

The Role of the ESL Teacher In Relation to Content Teachers

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Introduction

The estimated number of English language learners (ELLs) in the nation's public school systems is 4.5 million, as reported by the National Center for Education Statistics (NCES, 2016a). This increasing student population is concentrated in urban school settings. Also, 67% of the nation's ELLs are concentrated in the elementary grades (K-5; NCES, 2016b). The growing ELL population makes ELLs an important segment of the overall student population and their access to college, careers, and citizenship in US and globally (Llosa et al., 2016) is a civil right issue (Tate, 2001). This makes it imperative that teachers are prepared to teach science in rigorous and socially just ways. Teachers should also be prepared to be responsive to cultural and linguistic diversity of ELLs. Various consequences are linked to inadequate preparation of mainstream and English as a Second (ESL) teachers such as lower levels of academic achievement, lack of classroom participation, lack of meaningful teacher feedback and peer interactions, and lack of opportunities for meaningful language development (Langman, 2003; Sharkey & Layzer, 2000; Valdez, 2001; Verplaetse, 2000). Further, without adequate preparation, teachers tended to hold negative views or beliefs about teaching ELLs (Youngs & Youngs, 2001). With some training though, Youngs & Youngs (2001) found that the mainstream teachers held more positive beliefs in teaching them. The importance of adequate teacher preparation for ELL student populations has been raised both in the science education literature (Fradd & Lee, 1999; Lee, 2002; Rosebery, Warren, & Conant, 1992; Warren, et al., 2001) as well as in literature on Teaching English to Speakers of Other Languages (TESOL) teacher education (de Oliveira & Wilcox, 2017). Drawing on these two literatures, the current paper attempts to address the following questions:

1. *What are the main roles of ESL teachers in K-12 schooling? How may this vary in different contexts?*
2. *How are ESL teachers prepared to interact with content teachers in K-12 contexts? What activities and roles are assumed in that ESL teacher preparation? How might this relate specifically to STEM classroom contexts?*
3. *What do we know from research about collaboration between ESL and STEM teachers about how they can best work together?*
4. *Are there evolving views among TESOL professionals that would suggest that the preparation of ESL teachers may be changing in ways that will potentially impact relationships between ESL teachers and STEM teachers in K-12 contexts in the future?*

Changing Paradigms in Teaching Science in K-12 US Classrooms

Common Core State Standards (CCSS, Initiative 2016) have impacted the instructional practices, assessment, and curriculum across the nation in the core content areas such English language arts and literacy and mathematics. There has been a strong shift towards promoting higher levels of literacy in each of the core academic disciplines; reading-writing, mathematics, and social studies. Further, there has been an heightened emphasis on teaching and learning higher order and critical thinking skills. In science, similarly, the development and implementation of Next Generation Science Standards (NGSS) (NGSS Lead States 2013) has also influenced what teachers and schools need to pay attention to in

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teaching scientific content. Today's knowledge-based societies require "understanding the scientific dimension of phenomena and events; critical appreciation of the potentialities and limitations of science, its role in society, and its contribution to citizenship; and development of critical thinking, oral communication, and writing skills" (Veira & Veira, 2016, p. 659).

One imperative that emerged out of NGSS is to effectively teach science to *all learners*. NGSS framework emphasizes promoting scientific literacy by focusing on science and engineering practices, crosscutting concepts, and disciplinary core ideas. These three dimensions of the science framework define and represent what it means to be scientists and to engage in scientific inquiry. The science and engineering practices particularly highlight and involve scientific sense-making and language use (Lee, Quinn, Valdes, 2013). Engaging in the science and engineering practices such as asking questions and defining problems, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information are language intensive (Lee, Quinn, Valdes, 2013). What this means is that students need to engage in receptive (listening and reading) and productive (speaking and writing) modes of language use to engage in scientific discourse. When students ask questions and define problems, they must read or listen and speak. When students construct explanations and design solutions, they need to read, listen, view scientific phenomena and speak or write about explanations and solutions. The new standards basically require that these types of scientific literacy practices become accessible to all learners and that all learners are able to engage in these language intensive practices, regardless of English language proficiency, cultural or linguistic background, or SES. Engaging *ELLs* in scientific discourse and literacy practices is highly important because there has been a consistent gap in science achievement between *ELLs* and native English speakers (NCES, 2011; Shaw et al., 2014), and they are not widely observed to pursue advanced science degrees (Commission on Professionals in Science and Technology, 2007; National Academy of Sciences, 2010). However, *all children* need to be able to participate in the enterprise of science, which begins with effective science teaching in K-12 classrooms.

Studies addressing this challenge propose that teachers develop *ELLs'* language development along with science inquiry skills (Cervetti, et al., 2007; Lee, et al., 2008; Ovando & Combs, 2012; Rivet & Krajcik, 2008; Rosebery, & Warren, 2008). However, many teachers are unprepared to teach content to *ELLs* (Ballantyne, Sanderman, & Levy, 2008; Darling-Hammond, 2006; Gándara, Maxwell-Jolly, & Driscoll, 2005; Villegas, & Lucas, 2002). In science particularly, in a survey of elementary teachers, only 15 % reported feeling adequately prepared to teach science to *ELLs* (Banilower, Cohen, Pasley, & Weiss, 2013). Secondary science teachers similarly do not feel prepared to teach science to *ELLs* and they have to work with ESL teachers to meet the needs of these students. This interdependency between the two professions is not devoid of issues and challenges (Arkoudis, 2000; 2003; Davison, 2006).

Teaching scientific literacy to *ELLs*. Scientific literacy is defined by the ability to a) "ask, find, or determine answers to questions derived from curiosity about everyday experiences", b) "describe, explain, and predict natural phenomena", c) read with understanding articles about science" (Burkhardt et al. 2003, p. 18). This expanded view of literacy in science puts demands on the roles and responsibilities of the science as well as mathematics teachers at elementary, middle, and secondary classrooms. In any grade level, the central question that teachers need to ask themselves regards what literacy skills "students need to use to achieve the specific content objectives of this particular lesson" (Carrier, 2005, p. 6). Science literacy objectives essentially include the reading, writing, and oral communications skills needed to communicate and participate in science activities. Mastering the languages of mathematics and science is even more difficult for those learners who learn these subjects in their second language (Crandall, 1987). Brown and Kelly (2007) note that "learning to engage in the discourse of science requires developing new repertoires for interaction with people, texts, technologies, knowledge and assumptions about the world" (p. 283). Most scientific text and talk are aimed for highly literate scientific audience

(Sherer et al., 2009), which makes it harder for second language learners to access these texts. All teachers, including the science teachers, now have responsibilities to ensure that all learners are given opportunities to communicate about science concepts and participate in science activities.

