Science Units of Study with a Language Lens: Preparing Teachers for Diverse Classrooms

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Abstract

Recent educational policy reforms have reinvigorated the conversation regarding the role of language in the science classroom. In schools, the Next Generation Science Standards have prompted pedagogical shifts yielding language-rich science and engineering practices. At universities, newly required performance-based assessments have led teacher educators to consider the role of academic language in subject-specific teaching and learning. Simultaneous to these policy changes, the population has continued to diversify, with schools welcoming students who speak hundreds of different languages and language varieties at home, despite English continuing as the primary medium of instruction in science classrooms. Responding to these policy and demographic shifts, we have designed an innovation to prepare teachers and teacher candidates to design instruction that promotes students' disciplinary language development during rigorous and meaningful science instruction. We add a language lens to the widely used Understanding by Design® framework, emphasizing inclusion and integration with what teachers already do to design science curriculum and instruction, rather than an add-on initiative that silos language development apart from content learning. This language lens merges the principles of culturally and linguistically responsive practice with the three stages of backward instructional design to support educators in designing effective and engaging science instruction that promotes language development and is accessible to the growing number of students from linguistically diverse backgrounds.

Introduction

In science classrooms spanning urban, suburban, and rural regions, students enter with ever diversifying cultural and linguistic backgrounds (National Clearinghouse for English Language Acquisition, 2010). In the context of the United States, 20% of students speak a language other than English at home, with half of these students considered English learners (ELs) due to still-developing English proficiency as measured by standardized tests of listening, speaking, reading, and writing (Linquanti & Cook, 2013; National Center for Educational Statistics, 2015). Despite the benefits of linguistic diversity in schools, these demographic shifts provide unique challenges for science teachers, who typically mediate students' scientific learning, understanding, and achievement using the English language

(Lee, Quinn, & Valdés, 2013). To ensure that students have equitable access to science content, teachers must consider and account for language in their daily classroom instruction (Heineke & McTighe, 2018).

Concurrent to the diversification of schools, science education as a field has embraced a vision of students learning and doing science through language-rich scientific and engineering practices, as evidenced by the *Framework for K-12 Science Education* (National Research Council [NRC], 2013) and *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013). Indeed, the shift to the NGSS has resulted in instructional foci on science and engineering practices that simultaneously involve both scientific sense-making and language use (e.g., asking questions, constructing explanations, communicating information; Quinn, Lee, & Valdés, 2010). The resulting practice-oriented classroom thus serves as a rich language-learning and science-learning setting where science teachers are not perceived as language teachers but rather "supporters of the language learning that occurs in a content-rich and discourse-rich classroom environment" (Quinn et al., 2010, p. 1). Since the shift to the NGSS, scholars have indicated that explicit emphasis on language development is indicative of high-quality science instruction that effectively supports all students' learning, including ELs (e.g., Lee, Llosa, Jiang, Haas, O'Connor, & Van Boonem, 2016; Maerten, Rivera, Ahn, Lanier, Diaz, & Lee, 2016; Zwiep & Straits, 2013). But achieving this practice requires concomitant teacher education that prepares science teachers to integrate language in instructional design and implementation (e.g., Stoddart, Solís, Tolbert, & Bravo, 2010; Tolbert, Stoddart, Lyon, & Solís, 2014).

Seeking to respond to the diversifying student population and changing educational policy context of teaching content and language in disciplinary classrooms, we have added a language lens to Understanding by Design® framework that already supports the design of effective instruction in thousands of schools across the country and world. Understanding by Design (UbD) prompts educators to design rigorous and authentic instruction that deepens students' learning and understanding by beginning with the end in mind (Wiggins & McTighe, 2005). Curriculum designers progress through stages of instructional design – defining learning goals in Stage 1, designing assessments in Stage 2, and planning instruction in Stage 3 – as a means to promote meaningful learning that transfers to contexts beyond the classroom. In this article, we introduce the UbD framework with a language lens in the context of science teacher education. We (a) sketch the components of UbD with a language lens, (b) detail the integration of this approach to prepare teachers, (c) introduce the learning and application of two science teachers, and (d) share recommendations for implementation in science teacher education.

