**Methods to Increase Proficiency of ELLs in Science**

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**Abstract**

This paper discusses methods to increase the proficiency of English Language Learners (ELLs) and Multi Language Learners (MLLs) in the content area of science. ELLs have faced limited success across a number of graduation measures including the passing of New York State's Regents Examinations in Science. The literature identifies barriers that inhibit ELLs success in science include limitations on teacher preparation, outdated and inappropriate co-teaching models, and lack of second language acquisition informed practices. Research based best practices on theories of learning in language acquisition such as Cummins' BICS/CALP and Krashen's i+1. The implementation of specific language acquisition strategies based on these theories of learning can increase the success of ELLs within this content area. This paper presents a two-day professional development to address these barriers by better preparing science content teachers for differentiating instruction to meet the needs of ELLs. During the first day teachers attending this professional development are presented with the tools and supporting pedagogical theory necessary to modify and differentiate units across any science content area. The goal of the second day is for science teachers to use these methods and create lessons that meet the needs of ELLs and will increase their successes in science.

*Keywords:* English Language Learners, Second Language Acquisition, BICS/CALP.

# Chapter 1: Introduction

English as a New Language (ENL) Teachers, Science Teachers, and Administrators of Liberty Central School District (LCSD) have observed limited success for English Language Learners (ELLs) and Multilingual Learners (MLLs) in science assessments. ELL students have a lower graduation rate in Liberty Central School District than their non-ELL peers (NYSED, 2021a). Consequently, on a national level, ELLs are receiving lower science assessment scores, concluding that the students receiving low performance ratings in science assessments leads to lower graduation rates for ELLs (NAEP, 2019). This observation is not localized to this district, as it occurs across nearly all school districts in the United States, evident by similar disparities between assessment scores of ELLs and non-ELL students (NAEP, 2019).

In New York State high school students are required to earn seat credit hours and pass multiple Regents exams in order to be eligible for graduation. The most common graduation pathway of ELLs in LCSD in 2020 was the Regents Diploma, which requires students to take and pass one science Regents exam (NYSED, 2022); in 2020-2021, all ELLs that graduated received Regents Diploma designation. The four Regents exams available are: Living Environment, Earth Science, Chemistry, Physics. 58% of graduating ELLs in the 2020-2021 school year graduated, a combined 78% of all students including ELLs graduated. Furthermore, a Regents Diploma with Advanced Designation requires students to take and pass two science regents exams; LCSD had zero ELLs qualify for this graduation pathway (NYSED, 2021a).

In the 2020-2021 school year 10% of Liberty CSD students were classified as ELLs (NYSED, 2021a). Typically, LCSD identifies students based on their proficiency as determined by the New York State Identification Test for English Language Learners or the New York State

English as a Second Language Achievement Test. New York State Commissioner Regulation Part 154-2 determines the amount of contact hours students and supports that the school is required to give to the students based on these exams (SUNY, 2021). At Liberty CSD, co-teaching practices are prioritized in ELA and Social Studies classes. Rarely is there support by certified ENL teachers in math and science classes. The district recently created bilingual teacher's aid positions to provide support in science and math classes unsupported by ENL teachers. The math department created a pre-Regents level course, to create foundational math skills before the start of a Regents course. It is undetermined if this 'general math prep' course is beneficial to students as the program is new and assessment data is not yet available.

Science content teachers have expressed difficulties in meeting the needs of their ELL students as there are limited academic supports integrated into their programs. The Living Environment, Earth Science and non-Regents science courses are supported by bilingual teaching aids, but are not co-taught with ENL teachers. While the bilingual support has given relief, students still struggle with the academic load that these classes provide.

ELLs are students who are learning English and need additional academic support, as it is not their native language. ELLs can often be multilingual, putting them into the categories of MLLs. The Commissioner of Education's Regulation Part 154 provides the legal right for ELLs and MLLs to receive an inclusive education towards college and career readiness (OBEWL, 2014). This regulation establishes that unsupported immersion of ELLs in English-only speaking classrooms will not provide them adequate tools towards a successful academic career. The Blueprint for English Language Learner/Multilingual Learners Success is the framework for all stakeholders to utilize when supporting ELL/MLL students (OBEWL, 2014). The Blueprint provides guidance to staff, teachers, parents, board members, and administration through eight guiding principles that require an inclusive and supportive learning environment.

This project defines the causes of this disparity and creates a professional development program that can help teachers increase ELLs success in science. Chapter 2 reviews the literature, which identifies three main factors contributing to the limited success: 1) inadequate new teacher preparation and continued professional development (e.g., DelliCarpini & Alonso, 2014; Peercy & Troyan 2017); 2) unreliable collaboration between content teachers and ENL teachers (e.g. Hackett et al., 2020; Krammer et al., 2017); and 3) lack of Second Language Acquisition (SLA) supported instructional techniques and theories in science classes (e.g., Cruze et al., 2019). These SLA techniques and theories provide justification on how work towards rectifying the three issues can provide solutions to increase student success. Chapter 3 describes the professional development series designed for the science and ENL teachers in Liberty CSD. This professional development includes an overview of SLA theories and research that explain student struggles. The professional development aims to create interactivity and collaboration between science teachers and ENL teachers, and will leave teachers with turn key materials and knowledge of how to scaffold and differentiate materials and instruction for ELLs. Chapter 4 concludes with action steps to increase ELL student performance in science.

## Chapter 2: Literature Review

As discussed in Chapter 1, ELLs and MLLs have limited success on assessments, which restricts their pathways to graduation. This Chapter reviews the literature on current science instruction and barriers that are presented to inhibit ELL student success. The literature review frames the graduation consequences against the identified causes including: 1) inadequate new teacher preparation and continued professional development (e.g., Peercy & Troyan 2017); 2) unreliable collaboration between content teachers and ENL teachers (e.g., Hackett et al., 2020); and 3) lack of Second Language Acquisition (SLA) supported instructional techniques and theories in science classes (e.g., Cruze et al., 2019).

Before discussing the barriers limiting ELL success in science, I will discuss two learning theories tied to second language acquisition including Basic Interpersonal Communicative Skills and Cognitive Academic Language Proficiency (BICS/CALP) (Cummins, 1981) and the Input Hypothesis (Krashen, 1985). The lack of these theories implemented into instructional decisions are part of the problem limiting student success, and thus they are part of the solution described in this Chapter.

### Theories of Learning

The following second language acquisition theories are of particular importance when evaluating the problem of limited success of ELLs in science. Science content has an inherently higher order academic vocabulary that is difficult to acquire for multilingual students; this inhibits ELL students' ability to understand concepts around natural phenomena. Basic Interpersonal Communicative Skills (BICS) and Cognitive Academic Language Proficiency (CALP) as proposed by Cummins (1981) and Krashen's (1985) "i +1" are the two most relevant theories determined to benefit language acquisition in science, and supported by the literature review. BICS and CALP provides the scaffolding for academic language acquisition in science instruction through the multi-tiered vocabulary system. Krashen's "i +1" provides support in connecting language received by comprehensible input via reading, listening, or experiencing. The experiential aspect of the "i+1" hypothesis parallels pedagogical theory of John Dewey, (1938) that those who learn through experience will better understand, aligns with the instruction of natural phenomena of science.

