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# Insights from think-alouds on how multilingual learners engage in translanguaging in a multilingual science assessment

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This study aims to explore how multilingual learners utilize their linguistic and semiotic resources to engage in and complete a digital multilingual science assessment. A bilingual science task, accompanied by bilingual accommodations, was designed to allow students to use all their language and semiotic resources to demonstrate their understanding of the different states of matter. I employed a think-aloud method, incorporating both concurrent and retrospective protocols, to guide 15 middle school students in articulating their thoughts during the multilingual science assessment. This approach aimed to uncover how they utilized their linguistic and semiotic resources and the reasoning behind their selection of specific resources. The findings from this study provide insights into the cognitive processes and decision-making strategies of multilingual learners regarding the selection of language and semiotic resources in a multilingual content assessment. Additionally, implications for designing multilingual content assessments are also discussed.

## KEYWORDS

bilingual accommodations, multilingual assessments, multilingual learners, think-alouds, translanguaging

## 1 Introduction

In the United States, multilingual learners classified as English learners comprise nearly 10.6 percent of the student population, amounting to approximately 5.3 million students ([National Center for Education Statistics, 2024](#)). I use the term “multilingual learners” instead of “English learners” throughout the paper to highlight students’ multilingual strengths rather than imply deficits. These students face the dual challenge of learning the English language while also mastering a rigorous curriculum in English across various subjects, including science and mathematics. Consequently, schools and educators must identify effective instructional strategies to meet the needs of multilingual learners. Similarly, there is an urgent need for content assessments that genuinely evaluate students’ knowledge. Unfortunately, many of these assessments lack the linguistic sensitivity required to accommodate the diverse backgrounds of multilingual learners ([García, 2009](#); [López et al., 2015](#); [Shohamy, 2011](#)). By requiring students to respond exclusively in Standard English, these assessments create significant barriers to demonstrating understanding.

Content assessments that do not allow multilingual learners to utilize their full linguistic repertoire undermine the accuracy of score interpretations, particularly for those with limited English proficiency ([García, 2009](#)). As a result, students who have a deep understanding of the content but struggle with English are often misrepresented in their assessments, leading to an underestimation of their actual knowledge. It is essential to recognize and address these shortcomings to ensure fair assessment for all learners. In this study, I explore the integration of translanguaging in content assessment as an

alternative method for evaluating the understanding of multilingual learners. Specifically, I focus on how these learners use the languages in their repertoire to demonstrate their science knowledge.

## 2 Background

In this part, I will explore the concept of translanguaging, framing it both as a theoretical framework and as a practical pedagogical strategy. Additionally, I will provide an overview of how translanguaging has been effectively integrated into content assessments, highlighting its crucial role in fostering students' comprehension and communication skills across multiple languages.

### 2.1 Translanguaging

Translanguaging is a term that refers to the flexible use of a multilingual individual's entire linguistic repertoire (Canagarajah, 2011; García, 2009; García and Wei, 2014; Wei, 2011). García (2009) defines translanguaging as the use of all available languages to create meaning. This term denotes explicitly "the deployment of a speaker's full linguistic repertoire without regard for strict adherence to the socially and politically defined boundaries of named (usually national and state) languages" (Otheguy et al., 2015, p. 283). The prefix "trans-" in translanguaging indicates a movement beyond or transcending these language boundaries (Otheguy, 2016).

Translanguaging enhances students' understanding of subjects and improves their written and oral communication skills in all their languages by enabling seamless transitions between languages for educational purposes (García, 2009). It involves utilizing an integrated system of language features that multilinguals strategically select to communicate effectively (Canagarajah, 2011; García and Wei, 2014; Velasco and García, 2014). In this approach, languages are interconnected rather than treated as separate or isolated entities (García, 2009). They operate within a unified linguistic system (Shohamy, 2011) and draw on various semiotic resources (Canagarajah, 2013; Wei, 2011).

Translanguaging serves as both a theoretical framework and an instructional method aimed at enhancing language and content skills in educational settings by utilizing learners' entire linguistic repertoires (Cenoz and Gorter, 2021). Pedagogical translanguaging is a learner-centered approach that intentionally supports and develops all learners' languages. Teachers create environments where students can engage in translanguaging and offer instructional resources in multiple languages (Cenoz and Gorter, 2021). This approach fosters metalinguistic awareness by blurring the boundaries between languages during the learning process and can be effectively implemented in both language and content classes to protect and promote minority languages (Cenoz and Gorter, 2021; García and Wei, 2014).

In recent years, researchers have documented the experiences of multilingual students in science classrooms, highlighting both the barriers they encounter and the value of their communicative practices (Gravin et al., 2024; Hou et al., 2024; Pérez et al., 2022). Translanguaging supports collaborative knowledge construction and deepens understanding of scientific ideas alongside the language

needed to express them (Licon and Kelly, 2020; Probyn, 2019; Tai and Wei, 2025).

Careful observation of students' language use during activities such as modeling, debating, explaining, and data analysis reveals how they negotiate meaning and build scientific understanding (Lee et al., 2013; Pierson et al., 2021). Muthyalu (2024) reports that teachers welcome translanguaging because it makes science concepts more accessible, encourages questioning, and promotes more straightforward explanations. Ultimately, this creative and flexible approach to language is essential for generating new scientific knowledge (López and Turkan, 2025; Priyadarshini et al., 2025) and offers a pathway to more inclusive, effective science learning environments for multilingual students (Hou et al., 2024; Jakobsson et al., 2021; Karlsson et al., 2019). In the next section, I will discuss how pedagogical translanguaging can be integrated into multilingual assessments.

### 2.2 Integrating translanguaging in multilingual content assessments

Several scholars have emphasized the need to shift away from language isolation policies and adopt comprehensive approaches that recognize language as an asset in both instructional and assessment contexts (Cenoz and Gorter, 2017; Shohamy, 2011). Although there are challenges related to entrenched monolingual ideologies and concerns about consistency across different languages (Badham and Furlong, 2022), it is essential to address these issues in assessments. Traditional monolingual assessments significantly limit the ability to evaluate the knowledge of multilingual learners (De Backer et al., 2017; Gándara and Randall, 2019). Research clearly shows that utilizing students' full linguistic abilities in assessments not only enhances performance but also lets them emerge higher-order thinking skills (López et al., 2017; Schissel et al., 2018). Increasingly, educators and policymakers recognize the urgent need to develop valid multilingual assessments that align with contemporary understandings of multilingual competence, ensuring fair evaluations for linguistically diverse students (Schissel et al., 2019). Recent studies underscore the critical importance of implementing multilingual strategies in content assessments to accurately reflect students' linguistic diversity (García, 2009; López, 2024; López et al., 2017; Shohamy, 2011).

