileges SEAE as the expected norm, can create barriers for individuals from certain linguistic or cultural backgrounds. This emphasis on a narrow form of communication may hinder their ability to see themselves—and be seen—as legitimate members of the engineering community of practice. Teaching engineering students about language diversity within the context of engineering work not only prepares them to work with a diverse public, but also creates space for the diverse language practices embodied by the students in our classrooms.

1.1 Flint Water Crisis

The city of Flint, Michigan, is home to 100,000 residents, with 55% of them being African American and 36% of families living below the poverty line (Rosencrants et al., n.d.). This city has experienced significant fiscal hardship, mainly due to the population reduction from General Motors' decision to lower its factory base within that area (Leiser, 2022). In 2011, deficits reached $25.7 million, leading Flint to come under an emergency manager's control. Four were appointed from 2011 to 2015 to manage operations and finances (Dixon, n.d.). To cut costs, Michigan officials and Flint City Council approved purchasing water from the Karegnondi Water Authority (KWA) instead of the Detroit Water and Sewerage Department (DWSD). The KWA was under construction until 2016, prompting authorities to seek another water source. Despite DWSD adjusting rates to entice Flint, emergency manager Ed Kurtz signed a contract with KWA.

With access to water from the DWSD set to end in April 2014, Kurtz approved a resolution to hire Lockwood, Andrews & Newman, an engineering firm, to operate the city's water plant using Flint River as an interim source until the KWA became functional in 2016. On April 25, 2014, Flint started sourcing its water from the Flint River. However, the Michigan Department of Environmental Quality did not require corrosion-control treatment for Flint River water, which allowed lead to leach from pipes. Residents voiced complaints regarding the water's appearance and odor. In response, the city issued several boil-water advisories and undertook hydrant flushing and increased chlorine levels to address these complaints. Veolia, the contracted engineering firm, suggested hydrant flushing as a cosmetic measure to tackle the discoloration issues reported by residents (Veolia, 2015). By early 2015, Flint warned residents about elevated levels of total trihalomethanes (TTHMs) exceeding federal limits, a consequence of increased chlorine to combat e-coli bacteria in the water.

Throughout 2015, Flint residents raised concerns at City Council meetings, imploring members to investigate the water quality, suspecting something was amiss. One resident, LeeAnne Walters, shared her anxiety about bathing her son in Flint water after he developed rashes across his body. Following a council meeting, Walters reached out to Miguel Del Toral, an EPA regulations manager, after her lead test results indicated dangerous lead levels in the water. After conversing with the Michigan Department of Environmental Quality, Del Toral underscored his public health concerns regarding Flint, particularly due to the lack of corrosion control measures. Virginia Tech researcher Marc Edwards analyzed Flint's water quality and confirmed the corrosive nature of the water was causing lead leaching. Additionally, Dr. Mona Hanna-Attisha's research identified elevated blood-lead levels in Flint's children. These findings were disclosed in September 2015, leading Michigan’s Department of Health and Human Services to declare a public health emergency on October 1, 2015, advising residents not to consume the water. By late October, Flint reconnected to the DWSD water source, yet the risk of lead leaching remained, prompting the city to recommend lead filters or bottled water for residents.

Much of the responsibility or blame was placed on Michigan's Department of Environmental Quality, as their minimal approach to regulation and oversight was considered insufficient for protecting the public. Some responsibility can be placed on the engineers who were responsible for designing and maintaining the integrity of the water distribution infrastructure of Flint. The engineers technically failed by not recognizing the five warning signs of possible corrosion concerns in the water treatment plant (Masten et al., 2016). Beyond the ineffective design of the water treatment plant, another technical failure present in this case is the lack of awareness of the potential harm associated with the lead pipes in the homes of Flint residents and the absence of resolve. Proper engineering practice requires engineers to follow the standard set forth by the National Society of Professional Engineers, the engineering code of ethics. Contracted engineering firms (LAN and Veolia) failed to adhere to the ethical standards of engineers by brushing off the concerns about corrosion (Lockwood Andrews and Newman, 2015) and by recommending fire hydrant flushing, a cosmetic solution, to help with the discoloration complaints of residents (Veolia, 2015).

