SCIENCE TEACHERS' ESOL PROFESSIONAL LEARNING AND NEW HYBRID IDENTITY DEVELOPMENT

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Abstract

This multiple case study investigates four science teachers' experiences of boundary crossing through participation in an ESOL (English to Speakers of Other Languages) professional development program and the extension of their identity as ESOL/language teachers. The study examines how science teachers transform into science and language teachers by exploring teachers' disciplinary identity, their adoption of a new extended professional identity, and the mismatch between their new identity and its enactment in science classrooms. Through classroom observations, interviews, and document analysis, this study finds that the secondary science educators had a flexible disciplinary identity, and thus, adopted a new professional identity as ESOL/language teacher without strong resistance. However, their extended identity was not enacted in their classrooms. For successful transformation of science teachers into science and ESOL teachers, contextual adjustment and a continuous support system is required. The paper concludes with implications for further research on teacher education for content area educators teaching English learners.

Key words: science teachers, ESOL, boundary crossing, professional identity, transformation

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Introduction

Educators across the content areas are increasingly called upon to differentiate instruction to reach all students (Ballantyne, Sanderman, & Levy, 2008; Janzen, 2008; National Comprehensive Center for Teacher Quality, 2012), and current research suggests that many English learners (ELs) benefit from inclusive content area instruction (Gándara, 2011; Gándara & Orfield, 2012). However, teaching ELs requires science educators to increase their training and professional identities to include English to Speakers of Other Languages (ESOL) instruction. In most U.S. states, this means earning an ESOL certification or endorsement. Nevertheless, most research to date on ESOL education for science teachers has focused on short-term professional development efforts (August, Branum-Martin, Hagan, & Francis, 2009; Greenleaf et al., 2011), and little is known about how science teachers take on extended training and a professional identity as an ESOL educator. This multiple case study provides an in-depth portrait of the experiences of science teachers in one ESOL endorsement program as a boundary crossing experience and shows its effects on their professional identities and classroom practices.

The study addresses a number of gaps in the existing research. First, while the majority of research and professional development projects have targeted elementary school teachers (Avraamidou, 2014a; Kleickmann, Tröbst, Jonen, Vehmeyer, & Möller, 2016) or, to a lesser extent,

middle school teachers (Arce, Bodner, & Hutchinson, 2014; Lakin & Wallace, 2015), this study looks at high school science teachers, who might have the strongest disciplinary allegiance and identity. Second, while most research on ESOL training for in-service science teachers has examined only short-term professional development (PD) programs (August et al., 2009; Greenleaf et al., 2011), this study takes on the virtually unexamined impact of more sustained ESOL certification or endorsement programs. Third, while much science teacher education focuses on the quality of PD content and effective delivery models (Buxton & Lee, 2010; Johnson, 2010), fewer studies describe the identity that in-service secondary science teachers take on in the process of becoming ESOL/language teachers. This study provides new theoretical insights into science teacher preparation for working with ELs and has implications for how we support science teachers in becoming emergent language teachers.

The particular approach adopted in this study is the application of the concept of "boundary crossing" (Akkermna & Bakker, 2011; Dillon, 2008; Hobbs; 2013), an approach that offers a new perspective to understand diversity and mobility in content area teachers' ESOL instruction. In all, this study explores how, through the boundary crossing experience of participating in an ESOL professional development program, science teachers transform their disciplinary identity as science teachers into a new hybrid identity as science and language/ESOL teachers and how their new identity is enacted in their classroom practices.

Literature Review

Teacher Professional Identity Development

Identity has been defined by a number of scholars in various ways. The emphasis on identity development broadens the field of teacher education by including psychological and physical constructs in addition to cognitive constructs. Luehmann (2007) summarized four common characteristics of identity within a situated and social constructivist frame: 1) "socially constituted," 2) "constantly being formed and reformed," 3) "considered by most to be multifarious," and 4) "constituted in interpretations and narrations of experiences" (p. 827). Beauchamp and Thomas (2009) also summarized the topics frequently studied regarding the current interpretations of teacher identity: 1) the complex relationships between the self and identity including the role of emotion in shaping and expressing identity, the importance of narratives and discourse in understanding identity, the role of reflection in developing teacher identity, and the inextricable link between identity and agency; 2) the contextual factors influencing identity construction; and 3) the role of teacher education programs to develop new teacher identities.

A particular perspective of identity is a positional identity. A teacher's identification is found to be directly related to and essentially determined by various social factors such as ethnicity, race, age, religion, and gender (Moore, 2008; Rivera Maulucci, 2013), which can be explained by the notion of positional identities (Holland, Lachicotte, Skinner, & Cain, 1998; Moore, 2008; Rivera Maulucci, 2013). Positional identities have to do with "the day-to-day and on-the-ground relations of power, deference and entitlement, social affiliation and distance with the social-interactional, social-relational structures of the lived world" (Holland et al., 1998, p. 127). This view of identity highlights the claim that a person's position relative to others shapes the person's identity and that this identity results from the operation of language and emotion (Avraamidou,

2014b). The enactment of positional identity is described by positioning theory (Harré & Moghaddam, 2003). This theory asserts that positioning the self or others affects the "action or act repertoires" that they can access (p. 4). For example, positioning a teacher as unqualified excludes him/her from certain duties at school. Due to the relational nature of positions, positioning someone in a certain way, in turn, positions someone else with relation to that person, and the person who benefits from the position may design the situation far more than is justified in research. Therefore, teachers' positional identity affects and designs their classroom practices and interactions with their students and also positions their students in a certain way (Yoon, 2008).

With respect to teacher learning and development, professional identity has been widely studied (Beijaard, Meijer, & Verloop, 2004; Beijaard, Verloop, & Vermunt, 2000; Flores & Day, 2006; Samuel & Stephens, 2000). Researchers have been interested in how a teacher's professional identity is related to his/her knowledge and appreciation of the subject and influences his/her instructional practices, beliefs, and commitments. From a sociocultural perspective, professional identity is viewed as a continuous process of becoming (Beijjard et al., 2004) in a specific context, so the development of a content area teacher occurs along with his/her on-going process of identity construction, which arises as a result of the interaction with and reflection on his/her professional and personal experiences within a specific context (Kelchtermans, 2009). Hobbs (2013) borrowed Gee's notion of D/discourse and claimed that a teacher becomes a content area teacher by participating in subject teacher discourse[1]. Hobbs (2013) expanded this notion further in her study on out-of-field teaching, which is teaching a subject for which a teacher is not qualified. Hobbs (2013) argued that by not limiting the development of professional identity to only participation in subject teacher discourse, teachers need to have an awareness of their participation in the discourse and interact with the subject in the sociohistoric dimension in order to fully develop their professional identity and obtain competence and confidence in teaching the subject.

In the field of science teacher preparation, identity theory is used to explain the process of becoming a reform-minded science teacher. Luehmann (2007) suggested five processes to facilitate novice science teachers' implementation of the vision stated in science education professional standards: 1) "reconciling prior beliefs with reformed teaching", 2) "locating identity within a community of practice", 3) "managing emotional aspects of identity formation", 4) "integrating experiences and theory", and 5) "developing a sense of self-confidence" (p. 823-824). These five processes can be applied to experienced teachers' uptake of professional learning and have implications for teacher training program developers and school administrators regarding how to make professional development more successful.