Several studies have explored the use of translanguaging in content assessments for multilingual learners (e.g., Ascenzi-Moreno, 2018; Fine, 2022; Gravin, 2022; Gravin and Ascenzi-Moreno, 2024; López, 2023, 2024; López et al., 2019). Research indicates that incorporating translanguaging practices into assessments enables multilingual learners to utilize their entire linguistic repertoire, resulting in enhanced engagement and confidence (López et al., 2019; Rafi, 2023). Furthermore, translanguaging in content assessments is more appropriate than traditional monolingual approaches, as it enables newly arrived emergent multilingual learners to demonstrate what they already know and can do (De Backer et al., 2017; Gándara and Randall, 2019; López et al., 2017).

A few studies have explored integrating translanguaging into content assessments using multilingual accommodations (López, 2023; López, 2024; López et al., 2019). Commonly used multilingual accommodations include multilingual test forms, pop-up multilingual glossaries, reading

directions and questions aloud in multiple languages, and allowing responses in various languages (Abedi, 2009; De Backer et al., 2020; Pennock-Roman and Rivera, 2011; Yang, 2019). Content assessments that include multilingual accommodations enable multilingual learners to utilize their entire linguistic repertoire, including both standard and vernacular varieties, to demonstrate their knowledge and skills (López et al., 2017; Sayer, 2013). These assessments aim to promote linguistically adaptive multilingual practices within a single context, allowing students to use various semiotic resources to express themselves, whether in writing or orally (Shohamy, 2011; Wei, 2011). While items are available in multiple languages and modalities, students can choose their preferred language and mode to showcase their abilities (López et al., 2017).

Incorporating translanguaging into content assessments is essential for making these evaluations accessible to all students (Fine, 2022; Schissel et al., 2024). The integration of translanguaging in content assessments not only recognizes the multilingual identities of learners but also fully considers their varied language skills and cultural backgrounds. As a result, it leads to a much more comprehensive understanding of their abilities (Schissel et al., 2018). When students engage in translanguaging during content assessments, they can accurately showcase their knowledge and skills, regardless of their proficiency level in the target language (López et al., 2017).

Translanguaging enables students to effectively demonstrate their content knowledge and skills by utilizing their complete linguistic repertoire (Ascenzi-Moreno, 2020; López, 2023; López et al., 2019; Schissel et al., 2024). For instance, students often use a combination of languages, numbers, symbols, and translanguaging practices to respond to questions, and they have the advantage of viewing and listening to prompts in both languages (López, 2024). Research demonstrates that students exhibit a rich and versatile use of their language skills, whether they reply entirely in English or their home language or switch fluidly between the two, showcasing their exceptional bilingual proficiency and adaptability (López, 2023; López et al., 2019). This approach to integrating translanguaging in content assessments effectively eliminates language barriers and enhances multilingual learners' ability to convey their content knowledge (Grapin, 2022). Moreover, teachers have reported positive outcomes when implementing translanguaging in classroom assessments; however, challenges remain regarding standardization and execution (Fine, 2022; Grapin and Ascenzi-Moreno, 2024; López, 2024; Schissel et al., 2018).

The findings presented suggest that integrating translanguaging into content assessments holds great promise. This approach could lead to a more equitable and effective evaluation of the knowledge and skills of multilingual learners. However, further research is necessary to explore how multilingual learners utilize translanguaging in multilingual content assessments to ensure the best possible outcomes. Additional studies are needed to develop and validate assessment tools that can properly integrate translanguaging practices. Furthermore, exploring the experiences and perceptions of students engaged in translanguaging practices could provide valuable insights into its effectiveness and identify areas for improvement.

### 3 Goal of the study

I provided a comprehensive overview of translanguaging in the previous section, covering its origins, theoretical framework, and

practical applications in education. However, several areas warrant further exploration and research. The purpose of this study is to investigate how multilingual learners utilize their linguistic and semiotic abilities to participate in and complete a multilingual science assessment. A multilingual science assessment was created to enable students to draw upon all their language and semiotic resources to demonstrate their understanding of different states of matter.

Specifically, this research focuses on addressing the following two questions:

- RQ1: How do multilingual learners utilize their linguistic and semiotic resources in a multilingual science assessment?
- RQ2: What process do multilingual learners employ to determine which language resources to utilize?

## 4 Method

I employed a think-aloud method to help participants articulate their thoughts while completing a digital multilingual science assessment, aiming to gain insight into their cognitive processes and decision-making strategies when selecting their language and semiotic resources. I employed both concurrent and retrospective think-aloud protocols to improve our understanding of how multilingual learners utilize their linguistic and semiotic resources in multilingual assessments. In this section, I describe the multilingual science assessment, the participants, the think-aloud procedures, and the data analysis.

### 4.1 The digital multilingual science assessment

The digital multilingual science assessment used in this study was developed solely for research purposes. This means that students' performance in the assessment was not linked to their curriculum, and there were no consequences associated with the results. The primary objective of this task is to assess students' ability to utilize models to explain the behavior and distribution of particles during various phase changes (solid, liquid, and gas). The assessment consists of 16 items, requiring students to construct, use, evaluate, and revise models, followed by answering questions related to these models. See sample questions in Figure 1.

Specifically, students must create five models, answer eight selected-response items, and respond to eight constructed-response items. Selected-response items provide supplementary data on students' content knowledge; constructed-response items require students to explain their models in their own words. Refer to Appendix A to see how these items were scored. In models, students can include particles of different colors and sizes (particle characteristics). They can arrange the particles in various ways, packed closely together or apart (particle distribution). Students can also indicate whether the particles are moving by using arrows of different sizes (slow, medium, and fast). Table 1 illustrates what the assessment is expecting students to do.