To help meet these responsibilities, various instructional strategies stand out. First, Carrier (2005) suggests that the language functions embedded in the scientific literacy skills should be identified and lessons should be designed accordingly. For example, a science literacy skill such as 'describing the differences between plant and animal cells' would involve developing skills to meet the language function 'describing' and 'comparing/contrasting'. So then science and ESL teachers' role would be to design a lesson in which students understand and know the particular targeted content as well as students are able to use the scientific language to meet the two language functions. Similarly, taking a functional view of language, Mohan and Slater (2006) examined the integration of language and content in a mainstream ninth grade science class. The teacher guided students through the social practice of solving problems by linking theory with practice in the scientific data. In doing so, the teacher had the students reason through the physical properties of matter with regard to the cause and effect relations in the properties. These connections are made at the lexical as well as discourse levels of language use. This study shows how Systemic Functional Linguistics (SFL) theory could enable classroom teachers to help students make connections between language form and scientific meaning.

Other scholars (Buck, Mast, Ehlers, & Franklin, 2005; Fathman, Quinn, & Kessler, 1992; LaPlante, 1997; Bautista & Castenada, 2011) have also recommended various instructional strategies that are effective for teaching scientific literacy to ELLs. At the middle school level, an action research project (Buck et al., 2005) reflecting a collaboration amongst science educator, ELL educator, a first-year middle-level science teacher, and a graduate assistant revealed that use of authentic visuals was effective in teaching scientific concepts to ELLs, with the exception of the times when the visuals did not represent the scientific concepts directly. Also, second, it was observed that hands-on activities also help ELLs engage in learning science content as opposed to off-task activities that involve teacher lecturing or explanation of concepts. Further, cooperative learning strategies were observed to encourage the ELL students to engage in discussions more actively than just follow what the non-ELLs are doing. However, Buck et al., caution about the use of cooperative learning strategies in terms of finding the best match between students' personalities; otherwise, the cooperative activities could easily lead to off-task behaviors. This study also shed light on what it means to become a science teacher who can meet the needs of ELLs. In that, it is complex for novice teachers to utilize the three instructional strategies most effectively, irrespective of the circumstances.

At the elementary level, conceptual and empirical work (Bautista & Castenada, 2011; Buck, 2000; Laplante, 1997; Lee et al., 2008; Medina-Jerez, Clark, Medina & Ramirez-Martin, 2007) recommend various instructional strategies for teaching science to language minority students. Buck (2000) and Bautista & Castenada argue that teachers should pay attention to the proficiency levels of their ELLs and cater the instructional activities accordingly. Bautista & Castenada argue that it is important to "identify content objectives, modify instruction, make accommodations, and adapt assessments" according to students' proficiency levels (p. 37). When modifying instruction, the authors suggest that teachers should scaffold language and not simplify the content.

Several scholars write about how elementary pre-service teachers could be trained to better serve their ELLs. Cone (2009) employed community-based service-learning supplemented with discussions and activities about diversity to increase 81 preservice teachers' self-efficacy related to equitable science teaching and learning. The participants were enrolled in elementary science methods course. Community-based service learning included teaching science to diverse student groups in an after-school program, designing inquiry-based science lessons applied to real-life situations, and implementing lessons that promote higher-order cognitive skills in designated classrooms within the community center.

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The qualitative and quantitative data showed that participating pre-service elementary science teachers' self-efficacy levels increased during the duration of the course. The findings should be approached with caution found by Lee, Hart, Cuevas & Enders (2004) that beliefs might change in science teachers regarding equitable science instruction of ELLs but then actual practices might not.

Next, a review of TESOL teacher education standards and practices is provided to present how the field of TESOL has been responding to the demands in teaching content to ELLs.

Changing TESOL Teacher Education Standards and Practices

As the CCSS and NGSS standards emphasize better education of *all students*, the roles of ESL teachers in K-12 contexts become more pronounced. Responding to the shifting priorities, within the last decade TESOL revised the P-12 standards to reflect the significance of teaching and acquiring discipline-specific language ELLs need to succeed in content classrooms (TESOL, 2006), which represented a shift from focusing on social language development only. Now, English for speakers of other languages (ESOL) teachers are expected to teach language through content areas such as mathematics to help ELLs succeed in mainstream classes. More recently, TESOL International published Standards for the Recognition of Initial TESOL Programs in P-12 ESL Teacher Education (TESOL, 2010). These standards include five knowledge domains: 1) Language, 2) culture, 3) planning, implementing and managing instruction, 4) assessment, 5) professionalism. Under the domain of language, TESOL standards guide that the ESL candidates should attend to the functional use of language in specific academic domains and should not isolate language skills from the rest of the curriculum. Otherwise, "ESOL students will not benefit fully from academic instruction in other classes" (TESOL, 2010, p. 12). With this guidance, TESOL teacher education programs are now focusing on developing candidates' language awareness and knowledge of language pedagogy in the context of content classrooms. However, it may not be so easy to prepare ESOL teachers in teaching in the content areas (Tigert & Peercy, 2017). Tigert & Peercy (2017) explored how a group of four ESOL candidates felt prepared in their university coursework. The candidates were close to finishing their 13-month long MEd in TESOL program while teaching in their high school internships. During internships at high school level, one candidate taught ESOL mathematics while another one was teaching ESOL science and social studies and the other two candidates mainly taught ESOL language arts. The candidate who taught ESOL science reported to struggle with learning and integrating the science content that she had little experience with. The same candidate pointed to absence of coursework for teaching content in the MEd TESOL program. She resolved to find a job that allowed her to co-teach as she wanted to defer content area teaching to the prospective content teacher. In general, all four candidates reported that the integration of language and content was not simple and they needed hands-on experiences and more mentor support during their internship. This study points to a need for more content-focused teacher preparation for the ESOL teacher candidates.