Current theories in the field of teacher identity cover a broad range of topics; however, there has not been research that has addressed how new hybrid identities are added onto teachers' original disciplinary professional identity. Since add-on certifications have become common in U.S. K-12 schools, there is a need for research on how the professional learning required to earn add-on certification affects the identity of teachers.

[1] Gee defines Discourse as "the ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular socially recognizable identity" (Gee, 2005, p. 21).

Boundary Crossing

Boundary crossing involves "encountering difference, entering onto territory in which we are unfamiliar and, to some significant extent therefore, unqualified" (Suchman, 1994, p. 25). Emerging out of cultural historical activity theory on expansive learning (Engeström, 1987) and becoming a part of situated learning theory on communities of practice (Wenger, 1998), this concept has been employed to explore challenges, problem-solving, and learning potential at a boundary between two different domains, in particular, in education and work (e.g. Engeström, Engeström, & Kärkkäinen, 1995; Hinds & Kiesler, 1995; Hobbs, 2013). Scholars note that transporting expertise and collaborating with others between two unrelated domains is a challenging task. Different types of cognitive inertia and compartmentalization hamper boundary crossing (Engeström et al. 1995). Two major mechanisms contribute to this problem. One is groupthink (Janis, 1983), which results in "an overestimation of the in-group, closed-mindedness and stereotypes of out-groups" (Engeström et al. 1995, p. 321). Another mechanism that impedes boundary crossing is "the fragmentation of viewpoints" and "lack of shared mental models" which inhibit experts in different communities from being able to communicate and share ideas with one another (Engeström et al. 1995, p. 321). In order to overcome the difficulties in working in the new territory, boundary crossing requires "the formation of new mediating concepts" and "cognitive retooling", which can be directed and facilitated by boundary objects (Engeström et al., 1995, p.321-322).

In 1989, the concept of boundary object was introduced as a method of solving a wide array of problems (Star, 1989). Boundary objects exist in the spaces between actors with differing viewpoints and are "both plastic enough to adapt to local needs" and "robust enough to maintain a common identity across sites" (Star, 1989, p. 46). From that time, this concept has been refined and evolves as "the potentially shared or jointly constructed object" between two activity systems (Engeström, 2001, p.136). A recent view of boundary objects is of "organic arrangements that allow different groups to work together" (Akkerman & Bakker, 2011, p.141).

In their review on boundary crossing and boundary objects, Akkerman & Bakker (2011) summarized potential learning mechanisms at boundaries. They defined boundaries as "sociocultural differences leading to discontinuities in action and interaction" (p. 139). They highlighted that discontinuities can be resolved through a process of "reestablishing action or interaction" (p. 136) and lead to learning, which in turn leads to identity development/expansion and a re-conceptualization of practice (Akkerman & Bakker, 2011). The four dialogical mechanisms at boundaries are identification, coordination, reflection, and transformation. Identification focuses on a "renewed sense of practices and a reconstruction of current identity or identities" (p.146). Coordination highlights overcoming the boundary in order to establish continuity and facilitate smooth movement in the future between different domains. Reflection leads to an expanded set of perspectives and a new construction of identity that informs future practice. Transformation results in "profound changes in practices, potentially even the creation of a new, in-between practice, sometimes called a boundary practice" (p. 146). Transformation includes a series of processes: confrontation; recognizing of shared problem space; hybridization; crystallization; "maintaining uniqueness of the intersecting practices"; and "continuous joint work at the boundary" (p.149). Akkerman and Bakker (2011) made it clear that boundary crossing should not be seen as a process of replacing heterogeneity with homogeneity or moving from diversity to unity but rather as "a process of establishing continuity in a situation of sociocultural

difference" (p.152). Therefore, in the transformation mechanism, a new core practice emerges by exchanging the current practices because of their differences and thus, diversity remains.

Hobbs (2013) applied the concept of boundary crossing to out-of-field teaching. She conceptualized boundary crossing as "the process of extending and negotiating working boundaries beyond the in-field space to an out-of-field space" (p. 274). She used the Boundary Between Fields (BBF) Model to describe three groups of factors influencing the negotiation of teachers at the boundary between subjects and its impact on their professional identity. First is contextual factors, including rurality and conditions of teacher allotment. Second is support mechanisms, including provision of support materials or supportive people, professional development or collegial support, and personal research or experience. Third is personal resources, including adaptive expertise, teacher knowledge, and dispositions. This model is used to understand the participating science teachers' boundary crossing in this study.

While the concept of boundary crossing has been employed in the area of education, it has not been used to understand the experience of content area teachers' teaching ELs and participating in ESOL training. This concept potentially contributes to the field of teacher education by providing a new insight on how to make sense of teachers' experiences earning an add-on certification in a different field, developing an accompanying and new professional identity, and practicing their new identity in their instruction.

Theoretical Framework

Within a broad sociocultural framework, this study views identity as: 1) an ongoing process of becoming in relation with the personal world and sociocultural context (Beijjard et al., 2004; Holland et al., 1998); 2) constructed through participation in social practice and shaped by and shaping the knowledge and skills people acquire (Battey & Franke, 2008; Lave, 1996; Lave & Wenger, 1991); 3) continuously reshaped and reformed by acquiring new knowledge and skills through participation in a community of practice (Franke & Kazemi, 2001; Wenger, 1998); and 4) a mediating tool to make sense of contexts and make decisions about what knowledge and skills to use (Enyedy, Goldber, &Welsh, 2005). In this sense, this study assumes that teachers exhibit and enact their professional identities in relation with teaching, the content they are teaching, their students, and their classroom and broader community. Teachers' participation in professional development is a way of "acquiring new knowledge, re-crafting identities, and challenging exiting cultural and social practices" (Battey & Franke, 2008, p. 128). Teachers' professional identities mediate their decision making of what newly learned knowledge and skills are implemented in their classrooms (Enyedy et al., 2005). This study explores the science teachers' disciplinary identity and add-on identity in relation with their personal background, their instructional context, participation in professional development, and the new knowledge and skills they acquired from the training.

In addition, this study theorizes science teachers' entering the ESOL field through their participation in an ESOL endorsement program as a boundary-crossing event and applies the processes of transformation to the science teachers' professional learning, professional identity development, and the enactment of their identity (Akkerman & Bakker, 2011). Moreover, using the BBF Model (Hobbs, 2013), this study describes the contextual factors, support mechanisms,

and personal resources that the teachers brought for successful boundary crossing. In this light, this study explores how they transform their professional identity and develop their boundary practices in profound ways by negotiating contextual factors and creating and using support systems and personal resources.

The following research questions guided this work:
How do science teachers develop their hybrid professional identity as science and language/ESOL teachers through a boundary crossing experience by participating in ESOL professional development?

1. How do the science teachers' disciplinary predispositions affect their disciplinary identities?
2. What affects their acquisition and development of add-on language/ESOL teacher identity?
3. What do their hybrid identities look like and how do they affect their classroom practices?

