"When I Learned Science in Spanish, I had to Switch to English": The Stigmatization of Non-dominant Languages in Engineering

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Abstract: This paper investigates primary grade students' perceptions of language in engineering design. Students participated in three lessons/contents: windmills (mixing languages), magnetic levitation (Spanish-only), and water treatment (English-only). Drawing on bilingualism and science education research, we examine what are students' views of the field and their language practices in the different contexts. The findings suggest that students may hold negative perceptions about hybrid discourses and Spanish in engineering and society in general. Students tended to not associate non-dominant languages with academic ideas.

We live in a society that privileges some languages over others. In the United States, a nation with a growing diverse population, language shapes the reality of schools (Vogel, Ascenzi-Moreno, & García, 2018). Bilingual students are often caught between language ideologies that favor English (Flores, 2013). With the advent of the new frameworks for K–12-science education, the language demands of engineering also become part of the structure of science (NGSS, 2013). Even before the addition of engineering, scholars in science education have already recognize the important role of language for science learning (Osborne, 1998). The research on language in science mainly focuses on the complexity of scientific discourses (Fang, 2005), or the failure of schools to provide adequate science instruction (Brown, 2005). We have yet to expand the scholarship on *linguistic discrimination* in science and engineering. The privileging of ways of speaking in schools may emerge both from the internal hierarchy of epistemologies in science as well as the hegemony of languages tied to nation-states. Learning engineering in the science classroom often equates to learning a variety of English in the context of the subject as suggested by Rosebery, Warren, & Conant (1992). This paper seeks to examine how primary grade students see their language resources in engineering within science learning environments.

Theoretical framing

Language plays a critical role in learning. It shapes the world around us and vice versa (Valdés, 2015). Through language, humans engage in science and its discourses (Lemke, 1990). However, the medium of language as it is conceived in science research and practice isn't neutral. Some of the three major perspectives around language in science reveal a history of *linguistic discrimination*. On the epistemic task perspective (Perkins, 1997), oral or written practices require for the enactment of scientific discourse constitutes language. The second perspective, scientific literacy (Norris & Philips, 2003), limits language to the interpretation and analysis of written text, relegating oral traditions to a subordinate position. The third view, sociocultural (Brown, Reveles, & Kelly, 2005), places language in a meaningful context with less emphasis on the power dynamics. These perspectives acknowledge the importance of language, but they privilege written text and standard forms or use the non-dominant language in the service of attaining 'academic English' and technical discourses.

Students who have limited access to technical discourses are entering classrooms where their linguistic resources as not valued. The assessments created to measure their academic performance often failed to measure their knowledge and skills (Darling-Hammond, 2015). Researchers have already pointed to the language demands in science as potential gatekeepers for bilingual students (Licona, 2015; Poza, 2016). These scholarships call for understanding language in science. Lee, Quinn & Valdés (2013) invite us to engage learners in scientific talk instead of focusing on grammar and vocabulary. Along those lines, Garcia & Wei (2014) challenge traditional notions of language as separate systems. The division between languages is ambiguous and discriminate against other ways of speaking. Research on language in science mostly focuses in English and less on non-dominant varieties (Lee, 2005). Neglecting less privileged languages is not random. Societies place languages in hierarchies, favoring the languages of groups in power while alienating speakers outside of the dominant group. Language, therefore, becomes a tool for oppression and inequality (Baugh, 2003). Rather than understanding their struggle as a result of social inequalities, speakers of non-dominant languages police their own practices and those of others in academic settings. To challenge traditional conceptions of language and power, researchers have introduced *translanguaging* theory and pedagogy as a critical social justice tool of inquiry (Otheguy, García & Reid, 2015). In this paper, we define translanguaging as a students' ability to draw upon their full linguistic repertoire in any discursive educational space or setting. Translanguaging scholarship advocates for practices that disrupt monolingual norms especially when teaching

bilingual students (Garcia, 2019).