Several other observations and critiques have been made about TESOL teacher education programs. For instance, there is a cautionary note from Baecher (2012) who claims that the quality of the practicums included in TESOL programs is questionable because they mostly require classroom observations, as a way of fulfilling the requirement for clinical experiences, rather than actual teaching practice. Baecher claims that in the USA, "well-integrated clinical experiences are the exception rather than the norm, and for the majority of teacher candidates the experience is one characterized more by fragmentation than by integration" (p. 538). This fragmentation, according to Baecher, might be due to the fact that faculty teaching in TESOL programs come from various specialties such as linguistics and education, which makes program coherence challenging. Another critique Baecher brings up is that the

faculty members typically have more experience teaching adults than younger learners, whom the TESOL teacher candidates are most likely to teach.

The influence of faculty and staff on how the different elements such as linguistics, theoretical and sociocultural orientations should all be balanced in a given program is a recognized issue as well (Ramanathan, Davies & Schleppegrell, 2001). The study by Ramanathan, Davies & Schleppegrell (2001) compared two Master of Arts programs in TESOL (MATESOL) programs in the US. According to this study, course offerings in these programs were governed by the particular departments and how the programs fit in relation to the overall university culture. Also, the programs considered the local community needs as well as the job needs of their graduates. These findings in broad strokes show how MATESOL programs could be interacting with and shaped by a wide array of forces that are internal and external to the programs.

A recent review of MATESOL programs by Stapleton & Shao (2018) reports on both US based and non-US programs. In this review, a total of 3,877 course titles offered in the participating programs (n=241) were coded. 146 of the identified programs were offered at American universities. The authors followed a ground-up approach to identifying the codes that emerged from the data for analysis. The codes were also compared with the five domains prescribed by TESOL international standards for ESOL teacher education programs. The findings showed that the majority of the course offerings focused on teaching methods. Differences between US and non-US programs were observed especially in relation to the practicum requirements in that US programs required supervised practicum/internship. In other programs, MATESOL programs were not directly linked to licensure/endorsement like US programs are because elementary or secondary school teachers are mandated by some states to have licensure/endorsement in ESL. Another major finding of the study was that programs providing certification in teaching ESL focused on teaching methodology (i.e., how to teach a second language) as compared to Master's programs where the focus was on second language acquisition. This study showed how MATESOL programs in the US provide practicums based on the local education requirements. The implication here might be that the US TESOL teacher education programs take on the mission to address the needs of diverse students seriously.

Once ESL teachers graduate from TESOL teacher education programs, they serve in various instructional programs at the K-12 US schools. Next, we review how ESL teachers' roles vary depending on the ESL education program model that is followed at elementary versus secondary levels.

Roles of ESL Teachers and Variation of ESL Teacher roles and Practices in K-5 versus K-12 Contexts

ESL teachers play significant roles in various ESL education programs followed at elementary and secondary levels. As the grade level increases, so does the inclusion of ELLs in mainstream classrooms. With that, ESL teachers increasingly become co-teachers in later grades. At elementary schools, some of the program models in which ESL teachers play significant roles include pull out, push-in or inclusion model, and team teaching (Becker, 2001). Becker (2001) examines each one of these models and how ESL teachers role vary depending on the particular model and in relation to: "1) curriculum coordination (how well the ESL curriculum is coordinated with the grade-level curriculum, 2) social integration/stigmatization (how the model integrates the ESL students with their grade-level peers), 3) scheduling issues (how ESL instruction is scheduled into the students' school day), 4) teaching facilities (how the physical space where the ESL instruction takes place may affect students as well as teachers" (p. 38). In exploring the pull-out model, Becker (2001) finds that ESL teachers often are tasked to coordinate the ESL curricula with grade-level curricula by coordinating and establishing communication with grade level teachers. According to Becker, it could be taxing on ESL teachers if there is a big number of grade-level teachers to contact and coordinate the curriculum with. In terms of social integration of the ESL students in a pull-out model, ESL teachers mainly hold the responsibility to ensure that students don't

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feel stigmatized for meeting with the *special teacher* for “extra help” (Becker, 2001, p. 44). As for scheduling issues in pull-out instruction at elementary grades, ESL teachers are responsible for scheduling ESL pull out instruction during a time when ESL students do not miss out on the concurrent content instruction. Also, with pull-out instruction, ESL teachers are assigned to teaching spaces such as “closet, bookroom, cafeteria, office, hallway, or other non-classroom area” (p. 50). These spaces are not necessarily conducive to effective instruction. One anecdotal comment from a teacher about her overall experience with pull-out programs notes that “I don’t like the fact that the students are isolated from their classmates. Some seem OK about it, but I don’t think all of the other ones like going to a “special” teacher. It is difficult to communicate with the classroom teachers—sometimes days will go by before we can meet. They are all so busy.” (Becker, 2001, p. 52). This anecdote illustrates what important roles ESL teachers play in ESL students’ socio-psychological development and how they do their best within the constraints of pull-out programs.

Inclusion or push-in models of ESL instruction do not require much of coordination between ESL and grade-level curricula; instead, ESL teachers teach the ELL students in students’ own grade-level classroom. With that, grade level teachers take more responsibility and ownership of the ELL students (Torres, 1994 as cited in Becker, 2001). In terms of curriculum coordination, communication between the ESL teacher and grade-level teacher is smoother than pull-out model because the ESL teacher is working in the same classroom and communication about the curriculum can afford to be detailed, last-minute, and clear. Becker adds that the inclusion models may best suit ELL students with high level of English proficiency because if there is a big gap between ELL student’s English proficiency level and language level required in the class, ESL instruction may not be as beneficial. In such cases, various supplemental support programs could be developed depending on ELL students’ proficiency levels. In terms of social integration in inclusion models, ESL teachers play the role of helping ELL students not feel stigmatized to be receiving extra help while other students are not. In doing so, they need the grade-level teachers’ help to promote the ESL instruction with a positive attitude so all students view it as part of the usual classroom activity. The same spirit goes true for scheduling the instructional times together. ESL instruction should be planned during a time slot when a significant grade-level activity is not happening. Similarly, in terms of teaching facilities, it is upon the ESL teacher to coordinate with the grade-level teacher so there is no disruption to the flow of the classroom instruction. This way, for example, the ESL teacher can work with the ELL students while the rest of the class is also working in small groups. All in all, a lot falls on the ESL teachers to make sure that inclusion or push in models of ESL instruction are successful for ESL students.