**Cummins' BICS and CALP**

Basic Interpersonal Communicative Skills (BICS) and Cognitive Academic Language Proficiency (CALP) is a theory of second language acquisition proposed by Cummins (1981); Cummins refers to BICS as the everyday conversation language that is acquired by all people that are generally able to verbally communicate. This language is more easily noticeable, and can be acquired within two years for new language learners. On the other hand, CALP is predominantly written, and focuses on higher thinking skills in academic subject areas. That is, CALP is cognitively more challenging for everyone to acquire. Indeed, it can take new language learners anywhere from 5-7 years to catch up to their native language peers.

Comparing BICS and CALP to the commonly used 3 tiered vocabulary system will assist science teachers in helping ELL students gain proficiency in scientific language as the 3 tiered system is more likely to be in the schema of teachers outside of those focusing on SLA. Beck et al. (2002) introduced the three tiered categorization of vocabulary based on their use, frequency, and difficulty. The first tier of vocabulary is the simple and everyday vocabulary that is mainly used in verbal conversation. Tier 1 words are similar to BICS (Cummins, 1981) in that they are the lowest difficulty, fastest to acquire, and are frequent in verbal conversations. Both Tier 2 and Tier 3 vocabulary words could be considered to run parallel to CALP, in that they are cognitively driven and used with mature language users. Tier 2 vocabulary can also be considered "general academic vocabulary" (e.g., claim, evidence, endure) (COCSSO, 2021), tier 2 words can often be found in informational texts, technical texts, and literary texts (COCSSO, 2021 p.33). The meaning or essence of the tier 2 word may change depending on the context and can be used across multiple subject and content areas. Tier 3 words are specific in nature and are largely attached to a context idea (e.g., photosynthesis, watershed, coniferous). Therefore, they are not often used in literature, but more commonly used in informational texts (COCSSO, 2021). Science teachers by nature are required to use CALP, or tier 2 and 3 vocabulary in their instruction. If a student does not have the foundational skills built in BICS and tier 1 vocabulary, their success will be limited, this is pivotal information for science instructors to understand when assessing their own teaching. Science teachers using BICS and tier 1 vocabulary to assist students in learning the content and both the general and content specific vocabulary will be a stepping stone to growth in student success.

**Krashen's "i + 1"**

One of Krashen's (1985) hypotheses on second language acquisition is called the Input Hypothesis. Input means that the language is being received by reading, hearing, or experiencing. Krashen argues that language acquisition happens just one step above what the language acquirer already knows. For ELLs, this theory means that if their instruction is not based around prior knowledge, skills and familiar language, then they will not learn. The term "i +1" (i= input, 1= one step above current knowledge) is used to describe this area of growth, meaning, the learner already knows or has the skills for 70-95% of the language, and only when provided with such a high level of known language, the learner may acquire the remaining language so long as it is presented comprehensively. In order for science teachers to be successful, instruction must be presented in this manner. When students are presented with a lesson, or unit in which their background knowledge is a low percentage, and the information is not presented through comprehensible input, the language will not be acquired. Since so much of science content is dependent upon language, the skills will not be acquired either. For teachers, this means relying on prior knowledge as an instructional tool and slowing down the quantity of language used for students.

Both Cummins and Krashen focus on the building blocks of language acquisition being the language that has already been acquired (Cummins, 1981; Krashen, 1985). BICS are the foundation of language acquisition and once acquired, they lead a pathway to CALP. Science teachers aware of these steps may use them to their benefit, using BICS/CALP to guide instruction of academic vocabulary and understanding of natural phenomena in science. Krashen's input hypothesis shares the notion similar to Cummins of which one needs language that is understood in order to build a new language. Science teachers will use the sooner acquired BICS language, along with multiple methods of comprehensible input in their instruction to create the support for the "one step above" in academic language and skills for CALP growth and thus content skill growth for ELLs.

## Barriers Limiting ELL Student Success in Science

Three important factors limiting ELL success in science are: teacher preparation and continued professional development on teaching ELLs; co-teaching and collaboration amongst staff; and instruction not suited to meet the needs of ELLs / MLLs and their language proficiencies. Each factor is varied based upon state regulations, school and district climate and individual staff members.

## Lack of Sufficient and Appropriate Teacher Preparation for Teaching Science to ELLs

A lack of scholarly research in how preservice teachers are prepared at the postsecondary and graduate levels to meet the needs of English Language Learners indicates the reality that teachers are being sent into the field with gaps of knowledge and preparedness. The focus on pedagogical theory and best practices by teacher educators when training preservice teachers indicates that within teacher education there are inconsistent findings on how to develop and practice skills while applying the understanding of theory and research behind the skills. Additionally, each State Education Agency around the country has different requirements for pre and inservice teachers and how they are trained in supporting ELLs.

### Preservice and Novice Teacher Training

Preservice teachers can grow in their attitudes and skills in teaching ELLs through the implementation of successful training. This growth is evident as seen in a study of three cohorts from 2011-2012; the courses paired pre-service content and ENL teachers and resulted in a transformation of beliefs, attitudes, and pedagogical skills (DelliCarpini & Alonso, 2014). Initial data recorded from preservice content teachers at the beginning of a graduate-level course taught to secondary-level mathematics, science and TESOL teacher candidates detailed a negative and deficit viewpoint, focusing on what the students cannot do, or do not know. The end result of the course fostered responsibility by the content teachers to meet the needs of ELLs and an awareness of teaching the academic language necessary for students to understand content instruction: “Content teachers play a key role in helping ELLs develop essential strategies for deciphering words in English. I will provide ample opportunities for discussions, presentations, reading and writing tasks. Various exposure and methods for practicing vocabulary will strengthen ELLs reading and language skills as well as science skills. (Sofia, secondary-level science, reflection, November)”(p174).

The research of Peercy and Troyan (2017) is a self-study by Peercy, stemming from a lack of large scholarly research into teacher based pedagogy of teaching ELLs/ MLLs, specifically looking at the balance of theory to practice pedagogy. The first author (FA) conducted research in a self-study while teaching a graduate level ESOL literacy methods course to 24 novice teachers along with the second author (SA) who had previous experience in teaching graduate level courses of teaching ELLs. The data from the 24 novice teachers in M.Ed programs was gathered through video recording of a class by both authors, reflection papers, course survey participants, and transcripts from interviews with three participants. The data presents a gap in both teacher educators and teachers struggling to make a connection between research and theory with classroom practices. The uneven balance of theory to practice based pedagogy by teacher educators indicates that within teacher education, there are inconsistent findings on how to develop skills while developing the understanding of them.

