

College Multilingual Students' Use of Translanguaging in Science Problem Solving Contexts

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Abstract: As linguistic diversity increases in U.S. colleges and universities, understanding the language practices of multilingual students becomes critical in creating inclusive and effective learning environments. Hence, we examined the translanguaging of college multilinguals, specifically focused on the patterns and functions of language choice in completing science and math tasks. This paper reports findings from our analysis of translanguaging in a paired three-part activity session and follow-up interviews with Gujarati-English speaking college students. Drawing on the findings, we discuss important insights into multilinguals' language practices in STEM learning contexts. Ultimately, we hope to generate deeper knowledge that serves as a foundation for designing linguistically responsive classrooms in college-level STEM education.

Purpose of the study

In the context of ever-growing linguistic diversity in U.S. post-secondary education, it is crucial to address the needs and strengths of multilingual students to ensure inclusive and effective learning environments. While there is no nation-wide data on college students' linguistic backgrounds, it is suggested that college multilinguals account for roughly 20-25% of college enrollment, with a higher percentage enrolled in 2-year colleges (Bergey et al., 2018). Despite several studies on challenges faced by college multilinguals in English-only STEM instructional settings, the knowledge base is limited regarding participation and learning of multilinguals in college-level STEM classes. Our study aims to generate a nuanced understanding of college multilinguals' diverse language use in STEM learning environments. To that end, we designed a paired three-part activity session (hereafter, paired session) that asks co-linguistic pairs to respond to several science and math questions. We analyzed video recordings of the paired sessions to examine (1) noticeable patterns of mixing two languages, (2) relations between discursive functions and translanguaging patterns, and (3) roles of non-verbal communicative modes. By generating this knowledge, we hope to illuminate how flexible language use can facilitate college multilinguals' scientific sense-making and offer recommendations for designing linguistically responsive classrooms in college STEM education.

Theoretical framework: Translanguaging

Translanguaging refers to the discursive practice of mixing different linguistic components of multiple languages to aid sense-making and maximize communicative potential (Vogel & García, 2017). While a naturally occurring phenomenon, translanguaging also has been widely explored as a pedagogical strategy to address challenges faced by multilinguals and leverage their strengths. It acknowledges and values students' linguistic resources, thus allowing multilinguals to draw upon their entire linguistic repertoire to comprehend and express ideas. Recently, the concept of translanguaging has expanded to include non-linguistic modes of communication, such as gestures, body movements, and facial expressions (Tai & Wei, 2021). This holistic approach aims to create inclusive learning environments that foster meaningful engagement and learning for all students.

Scholars have highlighted numerous benefits of translanguaging in various learning environments. Translanguaging allows students to connect academic content with their prior experience and everyday life. Hence, it helps students obtain a more complete understanding of the academic content (Karlsson et al., 2019). Translanguaging also increases multilingual students' participation and engagement in classrooms as it provides better opportunities to express themselves in a comfortable language (Ryu, 2019; Thraya et al., 2023). Additionally, it makes the learning environment more conversational, informal, and enjoyable while making the content accessible for all students (Hamman, 2018). By using their full linguistic repertoire alongside the language of instruction, students feel empowered since their multilingual identity is validated. Overall, translanguaging in a learning setting motivates and increases students' desire to continue learning (Hamman, 2018; Pun & Tai, 2021).

Methods and data sources

Situated in a large urban university in the United States, we conducted paired sessions and follow-up one-on-one interviews with multilinguals of diverse linguistic backgrounds. In the paired sessions, pairs of multilinguals who spoke at least two shared languages, including English, were given one hour to engage in three types of tasks: (1)

solving problems pertaining to introductory college science and math, (2) reading a short essay about water pollutants in urban areas and writing responses to presented questions, and (3) conducting science minilabs using household items and generating explanations about their observation. Throughout this session, the participants were encouraged to use any language of their choice, which in turn generated rich translanguaging data. Participants were provided with a computer connected to the Internet to search for information online if they wanted. Several weeks later, the participants were invited to the semi-structured, one-on-one interview, conducted solely in English. Interview questions included their linguistic backgrounds, college STEM learning experiences as multilinguals, and multiple artifact elicitation prompts. During the artifact elicitation, we presented three short clips from the participant's task-based interview and asked them to elaborate on those moments. The collected data (video recordings, screencast of computer use) were transcribed and translated by multilingual professionals fluent in the language used by study participants.

