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From Experiences to Beliefs: An Exploratory Case Study on Science Teachers' Attitudes Towards Emergent Bilinguals

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FROM EXPERIENCES TO BELIEFS: AN EXPLORATORY CASE STUDY ON SCIENCE TEACHERS' ATTITUDES TOWARDS EMERGENT BILINGUALS

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ABSTRACT

Emergent bilingual (EB) students in the US are those who are in the process of developing academic English proficiency. EBs are some of the fastest growing populations of students in American public schools. There exists a great deal of research geared towards developing both curricular resources and instructional strategies to best support EBs in the science classroom, however many of these professional development studies lament the lack of growth in terms of achievement in science learning outcomes of EBs. It is possible that due to a lack of transformation in their beliefs that the teachers in these studies do not effectively implement the curricular and instructional strategies.

This exploratory multiple case study explored the personal transformative learning experiences of five science teachers. These science teachers self-identify as having experienced transformative learning which influenced their attitudes and beliefs towards EB students. Through in-depth interviews, I uncovered the salient aspects of their transformations as well as the barriers and resources involved in their transformations. I found three salient aspects of their TLEs: 1) the disorienting dilemma of inexperience, 2) the role of mentorship in the transformation of beliefs, and 3) the essential presence of EBs in transforming the sociolinguistic meaning perspective. I also found the following barriers and resources involved in their TLEs: 1) the barrier of time, 2) the barriers of language and culture, and 3) the resource of expert guidance. This work aims to impact both research and professional development in science education geared towards improving achievement for EBs.

ABSTRACTO

Estudiantes bilingües emergentes (EB, por sus siglas en inglés) en los Estados Unidos son aquellos que están en proceso de desarrollar habilidades académicas en inglés. Los EB son una de las poblaciones de estudiantes de más rápido crecimiento en las escuelas públicas estadounidenses. Existe una gran cantidad de investigación orientada a desarrollar recursos curriculares y estrategias instructivas para apoyar mejor a los EB en el aula de ciencias; sin embargo, muchos de estos estudios de desarrollo profesional lamentan la falta de crecimiento en términos de logros en los resultados de aprendizaje científico de los EB. Es posible que debido a la falta de transformación en sus creencias, los maestros en estos estudios no implementen de manera efectiva las estrategias curriculares y instructivas.

Este estudio de caso múltiple exploratorio investigó las experiencias personales de aprendizaje transformador de cinco maestros de ciencias. Estos maestros de ciencias se identifican a sí mismos como personas que han experimentado un aprendizaje transformador que influyó en sus actitudes y creencias hacia los estudiantes EB. A través de entrevistas a fondo, descubrí los aspectos más destacados de sus transformaciones, así como las barreras y recursos involucrados en sus transformaciones. Encontré tres aspectos destacados de sus experiencias de aprendizaje transformador: 1) el dilema desconcertante de la inexperiencia, 2) el papel de la mentoría en la transformación de creencias, y 3) la presencia esencial de los EB en la transformación de la perspectiva sociolingüística del significado. También encontré las siguientes barreras y recursos involucrados en sus experiencias de aprendizaje transformador: 1) la barrera del tiempo, 2) las barreras del idioma y la cultura, y 3) el recurso de la orientación

experta. Este trabajo tiene como objetivo impactar tanto en la investigación como en el desarrollo profesional en educación científica orientado a mejorar los logros para los EB.

DEDICATION

To my soulmates, Abbey & Axel, thank you for putting me back together when I fell apart. You are my light in the dark; without you, I am lost. I dedicate this dissertation to you.

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To my committee chair, Dr. Jeff Marshall, most days while writing this manuscript, I wish I had never bumped into you in the dairy aisle. As I write this today…I am beyond grateful that I did. Thank you for never giving up on me. To my ostensible committee co-chair, Dr. Brooke Whitworth, thank you for saving my academic career. You took a chance on me before you ever met me, and I will never forget that. To Drs. Megan Che, Luke Rapa, and Matt Voigt, thank you for your patience as I crawled towards my defense. Your offense was great, but your guidance was greater.

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CHAPTER 1: INTRODUCTION

Background

Among the six guiding principles for the development of A Framework for K-12 Science Education (2012) is the principle of *promoting equity* (NRC, 2012). The NRC (2012) describes the principle of *promoting equity* in the following way:

> The research demonstrates the importance of embracing diversity as a means of enhancing learning about science and the world, especially as society in the United States becomes progressively more diverse with respect to language, ethnicity, and race. (p. 29)

The Next Generation Science Standards (NGSS) based on this framework establishes the importance of making the NGSS accessible to all students. In a chapter titled *All Standards, All Students* (Achieve, 2013) the authors recognize the increased cognitive expectations for *all* students which are inherent to the NGSS. These types of applications, understandings and connections were previously only expected of "advanced," "gifted" or "honors" students. Science teachers now face the challenge of standardizing high expectations for all their students.

