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Multilingual, Multimodal, and Multidisciplinary: Deaf Students and Translanguaging in Content Area Classes

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Abstract: Translanguaging is an approach to the education of multilingual students that has been gaining in popularity in recent years. Translanguaging is defined as the use of multiple languages and modalities during classroom instruction with the express purpose of encouraging and teaching students to use all their linguistic resources to make sense of content and demonstrate their understanding. Though there has been a great deal of research on translanguaging in general, this article focuses on two less-studied areas for translanguaging: the intersection of translanguaging in deaf education and content area education. Here, the authors explore the literature available in the domains of translanguaging and science, translanguaging and deaf students, and translanguaging in science classrooms with deaf students. Using the findings from these articles, the authors present four recommendations for teachers who want to engage in translanguaging in the content areas with deaf students: First, teachers can use both signed language and English (or other written languages) during instruction to expose students to essential concepts in multiple languages. Next, teachers can expose students to discipline and subject-specific written and signed words, as well as colloquial meanings of similar written and signed words (e.g., evidence versus fact versus proof in American Sign Language). Additionally, teachers should attempt to be visually oriented while translanguaging. Finally, we recommend that teachers encourage students to respond to questions or prompts using multiple languages and/or modalities. Implications of each recommendation are explored.

Keywords: multilingual deaf education; translanguaging; science education; signed language; content area instruction

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1. Introduction

Schools are considered a critical site for individuals to learn and hone their language ability as students navigate between their home language, instructional language, and the type of language used in content area instruction, such as in science classrooms (Yore and Treagust 2006). However, students whose home language is the same as the school's instructional language are privileged and more likely to thrive in a school that may leave students with different language backgrounds, such as deaf students and English language learners (ELL), facing barriers in accessing the curriculum. Compounding this, many deaf and ELL students are mainstreamed in schools that do not have qualified teachers trained to work with these populations (Benedict et al. 2011; Villegas et al. 2018). As a result, not all of these students may have access to teachers who understand the languages they use.

For a number of years, the concept of translanguaging has been applied to deaf[1] bilinguals to describe how they developed their language knowledge and skill in school (Hoffman 2014). Swanwick (2017) also described how deaf students engage in multilingual and multimodal translanguaging by moving flexibly between signed, printed, and potentially spoken language. In this manuscript, we will present a comprehensive summary of what is known about translanguaging and disciplinary literacy in one area—science education. Then, through combining this literature with what is known about translanguaging

among multilingual and multimodal deaf students to offer our recommendations for how translanguaging can be utilized within the content area teaching, particularly in science, in deaf education classrooms.

2. Literature Review

2.1. What Is Translanguaging

Translanguaging is a way of considering language use that prioritizes and centers students' language ability as an integral part of their learning growth. It also promotes flexibility in language use across linguistic boundaries (García and Wei 2014). The term translanguaging has been used to refer to "gaining understanding and knowledge through the use of two languages" (Baker 2011, p. 288). This term has recently increased in popularity, arguably due to an improved understanding of how multilingual individuals use diverse language sources, often simultaneously, to make sense of the world (Lewis et al. 2012). Within both the contexts of deaf education and content area instruction, it is paramount that researchers and educators consider the linguistic strengths that can be built upon to support students' learning of concepts, the language used for communication in that content, and of course language and literacy more generally (Seah and Chan 2020; Yore and Treagust 2006).

Translanguaging is a hybrid approach that incorporates diverse repertoires of communicative strategies and resources that produce knowledge construction that goes beyond language learning, and that "focus[es] on meaning-making as a unitary activity with agents flexibility employing semiotic resources for both expression and understanding" (Iturriaga and Young 2022, p. 102). Charamba (2020) defined translanguaging as "the idea that bilinguals' languages are intertwined, belong to the same linguistic repertoire and support learning in one way or the other" (p. 1782). Making use of translanguaging in the classroom would allow teachers to harness these students' full range of linguistic knowledge to make sense of their learning experiences in school. Turkan et al. (2014) note that some teachers in the general education classroom can at times perceive students using languages other than English in the classroom as being disruptive to classroom dynamics. This type of attitude demonstrates the importance of providing teachers with the skills to teach culturally and linguistically diverse learners.

2.2. Disciplinary Literacy and Translanguaging

In this manuscript, we focus on disciplinary literacy, which "emphasizes the unique tools that the experts in a discipline use to engage in the work of that discipline" (Shanahan and Shanahan 2012, p. 8) in how we view translanguaging as a communicative instructional approach to support deaf students as they develop disciplinary literacy knowledge. Our article focuses on the science classroom because science is considered a linguistically demanding subject, as Yore and Treagust (2006) highlighted by quoting Gee's sentiment on language use in science:

> "No domain represents academic . . . language better than science. Science makes demands on students to use language, orally and in print, as well as other sorts of symbol systems, that epitomize the sorts of representational systems and practices that are at the heart of higher levels of school success." (Gee 2005, pp. 19, 295)

Science teachers need to mediate academic content with students' languages and cultural experiences to make the content accessible, meaningful, and relevant (Moje et al. 2001). For example, Pierson and Grapin (2021) consider engaging with disciplinary text to be a multimodal form of translanguaging, as disciplinary practices use specific features—images, graphs, tables—to convey meaning, as well as printed words. Gesture may be another modality that can be useful when making meaning of disciplinary concepts (Suarez 2020). Translanguaging could become a tool for teachers and students to communicate their ideas about content such as biology, with distinct subtopics: cell biology, structure–function of biology, and ecology (Shulman 2015)—translanguaging could provide an avenue for students to use their languages to navigate between all three concepts in biology.

Research has found that hearing multilingual students engage in translanguaging during science instruction by not only transitioning between languages but also in and out of science discourse (Karlsson et al. 2019). Researchers have noted the need to "explore ways teachers can merge children's in- and out-of-school science knowledge, including the potential for using children's home language to effectively mediate emergent bilingual children's science learning" (Martínez-Álvarez 2019, p. 801). This can include harnessing deaf students' signed and written language capacity to develop their linguistic repertoire. Teachers also should have knowledge of their students' language development in order to be linguistically responsive in their teaching to help students navigate their use of translanguaging (Villegas et al. 2018).