Methods

Setting and Participants

Data for this study were drawn from diverse secondary schools and participants in one Southeastern U.S. new immigrant community. Four schools were included in the study: 1) one school from a rural district with a relatively small English learner (EL) population (8.1%) and students from home language backgrounds other than English (31.1%), 2) two schools from a small urban area district that has an extremely high percentage of ELs (27%) and students from home language backgrounds other than English (80.6%) (New America Foundation, n.d.), and 3) a private secondary school with a high proportion (25%) of international students representing high levels of native language literacy, education, and socioeconomic status.

Participants were recruited from a university-based federally-funded ESOL endorsement program designed for in-service educators. Teachers took three graduate ESOL endorsement courses mandated for state licensure. These included "Language & Culture in the Classroom," which covers key principles of multilingual and multicultural education; "First and Second Language Acquisition," which explores major concepts in linguistics and first and second language acquisition; and "TESOL K-12 Methods and Materials," which introduces research-based strategies and techniques in EL instruction. The program is offered as a unique hybrid instructional model combining online instruction by a university-based instructor, on-site school-based teacher professional learning community groups that meet to watch video-recorded lectures and complete assignments, and regular instructor visits to participant classrooms and group meetings throughout the program. The following is the description of the three major activities as presented in the syllabi for the courses. The first two components are the same for all three courses. The third component varies for each course:

> Weekly Consult, Elaborate, Confirm Exercises: to dialogue and collaborate (*consult*) with peers from professional practice as to consistencies of understanding about the instructional content of the video; to critically reflect upon, debate (challenges/strengths), and differentiate (*elaborate*) what they have learned from session content vis-à-vis

differentiated strategies for their own schools/classrooms; field-test key strategies and verify (*confirm*) the impacts of theory-into-practice applications upon the cognitive and academic growth of culturally and linguistically diverse students and other students.

Reflection Wheel Journals: to write two reflection journals using a theoretically sound, pragmatic format for process thinking and critical reflection on professional practice and professional development.

Course project: for the first course, to conduct an interview project with someone who has undergone immigration and an ethnographic report of the interview and their learning; for the second course, a linguistic case study of a child with integration of the key linguistic theories, concepts, and research; for the third course, a poster presentation of the implementation of the key strategies from the curriculum.

From the teachers in the program, four secondary science teachers were selected for in-depth case study analysis. I invited all eight science teachers among 39 teachers in the program. Six science teachers agreed to participate in this study; however, I did not include two teachers' data for this study because one teacher had no ELs in her class, and the other taught a support class for underperforming students in science and reading, which was different from other science classes. The four remaining science teachers included one female and three males. One male teacher and the female teacher taught at the middle school level, and two male teachers taught high school biology. Teachers ranged in experience from two to thirteen years in K-12 schools. One teacher was certified only in science from 6th to12th grade, while other teachers were certified in multiple subjects including social studies, language arts, and reading. Three of the teachers had held jobs and careers in the private industry. Table 1 shows the variety of personal background of the teachers. The diversity of settings and participants provided opportunities to explore a broad range of individual and school responses to ESOL endorsement training.

Table 1
Background Information of the Science Teachers

	Public		Private	School level		Gender		Ethnicity	Year	Qualification	Work experience other than teaching
	District			Middle (Grade)	High (Grade)	male	female	White			
	A	B									
James			*	* 8th		*		*	13	B.S.: Agricultural Science M.Ed.: Social Science Education	Corporation
Scott	*				* 10th	*		*	2	B.A.: Sociology M.A.T.: Teaching	Technician

										Secondary Social Science	
Brad		*			* 9th	*		*	3	B.S.: Biology & Ecology M.A.T.: Science Education	
Maggie		*		* 7th			*	*	3	B.A.: Middle Grades Education	Business

Data Collection

The teachers were followed for one and a half years as they participated in the ESOL program. This study includes three main sources of data. Ten to 20 class observations, each of which is 35 to 90 minutes long, were conducted with each teacher over the course of two semesters. Sixty to180 minute-long interviews with each teacher were conducted at the end of the second and the third semester. Data also included the teachers' completed endorsement course assignments such as their journals and classroom artifacts such as the hand-outs and quizzes for their own science classes. These main data sources were supplemented by three to five researcher visits to participants' professional learning community group meetings each semester, pre- and post-program surveys for each participant, pre- and post-program classroom observations of each participant using the Biography-Driven Protocol (Herrera, Pérez, Kavimandan, Holmes, & Miller, 2011; Pérez, Holmes, Miller, & Fanning, 2012), and aggregated student school record data.

Classroom observation. I conducted pre-program observations during the first semester, which helped me ascertain teachers' entering dispositions and assumptions regarding ELs and multicultural education. While the teachers took the second course, I observed each teacher's class for a week or two. While they took the third course, I observed each teacher's class for a week or two again. I intended to select the class of each teacher that contains the highest number of ELs; however, some teachers preferred that I come during a certain period, and I respected their requests. During all observations, I focused on how the teachers structured their science classes and adopted, resisted, or negotiated what they learned from the training in their instructional practices, such as including ELs' language and culture and integrating science instruction with English language development. I also looked at how contextual, curricular, and personal factors played into their uptake of the training. I sometimes engaged in informal conversations. I audio-recorded the classes and took field notes during the observations.

Interviews. I conducted two separate 60 minute to three hour interviews with the teachers. These interviews took place once at the end of the second course and once at the end of the third course. These were semi-structured interviews where I asked a series of questions about their reflections on the courses they took, their instruction, their EL students, their beliefs about science, science teaching, and ESOL teaching, and their efficacy/preparedness to work with EL and integrate science and English language development as a result of the training. These interviews revealed their dispositions and thoughts about ELs; their motivations to join the training; their

reflections on their courses, instruction, and ELs; any changes in their instruction and beliefs; and any external and internal factors that influenced their uptake of the training. I audio-recorded, transcribed, and coded the interviews.

Documents. The curriculum required the teachers to submit diverse assignments, including journals, discussion reports, a student interview project, etc., throughout the courses. The teachers submitted their assignments to the online course website, and I collected these documents to examine how teachers' perceptions of ELs and teaching of ELs evolved through the courses. I collected the document data from three semesters. These data also showed what the teachers thought of the information and activity in the curriculum by revealing how thorough they were in completing the assignments.

Others. An orientation survey, a pre-program survey, and a post-program survey were conducted. These surveys showed the teachers' initial dispositions towards and assumptions about ELs, their motivations and expectations for the training, their experiences working with ELs, and the overall impact of the courses. Pre- and post-observation rubrics showed their development in instruction for ELs. Quantitative school record data with indirect identifiers showed any changes in the academic performance of the teachers' students.

Data Analysis

The data were analyzed using qualitative multiple case study methods, in which each individual case study comprises a whole study, seeking "convergent evidence of the facts and conclusions for the case" (Yin, 2014, p. 59). Data analysis was recursive and inductive (Merriam, 2009; Pascale, 2011). All interview data were transcribed. The audio-recorded classroom observation data were selectively transcribed. I focused on how the teachers enacted their disciplinary identity and add-on ESOL teacher identity. Thus, in the classroom audio-recordings, I looked for the instances in which the teachers structured scientific practices, such as labs or hands-on activities, for clues regarding science teachers' disciplinary identities and later ESOL teacher identities, and for the instances in which the teachers made specific accommodations for ELs during the class for the practices of ESOL teacher identity.