This challenge is especially difficult to overcome for the population of emergent bilinguals (EBs) in the science classroom. These are students who vary widely on a range of English proficiency and have a native or heritage language other than English at home. Many researchers in the domain of science pedagogy with EBs express concerns about the language intensive nature of the NGSS. Without thoughtful and intentional consideration from the teacher, the NGSS can prove to be untenable. A great deal of work has been done recently to uncover the practices most effective for supporting this population of science students. One such publication is the conceptual framework proposed by Lee (2019). This framework integrates both science

design principles and language design principles, streamlining the process for teachers to develop NGSS-aligned instructional materials to support all students. Lee writes, “the conceptual framework highlights the mutually supportive nature of science and language instructional shifts with [EBs]” (Lee, 2019). The framework was developed with a mix of both quantitative and qualitative data in the form of design-based research to achieve “...the dual goals of the development of theory and the improvement of instructional design” (Lee, 2019, p. 319). This framework attempts to provide very valuable support by meeting the demands of many teachers to incorporate the NGSS in their classroom while the population of EBs continues to grow in the US.

The belief-knowledge and belief-practice relationships have long been examined in the teaching profession (Nespor, 1987). Although the exact mechanisms through which beliefs influence practice are still debated, the effect beliefs have on student performance outcomes is widely documented (Rosenfeld & Rosenfeld, 2008). Mainstream (or general education) teacher beliefs regarding EBs are shaped by several different factors. The most salient of these factors is experience with racial and cultural diversity courses during their teacher preparation programs (Lee, 2004). In a study published by Flores & Smith (2009) they discuss this when writing, “teacher candidates need assistance to engage in diversity issues throughout their teacher preparation with the integration of culturally relevant pedagogy into all coursework” (p. 350). Cho & McDonnough (2009) also found that high school science teachers found it challenging to support EBs due to a lack of pre- and in-service training to specifically support that population of students. Lastly, Huerta et al. (2019) examined attitudes of science pedagogy towards EBs from science teachers across the elementary and secondary grades. They found the participants who reported to have received professional development specifically to work with EBs had attitude

scores that were statistically significantly higher than those that reported not having this type of training. I will theoretically frame the relationship between belief and attitude extensively in the following chapter as they are both constructs measured in this study. Additionally, I discuss the measurement of the attitude construct briefly towards the end of this first chapter. However, for the purposes of introducing the broader aspects of this study consider the construct of attitude as comprising several interrelated beliefs which influence teachers towards specific actions or behaviors within the classroom.

Despite the growing research base for best practices to support EBs, there is an inherent obstacle to overcome regarding the negatively oriented attitudes and beliefs that teachers hold about EBs. Research indicates that even when teachers know the benefits of utilizing reform-based practices, their beliefs will often influence if and how they implement that knowledge within the classroom (Flores & Smith, 2009; Pettit, 2011). Mezirow (1991) frames the complex relationship between beliefs, experience, and practice in his theory of transformative adult learning. Mezirow (1994) asserts that adult learning is a "social process of construing and appropriating a new or revised interpretation of the meaning of one's experience as a guide to action" (p. 222). The meaning which adults make from learning is situated within broad meaning structures which are two dimensional. Mezirow (1991) describes the first dimension, the meaning perspective, as a "habitual set of expectations that constitutes an orienting frame of reference that we use in projecting our symbolic models that serves as a belief system for interpreting and evaluating the meaning of experience" (pg. 42). Meaning perspectives serve as a type of perceptual filter which assimilate one's past experience and transforms new ones. Additionally, Mezirow describes how meaning perspectives generate the second dimension of meaning structures which he refers to as the meaning scheme. A meaning scheme is the

"particular knowledge, beliefs, value judgments, and feelings that become articulated in an interpretation" (Mezirow, 1991, p. 44). Meaning schemes are the specific manifestations of meaning perspectives such as actions and interpretations. Mezirow (1991) argues that meaning structures, the perspectives, and schemes, can be altered but they require a unique type of learning he refers to as transformative learning. Transformative learning is a specific form of learning through which one transforms their meaning perspective. This transformation results in a new set of assumptions and actions based on newly formed attitudes and beliefs. I discuss Mezirow's theory of transformative learning in more detail in Chapter 2.