Academic success for deaf college students is based less on their audiological or single language ability and more on how they use their communication flexibility to gain conceptual understanding (Iturriaga and Young 2022). Though translanguaging is a relatively new concept to be studied in educational research generally, it is especially novel in the field of deaf education. Swanwick (2017) noted that it took several years for the valuing of bilingualism to gain support in deaf education research. Perhaps this same hesitation, almost certainly related to audism and beliefs regarding the status of spoken over signed languages, is the reason that there is currently limited research on translanguaging within deaf education, though we also acknowledge that there is a lack of research into bilingual classrooms in general education.

3. Theoretical Framework

3.1. Disciplinary Linguistic Knowledge

In our review of the current research on translanguaging in deaf spaces and content area classrooms, we utilize the disciplinary linguistic knowledge (DLK) framework. This framework focuses on the role of language in teaching content, specifically on how teachers unpack the language demands of their discipline (Turkan et al. 2014). Teachers' knowledge of the academic discourse in their content area will help facilitate students' understanding and language usage in the classroom. DLK allows teachers to "unpack lexico-grammatical choices and discourse structures in an academic field, to model the disciplinary discourse for students, and to engage students in that discourse" (Turkan et al. 2014, p. 15). The two subdomains of DLK are:

1. The ability to identify the linguistic features and choices that are appropriate to the disciplinary discourse: form–meaning connection, where forming a string of words leading to expressing meanings.
2. The ability to model these for students to maximize access to content understanding and participation: modeling the construction of form–meanings discourse specific to the content.

The DLK framework aims to help teachers to make academic content accessible and meaningful to their students as the teachers use language in their disciplinary area teaching. Teachers need a solid foundation on how to unpack and represent content in accessible ways to help their students learn.

3.2. Scientific Literacy as an Example of Content Learning

Lin and He (2017) argued that dynamic interactions between students and teachers during content and language learning is a key component of translanguaging. Scientific literacy provides an example of content learning that incorporates different content areas tied to students' personal experiences interacting with the world. Thus, it is important for students (and adults!) to understand how science permeates and interacts with many aspects of humanity ranging from the personal to the social level. This includes opportunities for meaningful application of science learning in and out of school. The 21st Century Science Project in England highlighted characteristics of scientific literacy, which included the following features:

- Students will appreciate and understand the impact of science and technology on everyday life;
- Students will make informed personal decisions about things that involve science, such as health, diet, use of energy resources;
- Students will read and understand the essential points of media reports about matters that involve science;
- Students will reflect critically on the information included in, and (often more important) omitted from, such reports;
- Students will take part confidently in discussions with others about issues involving science (Roberts and Bybee 2014).

In essence, scientific literacy is a tool that people use to make decisions based on the ability to explain, argue, and evaluate the choices we make, such as reducing the carbon footprint of our lifestyles and changing the food we eat. Scientific literacy also includes other content areas to encourage students to contemplate the real-world implications caused by our behaviors such as developing land to mine rare chemical elements for technological advancement leading to consumers' technological purchasing choices that requires an understanding of how society functions (social studies), calculations of the economic and environmental benefits of technological improvements (mathematics), and communicating the problems and solutions to other people (language arts).

Lemke (2004) argues that there are multiple literacies in science, as there are multiple ways that scientists use hybrid texts, graphs, symbols, equations, and other multimodal semiotic forms to advance their research. These literacies require one to be creative with using language to convey meaning by kind and meaning by degree. Language presents a boundary for humans to use science as our knowledge continues to expand with new kinds and degrees of information. We describe our natural world through kinds and degrees of knowledge that reflect how we categorize conceptually, such as through units of measurement, animal and plant species, and humans through evolution and genetics. Phrasing and expression matter when describing phenomena, both natural and artificial, that help us to push our current conceptual knowledge into new frontiers. In turn, we expand, elaborate, evolve, or abandon the knowledge we construct over time based on our newfound understanding of the phenomena. It is through this lens of understanding science and scientific literacy that we view a potential application of translanguaging in content area learning.

3.3. Translanguaging in Content Area Teaching and Science

Translanguaging in the science classroom, like translanguaging across many disciplines, can be conceptualized as the teacher and student using all available language resources to make sense of the content. Different disciplines use different sources of knowledge that may be communicated via multiple languages and modalities. Historians may use images and firsthand accounts of events, while mathematicians use formulas, proofs, and graphs. Science, the content area we focus on here, uses graphical displays of data, and at times raw data, to communicate concepts about the world around us.

Recently, researchers have proposed a model of translanguaging in multilingual classrooms that specifically attends to content area perspectives (Pierson and Grapin 2021). The model proposed by the authors focuses on making connections between translanguaging activities and the kinds of activities that disciplinary experts engage in (such as representing natural phenomena visually and engaging in argumentation in science, or seeking out patterns in data in mathematics), as well as emphasizing multimodality as an essential element of learning in the disciplines. Although translanguaging most often refers to the use of multiple languages and modalities to make meaning, it has been argued that translanguaging could occur as students apply their linguistic repertoire for specific activities within disciplines (Flores 2020; Karlsson et al. 2020). Rather than learning content in decontextualized settings (as content area classrooms traditionally do), the application of translanguaging practices within content area learning can enhance the development of argumentation skill and con-

ceptual knowledge through real-world, application-based lessons that make use of students' experiences and language resources (Pierson and Grapin 2021).