Backward Design for Learning and Language Development

UbD with a *language lens* uses the existing design framework, but adds a language lens using principles of culturally and linguistically responsive practice to prioritize diverse students while planning instruction that mediates the disciplinary learning and language

development of all students (Heineke & McTighe, 2018). In this way, we begin with students, embracing and responding to their unique backgrounds, abilities, strengths, and needs. Grounded in culturally responsive pedagogy (Gay, 2010) and linguistically responsive teaching (Lucas, Villegas, & Freedson-González, 2008), the *pre-planning* component centers on getting to know learners to prompt dynamic instructional design that taps into students' background knowledge and experiences, including language backgrounds and proficiencies. Reflecting the foundational basis of responsive and rigorous science instruction, practitioners need to recognize the diversity of students, including students' language backgrounds, cultural background knowledge, and previous science learning and experiences. In this way, pre-planning involves amassing and analyzing data on students, including formal data (e.g., cumulative files, standardized test scores) and anecdotal data (e.g., observations, conversations).

Following pre-planning, *Stage 1* begins with the end in mind by prompting educators to identify the desired results of the unit, including goals for transfer, meaning, and acquisition. Based on *established* goals (i.e., NGSS), *transfer* goals prompt students to transfer and use scientific learning beyond focal units of study, *meaning* goals involve students grappling with essential questions to build deep understandings about scientific concepts, principles, and processes, and *acquisition* goals focus on related knowledge and skills, which serve as building blocks to achieve larger transfer and meaning goals.

When adding the language lens to Stage 1, we maintain the rigor of scientific learning goals, which promotes the high expectations for all students at the heart of this approach. But science prompts complex and nuanced uses of language, including discipline-specific words, phrases, sentence structures, and text features (see Table 1). In this way, while upholding the high expectations for all students' disciplinary learning, we want to explicitly target the development of pertinent scientific language, which fosters students' academic language development and ensures equitable access to content. To accomplish this in instructional design, we (a) analyze the complex and demanding language that students need to achieve the unit's transfer and meaning goals and (b) target the development of that language by writing objectives focused on language functions (e.g., analyze, critique) and language features (e.g., vocabulary, sentence structures, text features), as well as involving multiple language domains (i.e., listening, speaking, reading, writing; see Heineke & McTighe, 2018 for more information).

Table 1 (Click on image to enlarge)

Examples of Language Designs in Science

Table 1
Examples of Language Demands in Science

Level	Feature	Examples
Discourse	Amount of speech/text	Extended lectures, long texts, and passages
	Structure of speech/text	Varied structures (lab report, summary, glossary)
	Density of speech/text	Dense textbooks often written above grade level
	Organization of ideas	Varied text features (illustrations, diagrams, photos)
Sentence	Sentence types	Complex sentences with multiple embedded clauses
	Sentence structures	Cause-effect, problem-solution, compare-contrast
	Verb tenses	Conditional tense (what *could* or *might* happen)
	Logical connectors	*because, therefore, unless, consequently*
	Lexical bundles	*in the form of, as a result of, the nature of*
Word	Discipline-specific words	*organism, symbiosis, tsunami, conductivity*
	Discipline-specific phrases	*plate tectonics, gravitational potential energy*
	Words used in new ways	*matter, gas, space, order, solution, wave, crust*
	Nominalizations	*observe/observation; analyze/analysis*

Source: *Using Understanding by Design in the Culturally and Linguistically Diverse Classroom* (p. 89), by A. Heineke and J. McTighe, 2018, Alexandria, VA: ASCD. Copyright © 2018 by ASCD.