To integrate translanguaging into these assessment tasks and make them more accessible to multilingual learners, we employed several principles of translanguaging pedagogy. The goal is to empower

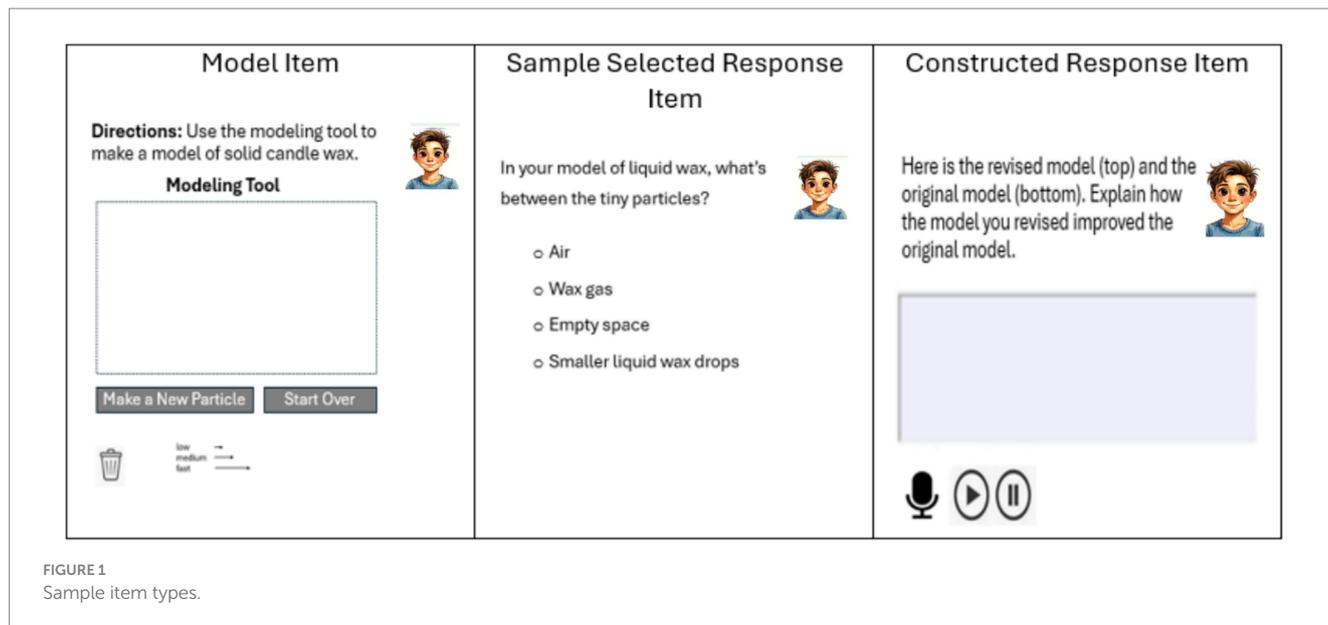


FIGURE 1  
Sample item types.

multilingual learners to utilize all their linguistic and semiotic resources to showcase their knowledge and skills. To facilitate translanguaging in the content assessment, a few bilingual accommodations were integrated. These accommodations are always available for test takers, but their use is not mandatory. The bilingual accommodations include presenting assessment items in two languages (linguistic resources). Initially, students will always see the items in English, but they can switch to Spanish at any time and toggle between the two languages. Additionally, students have the option to listen to someone read the directions and questions aloud in English, Spanish, or both (semiotic resources). Certain key words are glossed in both the English and Spanish versions; students can hover over these glossed words to see synonyms or pictures (linguistic resources). Moreover, students are provided with multiple modes of expression for the constructed response items (semiotic resources). They can choose to write or record their responses in either language or a combination of both. The bilingual accommodations are illustrated in Figure 2.

## 4.2 Participants

The original plan was to select a middle school that offered a bilingual (English/Spanish) science program and had a diverse group of bilingual students at various English language proficiency levels, including low, intermediate, and advanced. I invited teachers who had participated in previous studies and were willing to take part in this study. Eventually, I chose a middle school that provided a bilingual science program for 7th and 8th-grade students. The instruction was primarily in English, but students had access to numerous English and Spanish resources and were permitted to use English, Spanish, or both during instruction. There were 22 students in the class, and all were invited to participate, but only those who received written permission from their parents were included in the study. The final sample consisted of 15 students, aged between 12 and 14 years (with an average age of 12.9). There were ten 7th graders and five 8th graders, comprising nine girls (five in 7th grade, four in 8th grade) and six boys (five in 7th grade, one in 8th grade).

I asked the teacher to assess the students' language proficiency. The students' English language proficiency was determined by their scores on the state's English language proficiency test or the initial English language proficiency classification test for students who had recently arrived in the United States. According to the teacher, five students were rated as having low English proficiency (students 1, 9, 11, 12, 13), six as intermediate (students 2, 3, 4, 6, 10, 14), and four as advanced (students 5, 7, 8, 15). The teacher also assessed the students' Spanish language proficiency based on their interactions and performance in the bilingual science class. All the students were rated as highly proficient and literate in Spanish. Students were also asked to self-assess their English and Spanish skills, as well as their language use in science instruction and assessment, using the instruments shown in Appendix B.

## 4.3 Procedures

Four bilingual researchers underwent training to conduct the 15 think-aloud sessions. Each session took place individually in a quiet, comfortable environment to encourage natural thinking aloud. To help participants feel more at ease verbalizing their thoughts, the researcher guiding the session demonstrated the think-aloud process and provided training at the start of each interview. A similar science task was used to model and practice the think-aloud process. This training enabled the researcher to observe and offer suggestions to help participants enhance their verbal expression of thoughts. Participants were allowed to verbalize their thoughts in their preferred language, whether English, Spanish, or a mix of both, to enhance their performance (Bowles, 2010; Yanguas and Lado, 2012). Each session lasted approximately 50 min and was audio-recorded and transcribed.