These findings indicate that while teacher educators learn of their own methodology and skill shortcomings, their students, the preservice educators, may have large gaps in their instructional abilities. New teachers are entering the field with gaps due to the theory and practice weaknesses of their teacher educators. “FA: As I worked with students... a few of them pointed out [that they were] having a hard time discerning between scaffolding and comprehensible input .... I guess my point is that seeing more of this in practice and then trying to break it down and identify, ‘so what [core practice] was that there?’ ... it may be that, really this [comprehensible input] is - like an outcome, an effect of this [scaffolding], or, you know, like, scaffolding leads to comprehensible input, perhaps? It's hard to say for sure [what the relationship between the two is] ... and at one point I thought maybe scaffolding was the bigger umbrella - SA: Yeah because you have to be comprehensible to provide effective - FA: scaffolding. Right, but you could do other things - I mean I guess it all should be comprehensible if it's going to be effective scaffolding. I don't know - obviously I'm flailing around here trying to figure it out (emphasis added, meeting 12-20-13).” We can deduce that many current teachers’ teacher educators taught with gaps thus sending our current teachers into classrooms with gaps.

**National Inconsistency**

All State Education Agencies have methods to address the differing needs of students through their teacher preparation courses, certifications, and requirements, the quality and reach of these widely varies from State to State. Leider et al. (2021) discusses the many pathways to becoming ENL certified by analyzing State Education Agencies (SEAs) that have taken responsibility for their teachers being trained to teach students in accordance with federal law. This study analyzed the data provided from each SEA regarding bilingual or ENL teacher preparation, including what their pathways look like: coursework, Practicum, exams, and language proficiency. The data present a number of pathways in teacher preparation including alternative pathways. Receiving degrees, certificates, requiring previous teaching certification, endorsements or certificates are all variables that different SEAs offer or require. Additionally, this study examines current Professional teaching standards in all 51 SEAs. The goal of ESSA

(ESSA, 2015) is to ensure all students succeed, and all SEAs reference "diverse/diversity/all" (p. 19). Despite using diversity as a professional teaching standard, only 21 out of the 51 SEAs explicitly name ELLs in their standards (Leider et al., 2021).

Quantity of teachers certified in a given state carries less weight than the quality behind the certification. An additional study of teacher preparation for ELLs in three focus states was conducted to determine the consequences of their varied teacher preparation programs and requirements (Lopez & Santibanez, 2018). Like the data shown previously by Leider et al. (2021), Lopez and Santibanez (2018) analyzed the qualitative data of math and science testing for ELLs to determine the correlation between requirements for teaching of ELLs, and students' test results. Arizona requires all teachers to be trained in Sheltered English Immersion for ELLs, whereas California and Texas have varying requirements with California requiring a teacher of ELLs to have an authorization or certification, and Texas requires that all students have access to a teacher that is certified to meet their needs (Lopez & Santibanez, 2018). Arizona requiring all teachers to have training for working with ELLs in theory indicates more success for students, when in fact, test scores indicate Arizona behind both California and Texas in the same tests. Understanding this discrepancy requires a look at how each state individually requires teachers to be prepared to work with ELLs. The requirements in Arizona focus on aligning standards, and spend little time giving teachers opportunities to apply second language acquisition theory into teaching practice. Significantly, Texas and California make mention of using second language acquisition practices in their instruction, assessment, and curriculum. Notably, the state with the highest test scores out of the three, Texas, gives greatest emphasis on using students' first languages as an instructional tool in learning English and content.

Another state, New York, has implemented professional development for educators in order to support ELLs, it is worth noting this policy is full of inconsistencies that threaten how effective ELLs' educations can be. In New York there have been some attempts to support the ELLs with required amounts of Continuing Teacher and Leader Education (CTLE) hours (NYSED, 2021b) although not all educators are required to complete the hours. Teachers may have been grandfathered into not having to complete any CTLE hours. Additionally, New York State offers a waiver to schools and districts who have a low enrollment of ELLs; this waiver takes away the required hours of CTLE hours for addressing the needs of ELLs. Content area teachers who are required to continue their professional development hours may only be required to complete 15 hours of professional development on ELLs every five years, averaging three hours a year focusing on best practices for teaching ELLs (NYSED, 2021b).

The lack of hours in teacher preparation results in teachers not being able to turn around entire curricula, instructional materials, skills, and techniques necessary to adequately instruct ELLs. Similar to teachers, school district, building, and some related personnel are beholden to complete the minimum 15 hours every five years of professional development on ELLs, unless they are exempt from all professional development or receive a waiver due to low enrollment of ELLs (SUNY, 2021). Consequently, when building and district leadership has minimal professional development requirements on the education of ELLs, or if the district is waived from the hours entirely, any ELL will receive the consequences. If education leaders are only doing the minimum, when they observe teachers, it is not possible to give accurate feedback to the teachers on their instruction, assessment, and curriculum.

I worked in three geographically and demographically different districts in the same state for a total of 7 years, during that time no district provided professional development for teaching ELLs. In each district World Language teachers reported that their colleagues in other content areas frequently approached them to provide assistance in the lesson planning and instruction to support their ELLs as they were unprepared. Johnson et al. (2016) examined the ability of transformative, professional development, or TPD to transform science teachers' quality and their impact on science achievement, including a focus on ELLs. In this study, Johnson et al. asked: "Does participation in trance, formative, professional development result in improved science, teaching quality and enhanced performance on state science assessments for ELLs?" "What challenges do teachers experience with science education reform?" The results revealed that ELLs scored lower on testing than their monolingual peers.

The lack of consistency between states clearly impacts both pre-service and in-service teachers. The variations in novice teacher preparation and continued in-service teacher professional development for teaching ELLs lead to academic struggles for the targeted group of students, ELLs, making the determination that not all teacher preparation is created equally. The inequality in training has resulted in a large gap between ELLs and their mono-lingual peers. The use of professional development needs to be flexible to meet the needs of both the students and the needs of the instructional staff. A potential consequence of having a requirement for all teachers to receive any specific professional development is that all teachers may not be convinced or have a personal buy in that professional development will be necessary or effective. When administrators do not let teachers guide their professional learning, there is less buy in and therefore less effective.

**Co-Teaching Barriers**

A barrier to ELL success in science is lack of successful co-teaching practices. Cook and Friend (p 1, 1995) define co-teaching as “two or more professionals delivering substantive instruction to a diverse, or blended, group of students in a single physical space”. While Cook and Friend (1995) delved into the relationship between the collaboration of a general content area teacher and a special education teacher, Dove and Honigsfeld (2010) specify their co-teaching for teachers of ELLs. Co-teaching can be both a difficult and rewarding task which relies upon the personalities of the co-teachers, the support of administration, time, resources, and the willingness of teachers to collaborate. When co-teaching is not a feasible option, content teachers may not have access to the language experts. When co-teaching is an option there may be a problem of not implementing a successful co-teaching structure in a way that benefits the students.