Stage 2 of UbD centers on designing assessments for students to demonstrate progress toward the unit goals defined in Stage 1. The focal point of unit assessments, *performance tasks* prompt students to engage in authentic situations that require transfer of scientific learning to real-world problems and practices. As a part of these experiences, students take on particular roles (e.g., scientist, meteorologist, engineer) and use understandings of scientific concepts and processes in simulated situations aligned to the unit's learning goals. In addition to performance tasks, *supplementary evidence* involves students demonstrating learning across units via various measures (e.g., tests, quizzes, academic prompts; Wiggins & McTighe, 2005).

When adding the language lens on Stage 2, the goal is to design and integrate assessments that (a) capture data on both scientific learning and language development, and (b) provide equitable access for all students to demonstrate understanding (Heineke & McTighe, 2018). In this way, units should include performance tasks that are language-rich, culturally responsive, and linguistically accessible. When designed for authenticity, scientific performance tasks are naturally language-rich, as students interact with peers to discuss and solve problems (i.e., listening, speaking), as well as research and share findings via presentations, proposals, dioramas, or other products (i.e., reading, writing). To ensure all students can actively participate, tasks should (b) be culturally relevant to engage learners and not require prerequisite background knowledge, and (b) have linguistic scaffolds to ensure all students can contribute and demonstrate progress regardless of language background or proficiency. In addition to performance tasks, supplementary assessments are integrated to holistically capture students' abilities, strengths, and needs in both science and language learning.

Table 2 (Click on image to enlarge)

GRASPS Task Framework with Language Lens

Table 2
GRASPS Task Framework with Language Lens

Element		Prompts	Language Lens
G	Goal	Your task is to . . . Your goal is to . . . The problem or challenge is . . . The obstacle to overcome is . . .	Do students' background knowledge align with the stated goal of the task?
R	Role	You are . . . You have been asked to . . . Your job is to . . .	Are students familiar with the target role based on their prior knowledge (e.g., jobs, careers, positions)?
A	Audience	Your clients are . . . The target audience is . . . You need to convince . . .	Do students know the cultural values and practices that shape how they would interact with target audience?
S	Situation	The context you find yourself in is . . . The challenge involves dealing with . . .	How can students use language in authentic ways to engage in the situation?
P	Product, Performance, and Purpose	You will create a . . . You need to develop . . .	How can students use language in varied ways to demonstrate learning? What linguistic supports do students need to demonstrate learning?
S	Success Criteria	Your performance needs to . . . Your work will be judged by . . . Your product must meet these standards . . . A successful result will . . .	What are the expectations for students' language use? How does language develop as embedded in disciplinary learning?

Source: From *Understanding by Design Professional Development Workbook* (p. 172), by J. McTighe and G. Wiggins, 2004, Alexandria, VA: ASCD. Copyright © 2004 by ASCD. Adapted with permission.

In *Stage 3* of UbD, teachers design learning plans that authentically facilitate student learning and understanding as aligned to Stage 1 goals and Stage 2 assessments. This includes the *learning plan*, which involves hands-on experiences with real-world application and differentiation based on students' backgrounds, abilities, and needs, as well as *formative assessment* embedded in instruction to glean students' learning across the unit of study. When adding the language lens to Stage 3, we strategically plan instruction to achieve unit goals, including those for disciplinary language development, while responding to the unique and diverse needs of students (Heineke & McTighe, 2018). When planning the learning trajectory of science units, the language lens prompts consideration and purposeful integration of (a) students' cultural and linguistic background knowledge, (b) collaborative, cognitively demanding tasks that involve listening, speaking, reading, and writing in English and students' home languages, (c) complex texts that are culturally relevant and linguistically accessible, and (d) differentiated scaffolds and supports based on students' language backgrounds, proficiency levels, and learning preferences (Herrera, 2016; Walqui & vanLier, 2010).

Preparing Teachers for Backward Design with a Language Lens

In addition to serving as a template to design instruction for K-12 students, UbD with a language lens provides teacher educators with an approach to prepare teachers to support diverse students' language development in science instruction. In this section, we share ways to tackle this work with teachers in training, including in-class activities and resources for building the language lens on instructional design (for more detailed information, see Heineke, Papola-Ellis, Davin, & Cohen, 2018a).