3.4. Learning via Translanguaging in the Classroom

The translanguaging activities of teachers has been studied by researchers at both the K-12 (Langman 2014; Probyn 2015) and university (Mazak and Herbas-Donoso 2015) levels. For instance, among South African teachers surveyed and observed in K-12 science classrooms, researchers found that all reported that they would make use of both a local and national language during instruction. However, only one out of the eight teachers used the local language for a substantial amount of time (32% of the class time for the national language versus less than 10% of the class time for the local language) (Probyn 2015). This could be due to limited training, as one school in the United States with a high proportion of Spanish speakers reported that at the time of data collection, teachers were required to have only 12 contact hours with students to receive an ESL endorsement. Notably, no teachers in this study spoke a language other than English at any fluency level (Langman 2014). Current programs training teachers in Texas confirm that prospective ESL teachers do not need to speak a language other than English, though it is not immediately clear how many contact hours with students are currently required for certification (Texas Teachers of Tomorrow 2021). However, teachers in Langman's (2014) study used creative means of incorporating a language they did not speak into their students' science instruction. For example, one teacher flipped the typical teaching cycle of initiation by the teacher, response from the student, and feedback from the teacher by confirming with his student that his question has been understood, rather than asking the student to report when a misunderstanding has occurred. The purpose of this was to relieve the student/language learner from the burden of having to track understanding, and to place this burden on the teacher/native language user instead. This helped to ensure students' participation in the classroom regardless of their language level. How successful can teachers be with translanguaging if they do not use multiple languages frequently in the classroom, or who do not speak a second language, is an open and essential question.

The university setting studied by Mazak and Herbas-Donoso (2015) may be a better representation of how translanguaging can be used effectively in the science classroom. This school in Puerto Rico is an expressly multilingual environment, and the researchers described an intentional use of Spanish in the science context, which in this school has primarily been an English language-use space. Observations of this classroom revealed that teachers used both Spanish and English linguistic resources during descriptions of complex concepts, and presented texts and figures written in English, and then discussed their meaning with the class in Spanish. The authors argue that this use of translanguaging communicates to students that Spanish is a legitimate language for the conveyance of scientific information (Mazak and Herbas-Donoso 2015). Teachers should be intentional as they legitimize students' application of language knowledge to express academic meanings (Turkan et al. 2014). It is more useful for students to view how they can apply their linguistic repertoire to science concepts rather than emphasizing the specific way that a scientist may speak (Moje 1995).

There is still much to learn about teachers' understanding of how students use their language ability to learn science because many studies have focused on students' pre-conceived understanding of difficulties related to the content that does not pay enough attention to students' language usage (Seah and Chan 2020). In theory, translanguaging would allow the teachers to have a better sense of their students' language usage and allow them to support students as they apply their linguistic resources to content area tasks (Turkan et al. 2014). With a content area focus on translanguaging practice, students can develop their language skill in an array of settings.

4. Research Questions and Methods

Our purpose in reviewing the literature in the domain of deaf education and science education was to draw recommendations that teachers working in bi- and multilingual settings with deaf students can use for applying translanguaging to content area classrooms. Although we have focused on research in science, we believe there are lessons that can be applied across other content areas. Specifically, we asked:

- How can teachers use translanguaging to teach content, such as science, to deaf students?
- What do teachers need to know about translanguaging in content area teaching with deaf students?

The focus of our article is on translanguaging with signed and written language, alongside other means of conveying information such as pictures and graphs of data. We have chosen to minimize spoken language's function as a translanguaging tool with deaf students in this article because Turkan et al. (2014) explained that "when the learner is denied the equal opportunity to participate in the discourses of academic disciplines, it becomes an issue of equity" (p. 21). Centering spoken language in the classroom creates an unfair disadvantage for deaf students who do not use spoken language, and privileges those who do (De Meulder et al. 2019). We believe that spoken language has significance to some deaf students that could be appropriate in the translanguaging paradigm at the discretion of the teacher and depends on the students' spoken language use. We also believe that the presence of spoken language in settings with deaf students has been covered extensively by other researchers (see Nelson et al. 2014 for an example of such a publication). Our focus for this article is to ensure that all students have equal access to learning in their respective content areas, not to focus on developing or incorporating spoken language in learning.

To answer our research questions, we reviewed the literature (presented below) available on translanguaging and multilingual hearing students, translanguaging in science education, translanguaging and deaf students, and translanguaging in science classrooms with deaf students to identify common findings and themes with regard to successful translanguaging practices in these settings. Using these themes, we generated recommendations for teachers based on the literature. These recommendations are based specifically on science education and translanguaging with deaf students, but we believe can be adapted into other content area classrooms such as mathematics or history.

5. Findings

For our review of the literature, we utilized four common databases used in educational research: Academic Search Complete, ERIC, PsycInfo, and Google Scholar. These databases yielded articles that covered five major areas: translanguaging in multilingual contexts, translanguaging in science education with hearing students, translanguaging with deaf students outside of content area settings, translanguaging with deaf students within science classrooms, and translanguaging as an equity issue with deaf students. We used search terms such as "translanguage/translanguaging" AND "deaf or hard of hearing or hearing loss" OR "science education". Below, we summarize the research available in these three major areas, and then use this literature to make recommendations for teachers who wish to include translanguaging in their practice in content areas.

5.1. Translanguaging in Multilingual Classrooms

It is important for us to understand the role of translanguaging in bi- or multilingual classrooms with hearing students in order to apply the translanguaging framework with deaf students. One frequent byproduct of traditional bi- or multilingualism in the United States is that certain languages are used exclusively in certain spheres (e.g., English is the language of school, while Spanish is the language of the home), which could become a roadblock to students' language development (Lewis et al. 2012). Moreover, students would sacrifice their home language to acquire the language of science, creating more tension

between home and school language (Yore and Treagust 2006). It is possible that the use of translanguaging in these contexts might lessen these tensions as well as allow students to continue to grow in both their language proficiencies and their science knowledge.