A three year study in one school indicated positive results in English proficiency exams, the positive indicators also include a decrease in students testing at the lowest level after co-teaching implementation and an increase in students at the intermediate and advanced levels (Bauler & Kang, 2020). A successful implementation of cooperative teaching will lead to ELLs success in content skills and academic language in science. Slater and Mohan’s (2010) analysis of the collaboration of a science content teacher and an ENL teacher developing lessons to support both the content skills and linguistic development of ELLs. Both the science teacher and the ENL teacher have separate classes with different students. The ENL teacher in this study works with students who have a lower English proficiency and could also have lower background skills. The goal of this class is to prepare students with the background knowledge and vocabulary needed to participate in the grade 9 science class. The two teachers collaborated to create modified lessons which supported the succession of science courses that the ELLs would be taking, leading to students learning content-area tasks and the language relevant to the tasks**.** Whiting (2019) discusses teacher difficulty with beginning level proficiency in the integrated classroom. While instructional supports can be made to address the needs of these students, the results from co-teaching mentioned earlier (Bauler & Kang, 2020) indicates that successful co-teaching can lessen the amount of time a student is at the lowest proficiency level.

A school or state may require a predetermined quantity of minutes, or units, that ELL students and teachers work in an inclusive setting based on proficiency level. While a state or school may have an initiative for inclusive settings, any minimum quantity of minutes with ENL teachers creates a consequence of schools only meeting the bare minimum of minutes for co-teaching with ENL teachers. Additionally, in some cases, the minimum requirement of ELL services prioritizes English Language Arts classes, and therefore will likely not receive support in science or other content area classes. This district in particular pushes co-teaching support in ELA and History courses over Science because the aforementioned two are language heavy. This could be due to a misconception that science classes are not language heavy, or it could just be where administration and teachers think the highest language need is.

The Blueprint for ELL success prioritizes ELA co-teaching, then slowly decreases minutes that students are required to have an ENL teacher co-teaching with their content area teacher. Often, when there are unexpected increases of ELL or MLL populations, there is not enough staffing to go above the required minutes that NYS has allotted. In Liberty CSD, due to an increase in students and a change in staffing, the first half of the school year had no high school science classes with an ENL teacher, and the second half of the year increased to have one co-teaching section. This is insufficient as there are many sections in the high school that have ELL students that would benefit from the collaborative efforts of co-teachers.

The first problem is that the content areas in which teachers collaborate are not consistent, meaning that some schools emphasize teachers in classes with high literature such as ELA and history, and some classes focus primarily on classes with graduation required exams. This inconsistency often leaves classes such as Math, Science, and the arts with no support for the ELLs.

The second problem is that even if there are co-taught classes in science, there are many barriers to a successful co-teaching plan: limited/misaligned planning time, poor co-teaching models, and lack of administrative support. The misconception of the role and responsibilities of ENL teachers can also hinder the effectiveness of the co-teaching model, these misconceptions include: the continuation of the former pull out/push in model of ELL instruction and the utilization of ENL teachers as classroom aids rather than classroom teachers.

**Psychological Barriers of Successful Co-teaching**

Believing that both teachers are bringing expertise and are able to work cohesively with the other creates a team in full support of student needs, “The ESL teachers are a vital resource, because they bridge the language gap between the teacher and the student. They can properly assess the student's education and language and help you adjust your lesson plans to meet the needs of that student. (Kayleen, secondary-level biology, reflective journal)” (DelliCarpini & Alonso, 2014, p. 171).

A psychological barrier of successful co-teaching is the imbalance of power or status between both teachers in who makes the planning, instructional, and assessment decisions. Very often, the ENL teacher can be pushed into the role of a paraprofessional and not inputting any scaffolds or differentiation into the lesson planning. Whiting (2019) calls for planning time in which teachers conduct discussions and agreements on roles, responsibilities, and instructional decisions, as when there is a lack of agreement, content and language may not be made accessible for the ELLs. Self efficacy: in Krammer et al.'s (2017) claim that "analyzing collective self efficacy beliefs in teachers, who work cooperatively in front of a group of students would be important because it can certainly be assumed that the teamwork of two teachers also has an impact on their efficacy expectations." They reiterate as rationale the influencing factors of self efficacy the claim of Goddard, Hoy and Hoy's (2000) that collective teacher self efficacy may influence student outcomes via teaching skills, methods, and expertise (p.100). Thus, the result of Krammer et al.'s (2017) survey, indicates a barrier of belief (self efficacy) in collective co teaching has an impact on actual teaching, rather than singleton self efficacy. Additional positive impact on self efficacy in co-teaching our skills and external resources, includes logistical support and resources from administrators. Thus, school administrators and teacher educators need to provide assistance and resources to coach teachers. A barrier that experienced teachers possess is that having spent more time than inexperienced teachers as a singleton or general teacher independently teaching has fossilized their independent teaching skills, and thus it is more difficult to adjust to, and learn co teaching, models, practices, and skills. Thus impacting the self advocacy negatively for experienced singleton teachers in comparison to inexperienced singleton teachers.

In a class where co teaching is available for implementation, another barrier can be psychological safety. Beyond logistical barriers of common planning time, the feeling of being safe when working with a peer, allows one to take risks, not being afraid of ridicule or judgment or consequence, undermining or questioning peer training and experience. Focusing their study on the idea of psychological safety of the individual and team, Hackett et al. (2020) analyze the research of co teaching framework to determine that with our framework respective of psychological safety, there can be confusing and ineffective implementation resulting in equity. The co-teacher traveling to the general education classroom shared “For some reason, there is always this worry of overstepping my bounds. I don’t know if they [general ed teachers] feel that way, because they’re obviously saying ‘jump in’, there is some sort of kind of invisible wall there that their classroom is their space.” resulting in that same teacher teaching from the back of the room, giving the notion that she is not qualified or not able to teach all of the students, instead, only those on her caseload (p. 118). Additionally, educators may lose focus on student needs, and instead focus on their own attitudes and interests. The general education teacher in Hackett et al.’s research shared their frequent anxiety when they worked with their co-teacher, believing she was constantly being evaluated. This takes time away from focusing on student needs, when one is worried about being judged by peers on their job performance.

**Logistic Barriers of Co-Teaching**

The teachers in Peercy Ditter DeStefano’s (2017) study found that while a consistent routine in co-planning and co-teaching was critical for successful implementation of co-taught lessons, it was not always possible. Thoughtful planning was not easily found when there was a lack of reliable designated time for collaboration, thus emphasizing even with willing attitudes and a framework to support collaboration, teachers need more reliable opportunities to get together. Discussing instructional plans during lunch duty or when a teacher arrives in the classroom is not sufficient. Peercy et al. (2017) determined that inconsistent and lacking routines led to a waterfall effect ushering in the least effective method of co-teaching ELLs/MLLs: one teaches and one supports. This model often leaves the ENL teacher in a subordinate role and not providing the same level of support to the ELLs as the non-ELLs are getting from the general education teacher.