Team teaching or co-teaching models of ESL instruction are also common in elementary schools with large percentages of ELL students (Becker, 2001). The difference here is that the ESL teacher team teach with the grade level teachers for a number of hours per day. This allows the two teachers to coordinate the curriculum and lesson planning together. ESL teacher gets to have more of a classroom teacher role in this model. The two teachers should also schedule instruction together in ways that would most benefit the ESL students. In this sense, it is again up to the initiative of the ESL teacher to team up with a few grade-level teachers to benefit most of the ESL students in a school with high ESL student population. Becker suggests that the instructional models are most effective when teachers can stay flexible and arrange instruction according to the needs of their particular students.

As for secondary schools, ELL learners spend the majority of their time in mainstream classes where they need to develop their English language proficiency simultaneously with subject specific knowledge. The roles ESL teachers play in these classrooms require collaboration and collaboration with the content area teachers. Sheltered content classes are common in secondary education of ELLs (Faltis, 1993) to meet their language needs in content classrooms. Faltis (1993) notes that sheltered content classes help students transition from content courses taught mostly in students’ native language to mainstream

content area classes where English is the main medium of instruction. In sheltered content-area classes, ESL teachers work with content teachers to address the integration of content and language objectives. In doing so, they get familiar with the content standards (Becker, 2001). Sheltered content teachers and ESL teachers need to coordinate closely what content will be covered in the content class and in ESL class, respectively. In a sheltered math class, for example, Becker (2001) notes that sheltered math teacher might focus on ESL students' math-specific language needs and let ESL teacher work with other language needs in the ESL class period. Similarly, ESL and science teachers might choose to develop the essential language skills in ESL students in the sheltered science classes, which tend to be the initial course in the sequence of science classes (Becker, 2001).

The roles of ESL teachers naturally vary, albeit not examined closely, according to which grade level ESL teachers teach. In terms of lesson planning and designing in general education classrooms, it was found that elementary teachers focus more on the classroom activity than content goal (Kagan & Tippins, 1992). The study showed that secondary teachers wrote more detailed lesson plans over the course of a semester while elementary teachers' lesson plans became briefer and less detailed. Regardless of the grade level, in ESL classrooms, the lesson plans are complicated because ESL teachers need to design the lessons in a way that promotes students' content understanding as well as English language skills (Baecher, Farnsworth, Ediger, 2014). Liyanage & Bartlett (2010) note that "one of the major challenges for English language teachers is that the medium of instruction is also the object of instruction. Therefore, the lesson itself comprises the lesson activities, instructions for carrying out those activities, and the language required to engage in those activities" (p. 1363). As the content and language get more complex in higher grades, the language embedded in the content becomes a bigger focus of the instruction. It follows to reason that as the grade level gets higher, the complexity of ESL teachers' lesson planning increases. The main reason for this complexity might be that integration of content objectives and language objectives becomes more demanding in the higher grades.

Within the division of labor between ESL teachers and content or grade-level teachers at the elementary as well as secondary levels, it is most crucial that professional resources are provided to all teachers so the coordination and communication of ELLs' needs is as smooth as possible between ESL and content or grade-level teachers (Becker, 2001).

Instructional Approaches or Innovations Influencing the ESL Teaching in Content Classes

From the vantage point of ESL teachers, there are several theoretical perspectives or instructional approaches that have guided ESL teachers on how to teach content to ELLs or at the teacher education level, how to help content teachers with their ELL students. Instructional innovations such as the Cognitive Academic Language Learning Approach (CALLA, Chamot & O'Malley, 1994), the Sheltered Instruction Observation Protocol (SIOP, Echevarria et al., 2013), and Content-based Instruction (Stoller & Grabe, 1997) have all attempted to address the need to help ESL teachers address the language needs of their ELLs in content classrooms. To highlight one of them, content-based language instruction (CBI) is defined as "a curricular and instructional approach in which nonlinguistic content is taught to students through the medium of a language that they are learning as a second, heritage, indigenous, or foreign language" (Tedick & Cammarata, 2012, p. S28). In TESOL and teaching of world languages, this instructional approach essentially represents the integration of content and language teaching objectives (Brinton, Snow, & Wesche, 2003). The core principle that started the content-based language teaching (CBLT), or CBI, is based on Krashen's (1987) theory of the Monitor model and comprehensible input. These theories maintain that language learning is most effective when students do not focus on the grammatical forms and structures but instead engage in texts and activities that are meaningful to them. What this means is that students learn language as a result of learning the subject matter. In immersion

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contexts, there is evidence that learners learn content while also developing fluency and confidence in using the targeted second language (Genesee, 2004; Turnbull et al., 2001; Lazaruk, 2007). Learners' learning content through a second language demonstrates higher performance in content understanding than their peers learning content in their first language only (Morrison & Pawley, 1986; Day & Shapson, 1996). However, there is controversy in the field whether comprehensible input and meaning-based language instruction provided through content-based instruction is sufficient and whether there should also be an explicit focus on form as well. The worry here is that there may be incidental language teaching and teachers may prioritize content over language learning (Lyster, 2007). If, on the other end, there is too much emphasis on language learning goals more than on content, then meaningful content learning could be compromised (Cammarata, 2009). Further limitations of CBI have been noted. One limitation is that content and language integrated learning privileges those who already achieve high in both content and language and it is observed to succeed in schools where students are selected and teachers are provided a lot of instructional support (Paran, 2013). Another noted limitation of CBI as implemented in French immersion contexts is that students' language skills particularly in grammatical accuracy lag behind their content understanding even after years of being exposed to the immersion language (Lyster & Tedick, 2014). In consideration of these concerns, it has been argued that CBI should be enhanced and that there should be a more explicit focus on form (Ellis, Basturkmen, & Loewen, 2001; Schleppegrell, Achugar, Oteiza, 2004). The advocates of form-focused instruction take different approaches as to how the linguistic form should be taught along with the content. Some (Ellis, Basturkmen, & Loewen, 2001) believe that students should learn the form incidentally while learning the content. Others such as Swain (1988) argued for developing contexts that allow students to realize and make form/meaning connections. Further, Lyster (2007) argued for balancing form-focused and content-based instruction. Schleppegrell, Achugar & Oteiza, however, claim that "focus-on-form approaches are typically not informed by a theory of language that is discourse and meaning based and instead view language acquisition as the accumulation of sets of structures and rules" (p. 70). To bring an alternative lens to content based instruction, systemic functional linguistic (SFL) perspectives emphasize a functional theory of language and aim to show second language learners how specific linguistic choices made in disciplinary texts help to construct certain meanings in the discipline. This lens makes the connections between the linguistic forms and meaning that are specific to a particular discipline. An overview of the SFL perspective is provided next illustrating several in-service professional development projects aimed to help content teachers address ELLs' needs.