In the present study, we analyzed data from one pair of participants, Pravan and Jaimini, who spoke Gujarati (an Indian language) and English. To analyze the video recording of the paired session, we used process coding (Saldaña, 2021) to characterize each utterance's purpose line-by-line in the translated transcript, drawing on the video, screencast, and participant artifact data. Through constant comparison, we devised an 8-item codebook with definitions and examples (see Figure 1 for the list of the eight codes). Two researchers applied the codebook to the transcript and attained an initial 92.6% agreement. Disagreements were resolved through discussion. Then, we counted the numbers of words spoken in each language within each utterance to evaluate the relative dominance of each language. To understand the roles of multimodality, we identified moments in which participants employ multiple nonverbal communicative modes based on the criteria defined by Norris (2004). Then, we further analyzed these moments by foregrounding the actions contributing to participants' meaning making process and collectively interpreting their role in carrying out the activity. Lastly, quotes from the follow-up interviews were used to contextualize and corroborate our findings.

Findings

Pravan and Jaimini (freshmen in college) completed their education up to the high school in India. Growing up in Gujarati-speaking households in India, both considered Gujarati as their first language. As required by their university's admission policy, these students demonstrated proficiency in English through an authorized English proficiency test (e.g., TOEFL). They described their prior schooling in science and math as consistently multilingual. Typically, teachers introduced lecture materials in English and then explained and clarified in Hindi.

Noticeable patterns of mixing languages

During the paired session, Jaimini and Pravan used more English words than Gujarati words, demonstrating similar levels of English dominance (Jaimini: 69.3% English; Pravan: 54.6% English). A further analysis suggested that they primarily used Gujarati syntax and predicates, inserting English terms and phrases for scientific concepts and numbers. During the follow-up interview, Pravan and Jaimini described their language use with each other in the paired session as "the same" as their language practices when in class or studying together.

Below is an example of translanguaging during the paired session, wherein the participants were observing behavior of ground black pepper particles in a dish of water when touched with a toothpick covered in soap. The English translation is within square brackets. Italicized words denote English translations of words originally spoken in Gujarati.

- 1 Pravan: આ જો શું થઈ રહ્યું છે. એટલે લખ આ. પેલું થયું ખુલાઈ ગયું. શું કહેવાય એને. The particles released. [*Look what is happening. So, write this. That happened. It opened up. What to call that. The particles released.*]
- 2 Jaimini: એક મિનિટ ... When putting, નહિં dipping આવે ને. [*One minute ... When putting, no, it'll be dipping.*]
- 3 Pravan: Hmm. હજી એક વાર કરવા દે. સારું છે. જો કટ કરે છે, લખતો ... પેલું થયું [*Hmm. Let (me) do it one more time. (This) is nice. Look it is cutting (the surface), write it (down) ... that happened*]
- 4 Jaimini: In
- 5 Pravan: Black pepper sol
- 6 Jaimini: In black pepper sol
- 7 Pravan: In the bowl, ત્રણ મિનિટ જ છે. [*In the bowl, only three minutes (are left)*]
- 8 Jaimini: શું લખ્યું? [*What do (I) write?*]