The Values of Labels: A Case for Emergent Bilinguals

One of the most complicated issues in American education today is how to best educate students who speak languages other than English (Bunch, 2013). This population of students is labeled differently based on the context in which they are being referenced. In the research literature these students are most commonly referred to as English Language Learners (ELLs), while state and federal legislative documents refer to them as limited English proficient students (LEPs). Each of these prevalent labels is problematic for their deficit focused language. To illustrate this, consider the emphasis and value attached to the English language when we as researchers use the label ELL. This label immediately washes away the heritage, language, and culture of this population of students as it does nothing to even recognize a pivotal aspect of their identity which is their native language. In fact, it places all the value and importance on the target language of English. As Garcia (2009) writes, "Categorizing children as LEPs or EPs is a dubious construction that misleads educators and that robs emergent bilinguals of languaging and educational possibilities" (p. 323). Indeed, a label should not immediately disqualify a student from participating in certain instructional activities, but unfortunately such deficit-minded labels

influence educators into making pedagogical decisions before ever even meeting their students. A label should not preclude.

In the U.S., these students speak over 400 different languages, and as is well established the link between language, heritage, culture, and identity is strong (Vygostky, 1978). Research with this population of students has shown that leveraging their cultural capital increases their achievement across the board (Brooke-Garza, 2015). If one of our goals as science educators is to enable and empower our students to achieve in science, then we are obligated to celebrate the diversity of our students by utilizing a more appropriate label, a label which is growth- or asset-minded. So, while there is nothing inherently malevolent about labeling these students as learners when using ELL, it ignores the value of the language they natively understand. An unintended consequence of labeling these students as learners is that in part it presumes that they have not yet learned a language. As an ELL you are a learner of English, ostensibly not yet a speaker of any language. This label also inherently places a large cultural value on the English language while devaluing other languages with their notable absence. Additionally, the United States has no national language, so why should a label make English its target language? The other commonly used label is far more troublesome. The deficiency inherent to the word limited is astounding. Labeling these students as LEP quite literally limits their apparent potential not only to their teachers but more importantly to themselves. While it may be accurate that their proficiency in English is limited, this label also does nothing to celebrate or even recognize EBs' cultural resources. A label should be more than just accurate.

In this study, I refer to these students as EBs. I will do this in the spirit of highlighting not just the value added from learning English, but also to celebrate the language, heritage, culture, and diversity of each of these students. The EB label acknowledges the proficiency they will

develop in English, while simultaneously emphasizing the bilingual skill they are working to achieve. The EB label draws emphasis away from the monolingual English-obtaining-goal, to the bilingual reality in which English is just a part. A label is important because for many teachers it is the very first way in which they interact with a student. Thus, a label should maximize a student's potential. Although a broader, more encompassing term may be the emergent multi- or translingual, the reality is many of the students the term emergent bilingual seeks to support are learning English as a second language (not third, or beyond). Additionally, the conversation surrounding the practical linguistics theory of translanguaging has only been invigorated within the past few years (Cenoz & Gorter, 2020). A movement towards the term emergent translingual is inevitable for two reasons: (a) it captures the practices of translanguaging which view language as a process rather than a politically and nationally defined entity (Li, 2018) and, (b) it captures all students learning English as an additional language. However, in full consideration of the current educative landscape and the cognitive and cultural load such a term as emergent translingual will carry, the term emergent bilingual will refer to any student learning English as an additional language within the context of this study.

Problem Statement

Linguistic diversity continues to increase in American public schools (NCES, 2020). Indicator 1.8 of the 2020 Condition of Education Report (NCES) reveals an increase not just in quantity, but also an increase in terms of proportion of emergent bilingual (EB) students. This critical population of students now makes up more than 1 in 10 students in the United States. They vary widely in terms of their native or heritage language; although almost 75% of EBs speak Spanish at home they also speak Arabic (2.7%), Chinese (2.1%), Vietnamese (1.6%), Somali (0.8%), Russian (0.7%), Portuguese (0.7%), Haitian/Haitian Creole (0.7%), & Hmong

(0.6%) among many others (NCES, 2020). Further, Lee & Buxton (2013) cite the NCES data in writing that this critical population of students has more than doubled in proportion from 10% to 21% of all school-aged children in the U.S. from 1989 to 2009. These data reveals that EBs are some of the fastest growing minoritized student population throughout the past few decades.