Functional Linguistics Approaches to Teaching Content to ELLs and All Students

SFL perspectives have addressed the role of language in teaching content to ELLs. Its application started in Australia with the intention to make the language and genre of schooling explicit for students. Gebhard (2010) notes that SFL provides a way of "responding to the changing nature of teaching academic English and of supporting teachers in making disciplinary literacies more transparent and negotiable for students, especially ELLs" (p, 799). The larger idea here is that each discipline has its specific register and mode of communicating (Halliday & Martin, 1993). In learning mathematics and science, for instance, learners need to first master subject-specific discourse (Lemke, 1990). This means that being literate in mathematics and science is not just about knowing facts and figures but also entails the ability to participate in the discourse communities (Roth & Tobin, 2007; Solomon, 2009). SFL, as a functional theory of language, aims to help language learners engage in various activities that are specific to the discourse community such as solving a problem or justifying choices and so on (Lemke, 1990).

With that theoretical background, Gebhard notes that there have been three applications of SFL at in-service teacher education programs in the US. One was the California History Project (CHP) whereby

the teachers learnt to deconstruct the meaning of history text books and to plan their lesson incorporating SFL analyses. The observation of CHP teachers' practice showed that they had more in-depth discussion about history with the language learners. Also, the ELL students of these teachers performed significantly better than students whose teachers had not followed the SFL workshops. Another SFL-based teacher education program called Access to Critical Content and English Language Acquisition (ACCELA) emerged from Massachusetts where the in-service teachers, teacher educators, researchers collaborated to develop interventions and SFL tools and research about the effectiveness of the tools and interventions. The results of the case studies within the ACCELA project showed that emergent ELL writers produced coherent texts aligned with the written discourse. Another program from Massachusetts reported that 11 participating teachers developed expertise and confidence in planning and enacting various writing lessons that are aligned with various genres (Brisk & Zisselsberger, 2010).

Despite these innovations, it is not clear yet in the literature if there is any attempt to infiltrate SFL perspectives into the pre-service or in-service MA TESOL programs. If there is, it may be that ESL teachers are encouraged to identify language functions relevant to content and language objectives and simultaneously address the language demands at the discourse, grammatical, pragmatic, and metalinguistic levels. However, it appears that the utility of providing teacher candidates with SFL ways of addressing the discipline-specific language demands in content classrooms is still under investigation and exploration.

Instructional innovations or approaches such as the CBI and SFL aim to address the preparedness of content teachers and ESL teachers so as to help them meet ELLs' language and content learning needs. At the core of all the instructional approaches out there is the motivation to promote collaboration between content and language teachers so that language is not stripped off its meaning-base and likewise, content is not isolated from its essential language element. In the US, these approaches have also gained prominence due to the need to respond to the standards-based education reform such as the Common Core Standards and Next Generation Science Standards (CCSS Initiative, 2016; NGSS Lead States, 2013). Not only do these standards emphasize the integration of content and language, they also require from the content and language teachers to collaborate to meet the needs of ELLs. Next section is dedicated to understanding the challenges and opportunities in collaboration and co-teaching practices between ESL and STEM teachers, in particular.

Challenges and Opportunities in Co-teaching and Collaboration Practices between ESL and STEM Teachers

One of the historical issues in ESL research has concerned how ESL teachers could work with or provide advice to subject specialists who are not trained in teaching ESL (Clegg, 1996; Harklau, 1994; Richard-Amato, 1992). Collaboration is defined as "a style of interaction between at least two coequal parties voluntarily engaged in shared decision making as they work toward a common goal" (Cook & Friend, 1995 as cited in Dove & Honigfeld, 2010, p. 5). In teaching ESL, collaboration is intended to bridge the differences in styles of teaching between content and ESL teachers. Co-teaching is a more specialized term referring to the collaboration between general and special education teachers who share equal responsibility for teaching all students.

There are three models of co-teaching that Dove & Honigfeld (2010) propose. Models are categorized according to whether the content and ESL teachers work with the entire class or groups of students either comprised of homogenous groups of students (only ELLs and only Non-ELLs) or heterogeneous groups of students mixed of ELLs and non-ELLs. With the models of both teachers collaboratively teaching the entire class, the teaching style might take various forms: 1) they may teach the same lesson at the same time, 2) one teacher might teach while the other assesses targeted students

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through observations, checklists, and anecdotal records, 3) one teacher might assume the lead role while the other teacher serves specific needs of individual or small groups of students. When teaching mixed groups of students, two teachers could teach the same content to two student groups using differentiated learning strategies that are appropriate for each group of students. Alternatively, one teacher might preteach content to one group of students who have limited knowledge of the targeted content while the other teacher teaches the other group concepts related to the targeted content. Again working with the heterogeneous groups of students, one teacher could revisit some specific content with one group while the other teacher examines a related concept with the other group. Dove and Honigsfed (2010) claim that these models work better than pull out services that typically tend to isolate ELLs. The authors claim that without coteaching, students experience no sense of belonging, reduced achievement and disconnection from the instruction. Other research also shows that co-teaching influences students (Theoharis, 2007) and teachers (Davison, 2006).