Methods and context

Drawing on the bilingualism and science education literature, this paper investigates what are students' perceptions on language in engineering design. This study draws on data from an engineering program in the summer of 2017 at a California university. A purposeful sample of 19 students, with ages ranging from 7 to 13 years old, participated in the study. All students took part in three equivalent lessons on engineering design in the primary grades: alternative forms of energy (English and Spanish), magnetic levitation (Spanish), and water treatment (English). About 89% of students identified as Latino/a/x, and the rest as African American and Asian. The data encompassed eleven interviews of students. The conversations were video/audio recorded and transcribed using an external service. With these transcriptions, the researcher created a corpus of text data. Each corpus consisted of text files by participant for each of the constructs: language, engineering, and science/society. Each of the constructs corresponded to questions that seek to investigate a focus area of this research. There were three types of analysis using Python: VADER, characteristicness, and general inquirer tag. First, using the *Valence Aware Dictionary and sEntiment Reasoner (VADER)* tool, the researchers labeled the semantic orientation of students' responses as positive, negative or neutral and determined their magnitude. A compound score was calculated for each utterance. For each of the language contexts, the researchers also determined the terms most often associated with them. The *characteristicness* analysis consisted on the ranking of terms by the features of the corpus that makes the data unique (Kessler, 2017). Corpus characteristicness allow for comparisons between categories (Spanish and English) with a base corpus. The third analysis uses *scattertext* to explore the relationship between General Inquirer (GI) Tag Categories and Document Categories. Following Kessler (2017) approach, I looked at the relationship of the GI to languages by using the Z-Scores of the Log-Odds-Ratio with Uninformative Dirichlet Priors (Monroe 2008).

Findings

What were students' perceptions on language when engaging in engineering design? Students saw engineering learning in disassociation with non-dominant language. Participants described English as the language of power and education. Although all students identified as Spanish speakers, they tended to mention English when explaining positive perceptions about themselves and engineering. The compound scores by language reflected a greater preponderance of positive utterances when students referred to English than Spanish or translanguaging. Students associated English with expressions, such as 'they like' or 'would prefer', and 'to speak'. The graph of characteristic terms shows the characteristic scores (x-axis) versus class-association scores (y-axis) in Figure 1. As shown in Figure 1, the terms associated with the languages give the idea that students link English practices with the act of speaking while connecting Spanish with colloquialisms, actions verbs, and games. These terms are particular to our corpus. The terms "English", "speak", and "Spanish" are among the most characteristic words in the corpus with the term "speak" and "prefer" closely associated with English.

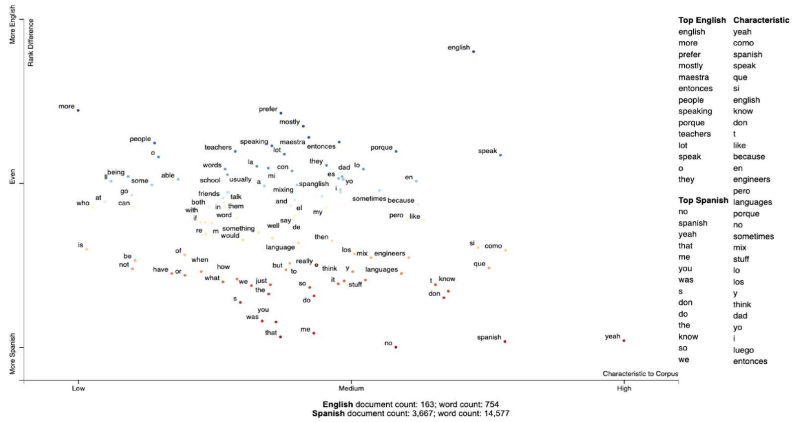

Figure 1. Characteristics terms in the corpus

The data points "prefer" and "more" offered an interesting view into students' perception of English in learning (see Table 1). The frequency of the terms associated with the languages was twice higher for English than Spanish when talking about themselves and engineering design. Katherine and Lionel' responses reflected a common pattern among all pupils with respect to students talking about English as their preferred and most confortable mode of communication. Students' responses suggested that they see themselves as more capable