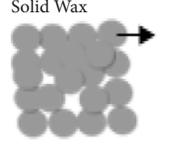
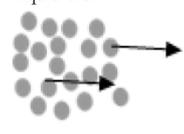
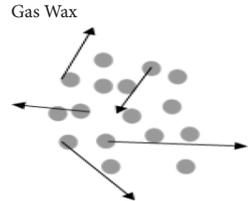
The bilingual researchers tried to be as unobtrusive as possible during the concurrent think-aloud portion. They refrained from correcting or assisting the participants and only intervened when the participants stopped talking. When this happened, the researchers prompted the participants to continue speaking. To address the limitations of concurrent think-aloud identified by Ericsson and Simon (1980), the bilingual researcher supplemented the process by

asking follow-up questions (retrospective think-aloud) immediately after the student completed each item in the multilingual science assessment. This approach provided additional insights. The researcher also took detailed notes on how the participants utilized their linguistic resources (e.g., English, Spanish, or both) and semiotic resources (e.g., drawn models, written and oral language). Refer to [Appendix C](#) for the think-aloud protocols.

Furthermore, the digital assessment platform yielded valuable process data on how students utilized various bilingual accommodations, such as translations, read-alouds, and oral responses, as well as information about the languages students used to view the items and the languages they used to answer them. By integrating all these data sources, I gained a more comprehensive view.

### 4.4 Data analysis

TABLE 1 Sample student responses and the scientific concept they are illustrating.

| Model   | Scientific concept  |
|---|---|
|    | Students use only one type of particle (same color and size); the particles are packed closely together and are moving slowly (indicated by the short arrow).   |
|    | Students use the same particles (color and size) as in the solid model; the particles are packed less closely together and are moving faster than in the solid model (indicated by a longer arrow).   |
|  | Students use the same particles (color and size) as in the other models; the particles are packed less closely together and are moving faster than in the liquid model (indicated by a longer arrow). |

To analyze the first research question about how students used their linguistic and semiotic resources to complete the assessment task, I used the process data provided by the digital online system. The process data included the languages students used to access each question, the languages they used to answer the questions, and the number of times they utilized each of the multilingual accommodations. These data were complemented with the transcriptions and notes from the think-aloud sessions. I used frequencies to identify patterns in the ways students used their languages (linguistic resources) and language modes (semiotic resources).

To answer the second research question, I used the transcriptions and the notes from the think-aloud sessions to identify similarities and differences in how participants selected linguistic (i.e., languages) and semiotic resources (i.e., language modes) from their repertoire. In the first stage of the analysis, two researchers independently read all the transcribed think-aloud sessions and the notes multiple times to fully immerse themselves and become more familiar with the data (Tesch, 1990). After repeated readings of all the transcribed spoken recordings, the two researchers independently developed an initial set of codes and a series of notes on emerging themes for each of the three categories (i.e., planning, monitoring, and evaluation) in the data using a grounded open coding process (Charmaz, 2014). These three

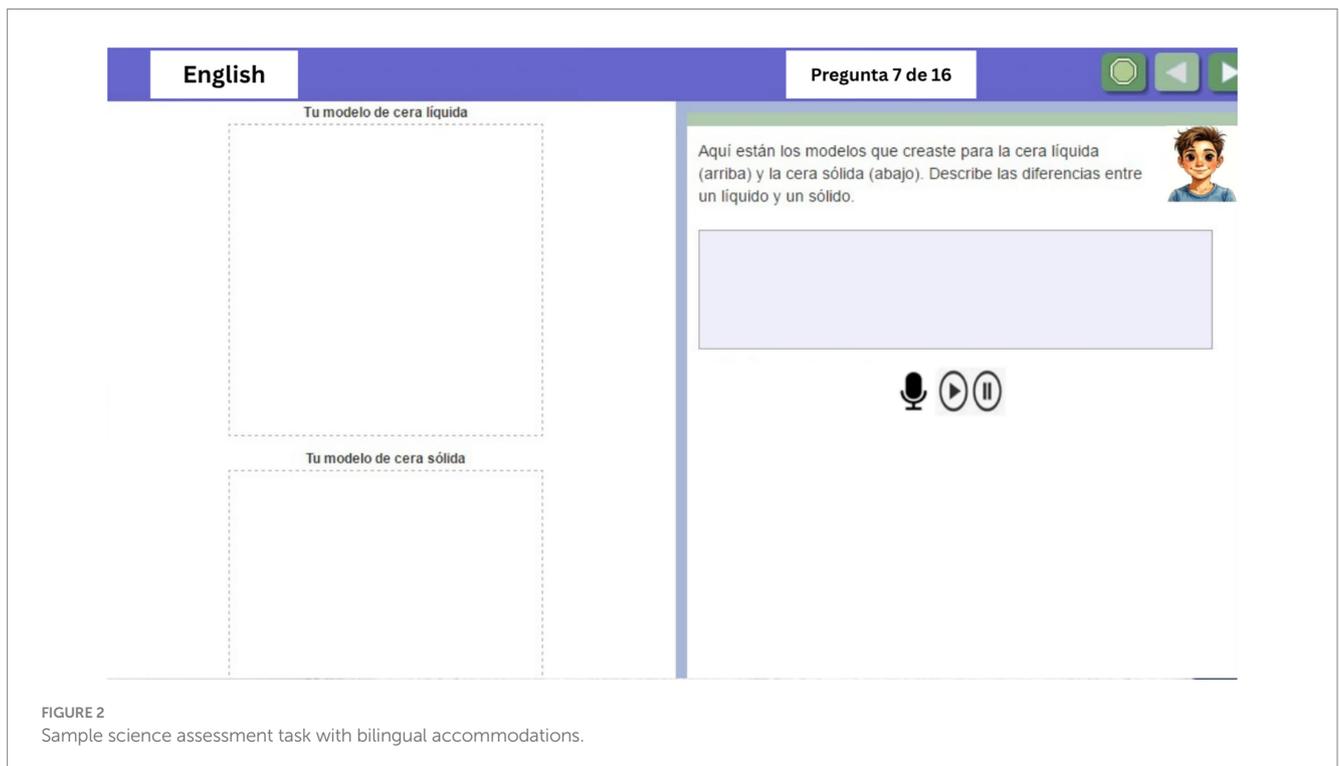


FIGURE 2 Sample science assessment task with bilingual accommodations.

categories are discussed in Table 2. The two researchers then met to compare and discuss their initial codes and themes to see if they reached similar interpretations of the data. Any disagreements in the initial coding were resolved through discussion to reach an agreement, as suggested by Strauss and Corbin (1990). The recurring themes were closely aligned with the second research question: how multilingual learners determined which resources to use.