The transcribed data, field notes, and notes from informal conversations were inductively coded using NVivo 10 software. I mainly used an attribute coding method to log essential information and characteristics of the teachers, their beliefs, and their practices, and the contexts, while simultaneous coding was also used since multiple codes were applied with qualitative data (Saldaña, 2013). During data analysis, I wrote analytical memos to reflect upon the data and relate emerging issues to research questions. While I coded the data, main themes and patterns were identified, and these emerging themes and patterns were verified and modified as new confirming or disconfirming data were found. The concurrent data analysis with data collection guided and reformulated the subsequent data collection.

In order to ensure the validity of the study, I used several tactics suggested by Yin (2014). For construct validity, I did not only use multiple data sources of evidence such as interviews, classroom observations, documents, and other supplementary sources, but also established a chain of evidence between a hypothetical conclusion, the specific data, the interview questions, and the research questions. For internal validity, I constructed explanations with the recursive process of

making a statement, comparing it with the findings, revising it, comparing the revision with other data, and revising. For external validity, I used two major theories about professional identity and boundary crossing to support my arguments.

Findings and Discussion

Data analysis yielded three main areas of themes. For one, it suggested that the science teachers displayed stronger identities as teachers in a general sense than they did disciplinary identities as science teachers. Then, I found that the teachers developed their add-on identity as ESOL/language teacher as a result of the new knowledge and skills obtained from the ESOL endorsement program; however, they were not yet transformed into science and language teacher. It became evident that they hardly enacted their hybrid identity in their classroom practices, and thus, I can argue that contextual adjustment and continuous support system is necessary for the teachers' successful transformation. Each of these areas will be further explored below.

Science Teachers' Professional Identity

The literature on teacher identity has focused on the traits of disciplinary specific identity and identity development (e.g., Luehmann, 2007); however, it has paid little attention to the traits of teachers who show the identity of a general educator rather than a subject teacher. The current study revealed new insights about science teachers' flexible professional identity in the areas of qualification, weak allegiance to a discipline, and beliefs about science and science instruction.

Qualification. In order to examine the characteristics of professional identity of the participating teachers, I first present their qualification. Table 1 above provides details on the four participant teachers identified from their applications and during the interviews. The literature on professional identity tends to assume that content area teachers have a significant degree of disciplinary socialization into the field of a specific subject (Siskin, 1994; Gutiérrez, 1998). Through pre-service teacher training of undergraduate majors and discipline-specific methods and participation in professional organizations, academic discipline is said to infuse high school teachers' professional identity and professional development throughout their career (Grossman & Stodosky, 1995). Notably, then, the current study found that only one teacher, Brad, has a degree in science, while the rest have neither an undergraduate nor a graduate degree in science. One middle school teacher, James, has a degree in agricultural science, which may provide him with some background knowledge in biology and environmental science. The other middle school teacher, Maggie, has a degree in middle grades education, which for her required only a few science courses. One high school teacher, Scott, does not have any degree in science or science education.

However, they all passed the state assessments for the certification of educators and are qualified to teach secondary science. The state-approved educator certification assessment program was developed by the state professional standards commission and a nationally well-known testing company. This test is a computer-delivered standardized test that individuals who want to teach at public schools and gain a credential in the state must pass. The test aims to help the state professional standards commission ensure that teacher candidates are equipped with the knowledge and skills needed to function as an educator in the state's public schools. This type of

test is typical in most U.S. states. The certification test offers science content assessment in four areas: biology, chemistry, physics, and middle grades science. Each assessment has two tests. The first test consists of 60 selected-response questions, which are 80% of the test score, and two constructed-response assignments, which are 20% of the test score. A group of content areas and topics are covered by the first test. The second test has the same format but covers different areas and topics. Teacher candidates must complete the examination within four hours. The minimum possible score is 100, and the maximum possible score is 300; the lowest passing score is 220.

Since the four participating teachers all passed the state-approved assessment, including those who did not have a degree in science, they all were confident that their credentials gave them adequate justification and preparation for teaching science. This confidence is demonstrated in Scott's comments on the autonomy that the teachers should be given in his school.

> You should have some autonomy. I mean you already proved that you can think, and we don't need job mastery. [The former school I worked in had] probably more rules, and just tighter constraints on the teachers, and I am not for that. (Scott, Grade 10)

Confidence is one important aspect of professional identity (Hobbs, 2013); however, teachers' confidence might be attributed to a lack of sophisticated reflection and interpretation of science education discourse. Hobbs (2013) noted that professional identity develops through "the interpretation or recognition of the participation" in the subject discourse and sociohistorical interaction with the subject (p. 275). It is unclear how the teachers in this study had participated in the discourse of science and the kinds of sociohistorical interactions with science they engaged in while they prepared for a standardized test for certification.

Weak disciplinary identity. In U.S. secondary schools, subject departments create a strong collective community, and members of the department share a distinctive discourse and beliefs about good teaching in their subject (Grossman & Stodolsky, 1995; Siskin, 1994). Deep divisions between departmental territories, in addition to strong allegiance to a department, often restrict the interdisciplinary approach of school reform efforts (Grossman & Stodolsky, 1995). Such divisions may also lead one to infer that a strong disciplinary science identity may make it difficult for teachers to adopt an additional identity as a language/ESOL teacher. Contrary to this assumption, the participating science teachers accepted a language teacher identity without strong resistance, which may have resulted from their identity as general educators rather than as science teachers who are committed to science. In response to the question of what they would say if they were asked what they do for a living, they answered:

> I tell them an educator. (James, Grade 8)

> I teach science. (Scott, Grade 10)

> My first response is I teach. That's it. I teach. If they really wanna know then, they will know I teach biology or whatever I happen to be teaching at that time, I teach biology, I teach environmental science, I teach earth system, I teach physical science, so I guess first from the most I consider myself a teacher and then secondly, a science teacher. (Brad, Grade 9)

> I spend my days with amazing, amazing kids all day long… I am a science teacher. I can teach English and reading because I passed the test. (Maggie, Grade 7)

Except Scott, these teachers tend to present themselves as "a teacher" instead of "science teacher." Maggie included the word "science," but also English and reading. This demonstrates that the science teachers who voluntarily participated in ESOL professional development have a flexible identity or strong identity as an educator rather than a strong disciplinary identity as a specific subject teacher.