**Second Language Acquisition Informed Practices**

Regulations on teaching students may not always reach the goal that is intended. Callahan and Shifter (2016) examined EL program effectiveness through course taking as their method of study (rather than the three topics in this literature analysis) their study determines that "suggesting a need to focus on the spirit, rather than the letter, of EL education policy to prioritize equity in access and achievement for all" (p. 489). Using high leverage language practices will conclude with success (Bunch, 2013). Years after the implementation of Structured English Immersion(SEI) in Arizona Public Schools, feedback from stakeholders indicates one benefit, along with nine challenges: "(1) limitations to curricular access and correlation to Arizona College and Career Ready Standards (AZCCRS); (2) deficit model concerns; (3) limited access to language acquisition; (4) limited access to high school graduation; (5) issues with language assessment; (6) classification concerns; (7) classroom segregation concerns; (8) lack of teacher preparation for instruction; and (9) concerns for student well-being." and three necessary changes being "(1) revisions to SEI model and ELP standards; (2) teacher endorsement and pedagogy; and (3) assessment to support EB learning and language acquisition" (Cruze et al., 2019). The singular benefit stated was ease of implementation, suggesting that the only advantage of not implementing Second Language Acquisition techniques and utilizing English Immersion is time gained from the absence of implementing new instruction to accommodate learners. If a school is using immersion because they are not implementing SLA, they can expect to face the same nine challenges that APS faced. Before and after the implementation of English Immersion model, teachers continue to be concerned with ELLs access to content, particularly in classes required for graduation at the high school level (Cruze et al., 2019). As previously mentioned, the need for teacher preparation of ELLs, language acquisition is a major component for teacher success, as stated from feedback from teachers involved in the English Immersion model (Cruze et al., 2019).

Comparing well researched instructional practices for ELLs to current teacher perception found that teachers surveyed by Rodriguez et al. (2020) did not identify instructional delivery as a difficulty for ELLs in classroom instruction and reading comprehension. This does not agree with student outcomes and suggests that teachers do not have an accurate perception of their own shortcomings.

**Consequences of Lack of ELLs Succeeding in Science**

In the survey conducted by Rodriguez et al. (2020), stakeholders of ELLs (teachers, administrators, counselors) list obstacles for ELLS as they describe causes of high dropout rates, passing the Regents examinations being the greatest obstacle to graduating. As previously mentioned, the lack of awareness of instructional techniques demonstrates the need for improved teacher preparedness and development in all content areas.

The difficulty that teachers face when not being prepared for teaching ELLs has created feelings of stress, resentment, and a sentiment that the students do not belong. A survey taken by thirty-three high school science teachers examined the needs and challenges of teaching ELLs (Cho & McDonough, 2009). Feedback from one teacher indicates that one issue of teaching ELLs in a mainstream classroom stems from the need for students to learn the same information and skills as their peers. The teacher suggests that changing learning and assessment standards for ELLs is not appropriate. The difficulty this teacher has lies in the teacher using the same instruction geared towards the standards and assessments for all students to pass state exit exams for graduation, promotion, placement, when the teacher feels they cannot instruct the students together or to the same standards (Cho & McDonough, 2009).

**Solutions: Explicit Vocabulary Instruction and Argumentative Discourse**

While there is a national and local problem with ELLs having success in science, there are also solutions that can be implemented on local levels. The Next Generation Learning Standards in Sciences focus on equity for ELLs, and the intertwining relationship of science learning and language learning (NRC, 2015). Lee et al. (2013) proposes that language learning and science learning can occur simultaneously in Table 1 titled: *Science and Engineering*

*Practices and Selected Language Functions*. Here they describe the language practices as: Develop and Use Models; Develop Explanations (for science) and Design Solutions (for engineering); Engage in Argument from Evidence; and lastly Obtain, Evaluate and Communicate Scientific Information. Within each practice are the three categories of: analytical tasks; receptive language functions and productive language functions. It is these functions and practices that can be used to tie science and language acquisition together to help increase success for ELLs in Science. This project presents two solutions that are supported through research that will increase capacity for ELLs in science, these are 1. Explicit Vocabulary Instruction and 2. Argumentative Discourse.

**Explicit Vocabulary Instruction**

Explicit vocabulary instruction in science classes will increase the success of ELL students and will have a positive impact on non-ELLs as well. Williams et al. (2019) conducted an inquiry to answer the question: "How Do I Teach Science Vocabulary Within the Context of Inquiry-Based Science to Students Who Speak English as a Second Language?". The assessments used focused on 10 vocabulary words from the 10 weeks of the chemistry unit, and the surveys were given to the students to determine their personal use of strategies for vocabulary. The teacher compared the strategies the students used that were noted in the surveys at the beginning and end of this study, as well as comparing the vocabulary knowledge at the beginning and end of this study. The findings show that prior to the practitioner inquiry, there were very few strategies that ELLs used to learn science vocabulary; 60% of students were not aware of cognates (Williams et al., 2019). After developing decoding strategies and using the students' first language, the teacher noted informal anecdotes about improving vocabulary skills.

The surveys determined growth in student awareness of using cognates as a vocabulary strategy (Williams et al., 2019). Because the students are arriving to the classroom with prior knowledge, the students were better able to develop academic language when new vocabulary was connected to root words, or cognates, that they know from their native language.

The use of students' first language and cognates adds to the successful science language acquisition because of how comprehensible it makes learning both the language and the content. In the study by Williams et al. (2019), the focus teacher is not fluent in Spanish, the students' first language. The teacher uses as much Spanish as he can when spontaneously speaking with his students to support the dialogue during lessons. The practice of using the first language along with formal cognate instruction creates a connection between native English speakers and English learners in the classroom (Williams et al. 2019).

The teacher in Williams et al. (2019) conducted a practitioner's inquiry through his master's degree program. This teacher felt his training lacked support for ELLs and this was supported by his analysis of test scores comparing ELLs to native English peers. The teacher was inspired by Frayer's model of graphic organizer and created his own graphic organizer. The categories to fill in for each science vocabulary term were: vocabulary word or phrase, definition, examples, non-examples, characteristics/picture, cognates/root and affixes (prefix/suffix) (p. 997). The teacher noted that all students struggled with this new learning strategy at first, specifically ELLs had difficulty with feeling pressure to fill every area of the graphic organizer. The teacher gave the students support by filling in the organizers during the whole class discussion at the beginning of the unit, and omitting different parts of the organizer if the lesson did not need all parts. As mentioned earlier, the use of cognates in the students' first languages were incorporated. In this classroom, all ELLs were native Spanish speakers and shared the same first language.

Vocabulary graphic organizers are mentioned in Williams et al. (2019), Van Orman et al. (2022), and Relyea et al. (2022). Graphic organizers provide multiple opportunities for students to make meaning. Only Williams et al. (2019) specify what is in their vocabulary graphic organizer, provided that Relyea et al.'s (2022) and Van Orman et al.'s (2022) organizers have similar components of visuals, definitions, first language support, examples, etc. the result is vocabulary acquisition. A graphic organizer provides support to students by providing multiple methods of input including BICS, CALP, visual, and L1, and grammatical cues and patterns. Having a multidimensional graphic organizer provides support when a student may not know one or more of the components of a graphic organizer, but can use the other pieces as reference.