## 5 Findings

In this section, I provide information to answer the two research questions. First, I will discuss how students used their linguistic (languages) and semiotic (language modes) resources to complete the digital multilingual science assessment. Then, I describe the students' decision-making process for selecting which linguistic and semiotic resources to use when interacting and responding to the items.

### 5.1 Students' use of linguistic and semiotic resources

In completing the multilingual science assessment, students employed a wide array of languages and language modes. For the language used in the assessment, seven students relied on a single language, either English or Spanish. Among them, five used only Spanish resources to access and complete the items, while the other two exclusively used English resources. In contrast, eight students utilized both English and Spanish resources to complete the task. When it came to the constructed response items, 11 students answered all the open-ended questions in Spanish, while two students used English. The remaining two students responded in both languages. Regarding the mode of response, only one student offered oral answers, while the rest submitted written responses.

Only five students used the read-aloud accommodation in English and Spanish. Students 2 and 15 used this accommodation to complete

each item. Student 2 listened to someone read aloud the items four times in English, nine times in Spanish, and three times in both languages. Similarly, Student 15 listened to someone read aloud the items once in English, 14 times in Spanish, and once in both languages. Both students explained that they used the read-aloud accommodation to confirm that they had understood the problems they read in English or Spanish. Student 8 used the read-aloud accommodation three times. The first time, she used the read-aloud to experience using this accommodation. She stated that she liked the accommodation and would use it if needed. She used it two more times to enhance her comprehension of the questions. She explained: "I was not sure if I had understood the question, so I listened to the item. The way the question was read helped me understand it." Students 13 and 14 only used the read-aloud accommodation twice, but used it for different reasons. Student 14 used it and positively perceived it because it enhanced her comprehension. In contrast, Student 13 did not perceive this accommodation positively because it did not enhance her ability to understand the question. She explained, "I did not understand the question in English, so I listened to it. But it's basically the same as what I read, so it did not help me much." The rest of the students did not use this accommodation because they felt it was unnecessary.

Regarding the pop-up glossaries, all students used this accommodation at least once. They used it only when they did not understand the meaning of the glossed words. However, they mentioned that the glossaries helped them understand the meaning of the unknown word, but not so much in understanding the overall meaning of the question. They encountered many unknown words and wanted to see this accommodation offered more widely. Instead of pre-assigned glossed words, they want this accommodation for any word they do not understand.

### 5.2 Planning which linguistic resources to use

Students' initial selection of which language resources to use was based on their language proficiency in English and Spanish, their

TABLE 2 Overview of the coding scheme for the think aloud sessions.

| Category   | Codes  | Number of participants |
|--|--|------------------------|
| Planning which resources to use  | Selection based on language proficiency          | 15                     |
|  | Selection based on language strengths            | 7                      |
|  | Selection based on language limitations          | 5                      |
|  | Selection based on language preference           | 2                      |
|  | Selection based on language of instruction       | 1                      |
| Monitoring and evaluating comprehension                                | Use the same language if successful              | 10                     |
|  | Use a different language if unsuccessful         | 8                      |
|  | Use the same accommodations if successful        | 7                      |
|  | Use a different accommodation if unsuccessful    | 11                     |
| Monitoring and evaluating their ability to answer open-ended questions | Based on the level of comfort using the language | 8                      |
|  | Based on language preference                     | 5                      |
|  | Based on the language of the task                | 2                      |
|  | Based on comfort level using the language mode   | 10                     |
|  | Based on the preference for language mode        | 4                      |
|  | Based on the language mode used in instruction   | 1                      |

experiences using these languages, or their perceived ability to use these languages to complete the multilingual science assessment successfully. The think-aloud sessions revealed that all students were clearly aware of their proficiency levels in English and Spanish, and this self-awareness enabled them to determine which resources they could utilize to complete the assessment task. The five students who completed all the items in Spanish stated that they did not feel confident answering in English because they were still developing their English skills. These students did not attempt to read or answer any of the items in English. Student 1 commented the following about why she planned to complete the task in Spanish: “It is easier in Spanish. I feel more comfortable and secure.” Similarly, Student 12 talked about his limited reading comprehension skills in English: “I have a lot of problems reading in English. It is easier when reading in Spanish.”

The other 10 students felt they were proficient in both languages, English and Spanish, so they could use any of these languages to complete the multilingual science assessment. However, six of them preferred to complete the assessment task in Spanish because they felt it was easier for them in this language and were very confident in their ability to understand the questions and answer them in Spanish. For instance, Student 15 commented the following about which language resources she was going to use to complete the assessment task: “I could probably answer all of them in English. I’ll probably try some in English, but I think I understand better when in Spanish.” Similarly, Student 10 stated the following about his perceived language abilities: “I can do it in English or Spanish, but I prefer Spanish. It is easier for me to write in Spanish. I feel more comfortable because I understand better the meaning of the words in Spanish. But I like that I can switch to Spanish if I do not understand.” These six students used resources associated with English and Spanish to complete the assessment task.

Moreover, two more students who said they were proficient in both languages planned to attempt the task in English first and then determine if they could complete it using this language. Otherwise, their initial plan was to switch to Spanish. For example, Student 2 commented that he was more comfortable using Spanish than English. However, he had a clear plan in place for addressing potential problems or challenges that could hinder his ability to understand the questions. He stated: “If I understand the question well in English, I respond in English; if not, I respond in Spanish.” Student 14 had a similar approach to selecting resources from her repertoire. She explained: “I am bilingual; I feel almost the same in both languages, but a little more comfortable in Spanish. But there are words I do not understand in English and some I do not understand in Spanish, so I might have to use both.”