Identities are shaped by knowledge and skills and constructed in relation to personal history, practices and communities, and a particular context, especially through the participation in social practices (Holland et al., 1998; Wenger, 1998). The teachers have multiple certifications. Three teachers, James, Scott, and Maggie, have degrees and certificates in social studies as well. Maggie even has language arts and reading certificates. Brad, with a degree in science, had worked as a writing tutor. Regardless of number and type of certificates, all the teachers teach the subject to which they are assigned. James was teaching science and history. Scott indicated that he was hired as a science teacher because there was very little demand for a history teacher. Brad was teaching biology that year; however, he was assigned to teach earth science the next year. Maggie taught language arts and reading in summer school. There are possibilities to teach something else than science. It has been argued that teachers' professional identity is mainly acquired from their academic subject area and the department (Helms, 1998; Little, 1993; Talbert, 1995) and that the subject teachers teach plays an important role in their thoughts about "what kind of person they are and what kind of person they want to be" and attempt to connect between discipline and other part of their lives (Helms, 1998, p. 830). Unlike this argument, the science teachers' personal and educational background, knowledge and skills from multiple certifications, participation in teaching various subjects, and contingencies of subject assignments influenced the science teachers' identities as general educators first, and then, as teachers of whatever they happened to teach, rather than being loyal to one discipline. Therefore, the participation in the ESOL professional development and earning of an add-on certification led them to re-craft their original professional identity and form a new professional identity (Battey & Franke, 2008). Given their flexible identity or strong identity as an educator without necessarily committing to one discipline, they were more likely to adopt an add-on identity along with an add-on certification.

Beliefs about science and good science teaching. In relation to the teachers' rather weak disciplinary identity, they tended not to attend very much to disciplinary precepts and standards for good science instruction. Teachers' identity includes their "relationships to [their] students, the classroom community, the discipline, and representatives of the school administration" (Enyedy et al., 2005, p.72). As discourse identity stems from the discourse or dialogue of other people (Gee, 2000), teachers' identities are constructed and upheld through discourse and dialogue about students, content, and teaching (Battey & Franke, 2008). Accordingly, the teachers' language practices about their profession "both hold the acceptable identities for teachers and carry the important knowledge, skills, practices, and value for teaching" (Battey & Franke, 2008, p. 129). Therefore, the teachers' identity as a general educator rather than a science teacher is closely related to what they discussed about science and good science teaching.

Both of the two high school teachers, Brad and Scott, mentioned that science is very strict and clear. They referred to this belief by using phrases such as "less grey area," "cut and dry," and "fact-based." Brad, the teacher with the strongest background in science, asserted that there is a "difference between how they [the students] are engaging with science and how a scientist does." This view is in conflict with the vision that the Next Generation Science Standards (NGSS) has articulated (National Research Council [NRC], 2011). This new standard aims at moving away from "detailed facts or loosely defined inquiry" (Lee, Quinn, & Valdes, 2013, p. 223). The Framework for K-12 Science Education, which was developed by the NRC of the National Academy of Sciences before the creation of the NGSS, strongly stated that students need to understand scientific and engineering core ideas by "engaging in the practices of inquiry and the discourses by which such ideas are developed and refined" (NRC, 2011, p. 218). The eight essential practices are 1) "asking questions (for science) and defining problems (for engineering)," 2) "developing and using models," 3) "planning and carrying out investigations," 4) "analyzing and interpreting data," 5) "using mathematics and computational thinking," 6) "constructing explanations (for science) and designing solutions (for engineering)," 7) "engaging in argument from evidence, and 8) "obtaining, evaluating, and communicating information" (NRC, 2013, p. 1). According to the quotes below, the two high school teachers do rarely provide opportunities for engaging in argument from evidence or obtaining, evaluating, and communicating information, and they do not think that these practices are feasible in a high school level science classroom.

> In biology, you do have less grey area for value judgment or ethics, so it is more strict. You don't have as much conversation point. It is so fact-based. (Scott, Grade 10)

> Science is a competition of ideas and it's very fierce and if your opinion has no basis in evidence, then your opinion doesn't matter. And for these kids, they don't have a whole lot of information or a whole lot of prior experience with science, so what I have found is that generally their preconceived notion or their opinions don't matter much.… So it's hard for me to communicate that kind of difference between how they are engaging with science and how a scientist does, I guess. (Brad, Grade 9)

James and Maggie, the middle school teachers, have a slightly different view of science. They pointed out the nature of hands-on activities and exploration in science:

> … [Science] gives them something tangible, something they can really put their hands on … they can do the experiments. They can actually have that hands-on experience of it. (James, Grade 8)

> I think it's most unique about science is the exploration aspect of it… in science you learn about the eco system, I can take you outside. I can pull up a rock … you are able to incorporate everything outside. You are able to see it and explore and feel it and taste it, experience it, and I think science is different because you know if you don't know, it's for field trip. Go look. (Maggie, Grade 7)

This exploration aspect of science described by James and Maggie does not fully match with what the NRC has envisioned through the NGSS either; however, middle school science classrooms seem to have more room for asking questions, engaging in argument from evidence and obtaining,

evaluating, and communicating information compared to high school science classrooms.

The beliefs regarding high quality science teaching and being a good science teacher are related to their identity as a general educator rather than as a science teacher as well:

> I think that a good science teacher is someone who's constantly pursuing better ways to teach, better understanding of materials so both pedagogy as well as the content. (James, Grade 8)

> Great science teacher is someone who is able to take questions, "I don't know. Let's find out." And you explore with kids… Just not giving up and trying…high quality science teacher is … being descriptive, being patient… offering as much support as possible. (Maggie, Grade 7)

> I would say a good science teacher is first and foremost to put students at ease. Because when they enter a science or math classroom, they're more, I guess, opposed to enjoying the class. …. first off, putting them at ease and letting them understand that what they are gonna learn in the classes is actually pretty easy, and showing them that anyone can learn, then, they will help put them at ease, and just making it fun. (Scott, Grade 10)

> I think a good science teacher probably has the same characteristics as has a good history, English, or math teachers. Someone is aware, managing the class, organized, productive, that sorts of things. (Brad, Grade 9)

Identity is formed by a discursive process in which talk about actions is translated into talk about states such as "*being* and *having*," and vice versa (Sfard & Prusak, 2005, p.16). This narrative and discursive nature of identity implies a self-prophecy effect, meaning that teachers tend to act like who they say they are (Holland et al., 1998). In addition, as a mediating tool (Enyedy et al., 2005), identity affects teachers' decision making about what knowledge to use and what classroom practices to implement. Their descriptions of the nature of science, high quality science teaching, and good science teachers reveal their identity as general educators rather than as science teachers and as traditional science teachers rather than as reform-minded science teachers, which are likely to lead to their actual teaching in the same way.

Each teacher has a different background in science and science education; however, all have quite similar beliefs about science and high quality science instruction, which are not those mandated in the science standards. Even Brad, the teacher with the most education and research experience in science, thinks that what a scientist does and what high school students need in a science class are different, and his thoughts about science teaching are similar to those of the other teachers who do not have strong science research backgrounds. Their identity as educators rather than science teachers might be malleable enough to be extended and reshaped; however, their quite traditional view of science, which does not value the aspect of communication, does not help them to construct a new practice generated at the boundary between the domains of science and ESOL.

Add-on Language/ESOL Teacher Identity

The field of teacher identity covers a broad range of topics about the disciplinary identity of subject teachers (e.g., Helms, 1998; Little, 1993; Talbert, 1995); however, few research studies have addressed new hybrid identity added onto their original disciplinary professional identity. This study addresses this gap by exploring how the add-on certification through professional learning affects the teachers' add-on identity development.