9 Pravan: થઈ ગઈ ને? બીજું શું છે? [*It's done, right? What else is there?*]

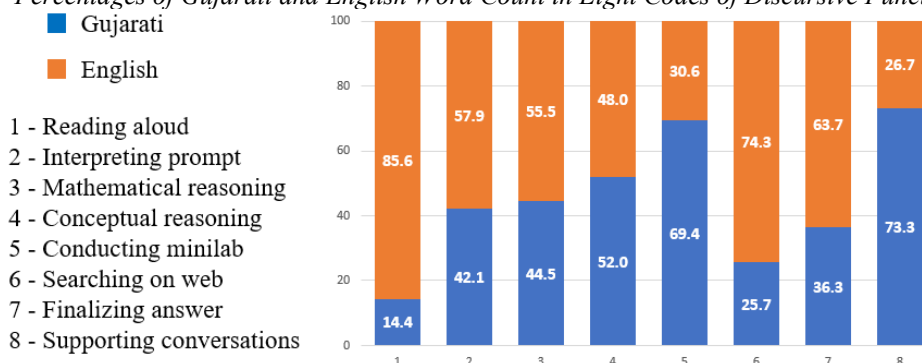
In Lines 1-3, the participants described their observations, mostly in Gujarati while mixing in English phrases. In doing so, they appeared to be searching for better expressions to describe the phenomenon (“it opened up [Gujarati],” “the particles released [English],” “it is cutting [Gujarati]”). The initial verbal description drew more on their Gujarati resources than English ones. However, Jaimini and Pravan did not rely on a Gujarati-to-English translation technique, but rather drew on linguistic repertoires in both languages readily available in that moment. In contrast, in Lines 4-6, both used solely English to generate a response to the given question “Describe your observation.” In Lines 8-9, wherein they are negotiating the tasks in hand (completing all questions given in the paired session), they spoke fully in Gujarati.

Relations between discursive functions and translanguaging patterns

Our coding and analysis of word count suggested a clear pattern in the relations between language choice and discursive functions, alluded to in the previous section. First, participants tended to use English mostly when they were engaged in tasks involving information input or output. As indicated by *Figure 1* these tasks included *Reading aloud*, *Searching on web*, and *Finalizing answers*. In contrast, they used both Gujarati and English at roughly the same ratio when working through the problems (*Mathematical reasoning* and *Conceptual reasoning*). Second, participants used more Gujarati in conversation when discussing the procedure or describing their observation while conducting minilabs (e.g., Lines 1-3, *Conducting minilab*). Third, *Supporting conversations*, such as expressing their feelings about question items, motivating the partner, and assigning tasks, were mostly carried out in Gujarati (e.g., Lines 8 and 9 in the excerpt).

Figure 1

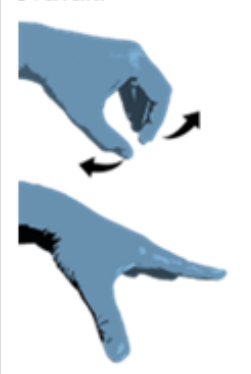
Percentages of Gujarati and English Word Count in Eight Codes of Discursive Functions.



Role of non-verbal communicative modes

Throughout the paired problem-solving session, participants employed various nonverbal communicative modes along with translanguaging to collaboratively carry out the tasks. Gestures especially seemed to play a significant role in expressing descriptive statements by bridging the gaps in meaning making. Figure 2 provides an example of a gesture that Pravan made in Line 1 in the earlier transcript. While saying “બેલું થઈ ગયું. [It opened up],” he held his hand up with fingers together and palm facing down and then quickly opened up the fingers as if the fingers represented pepper particles moving away from the center. When making this gesture, Pravan and Jaimini’s gazes were not aligned, indicating that the gesture perhaps played a role other than communicating well-developed ideas to the listener. Rather, Pravan’s translanguaging and iconic gesture use may have facilitated production of phrases that described his observation more accurately. This example highlights the interplay of translanguaging and other communicative modes, complementing each other in acting as key tools for articulating and refining multilingual students’ emerging ideas.

Figure 2
Gesture made by Pravan.