Furthermore, Davison (2006) identifies several stages of teacher collaboration to describe work between ESL and classroom teachers at the elementary level:

1. Pseudocompliance or passive resistance stage: Teachers would prefer to go back to the traditional pull-out or 'one teacher-one classroom' model.
2. Compliance stage: Teachers at this stage show good intentions towards collaboration but they mostly comply with the externally imposed collaboration arrangement and so show limited understanding about the implications of collaborative practices.
3. Accommodation stage: Teachers engage and experiment with practical implementations of collaborative teaching.
4. Convergence stage: Teachers become ready to learn from each other and share their opinions and beliefs with each other.
5. Creative co-construction stage: As teachers fully participate in co-teaching, it becomes their preferred way of working on ESL teaching. The partnerships and professional interactions become authentic, genuine and fluid.

In the study on English language and content teachers teaching in an English-medium international school, Davison (2006) finds that all the five stages could be observed as teachers move towards more autonomy in collaboration. All in all, Davison collaboration between ESL and classroom teachers is not easy and comes with issues even when the school administrators and teachers as a whole commit to collaboration and avoid pull-out practices.

The ways in which Davison's stages of collaboration might manifest themselves depend on what specific instructional programs are offered as part of district policies for ESL instruction. The nature of collaboration would mostly likely be different if in a given school there are sheltered content-area curricula for ESL students (see Chamot & O'Malley, 1987; Crandall, 1987; Mohan, 1986) in sheltered classrooms. Then, the teacher is either a sheltered English teacher who is usually an ESL teacher without any certification in the content area (Faltis, 1993) or there is collaboration between the ESL teachers and sheltered content teachers (Becker, 2001). Becker notes that if ESL classes adopt content-based curriculum, ESL teachers and sheltered teachers need to cooperate on what content is going to be taught and how ESL students' language needs associated with the content will be met. Becker reports an anecdote from the experiences of an ESL teacher working with seventh/eighth grade social studies teacher. The ESL teacher reflects that ESL students benefit from having two teachers as ESL teacher can model for the content teachers how to meet the language needs of the students. Also, this way, ESL students get more specialized and individualized help. When pull-out services for the ELLs are completely removed and replaced by full inclusion models, ELLs might benefit from classroom instruction offered by the collaborative efforts of mainstream and ESL teachers. For example, Causton-Theoharis & Theoharis (2008) showed that ELLs' achievement in reading increased in a Wisconsin school where the pull-out

services were eliminated for ELLs and special education students. The school went through a major restructuring and by utilizing the existing human resources, the school made co-teaching and collaboration the main model of delivering special and ELL education.

There are opportunities as well as challenges in co-teaching and collaboration between ESL and content teachers, which is reviewed next.

Opportunities and Challenges in Co-teaching and Collaboration

One main opportunity that collaboration/co-teaching presents to the ESL teachers and the welfare of the school environment is that ESL teachers get to have the “epistemological authority” to guide and shape mainstream curriculum on behalf of ELL kids. In the context of science classrooms especially at the secondary level, it is inevitable that science teachers claim authority over their subject matter (Arkoudis, 2003). Science teachers may form their own micro-political discourse that may overpower other teachers (Arkoudis, 2003). However, if ESL teachers could position their roles on equal footing through continued negotiation of roles and clear communication of ESL knowledge base to serve the needs of ELLs.

The challenges in collaboration between the math/science teachers and ESL teachers are evident in research (Tan, 2011; Arkoudis, 2000; 2003). Tan (2011)’s study shows how math/science teachers in a content based language teaching environment view their roles as content teachers only and do not assume any language-related responsibilities nor did they approach collaboration positively. This kind of negative stance is a big challenge for collaboration. Further, Arkoudis (2000; 2003) shows in the ethnographic work on ESL teachers’ roles in relation to the mainstream science teacher that the participating ESL teacher had less of an authority and agency over the lesson planning process. Arkoudis (2006) reports that ESL teacher positioned herself and her role as one that supports the science teaching of minority kids. That is, the participating ESL teacher aimed to assist the science teacher’s professional development in teaching ESL students. As such, she offered her professional opinion about planning the lessons for minority kids using language that is not accessible to the science teacher. It was observed that the science teacher and ESL teacher had different epistemological assumptions about the ‘content’ to be taught. The ESL teacher in the end focused on maintaining the professional relationship rather than insisting on her position about lesson planning by openly negotiating her position with the science teacher and using low assertion in her remarks such as “like to me almost it [content] doesn’t matter” (p. 426). Arkoudis comments that the epistemological authority and power that science teacher holds over the ESL teacher is directly linked to the institutional hierarchy within the education system. ESL curriculum is not visible to many school authorities. ESL curriculum is positioned as one that is situated within the domain of science curriculum.

The differential power issue is fundamentally a policy and practical one in that ESL teachers are seen to function as aids and not as “real teachers” by their colleagues and students (DelliCarpini, 2009; Ernst-Slavit & Wenger, 2006). Similarly, in Ernst-Slavit and Wenger’s study (2006), bilingual paraprofessionals were viewed as ‘hidden teachers’ and not taken seriously by certified teachers and administrators. DelliCarpini (2009) notes that ESL teachers typically teach in hallways and converted closets, not having access to resources. This marginalized status of ESL teachers is viewed as an extension of the marginalized status of the ELLs in US public schools (Liggett, 2010). To understand how collaboration practices could be weakened through marginalization of English language teachers, Liggett (2010) conducted interviews with and classroom observations in the classrooms of six white female English language teachers in both urban and rural settings. Liggett found that teachers in both settings felt physically marginalized as they were allocated spaces within the school that were not classrooms. The spaces these teachers were assigned to teach ELLs were equipment storage rooms, modular classroom, or ‘time-out’ rooms that the English language teachers and ELLs had to vacate if a student in

the school had to be disciplined. According to Liggett, these marginalized spaces reflect a general pattern in many English as a second language programs across the US. Liggett also found evidence for social marginalization of the ESL teachers as these teachers reported that they had to chase after the mainstream teachers for information about the content focus of the lessons. Collaboration did not feel like a reciprocal process for these teachers. Positive relationships with the general education teachers depended on the approach of the administrators and how they encouraged the general education teachers to make time for collaboration. In the end though for these ESL teachers, positive relationships and collaborations “meant being able to place students with general education teachers who made accommodations for ELLs” (Liggett, 2010, p. 227). Also, social and physical inclusion of the ESL programs and their teachers directly influence the sociopsychological dimension of language learning in terms of ELLs’ motivation to learn English and become part of the school community (Valdes, 2001). Since the isolation of ESL teachers and students holds serious detrimental consequences on the overall success of these teachers and students in US schooling, it is useful to examine next how challenges of collaboration could be turned into opportunities, as illustrated in the study by DelliCarpini & Alonso (2014).