Introducing science teachers to UbD with a language lens begins with buy-in. Science teachers are typically prepared as content experts with the pedagogical content knowledge to mediate students' scientific learning (Shulman, 1986). Because of the very nature of

schools, where English as a Second Language (ESL) and English Language Arts teachers maintain the primary responsibility for teaching language, science teachers might need convincing of their role in supporting students' language development. We have found the most poignant way to achieve buy-in is having teachers begin by exploring data related to students' linguistic diversity. When looking at formal data like home language surveys and English proficiency scores (e.g., ACCESS), teachers recognize students' diverse backgrounds and proficiency levels. We then have them probe the multi-faceted nature of individual learners by collecting formal and anecdotal data on students' background knowledge, cognitive strategies, language preferences, and scientific knowledge and self-efficacy (Collier & Thomas, 2007; Herrera, 2016). Our goal is for teachers to recognize diversity, paired with the need to maintain high expectations for all.

In Stage 1, we center efforts on deconstructing teachers' and candidates' *linguistic blind spots*. Science teachers are experts within particular disciplines, such as physics, chemistry, or biology, and in the context of the United States, many are also native English speakers. Taken together, teachers may not recognize the demanding, discipline-specific language that students need to access and engage in learning and understanding. To develop teachers' understandings through empathy, we begin by simulating what students might experience linguistically in the science classroom, asking teachers to read highly complex articles from peer-reviewed journals (e.g., *Journal of Chemical & Engineering Dat*a) and use them to engage in a particular task (e.g., making a scientific argument using text-based evidence). We then provide specific tools and examples of disciplinary language demands to help teachers uncover linguistic blind spots, such as WIDA's framework (2012) for academic language at word, sentence, and discourse levels, WestEd's detailed taxonomy of academic language functions (AACCW, 2010), and Understanding Language's overview of NGSS language demands (Quinn et al., 2010). Finally, after building empathy and awareness for the language lens in science teaching and learning, we move into analyzing unit-specific language demands and selecting those that are important, aligned, prevalent, and versatile to scientific content to then draft language-focused objectives.

In Stage 2, we want to teachers to embrace the value of performance tasks in promoting and measuring learning, understanding, and language development (Heineke & McTighe, 2018; Wiggins & McTighe, 2005). This begins by getting teachers to critically evaluate the traditional testing tools that may dominate their current repertoires. We use actual assessments, such as a summative paper-and-pencil test for a unit provided in the science textbook, to analyze for cultural and linguistic biases based on pre-planning data. Once biases are determined, we discuss the need to assess students' scientific knowledge and skills without requiring a set level of language proficiency or privileging any particular cultural background knowledge. This then springboards into the exploration of performance tasks as the preferred approach to unit assessment, specifically probing ideas within three language-rich categories (i.e., oral, written, displayed). We then use the GRASPS framework with a lens on language (Heineke & McTighe, 2018; Wiggins & McTighe, 2005) for teachers to

design performance tasks that align with students' cultural background knowledge and scaffold access based on learners' language proficiency (see Table 2). We use WIDA tools to determine developmentally appropriate language functions (i.e., Can-do descriptors; WIDA, 2016) and integrate authentic scaffolds (i.e., graphic, sensory, interactive; WIDA, 2007) to provide students' equitable access to participate in the performance task.

For Stage 3, we want to build from what educators already know, such as inquiry-based science activities or EL-specific instructional strategies. In our experience working with teachers and candidates, this facet may be familiar based on previous coursework or professional preparation. The key is emphasizing not using a strategy for strategy's sake, but selecting, organizing, and aligning instructional events and materials based on pre-planning data, Stage 1 goals, and Stage 2 assessments. Flexible based on the professional expertise and experience of the participants, adding a language lens to this stage centers on educators exploring the above facets (e.g., background knowledge, collaborative tasks, complex and relevant texts, differentiated supports) with the primary aim to build awareness of available approaches and resources that can enhance their current pedagogy and practice as science teachers (e.g., bilingual resources, amplification of complex texts). In addition to providing the space to explore high-quality, language-rich approaches and resources for various scientific disciplines, we model how to apply and integrate tools that align to the learning goals of instructional units of study.