Finally, the remaining two students, who claimed proficiency in both languages, planned to use only English to complete the assessment task, although their reasons for selecting these language resources differed. Student 8 stated that she is fully bilingual and can complete the items in any of the two languages. However, she prefers to use English because that is the language she uses in school. She also feels very confident using English and prefers this language over Spanish. She noted the following: “I’m going to answer all the questions in English because I feel like it is easier for me to respond in English. I think it would also be easier to answer in Spanish, but I prefer English.” Student 6’s plan to complete the task in English was somewhat surprising, as he stated that he is still developing his English skills and prefers to communicate in Spanish. However, he felt that the

expectations (e.g., from the school and his teachers) were for him to complete the assessment task in English, as this is the language of instruction and the language used in the science assessments he would take during the academic year. He believes he has enough English skills to complete the task successfully. He explained: “I prefer to use Spanish, but I decided to do the activity in English because it feels like the activities I do at school. I’m used to do all my tests in English. I think I can understand when reading the questions in English.”

### 5.3 Monitoring and evaluating comprehension

During the monitoring process, students actively assessed the effectiveness of the linguistic and semiotic resources they employed to interpret the instructions and questions for each item. Two distinct patterns emerged from the think-aloud sessions, highlighting their approaches. The first pattern showed that students tended to stick with the same resources when they found them effective for comprehension. For example, Students 1, 7, 9, 11, and 12 exclusively relied on Spanish resources throughout the assessment, demonstrating a clear preference for this language, which allowed them to grasp the instructions successfully. In contrast, Students 6 and 8 chose to utilize only English resources, indicating that their understanding was bolstered by sticking to a single language throughout the process. Additionally, Student 15 illustrated a versatile strategy by consistently employing the read-aloud accommodation in both English and Spanish for every item presented. This dual-language approach provided her with the necessary support to verify comprehension and ensure clarity in interpreting the tasks. Overall, the students’ strategies showcased their adaptability and the importance of linguistic resources in their learning process.

In the second pattern observed, some students utilized different linguistic or semiotic resources, such as another language, modality, or multilingual strategies, when they faced difficulties understanding the instructions or questions. For instance, Student 4 attempted to answer the first question in English but was unsuccessful due to the presence of many unfamiliar words. She then switched to Spanish and found it easier to understand what Item 1 was asking her to do. She remarked that he felt more confident completing the items in Spanish and preferred working in that language. Consequently, she chose to complete the rest of the assessment in Spanish.

In contrast, Student 3 actively monitored his comprehension for each item. If he understood the instructions and questions, he continued using the same language; if not, he would switch to the other language. For example, he began Item 1 in English but was unable to comprehend it, prompting him to switch to Spanish. He successfully understood the following two items in Spanish; however, he encountered difficulties with Item 4 in Spanish and reverted to English. He maintained this pattern throughout the entire assessment task.

During the assessment, two students decided to switch their language resources after initially starting in English. Student 10 began by tackling the first eight items of the assessment in English, demonstrating a good grasp of the material initially. However, when he encountered difficulties with Item 9, which involved complex language or concepts, Student 10 opted to switch to Spanish for clarification. This change proved beneficial, as he found it significantly

easier to understand and interpret the question in Spanish. Encouraged by this improvement, Student 10 then chose to answer the remaining items in Spanish.

Similarly, Student 14 also started the assessment using English and completed the first seven items. However, upon reaching Item 8, she faced challenges with comprehension. Realizing that Spanish could provide a clearer understanding, Student 14 decided to transition to that language for the rest of the assessment. This switch made it easier for her to grasp the content and respond effectively to the remaining questions. Both students demonstrated adaptability in their approach to the assessment, seeking the language that best facilitated their understanding.

I also examined how students selected the language resources they used to complete the constructed response items in the multilingual science assessment. Among the participants, a total of 11 students opted to respond in Spanish for all six constructed-response questions. In contrast, two students chose to answer every open-ended question exclusively in English. When asked about their language preferences, eight students reported that their selections were primarily influenced by their comfort level with each language. They felt more at ease expressing their thoughts and ideas in the language they chose. The remaining five students noted that while they were proficient in both English and Spanish, they preferred to respond in Spanish. Their rationale was that they found it easier to articulate their responses in Spanish and believed they had a better opportunity to convey their explanations effectively in that language.

Two students demonstrated the use of multiple languages while completing the constructed response items in their assessment. Student 14 started her responses in English but found it challenging to articulate her thoughts clearly, leading her to switch to Spanish for the fourth question. She explained her decision by saying, “I started in English at first. It was tough, but I was able to respond. Toward the end, I kind of got tired and just switched to Spanish because it was easier for me to say what I was thinking.” On the other hand, Student 10 uniquely incorporated both English and Spanish within a single response on two occasions during the assessment. He noted that he was writing down whatever ideas came to mind without worrying too much about language choice. One of his responses illustrated this bilingual approach: “The water, when *está congelada*, is in *estado sólido*, and when *se descongela*, *está en estado líquido*.” In English, this translates to, “The water, when frozen, is in a solid state, and when it thaws, it is in a liquid state.”

## 5.4 Language mode used to complete the constructed response items

In this section, I will provide a detailed account of how students selected the mode of communication to complete the constructed response items in the multilingual science assessment. Only one student, Student 8, provided oral responses. He explained that responding orally was easier for him because he could complete the items faster and provide longer explanations than he could in writing. Student 8 stated, “I recorded my responses because I am much better at speaking than writing. I can explain much better when I speak.” It is worth noting that four students initially attempted to record their responses but were unsuccessful and ultimately opted to write their answers instead. Student 5 shared, “I thought it would be easier to

record my answer, but when I started, I found it really challenging. I could not think of what to say and got very nervous. I tried again, but I just could not do it.” The other students discussed the differences between recording and writing responses, noting that they found writing to be easier than speaking. Student 12 remarked, “I tried recording first before writing. The writing process was so much easier. I wrote a little, paused, added more, read what I wrote, and continued. I wasn’t able to do that while I was recording.”

The other 14 students provided their responses in written form, citing three primary reasons for their preference for writing over verbal communication. The most common reason, given by 10 students, was that they found writing to be easier than speaking. For example, Student 2 expressed, “Writing is easier because it gives me more opportunities to explain my thoughts in detail.” This sentiment was echoed by Student 9, who noted, “I can express myself better when I write. When I speak, I sometimes lose track of my ideas and cannot go back to clarify my points like I can when I’m writing. With writing, I have the option to erase and revise until I’m satisfied.” In addition, three students revealed that their choice to write stemmed from a preference for writing over speaking, primarily due to feelings of shyness. Each of these students articulated discomfort with the idea of being listened to while they spoke. For instance, Student 7 explained, “I do not enjoy talking a lot in front of others. I find that I have to think carefully before responding, and that can make me anxious. Although typing my response took a considerable amount of time, I felt I was able to write what I wanted to say.” Lastly, Student 6 highlighted that she chose to write her response because writing is the standard method used in her classroom setting. She felt this was a familiar approach that facilitated her completion of the responses.