3 Method

3.1 Context

This study is being conducted at a research-oriented public institution in the Midwest, a prestigious and selective engineering college. The students were presented with the case study material within an intermediate lab-based writing intensive course in mechanical engineering. This course exposes students to a broad, comprehensive survey of subfields in mechanical engineering, including vibrations, motors and control, thermodynamics, and aerodynamics. Students are given project-based learning assignments where they write in response to a client who requests some sort of engineering work. Each of these assignments are therefore rooted in some sort of real world context that asks students to make arguments based on their work in the lab.

The activity focusing on the Flint Water crisis was part of a lecture that was focused on language and style. The goal of the lecture was to introduce students to language as a cultural phenomena and to recognize linguistic difference as intrinsic to all language practices. Students first did an activity where they explored accent and dialect differences in the student body in the classroom itself. Following this activity, the lecture presented a conceptual framework that emphasizes language as a phenomena that does not exist outside of the interactive practices of using language with other people, whether orally or through writing. Next, the lecture highlighted the linguist M.A.K. Halliday's description of grammatical metaphor, or the process of converting verb phrases into noun phrases in order to develop abstract descriptions of experience. This grammar was contrasted with Robin Kimmerer's emphasis on the verb-centered grammar of indigenous languages as a more ecological structure of thought. These two grammars worked to highlight how linguistic differences are more than identity politics but also open the possibilities for diverse thinking and potentials for action. The final segment of the class session focused on the Flint Water crisis as a case study to look at the tensions between diverse languages, socio-economic power, and engineering issues. In this portion of the lecture, students were given a timeline of events, a representative sample of community posts showing the range of comments by Flint community members, a predominantly Black community in mid-Michigan, and samples from technical reports sent from the city to residents in 2014 and 2015. Students also had access to a Google folder that contained several other screenshots of social media conversations as well as additional reports by engineering firms.

3.1.2 Assignment Description

The assignment provided to students begins by describing the events of the Flint Water Crisis in less detail than what was added above in the background section. The technical and social engineering failures were incorporated into the assignment, ensuring students understood the devastating impacts felt by the Flint community. Students were then given access to the slides shared in class, a timeline of the Flint water crisis events by the Detroit Free Press, and a dataset with multiple sources of primary and secondary accounts. The dataset included evaluation and water quality reports developed by Lockwood, Andrews & Newman (LAN), and Veolia, as well as the 2014 and 2015 Annual Water Quality reports created by the city of Flint. Alongside these technical reports, screenshots of social media posts from the Flint community discuss their concerns over water quality.

3.3 Data analysis

As previously mentioned, this assignment was distributed to a particular set of students enrolled in an intermediate lab-based writing intensive course in mechanical engineering. Consent was obtained by 82 of the total 95 students in this course. The assignment responses were de-identified and then read to get a sense of what the participants said. For the purposes of this paper, we chose to focus solely on the second question asked in the reflection assignment: How do you practice being ethical as an engineer through language? What lessons can you learn from the Flint Water Crisis? Next, the data were analyzed in two rounds of coding by both authors. General codes were used to describe the emergent themes within responses, using In-Vivo coding to keep the data rooted in the participant's language. In the second coding round, the codes were clustered to create broader themes related to ethical communication and ethical considerations for engineering communication and practice. After compiling the analyses conducted by both authors, a consensus on which codes to use was reached.

4 Findings

Across participants' responses, we observed differences in the ways students linguistically positioned themselves in relation to the engineering profession. Some students referred to engineers in the third person, using terms like "they" or "engineers", which suggests a degree of distance or disconnection from the professional community. Others used inclusive pronouns like "we," "our," or "I," which signals a stronger identification with engineering and an internalization of professional norms and responsibilities. For example, "I practice being ethical as an engineer…" or "I think that as engineers we have a responsibility…" reflects a student's claim of membership to the engineering community of practice. This variation in language use reveals differing levels of identification and belonging, which illustrates how discourse, specifically language, aids in the construction of a student's position within the community (Sfard, 1998). These shifts in pronoun use offer a small insight into how students are negotiating their developing engineering identities.

To explore engineering students' perceptions of practicing ethics through communication and writing techniques, we explored students' responses to the following questions: How do you practice being ethical as an engineer through language? What lessons can you learn from the Flint Water Crisis? This section will explore key themes illuminating students' views of ethical engineering.