The Language Lens in Action: A Closer Look at Two Science Teachers

Let's exemplify this approach by looking at the instructional design work of two focal science teachers, who participated in a grant-funded professional development series on UbD with a language lens (see Heineke et al., 2018a, 2018b). Using the activities and resources detailed above, these teachers collaborated with colleagues across grades and disciplines to learn about UbD with a language lens and apply learning to their science classrooms.

Bridget, Elementary Science Teacher

Bridget was a sixth-grade science teacher at Wiley Elementary School, a K-6 elementary school with 1200 students in the urban Midwest. With the support of her assistant principal, she secured data to understand the culturally and linguistically diverse student population, including home language surveys and language proficiency tests (i.e., ACCESS). By exploring these data, Bridget learned that the majority of Wiley students spoke another language and approximately 45% of students were formally labeled as ELs. She was not surprised to see that Spanish was the majority language spoken by families, followed by Arabic, but learned about the rich array of linguistic diversity in the community with languages including French, Urdu, Tagalog, Bosnian, Hindi, Bengali, Farsi, Yoruba, Serbian, Romanian, Malay, Gujarati, Korean, Mongolian, and Burmese. Bridget also discerned that 50 of her 54 sixth graders used another language at home, including 10 labeled as ELs with 5 dual-labeled as having special needs.

Bridget chose to work on the first science unit of the school year on space systems, which merged science, engineering, and mathematics principles with the goal for sixth graders to use data and models to understand systems and relationships in the natural world. Per the suggestion of the instructor, she brought a previous unit draft to apply her evolving understandings of UbD with a language lens. Having already deconstructed her expert blind spot to flesh out the conceptual understandings pertinent to science standards and transfer goals, she considered her linguistic blind spot with the support of the instructor and other science educators. Bridget found having examples of science language demands (see Table 1) to be helpful in this process, using the categories and types of word-, sentence-, and discourse-level demands to analyze the disciplinary language her students needed to reach Stage 1 goals, including vocabulary (e.g., *gravitational pull*), nominalization (e.g., *illuminate/illumination*), idioms (e.g., *everything under the sun*), sentence structures (e.g., *compare/contrast*), and informational text features (e.g., *diagrams*). After pinpointing these knowledge indicators, she used data on her students' language proficiency to draft skill indicators with attention to particular language functions (e.g., *explain*, *compare*) and domains (e.g., *reading*, *writing*).

After adding specific knowledge and skill indicators for language development in Stage 1, Bridget then shifted her attention to Stage 2 assessments. Following exploration of a multitude of language-rich performance task options, including those that prioritize oral, written, and displayed language (Heineke & McTighe, 2018), she decided to redesign her primary unit assessment using the GRASPS framework with a language lens (see Table 2). The resultant Mars Rover Team task (see supplemental unit) aimed to engage her sixth graders in authentic and collaborative practice with components strategically designed to promote disciplinary language use across domains (e.g., listening and speaking in teams, reading data tables, writing presentations) and scaffold for students' language proficiency (e.g., drawings, technology, small groups). She planned to evaluate the resultant tasks for precise disciplinary language, including the vocabulary, nominalization, and other language features pinpointed in Stage 1 goals. In addition to the performance task, Bridget also added the collection of supplemental evidence to the unit of study, specifically aiming to collect and evaluate data on students' scientific language development via journal prompts, personal glossaries, and resultant artifacts.