and knowledgeable in English. For instance, Sharky, a 9-year old student in 4th grade, expressed, "I like a lot of Spanish and English, just don't speak it because I just like more English." After communicating his predilection for both languages, he stated preference for English. When students referred to the term "speak", they privileged English over Spanish. Ryan expressed this sentiment. He said, "I mostly use English to speak with people", positioning English as his medium of communication. Sharky's statement further supports Ryan's ideas. He explained, "sometimes I would talk in English forgetting that I was supposed to speak Spanish the whole time". What is even more interesting is that despite reporting to live in Spanish speaking households, Sharky and Ryan favored English as their primary form of communication. Conversely, when students talked about Spanish, their sentiments reflected deficit-oriented perspectives towards themselves or others. Participants associated Spanish to linguistic deficiency or as a tool to help others with limited English proficiency. Bryan shared, "I speak Spanglish when I don't know the Spanish words." Randy offers a perspective of language where he describes the usefulness of Spanish as the language that will allow him to communicate with relatives in Mexico. He stated, "I wanna learn more Spanish so that I can speak it better for when I go to Mexico." Although the United States is the countries with the greatest number of Spanish speakers, Randy's sentiments associated Spanish with a the idea of Mexico as a nation. Students explained that they draw on their Spanish repertoire when others or themselves lack the vocabulary or proficiency in English. Students expressed perceptions of Spanish as a stigmatize language in academic contexts. Figure 2 visualizes the general inquirer tag categories and the document categories. Figure 2 illustrates the top categories associated with English and Spanish. Students' responses linked English with ideas of nation-state, schooling, power and privilege, and language/discourse while connecting Spanish with negative connotations, language, socio-emotional, and mental processes.

Table 1: Frequency and mentions of the word "prefer" by each language.

	Prefer		More	
Frequency Type	English	Spanish	English	Spanish
Per 25,000 terms	217	5	391	45
Per 1,000 documents	31	1	42	4

Students associated Spanish with negative feelings about themselves. For example, Katherine, an 8-years old Asian-Latina, connected her self-perception as a bad writer with her schooling in Spanish. She stated, "I'm not a good writer anymore, just in Spanish, because I was taught in Spanish." Katherine equates being a good writer to being able to write in English, disregarding her capacity in Spanish. Some students who speak both languages fluently expressed negative feelings towards Spanish. For instance, Lionel, an 11-years old Mexican-American from a Spanish-speaking household who has attended dual language programs expressed feeling uncomfortable in Spanish. He said, "I like that switch [Spanglish], because it's kind of difficult to speak Spanish." He continued by explaining why he needs to switch languages: "When I learned science in Spanish, I had to switch over to English because I'm not super great in Spanish, but I still can understand it and all of that, but I'm not that good at speaking." Students have a negative view of themselves as speakers of Spanish. Although a few students show appreciation for engaging in engineering through Spanish, the majority of students connected L2 with people' lack of English proficiency in connection to immigrant communities or students who recently arrived to the US.

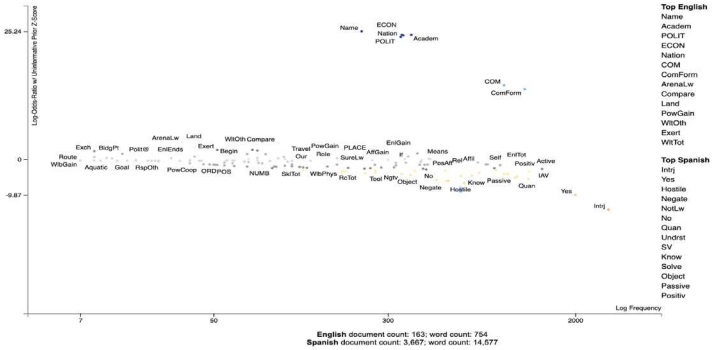

Figure 2. Relationship between general categories and the document categories of languages.

Conclusions and implications

This paper began by asking questions pertaining to student's perceptions about language in engineering. Preliminary results suggest that students have internalized hierarchies of linguistic power that privileges the

speaking of English over non-dominant languages. Students did not associate non-dominant languages with engineering or see themselves as capable in Spanish. Participants felt more capable of being themselves in academic settings, such as engineering learning, through English. They stigmatized Spanish as a non-academic language by categorizing its usage primarily for expressing feelings versus seeing it as a language for learning. The results suggest an unequal appreciation for languages, which, by default, mirrors the ways in which languages are privilege in society. An alternative explanation of students' responses could be that they never had engineering instruction in Spanish; thus the choice is not a negative one but simply caused by the lack of experience or engineering learning opportunities in Spanish. Yet, the references to being less proficient and/or capable suggest the contrary. Some researchers may go on to say that language specialization for specific domains is a well-documented reason for choosing the language of learning over the home language to communicate about an academic discipline. However, students tended to associated the home language with ideas of nation-state (often a foreign one) and dominant varieties with power and education. The lack of training data to generate an effective model represents a limitation of the study. This study has implications for imagining STEM environments with structures to support the social life and learning of bilingual learners.

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