4.1 Addressing Social/Human Impact

Students noted that acknowledgment of the social impacts of engineering decisions should occur throughout an engineer's practice. From the 82 responses, 21 students mentioned the importance of addressing the social and human impact of engineering decisions to practice engineering ethically. The following sentiments expressed by students demonstrate the importance of being aware of social impacts to avoid producing harm:

> "Without knowing what the actual problems are that the people you are engineering for are facing, you cannot fix the problem correctly and without causing more harm."

> "awareness of the social impacts of our decisions is critical, as we want our designs to help not hurt communities, especially those already facing systemic inequalities."

Two students, in particular, extended the importance placed on considering the social implications of engineering work by suggesting it should be present and at the center of all engineering. These views can be shown in the following quotes:

> "I believe that all engineering should be socially engaged"

> "ethical engineering requires not just technical knowledge, but also a commitment to social justice and community engagement."

Similar expansions of ethical engineering practice were observed among other student responses, particularly related to an engineer's obligation to disseminate information. This view is shown by a student's point suggesting that "ethical responsibility extends beyond technical solutions to how those solutions are communicated to the public and authorities." Students recognized the power and influence of writing and communication methods by stating:

> "The language engineers use can shape public understanding and influence decisions."

> "It is very important to practice being ethical through language because that is the most likely way the public will access engineering knowledge."

Since engineering communications can significantly influence public perception, engineers must deliberately approach their communication methods. Students emphasized the need for engineers to purposefully create written works that consider social and human aspects, ensuring that community voices are amplified and potential risks are highlighted. By giving a voice to the people through your work, any people involved are more likely to see a real solution to their issues or at least to have their voices heard because "engineering writing may be considered more legitimate and reputable" than work they could put forth. As an example of how an audience can not take away the desired message, one student expressed how Flint engineers failed to communicate the dangers and suggested that the presentation of these impacts and its associated danger should be made explicit using "language such as 'dangerous' or 'high-risk health-hazard'." Emphasis on communicating effectively was echoed by other students:

"effectively communicate the issue and the severity of it, without delay or hesitation due to non-engineering reasons"

"ensure language accurately can communicate the scope and impact of all projects to the average member of the public as well as those making the decisions."

4.2 Considerations of Audience and Diverse Language Practices

Students commented on the importance of attending to the needs of the audience, including awareness of linguistic differences that might emerge around engineering issues. Among the 82 responses, 24 students addressed issues related to audience and diverse language practices. A common theme on this issue was that students observed that it was important for engineers to know their audience. One student wrote that an engineer should "listen to the public, trust the community, establish trust with communities [sic] working with or for, try to talk in language/dialect community understands (turn technical information into digestable [sic] info) for nontechnical people." This focus on listening to community members was echoed by 12 other students. Two students framed this attention to the audience as an issue of empathy: "It is important to place yourself in their shoes and see the issue from their point of view. Then you can see the severity of the issue and seek to solve it in a way that makes the most difference to their lives, regardless of your personal bias."

Another student framed the key objective as knowing your audience. Drawing on language from the lecture, including Halliday's concepts of grammar as "congruent" when it is similar to lived experience versus technical language which becomes "abstract" by converting verb phrases into noun phrases. As this student explained:

> I practice being an ethical engineer through language by knowing my audience. When I'm writing a technical paper or speaking formally with a known professional, my language becomes abstract because there is an implied level of mutual understanding. When I'm speaking informally or addressing someone who is not well informed on the subject, my language becomes much more congruent, literal, and easier to follow. It is unethical to always assume a minimum level of understanding. When the person you assume the person you are communicating to knows more about a subject than they do, you end up talking over their head, insulting their intelligence, and not effectively communicating your message.

Here the student emphasizes the cultural basis of language by underlining shared experience and knowledge as a prerequisite for using abstract technical jargon. On the other hand, the student also points to the separation between language and understanding by cautioning against making assumptions about others' knowledge. This focus on knowing the audience was echoed by another student who emphasized critical analysis of the audience as a strategy to develop accessible language. However, this student also characterized Flint residents as “undereducated and poor,” thus causing gaps in understanding between engineers and the public.