Interestingly, much of the research available on translanguaging in science classrooms does not draw much upon the potentially unique contexts that these classrooms present, but instead explores translanguaging as it is generally understood as applied in these spaces. Content areas with a high degree of abstractness such as science are notoriously known for the use of complex lexico-grammatical structures that may alienate students with developing English skills (Lee et al. 2013). Although many authors express interest in the unique challenge inherent in navigating both multiple languages and the precise applications of language that would naturally manifest in these spaces (Karlsson et al. 2019, 2020; Poza 2018; Suarez 2020), additional research on the strategies used by teachers and students to make these linguistic moves would be a valuable contribution to the field. Teachers need to have the language and conceptual ability to support students' content learning, especially for the emerging and evolving language needs, that goes beyond the general linguistic background of students (Seah and Chan 2020). Overall, there is a significant need for more research in the area of translanguaging in deaf and signing spaces

5.2. Hearing Students' Use of Translanguaging in Content Area Classrooms

At the heart of students' use of translanguaging during content area instruction such as science is the essential notion that students cannot learn what they do not understand. Interview studies of multilingual students in South Africa found that these learners reported language as a significant barrier for them in acquiring knowledge and understanding of science content (Charamba 2020). Other studies have documented the translanguaging behaviors of students and teachers in science settings. For instance, observations of students in science classrooms that were purposefully using translanguaging or multiple languages for instruction found that students frequently navigated multiple languages during class discussions as they attempted to convey their own understandings as well as support their peers to learn science (Charamba 2020; Karlsson et al. 2019; Poza 2018; Suarez 2020). At times, students would transition between languages within the same sentence (Karlsson et al. 2019) or translate text written on the board in English into their native language (Suarez 2020). In some cases, but not all, classrooms that used flexible translanguaging in science had a multilingual teacher with knowledge of students' native language (Karlsson et al. 2019; Poza 2018; Suarez 2020). Students were also observed using gestures frequently as a means of conveying science terminology, as well as exploring science concepts using various languages, particularly local and national (Karlsson et al. 2019).

Despite these positive findings, researchers have identified potential pitfalls to the implementation of translanguaging in science classrooms. Both Karlsson et al. (2020) and Suarez (2020) note the potential for the use of translanguaging in science contexts to be oversimplified as merely translation of scientific words between languages or code-switching from one register to another. Code-switching represents crossing the boundary between two languages while translanguaging centers on the use of multiple languages and modalities to communicate ideas, understanding, and clarifications. There is also the potential for students to primarily use imprecise or colloquial terms in one language (most likely the home language or marginalized language) even when formal scientific terms are available, which could lead to assumptions about students' linguistic repertoires and scientific knowledge (Karlsson et al. 2020).

5.3. Translanguaging in Deaf Education

The use of translanguaging as a potential way of understanding language use in deaf education classrooms has been discussed and explored by researchers (e.g., Allard and Pichler 2018; Swanwick 2017). The translanguaging framework has been theoretically explored both from a place of positive application as well as from justified critique. Proponents of translanguaging in deaf education argue that the strategic use of this approach has as its

underlying assumption the goal of using *all* linguistic resources that students have in order to ensure effective instruction has occurred. "In the classroom, translanguaging tries to draw on all the linguistic resources of the child to maximise understanding and achievement" (Lewis et al. 2012, p. 655). However, others have pushed back on this idea, rightfully arguing that total communication (Holcomb 1970) was another theoretical approach to deaf education that approached teaching and learning with deaf children from a perspective akin to translanguaging. However, in the intervening years, this approach has been corrupted in some settings to often mean mainly sign-supported speech or simultaneous communication (a method of signing that is executed in conjunction with spoken language and that generally follows the grammar word order of spoken language) (De Meulder et al. 2019). Specifically, de Meulder and her colleagues argue:

> "Hearing signers' reliance on spoken language can and often do skew power relations in mixed settings. Indeed, while the combined use of spoken and signed language has been called 'translanguaging', only some forms of combining sign and speech are accessible, for some deaf people, in some situations." (p. 895)

An overall concern of de Meulder and colleagues appears to be the danger that hearing non-signers interpret the call for translanguaging in deaf education as hearing teachers learning individual signs or phrases to include in their instruction, rather than the need for teachers of the deaf to have fluency in a signed language. Given the history of how a spoken language like English has been prioritized in deaf education classrooms over a signed language like American Sign Language (ASL) (for critique, see Scott and Henner 2020), this is a wholly justified concern. It is important to take care when discussing implementation and theoretical debate with others who might not take such care.

5.4. The Role of Translanguaging with Adults

The use of translanguaging among deaf adults has been studied as well. These studies, which though not quite representative of the translanguaging activities of deaf children, can be informative for understanding how proficient signed language users engage with multiple languages (Ausbrooks et al. 2014; Hoffman et al. 2017; Iturriaga and Young 2022; Napier et al. 2019). One study asked participants to read and translate a text and were then interviewed on their translation processes specifically from the perspective of translanguaging activities (Hoffman et al. 2017). The participants specifically reported making connections between ASL and English, using conceptual translation during reading, and asking rhetorical questions of the text during reading as they made translation decisions (Hoffman et al. 2017).

Similarly, although Ausbrooks et al. (2014) did not expressly use the term *translanguaging* in their work, these researchers studied the relationships between language and literacy factors among deaf adults. These factors included metacognition, ASL knowledge, English knowledge, metalinguistic awareness between both languages, and translation of English texts into ASL. These factors are all related to the act of translanguaging between ASL and English. The authors found that ASL morphological knowledge was statistically related to reading comprehension, and that half of the participants reported specifically using ASL during English reading to support their understanding of complex information (Ausbrooks et al. 2014).

These two studies taken together suggest that proficient deaf adult readers engage in translanguaging during reading, using their primary language as a linguistic resource, to make sense of texts in English. Understanding how proficient language users engage in translanguaging is important for considering how to support younger deaf students who are building their linguistic knowledge. However, it is also important for us to consider what we know about deaf individual's translanguaging outside of narrative reading.

For instance, Napier et al. (2019) interviewed three deaf professionals on their experience working with interpreters that influenced how their identities were projected in the professional settings. The deaf professionals in this study utilized translanguaging to project their professional identity in the workplace. Much of their work involved em-

ploying signed language interpreters to interact with non-signers at work and relying on interpreters to represent them well. However, the participants were uncertain about the interpreters' familiarity with their roles, and their consistent availability. These issues could have undermined their expertise, which led to different reactions from colleagues on the degree of their respect for the deaf person as a professional. Translanguaging strategies allowed the participants to assert their professional identity by directly communicating with the colleagues in spoken or written language as well as drawings and gestures instead of having to rely on interpreters to represent them.