To better understand how science teachers develop extended professional identities, I theorized content area teachers' ESOL professional learning and teaching as a boundary crossing event. I employed Hobbs' (2013) BBF Model. The model suggests three groups of factors influencing identity construction: contextual factors, support mechanisms, and personal resources.

Contextual factors. The contextual barriers the teachers addressed include extra-curricular responsibilities, time constraints, standardized tests, block scheduling, lack of resources and funding, and an excessive number of standards. By hindering successful boundary crossing, these barriers prevented the teachers from making science class more culturally and linguistically responsive. The following quotes describe each barrier:

> So it is hard. Mostly the barrier is finding the time. Because we really can't do anything more than we are doing, so I gotta be more about changing what it is we were doing, I guess, more accommodate, more specifically address ELL [English language learner] students. But time is the main thing. Feel like I don't have time for anything. (Brad, Grade 9)

> Our barriers are always resources, funding, a lot of like we were talking about like audio and stuff like that, art, science book. We don't have a lot of resources. Most of what we teach, most of what we give the students, we make ourselves… There's not a lot of support for activities and worksheets or whatever… Not having the technology. Having to create everything. That's barriers. (Maggie, Grade 7)

However, they also mentioned several contextual supports that ease their boundary crossing such as colleague support, flexible and supportive administrators, and instructional freedom.

> I think we are very fortunate here our school. We have flexibility to incorporate language learning in as part of overall holistic approach to education… I think that's been the benefit. (James, Grade 8)

> Institutional[ly], I do have a fair amount of freedom in this classroom as far as what goes on, what I want to teach, how I want to teach. I do use, have a lot of freedom here compared to other places I have seen. So I appreciate that. So when I do have students, identify their needs, I know that I will have the freedom to implement kind of what I want. So that's good. (Scott, Grade 10)

As seen in the above quotes, the contextual barriers and facilitators created limitations and possibilities for the science teachers to construct their add-on identities and enact their identities

in their classrooms by influencing the availability of a range of supports and professional learning opportunities.

Support mechanisms. Hobbs (2013) found that support mechanisms are vital for safe boundary crossing. She stressed that support mechanisms should be continuous over time and targeted at the teachers' needs in order for the boundary crossing to lead to genuine professional development and identity development. She listed examples of support mechanisms such as instructional coaches and supportive materials that the school provided to the teacher who teaches out-of-field. She also found that the teachers sought opportunities for professional development, collegial help, and other external support. Findings in this study confirm the importance of support mechanisms. For example, one teacher, Maggie, found collegial help from an ESOL teacher at her school:

> I got on [Miss Taylor] who also teaches ESOL, and we worked together. We are like "Yes, let's rewrite this question even if just like one word, or just shorter phrase, or more descriptive phrase," depending on what it was. I mean they [ELs] were more successful because of that. (Maggie, Grade 7)

In his study on teachers' cognition, Borg (2003) argues that contextual factors determine the extent to which teachers actually practice what is congruent with their beliefs. The contextual factors and support mechanisms that the teachers found at school determined whether they pursue further professional development and the extent to which they enact what they learn from the ESOL endorsement program.

Personal resources. Hobbs (2013) pointed out personal resources as one group of factors that influence teachers' boundary crossing. One resource is adaptive expertise such as teachers' ability to cope with situations where they have to teach ELs. Before the teachers sought professional development and joined the program, they had already been teaching a number of ELs. Brad even had taught a sheltered biology class without any training when he started teaching. In the interviews, Brad mentioned his adaptive expertise:

> I found that it was okay. I mean you learn pretty quickly what sorts of vocabulary they are not gonna know… So just paying very close attention to what you are saying, how quickly you are saying it, that kind of thing. (Brad, Grade 9)

Another personal resource to help the teachers' boundary crossing is teacher knowledge. The ESOL endorsement program in which they participated provided a good amount of knowledge and strategies that allowed them to adapt their instructions for ELs. Except Scott, who was urged by his assistant principal, all teachers participated voluntarily in this ESOL endorsement program. Since they were already teaching ELs in a context where there is a large Latino population and have a greater chance of teaching more ELs in the future, they felt a need to get ESOL training and teach ELs better. What motivated them to participate in the program was to learn more strategies to help ELs in order to serve lower level ELs. They all thought that generally the courses were helpful to equip them with the knowledge and skills they need. They specifically pointed out the most insightful ideas they learned:

> [Basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP)] was really, I guess that was important for me to learn, something I really need to hear, because I don't think it matters that I teach science but you talk to students, hear them talk all the time, and because they seem literate but it doesn't mean they are. I think it helped me reexamine my expectations of students that seem capable of using English effectively because that might not be true. (Brad, Grade 9)

> I a lot more speak slower. I repeat often. I have a lot more visual aids. I ask "do you understand" more … I am more repetitive. I try different things. I will say the same thing eight different times because I know that they need that. I've always had multiple. I understand the kinesic learner, visual learner, and auditory, but with language learners, every single child is all of the above. (Maggie, Grade 7)

> I let the [students] kind of working in their own language as long as they always know that that helps them when they come back in English. (James, Grade 7)

Confidence and commitment is also one type of personal resource that teachers can bring to their boundary crossing event. Having confidence in the knowledge and skills to teach ELs appeared to be one factor that determined the degree of successful boundary crossing. Confidence is drawn from self-assessment that they are equipped with sufficient knowledge of content, strategies, and their learners. The science teachers were seen gaining confidence through participating in this program. As a result of the ESOL professional endorsement program, all teachers said that they are more prepared and confident to teach ELs. They assessed their preparedness on a scale of 1 to 5:

> I will go 5… I feel much better than I did before. So based on where I had been, I feel I am definitely around 4 now, because I feel much more equipped and knowledgeable about how to reach out to apply some things… (James, Grade 8)

> Oh, I think I'm 5 compared to say other biology teachers. I'd say 5. (Scott, Grade 10)

> I think I probably would've said 2 or maybe 3 to begin with, so I would say I feel better prepared to do it. And a lot of it, maybe some of it just validation. I was doing some of the things already. I didn't know specifically they were beneficial to ESOL students but now I know that this is what I need for them, whereas before I was just using my best judgment. So I think I do feel better prepared or at least more, I definitely feel more confident in doing it. (Brad, Grade 9)

Teacher commitment was demonstrated as "seeking better ways to engage students, devoting time to planning and showing an interest in the subject" (Hobbs, 2013, p. 290). Darby (2007) stated that teachers' commitment can appear to be a passion for students, for the subject, and for engaging students in the subject. In this study, the teachers displayed their commitment to serve ELs; however, the degree of commitment became even stronger upon the completion of the program.