While coteaching, both content and ESL teachers need to feel that they have worked together, shared and contributed equally. Their teaching philosophies and personalities should match, which may be hard to readily find or cultivate (Becker, 2001). Acknowledging such challenges in collaborations between content and ESL teachers, DelliCarpini & Alonso (2014) designed a promising teacher education course in which mathematics and TESOL education faculty worked together to educate pre-service or in-service teachers enrolled in graduate level secondary-level mathematics, science, and TESOL teacher education programs to teach STEM effectively to ELLs. The overall goal of this course was to cultivate effective collaborations between secondary-level ESL and STEM content teachers. Specifically, the goals were to implement a two-way CBI whereby not only novice secondary level mathematics/science teachers but also novice ESL teachers would be supported in their ability to 1) teach ELLs effectively in mainstream classrooms as well as to 2) effectively implement CBI without emphasizing content over language and vice versa. According to the authors, two-way CBI is different from traditional sheltered instructional practices such as SIOP (Echevarria, Vogt, & Short, 2000) in that language-driven objectives and content-driven objectives are collaboratively developed and complement one another. Both STEM and ESL teachers become aware of the linguistic demands inherent in STEM subjects and they collaboratively attend to the linguistic forms and language functions while developing the content and language objectives. The idea here is that language objectives should go beyond vocabulary and highlight the linguistic features of the particular discipline (Regalla, 2012 as cited in DelliCarpini & Alonso, 2014). A total of 33 in-service and pre-service teachers participated in the study. Before and after the course, they all filled out a survey examining participants’ beliefs, attitudes, skills and actual practices regarding working with ELLs. Qualitative and quantitative analyses of pre-course survey responses revealed that mainstream teachers had low expectations of ELLs reflecting even a deficit view of ELLs. The deficit view manifested itself in teachers’ views that the minority kids and their non-native English speaking families do not try hard to achieve in academics. This view is ingrained in the belief that poor academic skills are the fault of the learner, not the teacher or schools, which is supported in other studies in the literature (Valdes, 2001; Youngs & Youngs, 2001). Another pattern was that mainstream teachers did not show much knowledge regarding the role of language in mainstream and content classrooms. They also did not think it was their responsibility to develop language skills in ELLs. They were fully aware of the content they needed to teach but not how language plays a big role in teaching the content. After taking the course and collaborating to develop content-focused CBI as well as language-focused CBI, the teachers’ initial beliefs and attitudes significantly changed, developing more of a responsibility towards ELLs and understanding the role of language in content instruction. Also, mainstream teachers improved their views about the role of ESL teachers. Most importantly, they all assumed more agency to initiate

conversations and work with the ESL teachers and science/math teachers. Finally, both groups of STEM and ESL teachers developed a clear understanding as to how they could engage in collaborative practices, each assuming responsibilities in developing equally language-and content-driven instruction for ELLs.

Promises for Future Productive Relationships Between ESL Teachers and Stem Teachers

As a result of the changes in TESOL teacher education standards and increased awareness within the fields of ESL and STEM education regarding the shared responsibilities for teaching ELLs, there has been a number of studies reflecting promises in the future for improved relationships between ESL and STEM educators (Dermott & Honigsfeld, 2017; Jung & Brown, 2016; Sharkey & Proulx, 2017). Other studies show promises in educating TESOL teachers to meet the needs of ELL alongside the content teachers (Baecher, Farnsworth, & Ediger, 2014; Gonzalez, 2016; Jones, 2016; Lindahl & Baecher, 2016).

To start with the studies focused on ESL teacher preparation, Jones (2016) proposes an approach for teacher candidates to plan lessons focused on learning outcomes. Centering the warrants for the proposed approach to writing learning outcomes on the significance of lesson planning, Jones claims that this is a way to balance the language and content sides of content instruction in multilingual classroom settings. Although the paper is geared towards Singaporean English language teaching context, Jones argues that the proposed process applies to most contexts where English is the medium of instruction for content instruction. The five step proposed process includes 1) identifying the focus, 2) specifying the language, 3) ensuring appropriateness, 4) creating lesson coherence, 5) revising and evaluating. While these steps might seem mechanical, Jones claims that it is intended to guide thinking process and provides a generative lens to apply to any context. In identifying the focus of the learning outcomes, Jones guides the teacher candidates to identify the specific knowledge about language or language skills such as skim for details of information. Then, teachers are guided to specific the specific language feature (e.g., adverbials of time) that their students will notice by engaging in and applying the skill identified in the first step. In following the first step, teachers are encouraged to match the language with the context in which it is to be used; in other words, the genre of the text or talk that the language will be used in (e.g., recount of historical facts). Fourth step involves ensuring coherence among the targeted skills, language and genre in which the language will be used. In the fifth step then, teachers are guided to check for common difficulties such as designing the outcomes towards a classroom activity and subject matter or topic rather than language. Also, in this revision and evaluation stage, it should be ensured that the outcomes are specific to the lesson and student needs.

At its core, Jones' framework highlights the importance of lesson planning in relation to the language demands and skills embedded in the content that is being taught in ESL instruction. Baecher, Farnsworth, & Ediger (2014) question the extent to which ESL teachers are prepared to plan language instruction if and when they collaborate with content teachers to implement Content-Based-Instruction. With that, authors' study focuses on how the TESOL teacher candidates write the language objectives as part of lesson planning and what the major characteristics of language objectives embedded in content area lesson plans were. The study is grounded on teacher language awareness (TLA) literature and its role in instructional planning as a key component of teaching. The argument here is that without adequate language awareness of the linguistic demands of content, ESL teachers could defer to content learning goals over language. The construct of TLA (Andrews, 2007) includes teachers' metalinguistic knowledge, understanding of linguistic choices and language structures, and declarative knowledge about language. If ESL teachers' lesson plans lack thorough attention to language, then language learners' development of language and achievement of high levels of proficiency might be significantly compromised. One of the major areas ESL teachers could practice and demonstrate their attention to