## 6 Discussion

In this study, I aimed to investigate how students chose their linguistic resources (English and Spanish) and semiotic resources (language modes: written and oral language) to complete a digital, multilingual science assessment. In terms of how multilingual learners engaged with the multilingual science assessment, I found that they used various linguistic and semiotic resources. Some students relied on a single language, either English or Spanish, while others combined elements from both languages. For the constructed-response items, most students responded in Spanish, with a few providing answers in English or a mix of both languages. One student switched from English to Spanish during the task to express themselves more easily, while another alternated between both languages within their responses. Most students chose to write their answers; however, one student preferred to give oral responses, finding them easier to manage. Attempts to record answers often led to a return to written responses due to difficulties encountered. A few students utilized the read-aloud accommodation in both English and Spanish to enhance their understanding, although perceptions of its effectiveness varied. All students used pop-up glossaries to clarify unfamiliar words, with students expressing a desire for this feature to be available for any new terms they encountered.

The students effectively used their linguistic skills to complete the multilingual science assessment tasks, much like multilingual individuals do in various contexts (Cenoz and Gorter, 2022; Wei and García, 2022). Research has shown that both teachers and students in

multilingual classrooms often use multiple languages, despite institutional frameworks frequently prioritizing monolingual approaches (e.g., Bose and Clarkson, 2016; French, 2016; Velilla Sánchez, 2021; Ziegler et al., 2012). Multilingual learners also navigate different languages in their writing and frequently switch between them (Alvarez, 2018; Canagarajah, 2006), employing translanguaging practices that challenge monolingual ideologies (Brinkschulte et al., 2018). Studies on multilingual approaches in language classrooms demonstrate the advantages of utilizing students' linguistic repertoires (De Backer et al., 2024; Schissel et al., 2024). Research indicates that incorporating multiple languages can enhance comprehension and participation (Bose and Clarkson, 2016) and foster creativity in language use (Cenoz and Gorter, 2021).

An important finding is that the bilingual accommodations included in the digital science assessment facilitated students' use of translanguaging. Although many of the multilingual learners in this study used the language in which they are most competent or comfortable, the bilingual accommodations enabled them to engage in translanguaging practices because they were able to deploy their full linguistic repertoire as a single, functional resource for meaning-making (García and Wei, 2014; Wei, 2018). Choosing a stronger language to answer a question, explain a model, or reason through evidence is not merely a translational workaround; it is a purposeful pedagogical move that integrates languages to support cognition, clarify disciplinary thinking, and surface conceptual knowledge that would otherwise be masked by demands of the dominant assessment language.

When multilingual learners explain science ideas in their preferred language, they perform metalinguistic analyses (comparing, labeling, transferring concepts across languages) and reveal deeper conceptual understanding, demonstrating the metacognitive and metalinguistic functions central to translanguaging theory (Canagarajah, 2013; Creese and Blackledge, 2010). Allowing language choice reduces construct-irrelevant linguistic barriers so that assessment captures disciplinary competence rather than only proficiency in the language of instruction; this alignment with assessment validity is a core rationale for bilingual accommodations and a practical expression of translanguaging pedagogy (De Backer et al., 2024).

Previous studies have demonstrated that these accommodations are crucial for enabling multilingual learners to navigate content assessments accurately and fairly (De Backer et al., 2019; López, 2023). These accommodations utilize the translanguaging abilities and plurilingual practices of learners, significantly enhancing their academic performance and language proficiency (García and Sylan, 2011; López et al., 2017). By implementing strategies that address language barriers in content assessments, these accommodations make educational materials accessible to all students, regardless of their proficiency in the target language. This approach not only improves comprehension but also ensures that assessments accurately reflect what students know and can do in a subject, rather than being hindered by their language skills (Abedi, 2014; De Backer et al., 2020; Roohr and Sireci, 2017). Ultimately, these accommodations foster an inclusive learning environment that values and supports the diverse linguistic backgrounds of all students.

The second research question sought to investigate how the students selected their linguistic and semiotic resources to engage with and complete the multilingual science assessment. I discovered

that students initially selected linguistic resources based on their proficiency in English and Spanish, their experiences with both languages, and their perceived ability to complete the multilingual science assessment. Think-aloud sessions revealed that students were aware of their proficiency levels, which helped them decide which resources to use. Some students completed all items in Spanish due to their lack of confidence in English. Others, who felt proficient in both languages, chose either language but preferred Spanish for its ease and comfort. Additionally, some students planned to attempt the assessment in English first and switch to Spanish if necessary. A few students opted to use only English, either out of preference or because it was the language of instruction at their school.

It is worth noting that several students who demonstrated a high level of proficiency in English chose to complete the multilingual science assessment in Spanish. This trend is not surprising, as various studies show that even among highly skilled multilingual individuals, there is often a preference for using their native language in specific contexts. For example Dewaele (2011), found that multilinguals often revert to their home language when engaging in personal or emotional conversations, despite being able to communicate effectively in a second language. This preference may be attributed to the comfort and familiarity associated with their home language, highlighting the complex dynamics of language choice among multilingual speakers.

These findings indicate that students displayed an awareness of their proficiency in both English and Spanish, recognizing their linguistic strengths and weaknesses, as well as their ability to utilize their language skills in completing the multilingual science assessment. Previous research has shown that translanguaging serves as a powerful tool for multilingual learners. It not only aids in language development but also enhances students' awareness of their multilingual capabilities (Cenoz and Gorter, 2020; Velasco and Fialais, 2016). When teachers employ pedagogical translanguaging (Cenoz and Gorter, 2020; Cenoz and Gorter, 2021), they recognize and integrate all of their students' languages. This approach can also be applied in content assessments, creating more inclusive assessment environments. In such contexts, students feel empowered to use any of their languages as needed, leading to increased engagement and better opportunities to demonstrate their academic abilities.