> Having to do with all [whose] language is not their first language and so that's always been something that has been in my heart to wanna improve and do. (James, Grade 8)

> I think mostly just I feel for them. I think that helps my classroom because it gives me more patience with them. (Brad, Grade 9)

> Those duties, you know, that advocacy thing again, that was a big one. And that's something I did not stress. I haven't even really thought about before this program. (Scott, Grade 10)

> I said, "I wanna be ESOL next year," and he [the principal] said, "Well, I don't know who I have in ESOL." I said, "I always want to be in this type of environment. This is where my heart is." (Maggie, Grade 7)

They started to see themselves as language/ESOL teachers and were willing to teach ESOL classes and try out what they learned from the courses. The extension of identity as language teacher is closely related to their knowledge, confidence, and commitment. As a result of the participation in the ESOL endorsement program, they all admitted that they have a new professional identity as ESOL/language teacher in them.

> Learning our duties as the primary ESOL teachers. To me, that was a big deal. (Scott, Grade 10)

> I do want to be an ESOL teacher. I do think of myself as an ESOL teacher. (Maggie, Grade 7)

> It adds another layer to it. You know. You are now a language teacher as well. (Brad, Grade 9)

> I haven't really. I feel like I am growing into that… And I guess I have been very pleased to share with others over the last 18 months and that I am learning to be a teacher of students learning the English. I think that's been an ESOL part, has been something that I am working toward, but I guess I haven't really concerned myself having achieved that yet, but I guess the courses are over so maybe I can. (James, Grade 8)

The context where the teachers were working has a large and growing EL population, and the teachers are likely to teach more ELs. This context provides them with a strong pedagogical imperative to gain adequate knowledge and skills to serve ELs. The confidence and commitment in addition to knowledge and skills facilitated their add-on identity development. Also, the contextual factors and support mechanisms that eased their boundary crossing also helped them to add another professional identity successfully.

No Transformation, Yet

Even though the teachers developed a new professional identity, this does not mean that they enacted their identity in their pedagogical practices. The theoretical concept of boundary crossing has been researched in cultural historical activity theory on expansive learning

(Engeström, 1987) and situated learning theory on communities of practice (Wenger, 1998); however, it has not been used to elucidate content area teachers' experience of earning add-on certification. Since add-on certification is becoming common in the U.S. K-12 setting, there needs to be much more work in this area, which this study addressed.

Transformation, one of the four mechanisms that creates the learning potential of boundary crossing, is employed to understand the mismatch between professional identity and practices. Akkerman and Bakker (2011) noted that transformation results in significant changes in practices and potentially creates a new, in-between practice, which they call a boundary practice. Transformation involves a series of processes, starting with confrontation of problems or deficiencies that cause people at a boundary to rethink their practices (Akkerman & Bakker, 2011). While teaching ELs, the teachers felt they lacked the knowledge and skills to work with them. At the boundary between ESOL and science teaching, they reconsidered their current practices and interactions with ELs as well as the difficulties that ELs have in science classes.

> I have realized that I don't know nearly enough about how to identify and address [race issues] in a classroom, and I am hoping to learn more throughout the course of this program. (Brad, Grade 9)

> Academic vocabulary. I think the biggest hurdle they face is comprehending test questions because of the way that they are worded with all of the academic AND content vocabulary that is all loaded with, and just having the ability to pick a part those questions, especially like EOC [End of Course test] style questions are written without any regard to literacy of the students. What I think about them the most is their inability to comprehend the questions on a test. (Brad, Grade 9)

This confrontation with problems led to recognizing a shared problem space, which can be a form of boundary object. While the original conception of boundary object (Star, 1989) is mediating artifacts between two activity systems, Engeström (2001) later described it as "the potentially shared or jointly constructed object" (p. 136) between two activity systems. In this study, boundary objects are closer to the latter view, which is a space for culturally and linguistically responsive science teaching and making accommodations for ELs. Throughout the coursework, the teachers understood the value of multiculturalism, the characteristics of ELs, and useful strategies to make their science classes more culturally and linguistically responsive by incorporating culture and language lessons. The teachers' recognition of the space for implementing what they learned is the second stage of transformation (Akkerman & Bakker, 2011). All teachers made room to incorporate language learning opportunities by allowing students to use their native languages, using cognates, or accommodating test questions such as providing a word bank or reducing the choices for multiple choice questions. However, in terms of incorporating ELs' culture, while the high school teachers did not create space for bringing in culture in science, the middle school teachers thought that culture could be included in all topics in science if a teacher makes the effort.

> That's a huge challenge. The culture thing is a big challenge for me. I mean, there's not a lot of room for that in science standards, and I am always thinking. It's always in the back

> of my head when I am hearing about how I need to incorporate culture into my lessons that you know science kind of transcends culture to an extent. (Brad, Grade 9)

> What makes incorporating culture hard, it's just you don't try to do it. I really believe that. We talk about genetics and heredity in science. Let's research and find out where your families are from, find out why you look like your uncle, Steve. You are gonna find biomes all over the world. You are gonna find people all over the world. They talk about melanin, which makes have, you know, different color skin, and then we talk about hair, protects skin from ultraviolet rays, and then that's where we can bring in different culture. (Maggie, Grade 7)

The third process of transformation is hybridization, in which a new hybrid form emerges at the boundary (Akkerman & Bakker, 2011). In this study, hybridization is manifested as a form of the science teachers' hybrid identity as science and language teachers in terms of new practices of ESOL science instruction and new thoughts about ELs. These quotes describe the hybridization:

> I think maybe my level of empathy has increased. I don't know maybe it is not the best attitude I have, but I see students, they come to me essentially as equal and I am gonna treat them as if they were equal. But when I think about my ELs now, I think more about their history and their background and where they have been and how much more difficulties for them to do basic things like read paragraph and answer questions about it because of their lack of background of our language. (Brad, Grade 9)

> I think I became more passionate because now I understand why things are the ways are, and how to support more… I think the only way that my content will work is if I can help them with their language… I realize that what was gonna keep him [an EL], the focus, wasn't on the content… They may need to learn more about how to structure sentence, *the cat ran over to the hill* more so than *the cat is mammal* whatever, but my job is to teach how to communicate in day-to-day life. (Maggie, Grade 7)

The fourth process of transformation is the crystallization of the newly created hybrid form (Akkerman & Bakker, 2011). In other words, the hybrid form at the boundary needs to be incorporated into practice and reified as a boundary object, which is a shared or jointly constructed object. In addition, in this process, "new routines or procedures that embody what has been created or learned" are built (Akkerman & Bakker, 2011, p. 148). In this study, one form of evidence of crystallization would have been the science teachers' enactment of professional learning as a routine. Even though crystallization is considered very important, there have rarely been many empirical findings (Akkerman & Bakker, 2011); similarly, this study did not find solid crystallization of learning at the boundary.

Mismatch between their professional identity and practice. The data revealed that the science teachers had not been transformed into science and ESOL teachers due to the absence of the crystallization process. They indicated that they recognized themselves as language teachers and advocates for ELs in their schools. In addition, they evaluated themselves as being well equipped with knowledge about the language acquisition process, characteristics of ELs, and strategies to help them. They stated that they were confident and prepared to teach ELs and willing

to have more ELs in their classrooms. However, their hybrid identity as boundary crossers was not fully evidenced in their actual classroom practices. They provided language learning opportunities such as reading and writing activities in science classes; however, they rarely gave linguistic feedback to ELs. Brad had a special education (SPED) paraprofessional (parapro) who made the most individual accommodations for ELs and SPED students. Maggie had an ESOL parapro who also took the majority of the responsibility for ELs. Moreover, even though they indicated that they were now language teachers, they explicitly said that they do not comment on English but only content since they are not English teachers. Furthermore, they were reluctant to give linguistic feedback because they are "science" teachers and feel obligated to focus on content.