**Argumentative Discourse**

The treatment group of students in Relyea et al. (2022) used science content and general academic vocabulary to develop a scientifically sound argument by utilizing claim, evidence, and reasoning to answer an essential question based on their space exploration unit. Students participate in small group discussions based on provided argumentative texts. Grouping was determined by the teachers, who then facilitated the conversations. Post discussion, students summarized their ideas in the format of: claim, evidence and reasoning. A claim, evidence, and reasoning graphic organizer was completed as students worked independently to address their overarching question. After repeated weeks of this process, students reviewed their class arguments and prepared a recommendation letter to complete the evaluation state of the project. The repetition of claim, evidence, and reasoning through reading, discussion, and writing supported their ability to create an argument building their language acquisition and content knowledge. Results showed a significant increase in the treatment groups' posttest scores, specifically the ELLs, while the monolingual students also increased in comparison with the control group (p. 45).

Swanson et al. (2014) conducted a study to answer the question "(1) How did Ms. H engage and support ELLs in the discourse-intensive science practices of argumentation and communication? (2) Given these opportunities for learning, how did ELLs construct and communicate arguments from evidence across instructional contexts?" (p. 32). In the two classes that made up the student participants, 44% of the students were classified as current ELLs. Ms. H conducted lessons where students engaged in explicit science argumentation within a physics unit on sound waves and a chemistry unit on atomic structure. Ms. H supported her students' science language acquisition through reading and discussion activities where she created one group poster with a learning goal of independently writing a statement made up of a claim, evidence and reasoning. The analysis of the feedback provided by Ms. H indicates that students appropriately applied claims, evidence, and reasoning in their oral discussions, but frequently struggled to apply reasoning. and in a few instances did not have appropriate evidence. The takeaway from this research is that the teacher did not spend enough time formatively assessing writing skills. Her time was mainly spent assessing students on their oral discussion, yet she used writing as the summative assessment. This misalignment in practice and assessments left students with some gaps in identifying evidence and reasoning, therefore the assessment data showed positive growth in discourse, but limited growth within the writing component.

The data of Relyea et al. (2022) is strengthened with the suggestions given by Swanson et al. (2013) that students were most successful when argumentation is best supported by both small group and whole class discussion, with frequent written tasks based on the previous discussions.

## Chapter 3: Description of the Product and Tools

Research in Chapter 2 has revealed the barriers that limit ELL/MLL success in science. These barriers include teacher preparation (e.g., DelliCarpini & Alonso, 2014; Leider et al., 202; Lopez & Santibanez, 2018; Peercy and Troyan 2017), co-teaching (e.g., DelliCarpini & Alonso, 2014; Hackett et al., 2020; Krammer et al., 2017; Whiting, 2019) and second language acquisition informed practices (e.g., Cruze et al., 2019). Research has also called for actions that schools and teachers must take to improve ELL success in science. In this Chapter, I present a targeted professional development that aims to improve ELL and MLL student performance in science in the secondary grade levels and across all English proficiency. This two day professional development will include all science teachers, teaching assistants, and aides in the Central School District, ranging in grades nine to grade twelve. Below I discuss the agenda of events, Blueprint for ELL Success, Second Language Acquisition Theory, Argumentation: Claim, Evidence and Reasoning, and Explicit Vocabulary Instruction.

### Agenda of Events

The two day professional development will take place during the two conference days which occur before the arrival of students at the beginning of the school year. Each session will take place from 8am to 3pm, with an hour lunch break each day. This professional development will be held at the district level, using the district conference room. This schedule allows for the work to be started and materials to be created prior the start of the year, and it also ensures that all staff members are present. Most of the first day will be dedicated to discussing the data of the student population, finding state resources and regulations and the research behind the instructional materials and methods to be later discussed; day one is broken down into six sessions: 8-8:55-Objectives & Agenda, 9-10:55- Jigsaw Blueprint to ELL Success, 11-11:30-BICS/CALP, 11:30-12:30-Break, 12:30-1-Input Hypothesis, 1-1:55-Two Methods for Science Success, 2-2:55-Resource Location. Day two in the consecutive training will consist of five sessions: 8-9:25-Introduce Method 2: Explicit Vocabulary Instruction, 9:30-10:25-Prefix/Suffix, 10:30-11:30-Student Friendly images/visuals, 11:30-12:30-Break, 12:30-1:55-BICS Definitions, 2:00-3:00- Examples & Non-Examples. A small portion of the first day and all of the second day is devoted to material planning and creation to ensure that stakeholders are starting the school year with ready to use materials. Additionally, stakeholders are completing the planning and creation of materials together in order to share resources and create connections between colleagues to be able to better support one another in the future. Group collaboration will lead to more shared resources and awareness of what different classes are using, creating an aligned school.

**Blueprint to ELL Success**

It can be intimidating and nerve wracking to attend professional development, having to show your colleagues what skills and knowledge you do or do not have, thus the opening activity of asking what each stakeholder has been taught or trained in relationship to teaching MLLs puts the emphasis on the responsibility of their pre and in service training, rather than on the stakeholders themselves. It is much easier to admit in front of colleagues that your teacher preparation program did not address the needs of a certain group of students rather than admitting that you personally and professionally do not know the best methods of teaching groups of students.

The two day PD will begin with the first two sessions (three hours) creating the foundational knowledge and justification for the professional development. To ensure that all stakeholders are aware of regulations and procedures, the participants will be placed into groups which will examine the goals of the Blueprint. Each group will be given a question in a jigsaw style activity and tasked with finding the answer using NYSED's Blueprint for ELL/MLL success. The questions and group responses will be written on large posters around the room, so that they are visible to the group throughout the remainder of the professional development. The five questions are: 1) What does Regulation Part 154 state in regards to Education of ELLs? What does that mean for non ENL teachers?; 2) According to the Blueprint for ELL/MLL Success, how do districts and schools involve families?; 3)What assessments do districts use for formal testing of ELLs/MLLs, and how do they use this data?; 4)How do districts and communities leverage the expertise of faculty and staff?; and 5)What types of prior knowledge/abilities/resources are the students bringing into the classroom, and what do districts need to do with these? After writing their responses on the poster boards around the room, stakeholders will have sticky notes and will complete a See, Think, Wonder response gallery walk.

To start the understanding that ELLs are in different places of their English Proficiency, and how that level impacts how they should be taught, the groups will brainstorm what they know about New York State's proficiency levels for ELLs. Using whiteboards at the tables, the group will be asked what the five levels of proficiency NYS uses to identify MLLs for their English acquisition. The groups collaborating and writing their answers gives them an opportunity to demonstrate their background knowledge and comfort with the subject. After each group has provided their answers, the group will look at the various levels written in the presentation. There is an emphasis of growth, represented by the available space in the last test tube, for students that have tested as commanding, as students are continuously growing and that learning does not have a solitary end goal.