language is in how they think about the language objectives. With that, Baecher et al include 75 TESOL teacher candidate participants in the study as part of their enrollment in a supervised teaching course in the authors' TESOL program. Using a taxonomy of issues and descriptors of clear lesson objectives, a total of 107 lesson plans were analyzed. The content focus of the lesson plans ranged from ELA, mathematics, science to social studies. According to Baecher et al., the taxonomy identified that strong language objectives embedded in the lesson plans showed the following characteristics: "(a) one or more specific language functions, grammatical structures, microskills, learning strategies, or vocabulary that learners will learn about and be able to use in a period of instruction; (b) specific activities to either expose, introduce, and/or provide guided or freer practice to develop this understanding or skill" (p. 127). In their analyses, the authors looked for alignment between language and content objectives in that they should carry logical connection. The findings showed that TESOL candidates struggled writing clear language objectives. The most apparent problems were three fold: 1) the objectives were vague, 2) most objectives focused on activity, not on student skills or understandings to be addressed, 3) the objectives focused on ELA and not on ESL which appeared more in secondary level lesson plans than elementary ones. Also, some language objectives were taken directly from the State ESL Standards and not digested as a pedagogical reasoning about the lesson in hand. Overall, Baecher et al showed that TESOL teacher candidate participants in the study sample were less successful in writing language objectives as much as they were in writing content objectives. Their language objectives focused on four language skills and vocabulary and less so on language functions, grammatical structures (transition words, parts of speech, and sentence structure). This may suggest that teachers in this particular study may not have received adequate help with language analysis and mostly know how to focus on vocabulary as part of their CBI training. Andrews (2007) posits that teacher candidates' level of language awareness is closely connected to their capacity to design clear academic language objectives.

The issue as to whether TESOL teacher candidates have sufficient language awareness needed to teach in CBI contexts has been raised before (Bigelow, 2010; Lindahl, Baecher, & Thomas, 2013; Regalla, 2012). Building on this issue, Lindahl & Baecher (2015) examined how supervisors contribute to addressing candidates' awareness in their feedback to them. Ten TESOL candidates enrolled in a MA-TESOL program and 10 part-time practicum supervisors participated in the study. Candidates submitted their lesson plans and received feedback before teaching the lesson. Supervisors observed the candidates six times in total after the candidates submitted their lesson plans and evaluated the class using the rubric provided by the program. Supervisors' language related comments were analyzed from 1) the initial lesson plan, 2) pre-observation feedback on the lesson plan, 3) revised lesson plan, and 4) post-observation feedback on instruction. Based on an analysis rooted in the domains of TLA (Andrews, 2007), Lindahl & Baecher (2015) ranked the supervisors into a continuum of 'high TLA' and 'low TLA'. The findings showed that as supervisors proceed from the pre-observation stage to the post-observation, there is less attention paid to declarative knowledge about language. Supervisors' attention shifted more towards pedagogical practices than language. Attention to language varied according to the level of language awareness that the supervisors were assigned to. The authors draw the implication that we should not only focus on candidates' language awareness but also the language awareness of the supervisors.

The attention to support preservice teachers in highlighting the language planning an explicit part of their lessons is also showing up in science teacher education. To help preservice elementary science teachers with language planning, Jung and Brown (2016) developed Academic Language Planning Organizer (ALPO). They aimed to understand how effective the ALPO is by examining the interactions seven preservice teachers had with the ALPO. Specifically, the authors analyzed how the participants used the ALPO and linked the language supports to science activities. They found that ALPO did not help the preservice science teachers identify discourse and syntax demands associated

with the language functions. However, preservice science teachers were able to link previously identified language supports to their lesson plans and they used the ALPO for finding the vocabulary terms related to the science content objectives. This finding provided the authors with the implication to separate the language function from the Task section so that preservice teachers could have the explicit place to identify the appropriate language function for the particular science content objective.

Sharkey & Proulx (2017)'s work represents another source of promise for how writing could be integrated into science lessons for developing scientific literacy in ELLs. Sharkey and Proulx also model an effective collaboration between a TESOL researcher and a practitioner 7th grade science teacher. They worked together to plan and implement the science lessons in linguistically responsive ways. Fourteen students participated in the study engaging in daily quick writes, ongoing science journals, and weekly dialogue partners. With daily quick writes, the students responded to the teachers questions such as "we are going to continue talking about who studies the water cycle. Why do you think some scientists study the water cycle?" (p. 146). This also helps focus EL students' learning. With science journals, ELLs were able to record notes on the discussions, experiments and drew models. They also reflected on their learning. With dialogue partners, ELLs were paired up with native-English-speaking peers in other classes to authentically interact with one another about scientific concepts and topics. Overall, the profiles of the four students illustrated in the chapter show that the students very closely engaged with science learning and showed enthusiasm. In this study, integrating writing activities into curriculum could form the basis of a promising practice to share between science and ESL teachers.

Conclusion

In response to the standards-based education reform such as CCSS and NGSS, STEM and ESL teachers and teacher education programs are changing their orientation towards integrated language and STEM content instruction. That is, TESOL teacher candidates are taking on new and demanding roles as content teachers while science content teachers are also assuming new roles. In addition to the new content standards, these changes are driven by changes in instructional models (Davison, 2006; Dove & Honigsfeld, 2010), a new emphasis on meeting the disciplinary language demands (de Oliveira & Wilcox, 2017; Turkan et al., 2014). As a consequence, ESL teacher education programs are emphasizing the integration of language objectives and language functions in lesson planning (Baecher, Farnsworth, Ediger, 2014). Also, there has been a growing emphasis on the need for collaboration and co-teaching between ESOL teachers and STEM teachers. Collaboration is not easy nor without issues or problems, especially considering the historical traditions of marginalizing the ESL profession. It is known that ESL curriculum is focused on teaching strategies while the mainstream subject matter takes the prominence in curriculum planning and professional positionality (Arkoudis, 1994). However, the power differential in co-teaching between content and ESL teachers should be reconstructed (Roth & Tobin, 2004). In situations where the co-teaching is mandated and not freely initiated by the collaborating teachers themselves, Hargreaves (1994: 204) argues, "sharing should not be construed as sharing among the skilled and less skilled, the expert and the novice, but among communities of professional equals committed to continuous improvement." Once this stance can be construed, the challenge in collaboration between content and ESL teachers could be turned into an opportunity.

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