Discussion and significance of the study

This current study demonstrated that the Gujarati-English-speaking college students used both languages at similar frequencies when immersed in *Conceptual* and *Mathematical reasoning*, whereas they used more Gujarati

to motivate and orient each other to the task (*Supporting conversation*) or carry out experimental steps (*Conducting minilab*). Our findings are consistent with the findings of Karlsson et. al. (2019) which indicate that multilingual elementary students often convey science-specific content in the language of instruction while using their first language to express phrases establishing semantic relations. Additionally, our findings provide supporting evidence to Pun and Tai's argument (2021) that lab settings and experimental processes in high school science classrooms allow students to use dynamic linguistic practices even when the instructions are solely provided in English. Thus, the current study suggests that the knowledge and pedagogical approaches gleaned from in the K-12 settings regarding translanguaging may be applicable to college STEM education settings.

Our study presents at least three critical significances. First, it offers evidence that college multilinguals, who are considered "English-proficient" based on English proficiency test scores, routinely mix languages to accomplish STEM tasks, because they can leverage their knowledge and strengths across languages. That is, multilinguals' use of languages other than language of instruction should be understood as activation of their sense-making resources rather than an indication of limited English proficiency. Second, our findings challenge the simplistic notion that fluency in conversational English (e.g., Basic Interpersonal Communicative Skills) develops faster than in academic English (e.g., Cognitive Academic Language Proficiency). Depending on language socialization contexts, some multilinguals like our study participants, may learn academic English first through formal education and then conversational English, while others may learn conversational English through socializing with peers or popular media. Thus, multilinguals would engage in translanguaging practices in ways to leverage their specific language skills. Third, our findings provide evidence for the integral role of non-verbal modes in bridging the linguistic gaps in scientific meaning making and collaborative learning. Overall, our findings suggest the importance of understanding the diverse language socialization contexts of multilinguals as well as their dynamic use of multiple languages and non-verbal communicative modes. In designing linguistically responsive STEM learning environments, we urge educators to adopt flexible linguistic policies and create learning environment that encourages purposeful student-student discourse.

References

- Bergey, R., Movit, M., Baird, A. S., & Faria, A. M. (2018). Serving English language learners in higher education: Unlocking the potential. *American Institutes for Research*. Retrieved from <https://www.air.org/sites/default/files/downloads/report/Serving-English-Language-Learners-in-Higher-Education-2018.pdf>
- Hamman, L. (2018). Translanguaging and positioning in two-way dual language classrooms: A case for criticality. *Language and Education*, 32(1), 21–42. <https://doi.org/10.1080/09500782.2017.1384006>
- Karlsson, A., Nygård Larsson, P., & Jakobsson, A. (2019). Multilingual students' use of translanguaging in science classrooms. *International Journal of Science Education*, 41(15), 2049–2069. <https://doi.org/10.1080/09500693.2018.1477261>
- Norris, S. (2004). Modal density. In *Analyzing Multimodal Interaction: A methodological framework* (1st ed., pp. 79–94). Routledge.
- Pun, J. K. H., & Tai, K. W. H. (2021). Doing science through translanguaging: A study of translanguaging practices in secondary English as a medium of instruction science laboratory sessions. *International Journal of Science Education*, 43(7), 1112–1139. <https://doi.org/10.1080/09500693.2021.1902015>
- Ryu, M. (2019). Mixing languages for science learning and participation: An examination of Korean-English bilingual learners in an after-school science-learning programme. *International Journal of Science Education*, 41(10), 1303–1323. <https://doi.org/10.1080/09500693.2019.1605229>
- Saldaña, J. (2021). *The coding manual for qualitative researchers* (4th ed.). SAGE Publications
- Tai, K. W. H., & Wei, L. (2021). Constructing playful talk through translanguaging in English medium instruction mathematics classrooms. *Applied Linguistics*, 42(4), 607–640. <https://doi.org/10.1093/applin/amaa043>
- Thraya, S., Takeuchi, M. A., Koppala, M., & Chowdhury, A. (2023). Co-fostering translanguaging spaces through design for embodied (re)connection. In P. Blikstein, J. Van Aalst, R. Kizito, & K. Brennan (Eds.), *International Conference of the Learning Sciences Proceedings* (pp. 361–368).
- Vogel, S., & García, O. (2017). Translanguaging. In *Oxford research encyclopedia of education*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780190264093.013.181>

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