**Second Language Acquisition Theory**

Sessions three and four on day 1 provide background knowledge on second language acquisition. Because the stakeholders attending are focusing on high level content, skills, and language, they will be seeing a visual representation of BICS and CALP (Cummins, 1981). This explanation will provide stakeholders with the background of why this professional development needs to be implemented into their teaching, since there is often the misconception that if students can have social conversations they should be able to interpret and produce academic language. Additionally, understanding that Krashen's (1985) input hypothesis is foundational in SLA provides the evidence to participants that their teaching needs to be intentionally supporting the MLLs. Using BICS, repetition in argumentation, and a multimodal vocabulary graphic organizer creates the foundation of comprehensible input, scaffolding CALP in small doses appropriate to proficiency level is the +1 where language growth happens. Argumentation using claim, evidence and reasoning and explicit vocabulary instruction are techniques that support science skills as both are integral to the academic vocabulary needed in the content instruction.

**Argumentation: Claim, Evidence, Reasoning**

The instructional technique of Developing a Scientific Explanation, which we discuss as the language process of argumentation, through CER is common knowledge for some educators, but not all. Given that this is a push in the Next Generation Learning Standards, the participants are combining a needed content skill with how to support MLLs effectively using that skill. The teachers will be provided different scaffolds for the students (Appendix B), and will categorize the scaffold according to proficiency level; this categorization of differentiation strategies by proficiency level will be completed using manipulatives, teachers matching the scaffold to the correct proficiency level (Fairbairn & Jones-Vo, 2019). Then, the participants will look at the process of completing a CER lesson and how each step supports language acquisition and builds content skills (Appendices C, D, E).

The first input for the argumentation topic can be generic because the information can be from multiple sources of information: readings, visual interpretation, data. The research emphasizes linguistic repetition, thus the course of the argumentation utilizing CER suggested at this PD is a six step process: 1) receiving input of the argumentation topic consisting of different data points in multiple forms; 2) small group verbal share-outs using scaffolded supports such as a graphic organizer, sentence frames, or a word bank, providing an opportunity for students to receive oral input from peers before a writing assessment; 3) summarizing individuals' discussion responses in writing using scaffolded responses. The teacher will use this as an opportunity for a formative assessment of writing skills and scientific explanation of the essential question, providing necessary feedback; 4) students will have a second repetition of input using scientific explanation (CER), this input is in the form of reading peers' work from step 2. The gallery walk of peer work cements the linguistic terminology and the concepts of scientific explanation; 5) as a class the teacher will present student work, and students will respond with counterclaims or agreements using scientific argumentation language, this is both a language output and language input activity as students are using interpersonal language in both reading, speaking and listening when responding spontaneously to peer ideas; 6) now that students have had multiple repetitions of input and output, they are ready for their final summative writing assessment, where they can finalize their claim evidence and reasoning.

Teachers will use their knowledge of the different proficiency levels and the multiple steps to support ELLs using CER to research materials that can be scaffolded to the different language levels. It can be challenging to find materials at different levels, which is why performing this as a group activity provides participants with additional support. Having administrators involved in this activity provides an opportunity to the challenges in providing students with appropriate and accessible materials. Since everyone is coming into professional development with different experiences, the group will share the physical and digital resources in the school's shared drive.

To conclude the first day, I will preview day two's topic of explicit vocabulary instruction by connecting day one's focus unit for each group, and I will assess the participants' understanding, and gain feedback for improvements. Participants will use the focus unit from the Argumentation materials search, to brainstorm the top vocabulary necessary to be successful in the unit, this may be general science academic vocabulary, or science discipline and unit specific vocabulary, typing the vocabulary in a shared document (Appendix F). Then, participants will use their science knowledge of using signs to represent meaning to write a plus sign and indicate what went well, and write a delta which means change, thus informing me of any need for changes for participants to better understand the content in day two of the professional development.

**Explicit Vocabulary Instruction**

The second day is devoted to explicit vocabulary instruction with built in time to create materials. Working in the same groups as day 1, the participants will focus on the same units as day 1 for the argumentation material search. There are two graphic organizers, both include: vocabulary term and BICS/CALP definition (Appendix G). Additionally, both graphic organizers should be presented to the students using both English and their preferred language. The difference in the two graphic organizers is that the first one uses prefix/suffix and illustration/visual representation while the second one includes space for an example and non-example. The teachers will determine which graphic organizer best fits each vocabulary term. The teachers will then use their vocabulary lists to create completed vocabulary graphic organizers. The day is broken down by sessions geared towards separately creating each part of the graphic organizer, as to not overwhelm the stakeholders and to ensure they have equal practice for each method of explicit vocabulary instruction.

**Closing Activity**

The participants will upload and organize all of their created and found materials into a shared drive or folder that they will all share and add to as they instruct each unit throughout the year. There will be a short time for verbal reflection to see what the participants gained from the work they have put in and what work still needs to be done towards continually supporting ELLs/MLLs in Science.

## Chapter 4: Conclusion

The purpose of this research was to identify the causes of low success of ELLs in science and solutions that will be most effective to increase the proficiency of ELLs in science. Science is one of the New York State Regents exams that restricts the graduation rates of ELLs. Additionally, science teachers at Liberty High School feel unprepared to instruct their ELL students.

### Literature Review

The literature review found three causes that limited the success of ELL students, these are the inadequate new teacher preparation (e.g., Peercy & Troyan 2017) and continued professional development, unreliable collaboration between content teachers and ENL teachers (e.g., Whiting, 2019), and lack of Second Language Acquisition (SLA) supported instructional techniques and theories in science classes (e.g., Cruze et al., 2019). The importance of SLA including BICS/CALP and i+1 are important for teachers of ELLs to be knowledgeable of, as using these methods to build science academic language, which is a stepping stone to learning science content skills. Additionally, The Blueprint ELL/MLL Success offers a roadmap to the considerations that teachers are required to make when instructing ELLs. With an understanding of SLA and the guidance of The Blueprint, all teachers of ELLs can increase the successes of their students, especially in areas such as science.

### Implications for Stakeholders

In order to enact these recommended changes teachers and administrators must ‘buy in’ and support specific changes within their organizations. The changes outlined in this paper will only be feasible if teachers come with an open mind set and attend focused professional development. Once teachers are given the tools to be successful, they will need to take extra time to update lesson materials to align with their new pedagogical best practices. Additional time will be necessary for both of the co-teachers to thoughtfully and effectively co-plan. They must also have an openness to the currently accepted co-teaching model and throw out the old paraprofessional mindset.

Administrators should be cognizant of the supports that teachers will require to put in place a successful teacher training and co-teaching program. They should look at their professional development calendar and schedule sessions appropriately. When planning schedules, administrators should look at all classes that ELLs will need and determine the best placement for co-teachers, along with this they should allocate shared planning times outside of lunches and hall passing. Lastly, a successful co-teaching relationship is a careful dance between two experts in their field. If there are any issues between the two co-teachers the administrators should be ready to remedy the problem with mediation.