> If I have a student, this maybe, doing well with their choice of words, and understanding content, but their syntax is all, you know, [wrong], I am not gonna stress over that. I am not making mention to it… If they understand the material that's what I wanna see. (Scott, Grade 10)

> With spoken language, it's harder for me because I know you are not supposed to correct them like little conventions of language that they are getting wrong. I never did that anyway because it was never really the point anyway for science. If your grammar, your spelling is wrong, I never worried about that. So I don't really know how I would provide feedback to that because I know that the micromanaging their language is not really what you are supposed to do. (Brad, Grade 9)

Hobbs (2013) found that some of her participants easily embraced a new professional identity of "in-field" because they were satisfied with maintaining traditional approaches. On the other hand, others felt "out-of-field" because they felt a deficit of knowledge regarding how to engage the students. The science teachers who adopted a language teacher identity in this study did not intend to perpetuate traditional teaching methods for ELs. Rather, standardized tests and time constraints on covering standards prevented them from engaging with the crystallization process. The teachers were under heavy pressure to cover all standards to prepare their students for the tests. Even though the NGSS requires rigorous literacy skills, standardized tests have not been developed to reflect the standards. The standardized tests for biology have only multiple choice questions, which discouraged them from implementing more reading and writing activities and providing substantive feedback on ELs' English development.

> That's hard because their knowledge of standards is not assessed based on their literacy. It's what it is. But it's they are not writing or speaking. They are taking EOC, which is multiple choice questions. So it is hard for me sometimes justify evaluating their language. So that is difficult to do. (Brad, Grade 9)

> It comes down to the quality of that feedback really deals with my time. I mean it truthfully, you know as far as the time I have to grade and to give feedback, that would definitely be the best. (Scott, Grade 10)

In addition, since they had either SPED or ESOL parapros in their classrooms, they did not see themselves as primary ESOL teachers or ESOL experts despite their completion of the program.

> They [ELs and SPED students] do have the coteaching which, when I have one, the accommodations for those two groups are pretty similar. So I lump them together. (Brad, Grade 9)

The last two processes of transformation, "maintaining uniqueness of the intersecting practices," and "continuous joint work at the boundary" (Akkerman & Bakker, 2011, p. 149), should be built on crystallization of new boundary practices. Therefore, without the crystallization process, the last two processes are unlikely to be expected to occur in the teachers' classrooms. For lasting transformation, with a basis of a new routine of ESOL practices embedded in science classrooms, the teachers may need to find a balance between the creation of a hybrid form and the maintenance of the integrity of both science and ESOL. Furthermore, even though one teacher had asked for an ESOL teacher's help and made efforts towards collaborative work, for more productive boundary crossing, the teachers may need sufficient and on-going systemic supports for genuine dialogue and collaboration with ESOL professionals.

In all, then, this study suggests the usefulness of extending Hobbs' (2013) model and Akkerman and Bakker's (2011) transformation mechanism as theoretical lenses for examining science and other content-area teachers' experience with ESOL endorsement program. This study found that the teachers developed their add-on identity as ESOL/language teachers by gaining new knowledge and skills obtained from the ESOL endorsement program and confidence and commitment to support ELs, as well as adaptive skills to deal with challenging situations. In addition, they negotiated the contextual barriers and facilitators in order to incorporate the new knowledge and skills. They also looked for and created support mechanisms to develop and modify their instruction and assessment further.

However, the teachers have neither practiced their identity in their science instruction sufficiently and routinely nor yet been transformed into both science and ESOL teachers. According to the six processes in the transformation mechanism at boundaries that Akkerman and Bakker (2011) proposed, these teachers demonstrated that they had undergone the first three processes –confrontation, recognition of a shared problem space, and hybridization – but not the fourth process, crystallization, and beyond. The incongruence between their indicated new identity and their classroom practices calls for contextual adjustment, such as sharing responsibility for ELs with parapros and a modified assessment system that emphasizes scientific language and literacy.

Conclusion and Implication

This paper provides a platform for understanding science teachers' entry into the ESOL field as a boundary crossing event and its effects on their professional identity and classroom practices. Based on their qualifications and their beliefs about science and science education, the four science teachers had a weaker disciplinary identity as science teachers than was expected and had a stronger identity as general educators. The participation in the long-term ESOL endorsement program equipped them with the necessary knowledge, skills, and dispositions to work with ELs. With a flexible identity as educators, extensive professional learning, and confidence and commitment to EL education, they indicated their willingness to adopt an add-on professional

identity as ESOL/language teachers. However, their new hybrid identity did not match with their classroom practices. They insisted on their science teacher identities and were reluctant to take a major role as ESOL teachers in their classrooms, partly because they had assistants who relieved them of their responsibility and accountability for ELs and partly because of time constraints and the absence of literacy demands in standardized tests, which limited their attempts to provide substantive language instruction.

In order to overcome a discontinuity between their self-reported professional identities and their practices, Hobbs (2013) suggested that professional development take an individualized approach and identify where the discontinuity appears when a teacher crosses a boundary and what supports need to be provided. The support needed can be knowledge, strategies, commitment, or aesthetic appreciation (Darby, 2007). Likewise, in order for the science teachers' add-on professional identity of ESOL/language teacher to be enacted in their classrooms, professional development needs to be more targeted at and focused on individual teachers' needs and contexts. In addition, teachers need opportunities to interpret and recognize their professional learning and classroom practices instead of just participating in the training program and teaching ELs. Teachers will only continuously interpret and recognize their learning if professional development is not simply disjointed, one-time events, but builds continuous support systems. Battey and Franke (2008) suggested that professional development programs must provide ways to help teachers renegotiate new identities and practices with pre-existing structures and norms. To avoid superficial changes and lead to genuine transformation, teacher educators should help teachers to reconstruct and make a new relationship with already established content, practice, and norms. In addition to on-going support and reinforcement, the findings suggest that real transformation of science teachers into science/language teachers can take place by contextual adjustments. The teachers will be motivated to generate new practices at the boundary between ESOL and science domains and incorporate their boundary practices into their instruction only if they receive some form of incentives for their efforts and successes, such as improvement in students' outcomes on tests.

Last, one teacher mentioned that he learned how to teach ELs quickly when he taught sheltered classes prior to receiving any specialized training. In order to attract more educators to ESOL professional development, teacher educators need to develop more informative and meaningful content instead of repeating what teachers think they already know and do. Thus, it is vital to do research on how the curriculum of professional development programs is different from what highly committed and effective teachers instinctively know.

This study looked at a small group of educators in one Southeastern community. Science educators in settings with different credentialing requirements or with other supports/hindrances in place would not experience ESOL professional development in the same way. Future studies could look more broadly across science educators.

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