Moreover, students selected their language and communication mode to complete the open-ended questions based on their comfort and proficiency levels. Eleven students chose to respond entirely in Spanish, while two used only English. Eight students preferred the language they felt most comfortable in, and five, despite being proficient in both languages, opted for Spanish for better articulation. Two students switched languages mid-task, with one starting in English and switching to Spanish, while another used both languages within single responses. Only one student, preferring to speak, gave oral responses, but four attempted and abandoned this method due to difficulty, choosing writing instead. Fourteen students favored written responses for clarity, comfort, or familiarity, with 10 finding writing easier, three preferring it over speaking due to shyness, and one citing it as the standard classroom method. Overall, the preference for writing among these students illustrates a significant connection between their comfort levels and their chosen methods of communication. This highlights the importance of language proficiency and personal comfort in allowing students to express their knowledge in an assessment environment.

It is important to emphasize that incorporating translanguaging into multilingual science assessments increases opportunities for student agency and empowers students to take a more active role. Student agency refers to students' ability to navigate, influence, and take responsibility for their learning and educational environments (Klemencic, 2023). In the context of multilingual content assessments where students can translanguage, student agency pertains to multilingual learners' ability to decide which linguistic and semiotic resources to access and complete the assessment items. Student agency also encompasses multilingual learners' capacity to choose bilingual accommodations to overcome language barriers. Prior research has demonstrated that student agency in assessment is achieved when students are given choices (Clark, 2012). Think-aloud sessions showed that allowing students to engage in translanguaging practices gave them greater control and responsibility over how to utilize their linguistic and semiotic resources. This approach can lead to deeper engagement and more meaningful assessment experiences for multilingual learners.

## 6.1 Implications for designing and using multilingual assessments

In this study, I found that bilingual accommodations significantly enhanced students' engagement in translanguaging. As a result, students were able to leverage their entire linguistic resources (e.g., English, Spanish, or both) and semiotic resources (e.g., viewing and listening to items, providing written or oral responses) effectively when completing the digital multilingual science assessment. This finding highlights the importance for test designers to incorporate the principles of "pedagogical translanguaging," as outlined by Cenoz and Gorter (2020), when creating assessments for multilingual populations. By embracing these principles, assessment developers can affirm the value of the diverse languages spoken by multilingual learners and motivate them to utilize their full linguistic repertoire, enabling them to demonstrate their knowledge and capabilities in a more comprehensive manner. Integrating "pedagogical translanguaging" principles into multilingual content assessments not only makes the assessments more culturally relevant but also aligns them with the linguistic needs of multilingual learners. This approach fosters an inclusive environment that recognizes and respects the diverse linguistic backgrounds of students. These culturally and linguistically responsive content assessments can help students effectively convey their understanding and skills (Ascenzi-Moreno et al., 2023; López, 2023; López et al., 2019; Schissel et al., 2018).

To support students in accessing the content of assessments, a range of bilingual or multilingual accommodations can be employed. These accommodations may include translations that allow students to understand the material in their preferred language, read-aloud supports that help in comprehending complex instructions and terminology, as well as multilingual and pictorial glossaries that provide context to facilitate understanding. Such tools not only aid students in accessing assessment content but also empower them to exhibit their knowledge and skills in a meaningful way (López, 2023). The overarching goal of implementing these accommodations is to render linguistically accessible assessments for multilingual learners. By granting students the opportunity to draw upon their full

linguistic capabilities—rather than confining them to a single language—these accommodations create a more equitable assessment environment that aligns with the diverse linguistic experiences of learners (Abedi, 2014). In doing so, we can better support multilingual students in showcasing their true potential and achievements in academic settings.

## 6.2 Limitations and future research

The current study has several limitations that should be considered for future research. The 15 students who participated in this study were from the same school and had similar backgrounds, which may limit the applicability of the results to other contexts. While the sample size is adequate for preliminary insights, it may not represent all student populations. Additionally, the young age of the students posed challenges in articulating their thought processes, restricting our ability to fully understand their complex cognitive activities. In summary, although the findings are promising and provide valuable insights into how students select language and semiotic resources while completing a digital multilingual science assessment, more extensive studies with larger samples and diverse data sources are necessary to confirm these outcomes. For instance, future research could gather additional data to ensure that think-aloud sessions accurately represent the participants' natural thought processes. Furthermore, future studies could examine the varying impacts of different bilingual supports, investigate the criteria students use to determine their need for accommodations, identify which specific linguistic and semiotic resources students find most effective, and explore how students' prior experiences, such as multilingual assessments and classroom instruction, influence their language and semiotic choices.

## 7 Final thoughts

This study explored how multilingual learners effectively utilized their diverse language and semiotic skills to complete a digital multilingual science assessment. The key findings indicated that students skillfully switched between English and Spanish, depending on their comfort levels and the context of the task. Most participants preferred written responses, as this medium allowed for a more precise and accurate expression of their thoughts. Some students initially attempted to provide oral responses; however, they switched to writing when they faced challenges in verbally articulating complex scientific concepts, showcasing their adaptability in overcoming communication barriers.

Bilingual accommodations played a crucial role in promoting translanguaging, which enabled students to integrate multiple languages seamlessly. This approach not only enhanced their engagement with the content but also improved their interaction with the assessment material. By leveraging their full linguistic abilities, students significantly deepened their understanding of the assessment tasks, which, in turn, boosted their motivation and participation in the assessment.

When selecting which language to use, students carefully considered their language proficiency, comfort, and the specific requirements of the assessment tasks. Many students prefer to use

their home language in specific contexts, especially when discussing complex or abstract scientific ideas. This highlights the nuanced dynamics of language preference and the importance of personal identity in language use.

Overall, bilingual accommodation effectively addressed language barriers, making the multilingual science assessment more inclusive and accessible. This approach ensured that the assessments evaluated students' comprehension of scientific concepts rather than their language proficiency. The study highlights the importance of acknowledging and incorporating students' diverse linguistic backgrounds, allowing educators to develop more inclusive, accurate, and responsive assessment environments that reflect the unique strengths of multilingual learners.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors without undue reservation.

## Ethics statement

The studies involving humans were approved by Educational Testing Service (ETS). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

## Author contributions

AL: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcomm.2025.1583494/full#supplementary-material>

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