**Final Thoughts**

The best way to increase the success of ELLs is to increase the capacity of teachers to instruct them through practices based in pedagogical theory. Both preservice and inservice teachers are in need of these supports in all content areas. Science is often overlooked for more literature based content areas, but higher-order language that makes acquisition difficult is inherent in science curriculum. With the proper training, collaboration, and support, science teachers can be better prepared to work alongside ENL teachers and meet the needs of ELLs in their classroom.

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## Appendix A: Google Slides Presentation

https://drive.google.com/file/d/1HTQcGdd3wb5_zhOuqlJgQZQgrudclqmt/view?usp=sharing

## Appendix B: Differentiation Guide

**DIFFERENTIATION GUIDE FOR ELLs**

**Developed by Shelley Fairbairn, Ph.D. and Stephaney Jones-Vo, M.A.**

| | I-ELDA Level 1 TESOL Level: Starting | I-ELDA Level 2 TESOL Level: Emerging | I-ELDA Level 3 TESOL Level: Developing | I-ELDA Level 4 TESOL Level: Expanding | I-ELDA Level 5 TESOL Level: Bridging |
|---|---|---|---|---|---|
| STUDENT BEHAVIORS | *Listening:* Starts to process new language (common words and phrases) supported visually and/or contextually; demonstrates understanding through gestures or actions; requires repetition *Speaking:* Mostly silent; speaks or repeats only individual words or memorized utterances; relies upon gestures to communicate *Reading:* Derives meaning from pictures only; may begin to transfer first language literacy skills if supported with explicit instruction (if not literate in the first language, may begin to recognize print); *Writing:* Draws to demonstrate understanding and express ideas; begins to copy written text | *Listening:* Recognizes and responds to language heard often *Speaking:* Uses short phrases, memorized utterances, and telegraphic speech (incomplete sentences that communicate complete thoughts) *Reading:* Derives meaning primarily from pictures; begins to recognize letter/sound correspondence; may recognize words seen often *Writing:* Draws, copies, and begins to write words and phrases to demonstrate understanding and express ideas | *Listening:* Comprehends simple and compound sentences, particularly in social contexts; ascertains main ideas of conversations; attends to basic grammatical features (e.g., plurals, tenses) *Speaking:* Begins to produce original sentences, though errors are likely to be frequent *Reading:* Comprehends individual words and simple sentences with teacher/visual support; connects text with prior knowledge *Writing:* Engages in sentence-level production, relying on developed BICS(basic interpersonal communication skills) vocabulary and explicitly taught CALP (cognitive academic language proficiency) vocabulary | *Listening:* Understands most social/general language and increasing amounts of academic language that is supported visually or contextually *Speaking:* Produces speech to meet both social and academic needs; errors do not generally impede understanding *Reading:* Successfully reads text on familiar topics; continues to need visual/contextual support to read text on unfamiliar topics *Writing:* Writes paragraph-level text for both social and academic purposes; errors do not generally impede meaning | *Listening:* Comparable to grade-level peers *Speaking:* Comparable to grade-level peers *Reading:* Comparable to grade-level peers *Writing:* Comparable to grade-level peers |

Taken from Fairbairn, S., & Jones-Vo, S. (2019). *Differentiating instruction and assessment for English language learners: A guide for K-12 teachers* (2nd ed.). Caslon

## Appendix C: Argument Flowchart, Teacher Directions

**Teacher Directions: Argumentation: Claim, Evidence, Reasoning**

| | |
|---|---|
| Step 1 Question & Input | Viewing multiple sources of information to answer the question. |
| Step 2 Speak/Listen | Speak/ Listen: Students share their initial ‘Scientific Explanation-CER’ in small groups using sentence frames. |
| Step 3 Write | Write- Students Write their own ‘Scientific Explanation-CER’ (Formative Assessment, the teacher returns work after provided feedback to students) |
| Step 4 Read | Peer Reading- Gallery Walk- Students read their peers’ writing |
| Step 5 Speak/Listen | Speak/Listen While projecting student work, the students verbally respond with counterclaims/ agreements |
| Step 6 Write | Write- Now that students have provided their claim in oral and written form, received feedback, read peer work, and discussed counter-claims to peers, they will end their argumentation with a final written scientific explanation to the initial question. This is a summative assessment. |

## Appendix D: Student Directions: Science Argumentation: Claim, Evidence

**Instructions:**

| Learning Target: | Essential Question: | Argumentation Question: |
|---|---|---|
| Step 1 Question & Input | You will view multiple sources to determine an answer to the argumentation question. You will be answering the Argumentation Question using: A Claim, Evidence, and Reasoning. | |
| Step 2 Speak/Listen | Speak/ Listen: Students share their initial 'Scientific Explanation-CER' in small groups using the sentence frames below. | |
| Step 3 Write | Write- Now you will write your claim, evidence and reasoning of the argumentation question. You may use the sentence structures provided below. You will hand this in and read comments when returned. | |

Use the following sentence starts when you present your argument using CER:

| | |
|---|---|
| Claim:<br>Answers the Question | The data supports<br>The data does not support<br>I observed __ when __. |
| Evidence- data, observations, etc. from a source to support your claim | The evidence I use to support __ is __.<br>The data table/graph shows __.<br>I observed that__.<br>As a result of __, __occurred/happened. |
| Reasoning: explanation of how your evidence supports your claim. | Based on the evidence, we can conclude__.<br>The evidence supports the claim<br>The reason I believe __ is __. |

| | |
|---|---|
| Step 4 Read | Peer Reading- Gallery Walk- Students read their peers' writing. |
| Step 5 Speak/Listen | Speak/Listen- While the class examines peer work, you will verbally respond with counterclaims. |
| Step 6 Write | Write- Now that you have read/observed evidence, created your claim, argued the claim with evidence and reasoning by speaking with your small group, by writing your initial claim, reviewed work from your peers, and provided counterclaims to peer work, you will end this argumentation with a final writing activity. |

<table>
<tr><th></th><th>Writing & First Speaking</th><th>Second Speaking: Counterclaim</th></tr>
<tr><td>Claim</td><td>The data supports<br>The data does not support<br>I observed __ when __.</td><td rowspan="3">It might seem as if ___ however, the evidence suggests ___.<br><br>While ___ may be true, ___.<br><br>What they don't consider is ___.<br><br>It is easy to think ___, but when you look at a different point of view it is clear ___ .</td></tr>
<tr><td>Evidence</td><td>The evidence I use to support __ is __.<br>The data table/graph shows __.<br>I observed that__.<br>As a result of __, __occurred/happened.</td></tr>
<tr><td>Reasoning</td><td>Based on the evidence, we can conclude__.<br>The evidence supports the claim<br>The reason I believe __ is __.</td></tr>
</table>

**Appendix E: Vocabulary List Organizer**

| Vocabulary List Organizer-<br>List vocabulary from the unit, starting with most used/important. | |
|---|---|
| General Academic Terms- (High Frequency/Used Across Disciplines ) | |
| Unit Specific Science Academic Terms (Low Frequency, Subject/Unit Specific) | |

## Appendix F: Vocabulary Graphic Organizer