A few students (n=4) connected their consideration of the audience to language differences between the public and the engineering reports. Students highlighted the engineer’s responsibility to create understandable language, and to attend to matters of style and word choice in their communication. As one of these students explained,

> In practice, being ethical as an engineer means using language that conveys both sufficient technical information about the subject matter while also making the language, through which such information is conveyed accessible to those who may not be experts in the subject. A lesson that can be learned from the Flint Water Crisis is that one must be aware of language differences and stereotypes of such differences and, despite these, work to take public input seriously and handle problems accordingly. Another lesson that can be learned is that one must take into account all the potential social and economic repercussions of city management and engineering decisions so as to avoid another situation like the Flint Water Crisis.

These responses suggest that students are aware of how engineering discourse and the discourse used by members of the public are culturally distinct. Students pointed out how the technical reports were not composed in a way to support the understanding of the community. Thus, one student reflects “I think that an important part of ethical use of language is making sure to communicate the results of any test or findings in such a way that it can be understood by the population it affects.”

5 Discussion

Considerations of the social and human impacts related to engineering work and recognition of the importance of disseminating technical information to different audiences suggests students conceptualize ethical engineering work as human-centered. The results of this work implies students’ understanding of engineering as a sociotechnical discipline. One question that is brought up from assessing student’s responses to practicing ethical engineering is: How do students classify the role of engineers in relation to the communities they serve? Yanna Lambrinidou, a researcher whose work focuses on lead in drinking water, critiques the traditional approach to solving environmental injustice issues, following a deficit oriented “doing good” intervention (Lambrinidou, 2018). A sentiment found across several of engineering students responses follows the assertions made by environmental scientists and engineers who believe they have a commitment to protect the public’s health and welfare (Lambrinidou, 2018).

According to Lambrinidou, technical experts should adopt an approach of “transformative engagement” (Lambrinidou, 2018). This requires explicit questions surrounding equity and power, repositioning the role of technical experts as listeners, sharers, and ones who accompany communities (Lambrinidou, 2018). Using this framing, engineers should listen to community members to acknowledge their technical and moral values, making sure to allow space for your mind to change. Among the responses on how to ethically practice engineering, some of of responses (n = 15) discussed the importance of listening to the concerns of community members. An expanded view of engagement was found among some of students responses, where they discussed the importance of maintaining open and accessible communication with communities to maintain trust. As shown in the following excerpt:

“interact with the community listen to their opinions and be open and honest in all communications to build trust and maintain professional honesty.”

The second component of practicing transformational engagement is to share specialized technical knowledge in a way that empowers communities to assess, inform, expand, and challenge officially sanctioned positions while claiming technical and moral authority in their own right (Lambrinidou, 2018). As previously stated, students identified the impact of technical writing and engineering communication as affecting public understanding. It seems that students have an understanding of the importance of communicating in a way that is accessible and understandable to a variety of audiences, including local communities. The position of empowering the public was not present among students’ responses, indicating opportunities for students to grow in their justice oriented engineering practice.

Lastly, transformational engagement with communities looks like technical experts accompanying community members in the quest to solve the challenges facing them. Under this framing, engineers and other experts should walk side by side with communities till the repair is deemed as complete(Lambrinidou, 2018). As mentioned previously, two students discussed considerations of community engagement. These students were unable to expand on what exactly community engagement looked like to them. This is one of the limitations of our work, the inability to capture in depth responses of students’ perceptions of ethical engineering practices because of the construction of the assignment and classroom constraints. Another limitation of this work is the one-off nature of this intervention, where students were exposed to this content once, and the responses were collected within a week of the class date. Thus we could only capture a small snapshot of students' perceptions around engineering language practices and ethics considerations.

6 Conclusion and Future Work

In conclusion, this study highlights students' perceptions of practicing engineering ethically through language. Based on the initial run of the case study on Flint's water crisis, students demonstrated an understanding of the importance of addressing the social impacts of their engineering decisions directly and transparently. The findings indicated that students acknowledged the importance of considering the social impact of engineering solutions and addressing these consequences explicitly in their communication. Additionally, students identified the value of diverse language practices, emphasizing the need for communication that is accessible and comprehensible to a wide range of stakeholders, including government officials, fellow engineers, and community members. The initial use of these case study materials demonstrated the potential for encouraging reflection on the relationship between language and ethics in engineering. Future efforts will further expand the application of these materials to explore how students engage with concepts of language and ethics in engineering contexts. This ongoing work may provide additional insights into the ways in which students perceive and approach ethical communication in their professional development.