5.5. Research on Translanguaging among Secondary and Post-Secondary Deaf Students

The notion of translanguaging for deaf students has been examined both theoretically and empirically. In a theoretical example, Swanwick (2017) explored the notion of translanguaging among deaf students from both a general perspective and from the perspective of science learning in particular. Specifically, she discussed fluid transition between signed language, written language, and fingerspelled letters, during science lessons with deaf learners. Swanwick also noted that individual deaf children have different experiences interacting with language during their upbringing, which means that their linguistic repertoire changes over time. The deaf child's language knowledge grows as they acquire new knowledge and skills over time, which in turn shapes the identity of the deaf individual.

The role of translanguaging in the education of deaf learners has also been explored qualitatively. For instance, researchers completed an observation/interview study of 7th grade students learning science in Zimbabwe (Charamba et al. 2019). The interview results suggest that the teachers started incorporating Zimbabwe Sign Language (ZSL) into their teaching when an English-only teaching approach was not successful in terms of their students' learning outcomes. The teachers specifically and actively encouraged students to use both ZSL and English during discussion and learning activities. One participant was quoted saying, "Since [. . .] deaf learners might have different proficiencies in the two languages, the use of both entails that the one offsets the limitations of the other. This approach enables the deaf learners to make optimum use of their linguistic repertoire" (Charamba et al. 2019, p. 71). The researchers further specify:

> "As witnessed during the lessons, translanguaging allowed both teacher and learners to **leverage both languages, to discuss and clarify content for maximum comprehension by all**. This allowed the deaf bilingual learners to draw from their daily experiences to create scientific knowledge during execution of academic activities in the classroom. Unlike other monolingual classes at the same school that impose one language in class, the use of learners' home language together with the language of instruction in the classes observed by the researchers made the learners participate willingly and eagerly during lessons." (p. 72, emphasis added)

In other words, the researchers argued that translanguaging activities were present in the classroom that specifically used the student's more fluent ZSL to make sense of materials and information provided in English. This single study is important but must be built upon in other content areas to amass more data regarding translanguaging, deaf students, and classroom learning. Others have recommended research to investigate the use of signed language in science instruction (Kurz et al. 2015), which would be encompassed in the research on multimodal and multilingual translanguaging.

Similarly, Iturriaga and Young (2022) conducted an ethnographic study with five deaf students who were enrolled in a transitional program from secondary to post-secondary education in the United Kingdom. Most of these participants were 18–19 years old with one exception of 29 years old. The study observed these students taking various courses on language and content learning plus tutorial sessions individually. The researcher explored how these students' translanguaging practices shaped and were shaped by different contexts in college. These students used visual and gesture properties alongside written and signed languages to ensure clarity with conversational partners. Translanguaging

was restricted when deaf students interacted with their hearing tutors, who did not know signed language, making direct communication challenging. Each student had a different approach to this kind of situation. For example, one student would communicate through writing, while another student used an interpreting service. One student spoke a single word accompanied with drawings, gestures, and written text. These varied approaches to communication demonstrate translanguaging in action.

Though not focused upon deaf students in particular, there are two studies that qualitatively explore the use of translanguaging among hearing people learning signed languages that can be informative for a multimodal and translanguaging space. Both of these studies employed an ethnographic approach to research (Holmström and Schönström 2018; Snoddon 2017). Snoddon's (2017) research explored the ASL learning of hearing parents of deaf children, rather than the deaf children themselves. These parents underwent a 14-week training program designed to support their ASL skills. This richly descriptive study noted how language negotiations occurred between deaf instructors and hearing parents, both in terms of communication goals and preferred signs (e.g., English-influenced signs versus traditional signs). Similarly, Holmström and Schönström (2018) found that deaf teachers of Swedish Sign Language (SSL) working with hearing university students in Sweden engaged in creative translanguaging practices, such as using multiple signed languages (SSL and ASL), and written languages to ensure effective teaching of signed concepts. Both of these studies demonstrate the flexibility in presentation and communication that is afforded by using translanguaging techniques with hearing learners of signed languages.

5.6. Translanguaging for Equity and Inclusive Classrooms

One of the most salient purposes of using translanguaging in classrooms with deaf learners is arguably to enact principles of equity and inclusion. In the past, deaf students have not always had access to classroom communication because it was often presented in spoken language only (Meristo et al. 2007) or through difficult-to-comprehend simultaneous communication (Tevenal and Villanueva 2009). Approaching education through the lens of translanguaging, when done right, has the potential to improve equity and access where it has been weak or nonexistent in supporting deaf students to increase their academic achievement.

The research on translanguaging with deaf students that uses an explicitly equity-focused lens consistently examines power dynamics and how they relate to communication in mixed hearing level spaces (e.g., deaf individuals communicating with hearing individuals, and vice versa) (Liberali and Swanwick 2020; Swanwick et al. 2022), including with family members and teachers (Allard and Wedin 2017). Though all research teams note the potential for translanguaging's ability to improve communication and understanding, there were also areas for concern. For instance, for two 11-year old deaf students working with hearing adults in a classroom setting, translanguaging was at times successful for coordinating communication, though the authors note that translanguaging alone was not sufficient to ensure equity in access (Swanwick et al. 2022). Specifically, they note,

> "Translanguaging in this context does not guarantee an inclusive experience for learners, and indeed can give rise to confusion and a fragmented language experience if the semiotic resources are not sufficiently coordinated in both space and time around the sensorial asymmetries of the interlocutors". (p. 13)

The situation appeared more positive for adults in a master's and doctoral level monthly discussion group focused on equity in Brazil, where researchers noted how group members employed the use of spoken and signed languages, gestures, and facial expressions to express the meaning of a poem within their groups (Liberali and Swanwick 2020). The authors argued that the use of translanguaging allowed participants from frequently marginalized backgrounds to participate in activities in a mixed deaf/hearing space. Similarly, interviews with a deaf immigrant who moved from Kosovo to Sweden revealed the powerful educational and personal impact of teachers and classmates recognizing his native language as he learned to communicate in Swedish and SSL (Allard and Wedin 2017).