The final facet of the professional development focused on Stage 3, where Bridget revised the unit's learning plan to target demanding disciplinary language, integrate students' cultural backgrounds, and differentiate for multiple language proficiencies. Having embraced an inquiry-based approach to teaching science, she already had frequent opportunities for students to collaboratively engage in hands-on exploration and application of scientific concepts. By participating in language-focused professional development, she enriched students' inquiry by adding opportunities for them to use their home languages as resources for learning, as well as tap into culturally specific background knowledge. For example, she modified her use of space mission notebooks to include personal glossaries for students to

document pertinent scientific language, including translations into their home languages. Bridget also sought out and incorporated complex and culturally relevant texts, such as space-related myths, legends, and folktales from students' countries of origin in Asia, Africa, and South America. Designed with her unique and diverse students in mind, the Stage 3 learning plan outlined her instructional trajectory for students to successfully achieve unit goals.

Jillian, Secondary Science Teacher

Jillian was a science teacher at Truman High School, a neighborhood public high school situated in a vibrantly diverse community in the urban Midwest. She began by exploring the rich diversity of her workplace, learning that 80% of the 1350 students use a language other than English home, representing 35 different languages. Spanish was the primary home language spoken, and 75% of the student body identified as Latina/o, but from countries spanning North, South, and Central America, as well as the Caribbean. Jillian also discovered that of that larger group of bilingual students, 25% are labeled as ELs, spanning a range of proficiency levels across language domains and including both newcomers to the United States and long-term ELs who had enrolled in neighborhood schools since the primary grades.

Jillian decided to focus on a weather and climate unit previously drafted for her earth and space science class. Working with other secondary teachers and using graphic organizers of academic language functions (AACCW, 2010) and features (WIDA, 2012), Jillian analyzed the unit's transfer and meaning goals for language demands. She noted that her students would need to (a) interpret scientific evidence requiring diverse text features like maps, graphs, and charts, (b) describe weather using words that may be familiar from other contexts (e.g., humidity, temperature), (c) compare climates between local and global settings using distinct measurement systems (i.e., Fahrenheit, Celsius). From that analysis, she pinpointed the linguistic knowledge that her students would need to develop to access the larger learning goals, including weather-based text features and vocabulary terms and comparative sentence structures. She then refined skill indicators to target her students' language development simultaneous to content, including analyzing weather-related data, interpreting weather patterns, and comparing climates. In this way, Jillian maintained the rigor of scientific learning while adding a lens on disciplinary language development to the Stage 1 goals.

Jillian wanted to design a performance task aligned to unit goals. After analyzing the paper-and-pencil test used by the previous earth science teacher, she realized the need to design an authentic, language-rich task that actively engaged her students in listening, speaking, reading, and writing focused on the disciplinary topics of weather and climate. Reflecting the instructor's consistent messaging regarding responsive practice, she aimed to tap into her students' rich sources of background knowledge, including their various global experiences and multilingual backgrounds. Using the GRASPS framework, she drafted a performance

task where learners take on roles as potential weather reporters who use multiple sources of evidence to describe how weather affects human life around the globe. Students needed to use disciplinary language (in English and home languages) to compare and contrast how weather and climate influenced one facet of human life in various contexts. To ensure she had data to measure progress toward all Stage 1 goals, Jillian integrated opportunities to collect supplementary evidence throughout the unit.

After refining her goals and assessments with a language lens, Jillian wanted a learning plan that was rigorous, engaging, and interesting for her diverse students. Based on pre-planning data, she wove in students' cultural and linguistic background knowledge. She began with a context-specific hook, prompting students to compare their city with other locations they had lived or traveled, and continued this strand by using global inquiry teams to analyze weather by continent and expert groups based on learners' various countries of origin. Jillian then used approaches and resources explored during workshops to attend to disciplinary language, including consistent teacher modeling and student application with strategic scaffolds, such as sentence frames and graphic organizers. Having used the UbD template throughout the process of learning and applying the language lens, she completed a unit with a consistent and deliberate lens on scientific language. In this way, Jillian strategically designed experiences to support learners in reaching unit goals for learning and language development.