7 References

Aduúriz-Bravo, A. , Chion, A.R. & Pujalte, J.P. (2013). "Scientific Literacy." Encyclopedia of Science Education. DOI 10.1007/978-94-007-6165-0_262-1.

Artemeva, Natasha. "Stories of becoming: A study of novice engineers learning genres of their profession." *Genre in a changing world* (2009): 158-178.

Baker-Bell, A, et al. (2020). "This Ain't another statement! This is a DEMAND for Black linguistic justice!" Retrieved from: https://cccc.ncte.org/cccc/demand-for-blacklinguistic-Justice

Dixon, J. (n.d.). *Time line: How Flint's water crisis unfolded—Detroit Free Press*. Detroit Free Press. Retrieved January 14, 2025, from https://www.freep.com/pages/interactives/flint-water-crisis-timeline/

Halliday, M. A. K. & Webster, J. (2004). *The language of science. The collected works of M.A.K. Halliday*; v. 5. New York ; London: Continuum.

Huttner-Koros, A. (2015) "The Hidden Bias of Science's Universal Language." *The Atlantic.*

Hyland, K., and F. Jiang. (2017). "Is academic writing becoming more informal?" English for specific purposes (New York, N.Y.). Elsevier Ltd.

Kimmerer, R. (2013). Braiding sweetgrass: Indigenous wisdom, scientific knowledge and the teachings of plants. Milkweed editions.

Lambrinidou, Y. (2018). When Technical Experts Set Out to "Do Good": Deficit-Based Constructions of "the Public" and the Moral Imperative for New Visions of Engagement. *Michigan Journal of Sustainability*, *6*(1). https://doi.org/10.3998/mjs.12333712.0006.102

Leiser, S. (2022). *A 20-year review of Flint finances shows consequences of lack of investment | Gerald R. Ford School of Public Policy*. Ford School of Policy. https://fordschool.umich.edu/news/2022/20-year-review-flint-finances-shows-consequences-lack-investment

Leydens, Jon A. "Sociotechnical communication in engineering: An exploration and unveiling of common myths." *Sociotechnical Communication in Engineering*. Routledge, 2015. 1-9.

Masten, S. J., Davies, S. H., & Mcelmurry, S. P. (2016). Flint Water Crisis: What Happened and Why? *Journal - American Water Works Association*, *108*(12), 22–34. https://doi.org/10.5942/jawwa.2016.108.0195

Mazzurco, A., & Daniel, S. (2020). Socio-technical thinking of students and practitioners in the context of humanitarian engineering. Journal of Engineering Education, 109(2), 243–261. https://doi.org/10.1002/jee.20307

McGowan, V. C., & Bell, P. (2020). Engineering Education as the Development of Critical Sociotechnical Literacy. Science & Education, 29(4), 981–1005. https://doi.org/10.1007/s11191-020-00151-5

Paretti, M. C., and J. D. Ford. "Written communication in engineering work." *The Routledge International handbook of research on writing*. Routledge, 2023. 460-474.

Paretti, Marie C., Lisa D. McNair, and Jon A. Leydens. “Engineering Communication.” Cambridge Handbook of Engineering Education Research. Ed. Aditya Johri and Barbara M. Olds. Cambridge: Cambridge University Press, 2014. 601–632. Print.

Poe, M., et al (2010). Learning to communicate in science and engineering: Case studies from MIT. MIT Press.

Rosencrants, T., McCloskey, M., & McDonnell, S. (n.d.). *City of Flint Community Profiles by Ward*.

Rodrigues, R. B., & Cicek, J. (2024). A scoping literature review of sociotechnical thinking in engineering education. European Journal of Engineering Education, 49(5), 807–833. https://doi.org/10.1080/03043797.2024.2346344

Sfard, A. (1998). On Two Metaphors for Learning and the Dangers of Choosing Just One. Educational Researcher, 27(2), 4–13. https://doi.org/10.3102/0013189X027002004

Sfard, A. (2008). Thinking as Communicating: Human Development, the Growth of Discourses, and Mathematizing. Cambridge University Press. https://doi.org/10.1017/CBO9780511499944

Veolia. (2015). *Veolia Water Quality Report to Flint*.

Winsor, Dorothy A. *Writing power: Communication in an engineering center*. Suny Press, 2003.