Overall, this literature suggests that translanguaging has the potential to be a powerful tool for equity and inclusion, but only when implemented correctly, and perhaps will be most effective with a deaf classroom instructor (Swanwick et al. 2022). Deaf students and instructors alike often engage in translanguaging practices for the purposes of reading in English (Ausbrooks et al. 2014; Hoffman et al. 2017), teaching, learning from, or communicating with hearing people (Allard and Wedin 2017; Holmström and Schönström 2018; Liberali and Swanwick 2020; Snoddon 2017; Swanwick et al. 2022) and understanding science (Charamba et al. 2019). Below, we present recommendations based on this literature that we believe will be helpful for content area teachers who wish to purposefully engage in translanguaging practices in their classrooms with deaf students.

6. Recommendations for Teachers

Translanguaging is about strengthening students' language resources because it is important for students to practice using multiple languages and modalities to communicate effectively about content area knowledge (Buxton et al. 2019). This can occur even if the students are still developing language and content knowledge (Scott et al. 2021). Our recommendations include purposefully using multiple languages and modalities during instruction, teaching students about word meanings within the context of science in both signed and written languages, using multiple modalities, and encouraging students to use multiple languages for their discussion and responses to prompts. We explore each of these recommendations in detail below. See Table 1 for a summary of each recommendation and examples.

Table 1. Recommendations for translanguaging practices in disciplinary content areas with examples of how these practices can be enacted.

Recommendation	Examples
Teacher's role in language usage: use multiple languages during instruction to expose students to essential concepts in both signed language and written language	- Use chaining and sandwiching during instruction - Create spaces where students can practice using their language repertoire in the context of the discipline
Techniques to use with students: expose students to content-specific written and signed words and phrases, as well as meanings of similar words and phrases in other contexts (e.g., evidence versus fact or proof in ASL and English)	- Teach students about discipline-specific appropriate terminology usage in ASL and English texts - Discuss the multiple meanings of signed and written words in different contexts
Being multimodal during content teaching: use multiple languages and modalities and be visually oriented during teaching	- Use all of the linguistic resources available to communicate disciplinary ideas - Scaffold students as they practice using their language knowledge in the context of science - Translanguage using signed language and written text as well as gesture, images, and other forms of communication
Centering students' cultural–linguistic assets: encourage students to respond to questions or prompts using multiple languages and/or modalities	- Encourage students to respond to content using all of their language and modality resources - Direct students to communicate ideas and content understanding among one another to provide more opportunities to use language for learning

6.1. Recommendation 1: Teacher's Role in Language Usage: Use Multiple Languages during Instruction to Expose Students to Essential Concepts in Both Signed Language and Written Language (Mazak and Herbas-Donoso 2015)

Our first recommendation is that teachers use language flexibly during instruction. The classroom teacher can create spaces where various uses of language intersect to legitimize how students communicate complex and abstract ideas regardless of the language and/or modality being used (Turkan et al. 2014). For deaf students, we expect this would be enacted through making references to words or images and structures written in print that connect them to signed language, or vice versa. This instruction may not only expose

students to essential concepts, allowing for multiple ways of accessing and understanding new information (Mazak and Herbas-Donoso 2015), but also allow them to understand differences in how certain concepts are expressed across languages (Liberali and Swanwick 2020; Swanwick 2017).

For this recommendation, we wish to emphasize the word *language*, as we strongly believe that the use of occasional signed words embedded into a primarily spoken language discourse would be not translanguaging, nor would it be visually oriented for deaf students. Given De Meulder et al.'s (2019) concerns regarding the history of language in deaf education spaces, it is essential to clarify that the teachers in these classrooms should be fluent in a signed language (as well as proficient in a written language), and that they are a language model for their students. Deaf students have varying levels of language proficiency in home and school languages, and the translanguaging framework allows the teacher to use students' linguistic repertoires to mediate content learning in the classroom.

Modeling the use of different linguistic repertoires through multiple languages, modalities, and information sources will not only expose students to language and words used in different ways in different contexts, but also likely present new and complex information in a way that is more easily understood. The use of multiple languages seems to allow students and teachers alike to identify the best way of communicating information so that it may be understood (Charamba et al. 2019; Holmström and Schönström 2018). This could also include asking students to share with the class how the same concept could be conveyed across multiple languages (Pierson and Grapin 2021). Swanwick (2017) points out that this type of instruction also encompasses pedagogical approaches such as chaining and sandwiching, a method of presenting new terminology to students through connecting a printed word with signed word, fingerspelling, and when appropriate, pictures and realia (Humphries and MacDougall 1999). The example of adapting current pedagogical approaches to a translanguaging environment would leverage the teacher's existing pedagogical repertoires and only require a slight adjustment to create a more inclusive learning environment. The novel suggestion here may not be the use of multiple languages, but rather to present information between languages flexibly, in accordance with students' language levels, and to encourage *students* to use all of their linguistic knowledge and resources (see recommendation 4). This echoes proficient language users who reported moving between languages while reading an English text to translate phrases into ASL (Ausbrooks et al. 2014; Hoffman et al. 2017).

The way the teacher uses language has an important effect on the nature of the classroom culture and student's belief and action in the science classroom (Moje 1995). This may also have the dual benefit of exposing students to the idea that *all* languages, including signed languages and home languages, are apt vehicles for communicating complex concepts rather than such concepts being solely or primarily in English (Allard and Wedin 2017; Liberali and Swanwick 2020; Mazak and Herbas-Donoso 2015). Teachers could model for students how they might make choices about language. For instance, when reading about a new scientific concept, the teacher might pull up written text, read it, and think aloud to their students, "This text is a little confusing. I'll look for other resources to help me understand", and model for students identifying graphic information, ASL videos, and other text resources to clarify challenging concepts. Because of the use of multiple languages, including ASL, in this type of instruction, teacher fluency in all classroom languages is essential to support deaf students' learning through translanguaging (Karlsson et al. 2019; Suarez 2020).