Conclusions & Recommendations

UbD with a language lens aims to provide all students with equitable access to rigorous learning and language development (Heineke & McTighe, 2018). By adding a language lens to the widely used UbD framework, educators learn to maintain the rigor of science teaching and learning while attending to disciplinary language demands (Heineke & McTighe, 2018; Lee et al., 2013). This timely innovation in science teacher education corresponds with current policy initiatives in K-12 schools and universities, including the NGSS that emphasize language-rich scientific and engineering practices (NGSS Lead States, 2013) and the Teacher Performance Assessment (edTPA) that prioritizes academic language embedded in content instruction (SCALE, 2018). In line with these broad policy shifts that bolster the role of language in science teaching and learning, this framework can be used with K-12 in-service and pre-service teachers, whether approached through professional development or university coursework.

Application in Practice

We originally designed and implemented this approach through a grant-funded, professional development project with in-service teachers working in 32 public schools in the urban Midwest, which included Bridget, Jillian, and other teachers spanning elementary, middle, and high schools in culturally and linguistically diverse communities (see Heineke et al., 2018a for more details on the project). Findings indicated that teachers, as well as

participating school and district leaders, developed awareness and knowledge of discipline-specific language development, pedagogical skills to effectively integrate language in content instruction, and leadership abilities to shape implementation in their unique educational settings (Heineke et al., 2018b). By integrating the language lens into the existing UbD template, of which they were already familiar and comfortable in using, teachers embraced language development as a part of their regular teaching repertoires, rather than an add-on initiative.

We are currently integrating this approach into a university pre-service teacher education program, and our preliminary work indicates close alignment between the edTPA and UbD with a language lens. Of the many rubrics that are used to assess teacher candidates on the edTPA, over half directly relate to the components of the approach shared above, including planning for content understandings, knowledge of students, supporting academic language development, planning assessment, analyzing student learning, analyzing students' academic language understanding and use, and use of assessment to inform instruction (SCALE, 2018). In addition to our previous research with in-service teachers, we plan to collect data on the implementation of UbD with a language lens with pre-service teachers, investigating how the approach and related professional learning experiences facilitate understandings, knowledge, skills, and dispositions for supporting language development in the science classroom.

Suggestions for Implementation

Based on our experiences in designing and implementing this approach, we have suggestions for science teacher educators who endeavor to prepare teachers and candidates for instructional design with a language lens. First, use the UbD template as a common tool to mediate both learning and application, adding the language lens to what educators already know and understand as sound instructional design (see Heineke & McTighe, 2018 as a potential resource to mediate teachers' learning). Next, utilize the expertise of the educators themselves and build capacity more broadly across schools and programs, prompt collaborative learning and application in science-specific groups of teachers and candidates, as well as more diverse conglomerations of educators to promote co-planning and co-teaching with ESL, special education, or STEM teachers (see Heineke et al., 2018a). Finally, to avoid the conceptualization of language as an add-on initiative, integrate the language lens into science methods coursework and professional development for teacher candidates and teachers, respectively.

When approaching this professional learning in either coursework or professional development, we recommend expending ample efforts to initially build the needed buy-in that science teachers indeed play a role in supporting students' language development. Since the educational institution has long maintained silos that separate language and content, those need to be broken down for educators to embrace learning and application to practice. Awareness of the role of the language in scientific learning can support these efforts, which

can be effectively developed via simulations that build educators' empathy for students' interaction with discipline-specific language. When teachers are put in the position of students, such as needing to maneuver complex journal articles, they begin to recognize the need to attend to language in science teaching. Finally, emphasize the importance of students' assets and teachers' high expectations. The purpose of the language lens is not to reduce rigor in the science classroom, but rather to enhance instruction and provide equitable access for all learners.

Supplemental Files

Supplemental-ELEM-Science-Unit.docx
Supplemental-HS-Science-Unit.docx

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