6.2. Recommendation 2: Techniques to Use with Students: Expose Students to Content-Specific Written and Signed Words and Phrases, as well as Meanings of Similar Words and Phrases in Other Contexts Using Multiple Languages (e.g., Evidence versus Fact versus Proof in ASL and English) (Enderle et al. 2020)

Communicating scientific conceptions involves nuanced ways to use language to evaluate, argue, and critique knowledge in the science classroom. Following the argument that translanguaging not only occurs between languages but also between particular

applications of one's linguistic repertoire in diverse settings (Flores 2020; Karlsson et al. 2020), we suggest that teachers explicitly engage in translanguaging activities that expose students to various disciplinary discourses and concepts across multiple languages. Subject matter is constantly being defined and redefined, such as the differences between disciplinary knowledge in physics versus the school subject of physics that marks the language boundary between school and discipline (Deng and Luke 2008). Subject matter teaching helps students develop the logic, epistemology, psychology, pedagogy, and sociocultural knowledge of physics while the discipline of physics refers exclusively to the work of academic physicists. These differences make it challenging to create academic vocabulary in signed language for science classrooms. However, ASL *has* linguistic features that allow teachers and students to discuss the habits of mind used in the science discipline, which employs complex and abstract discourse. For instance, when exploring the concept of "heat transfer", signing students might use signed words related to increasing and decreasing heat levels that is inaccurate in the context of the first thermodynamic law, which states energy is not created or destroyed but is altered. Eventually, they will learn the precise signed ways to convey how heat is transferred. Teachers should not rush to correct students' vocabulary choices as long as they are building their understanding of scientific concepts—though later they can model language use to allow students to hone their scientific explanations (Seah and Chan 2020). Understanding nuanced differences in written and signed word meanings between content area settings and other meanings of the word will likely enhance students' understandings of the content (Enderle et al. 2020).

Teachers who are implementing this recommendation might consider specifically exposing students to the idea that the use of a word in signed and written language in one content area (e.g., the ASL sign for PROOF in mathematics) may have a nuanced or more precise meaning that differs from other content areas (e.g., the ASL sign for EVIDENCE in science or the ASL sign for FACT in social studies/language art). This can be thought of as akin to teaching multiple meaning words in the English Language Arts context. Teachers could consider presenting information to students using a variety of presentation styles and discussing the differences in approach with them before implementing the translanguaging activity to maintain communication flow during the lesson (Swanwick et al. 2022). To support teachers in identifying signed words for specialized terms, there are online resources that may be valuable. For instance, in Science, Technology, Engineering, and Mathematics (STEM) fields, there are various instructional resources that teachers can use to learn about signs used to convey a specific concept (e.g., ASL Clear, ASL Core, and DeafTEC), or explanatory ASL videos that teachers can have students view and then build discussion prompts or questions based off of the information contained in the videos (e.g., Atomic Hands). Teachers can browse these publicly available websites to find signed words for the terminology for the lesson they are about to cover and use these videos as examples of scientific ASL discourse to deaf students in the classroom that will help them see different ways of using ASL to convey complex concepts.

6.3. Recommendation 3: Being Multimodal during Content Teaching: Use Multiple Languages and Modalities and Be Visually Oriented during Teaching (Allard and Pichler 2018)

Each discipline has its own way of communicating with a reader, and these unique modes of communication should be capitalized upon. There are many ways for a teacher to be multimodal in their instruction, some of which are also multilingual (e.g., spoken English in the auditory mode; signed language in the visual mode), though language is not necessary for one to operate multimodally (e.g., using graphs is a visual mode used in many disciplines). Below we explore the ways that visual and tactile modes can be used for content area teaching.

Visual Instruction as Asset-Based Learning

Multimodal instruction used in a translanguaging paradigm means being asset-driven rather than modality-driven. For multilingual deaf learners, visual perception and multi-

modality are areas of strength that should be capitalized upon in their classrooms. Teachers can use scaffolding techniques to help students develop a deeper understanding of novel concepts. There is evidence that deaf students who are still developing their English language skills are very capable of engaging with disciplinary communication, especially via visual modalities such as graphs and charts (Miller et al. 2018; Scott et al. 2021). Classroom arrangement plays a big role in fostering or hindering opportunities for students to participate (Swanwick et al. 2022). Teachers need to consider students' line of sight to the teachers, their peers, and other instruments in the classroom such as white/black boards, television, or posters. Teachers can draw students' attention to figures and graphically display data with ease as they discuss the content of these resources using a signed language. Teachers can also teach deaf students about sound through capitalizing on other senses, such as the visual or tactile modalities. For example, using sensor probes allows deaf students to visualize sound waves such as pitches from a Chladni plate (Lang 1981). Given the importance of visual communication in spaces with deaf children, a disorganized classroom set-up can hinder their ability to process and respond to the information.

Sensory-focused pedagogy for deaf students can utilize the senses of touch and sight—a "see and feel" pedagogy, rather than the common "hear and see" pedagogy used with hearing students, because the former is focused on deaf students' two strongest learning senses. In contrast, hearing is not deaf students' strongest learning sense (Vongsawad et al. 2016). With the "see and feel" approach, concepts that are being learned should be communicated using words in both ASL and English, as well as through graphics, pictures, and when appropriate, touch. The word *pressure* is common, but *wave* is uncommon as the signed word is closely associated with water waves instead of sound waves. Likewise, there is no ASL signed word for *resonance*, so the instructor may use the signs for *vibration* and *pressure* in its place. Images of sound waves and a discussion of the traits of sound waves that one can see with the eye would also be appropriate from this type of instruction that helps students understand the concept by connecting different linguistic resources.

6.4. Recommendation 4: Centering Students' Cultural–Linguistic Assets: Encourage Students to Respond to Questions or Prompts Using Multiple Languages and/or Modalities (Lopez et al. 2019)

In many ways, recommendation 4 is the inverse of recommendation 3. Not only do we recommend that teachers use multiple languages, but students should be allowed—and encouraged—to respond to classroom discourse in multiple languages and multiple modalities. Students are thinking partners in the classroom that can pool together their semiotic resources to develop rich conversation leading to conceptual understanding (Iturriaga and Young 2022). Teachers need to demonstrate language usage to their students to promote personal growth and solidarity among students during learning to help them acquire the concepts. Avoid the discourse revolving around finding the "right answer" or "correct conception", that is devoid of the opportunity for students to construct their conceptual understanding about their learning (Moje 1995). Students need the flexibility to answer questions in multiple languages and modalities. This flexibility allows students to draw upon all linguistic resources they have available to demonstrate their understanding (Lopez et al. 2019; Snoddon 2017). More opportunities for students to use language with their peers leads to more connection with language usage and content learning because individual students connect to others through communicating ideas (e.g., the interactionist view of language development; Pica 1996).

Students should learn how to strategically use their linguistic repertoire, such as their prior knowledge (Moje 1995) or signed or spoken languages they use in addition to the classroom language (Allard and Wedin 2017). This is not only beneficial for the student, who does not have to worry about their ability to express themselves in a language they are still developing, but also is beneficial for the teacher, who can use student responses to gain a fuller picture of that student's knowledge and learning progress without the constraint that a particular language might place upon them. Though there are times to ask students to use a particular language to ascertain their ability to communicate in that

language, especially in the disciplines, the priority should be placed upon their conceptual understandings with scaffolds in place to develop linguistic development.

The application of this recommendation will likely require the use of scaffolding by teachers. Multiple ways of mixing and matching linguistic usage can afford teachers the flexibility to use translanguaging in different sequences. For instance, providing students with the option to respond to prompts in science class not only using the language(s) of their choice (e.g., written or signed language, using a home language other than English, or using multiple or all of these resources) (Allard and Wedin 2017), but also within that to use varied modalities (graphs, images, real world representations, writing, signing, and graphic organizers) (Pierson and Grapin 2021; Wolbers et al. 2014). Teachers might also display how this same information might be communicated in a written language to provide their students with opportunities to engage with content in multiple languages (Holmström and Schönström 2018; Snoddon 2017; Swanwick et al. 2022). Students may construct a first draft of what will eventually be a piece written in English through a signed video in ASL or writing in a home language—or the communication of the concept in the signed and/or home language could itself be the final product (Lewis et al. 2012; Liberali and Swanwick 2020). This could also manifest in controlled choice in responses, especially for younger students, where for a given activity that they choose from a limited array of response types (e.g., make a video in ASL, or a drawing, or a written paragraph explaining the water cycle).

7. Conclusions

7.1. The Novelty of Translanguaging—An Opportunity for Growth

Translanguaging in content area learning is an area of study in its earliest stages that offers potential on recontextualizing language and communication as a learning vehicle for deaf students (Iturriaga and Young 2022). There is emergent research about instructional strategies to promote translanguaging, though there is evidence that multilingual students engage in these practices (Mazak and Herbas-Donoso 2015). Multilingual and multimodal deaf students already use translanguaging both in and out of the classroom, including in classes like science or history (Charamba et al. 2019; Swanwick 2017). However, translanguaging can become challenging if the students and teachers do not share the semiotic resources. This creates a "ceiling effect", preventing deaf students from advancing their learning.

7.2. Forming a Translanguaging Culture in School

Emerging research on training teachers to work with culturally and linguistically diverse groups of students in their classrooms acknowledges the teachers' role as a language model. Therefore, our recommendations might be expanded, eliminated, modified, or enhanced as research continues to accrue findings on teachers' knowledge and use of translanguaging in multilingual classrooms. However, the goal of the disciplinary linguistic knowledge framework is to help teachers to make the language of the content accessible and meaningful to their students because the teachers' knowledge of language is integral to how they teach the content knowledge and contributes to students' conceptualization of the discipline. Turkan et al. (2014) highlighted the importance of "viewing knowledge of language as integral to teachers' content knowledge for teaching is a potential contribution to the conceptualization of specialized content knowledge for teaching" (Turkan et al. 2014, p. 24). Teachers move their students back and forth in hybrid spaces where various languages and modalities intersect to legitimize students' use of language in academic contexts. Thus, the reason it is important for teachers to scaffold their students' language ability is to help them develop the language skills for content-area communication. Therefore, teachers need to be intentional when creating more opportunities for students to use language with their peers leading to more connection on language usage and content learning.

Unfortunately, school systems have experienced a disconnect in the linguistic and cultural knowledge of educational specialists and classroom teachers who are working

with multilingual students, making it more challenging to prepare classroom teachers to work with students of all backgrounds. It is important to consider that each deaf individual uses translanguaging differently depending on their linguistic resources and the context of the communication environment. Another consideration needed to make translanguaging conducive between deaf people and non-signers is to have conversations on communication and language policies and practices in the classroom to develop a communal sense of using diverse languages and modalities. We need more effective classroom practices with strong theoretical and evidential bases (Yore and Treagust 2006). It is essential that educators create spaces that will allow their students to take advantage of the linguistic resources at their disposal to develop and demonstrate their knowledge.

There are increasing studies conducted from a strengths-based perspective being published in the present day. However, historically many deaf education researchers and educators of deaf students have inordinately focused upon the hearing levels of their students rather than focusing on students' strengths and skills (e.g., Gibbs 2010; Wake et al. 2005). The concept of translanguaging, when applied to deaf students, encourages a paradigm shift that encourages a reorientation of focus on linguistic strengths. To further apply translanguaging practices to content area classrooms not only has the potential to improve the content understanding of deaf students, but also to demonstrate the value that a signed language has in the context of disciplinary communication. Using a translanguaging approach in multilingual classrooms has far-reaching implications for content area teaching with deaf students that enter school with diverse language experiences.

Providing students with opportunities to learn new concepts in multiple languages allows them to use all of their linguistic repertoire to make sense of new information. This type of instruction may also be important for learning and differentiating the meanings of terms in one context that may have different meanings in other contexts. Teachers would need to have a deep understanding of the content to afford flexible ways to help students construct conceptual meanings and engage in translanguaging forms during content instruction. We believe that this type of knowledge is essential for creating a classroom environment that truly enacts and embraces translanguaging.

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Note

[1] There are multiple ways of referring to deaf and/or hard of hearing individuals in print. To be inclusive, in this manuscript we use the term "deaf" to refer to all deaf and hard of hearing people regardless of hearing level or language use.

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