This trend in the student population complicates the state of science education in unique ways. For one, it coincides with a recent trend towards three-dimensional learning which is the cornerstone of the Next Generation Science Standards (NGSS) (National Research Council [NRC], 2012). Three-dimensional learning refers to the Science and Engineering Practices (SEPs), Crosscutting Concepts, and the Disciplinary Core Ideas. Together, these three dimensions make up the foundation of the Framework for K-12 Science Education. Of particular interest are the SEPs which can be interpreted as the literacies of science; in other words, they are the distilled practices of scientists and engineers in their profession. The SEPs also enable science teachers to create the type of situated learning environments championed by Brown et al. (1989) and Lave (1991).

The problem arises when one considers the increased linguistic demand when students enact the SEPs (Lee et al., 2013). Four of eight practices are particularly linguistically demanding: (a) asking questions: a practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested; (b) constructing explanations and designing solutions: the products of science are explanations and the products of engineering are solutions; (c) engaging in argument from evidence: argumentation is the process by which explanations and solutions are reached; (d) obtaining, evaluating, and communicating information: scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate - critiquing and

communicating ideas individually and in groups is a critical professional activity. These types of practices are more rigorous and demanding for all students in terms of both cognition and linguistics than the previous iteration of standards (NRC, 1996), but they are especially challenging for EBs (Lee et al, 2013; Lee et al., 2019).

According to the National Assessment of Educational Progress (NAEP, 2009) 67% of EBs in the 4th grade scored below basic proficiency in science; the same is true for 81% and 70% of 8th and 12th grade EBs respectively. EBs require unique support in order to generate better outcomes in terms of science achievement. Much of the research in this domain has surrounded professional development with an emphasis on curriculum and curricular materials to enable science teachers in reforming their practices to best support EBs (August et al, 2014; Echevarria et al., 2011; Llosa et al., 2016; Maerten-Rivera et al., 2016). Yet, mainstream teachers continue to feel unprepared to support EBs in their classrooms (Pettit, 2011). Beyond recognizing their lack of knowledge on how to best support EB students in their science classrooms, science teachers may unknowingly fall prey to their own beliefs and attitudes towards this student population. Reeves (2006) discussed how secondary teachers held misconceptions about how children acquire a second language. In their study examining beliefs, secondary teachers indicated that they believed EBs should be able to acquire English within two years, and that EBs should avoid using their native language as they acquire English. First, the research on language acquisition indicates that based on several different factors it could take more than seven years for children to acquire academic English (Cummins, 2000). Second, linguistic research also indicates the utility of not just maintaining but further developing one's first language to facilitate the learning of a second. These teacher beliefs which contradict the linguistic literature are likely to lead science educators to use ineffective teaching practices with

EB students. In fact, the specific belief that English proficiency must be a prerequisite to learning science in the general education classroom limits the types of instructional strategies a teacher may consider efficacious like student driven laboratory explorations. Better understanding the academic and professional experiences which influence various negatively oriented attitudes and beliefs towards EB students will better allow teacher education programs and policy makers to tailor the transformative learning experiences (TLEs) both our pre- and in-service science teachers desperately need.

Purpose Statement

This study addresses a gap in research that has failed to incorporate a transformation of science teachers' attitudes and beliefs as a key component of their professional development to support EBs. The purpose of this study is twofold:

1. Explore the unique TLEs of science teachers which influenced their positive attitudes and beliefs towards EBs. Positive attitudes are defined quantitively as scores on the belief rating survey that are at or above the mean, which can be found in Appendix A. The subsection below will describe what these survey items measure.
2. Uncover the institutional and structural barriers which may have worked against those transformative learning experiences, as well as uncover the institutional and structural supports which may have enabled these transformations in belief to occur and sustain over time.

Attitudes Towards EB Students

The attitudes science teachers hold towards their EB students will be measured using a survey instrument developed by Huerta et al. (2019). This instrument measures two important attitudinal constructs: (a) science teacher attitudes towards linguistic diversity, and (b) science

teacher attitudes towards science pedagogy forEBs. Each of these attitudes are constituted of multiple belief clusters, and each of these belief clusters are constituted of multiple belief rating items (i.e., beliefs). As mentioned previously, the theoretical framing of the constructs attitude and belief is described in detail in Chapter 2.

Within the attitude towards linguistic diversity there are three belief clusters: (a) beliefs about EBs and learning, (b) beliefs about external supports for EBs, and (c) beliefs about language value in home country. Beliefs about EBs and learning contains belief rating items (i.e., beliefs) that probe science teachers for their beliefs about English and its priority and importance for learning in educative settings for students who are still developing English proficiency (e.g.., it is unreasonable to expect a regular-classroom teacher to teach a child who does not speak English). Beliefs about external supports for EBs contains belief rating items (i.e., beliefs) that probe science teachers for their beliefs about the types of educational supports EBs should receive at an institutional level (e.g., regular-classroom teachers should be required to receive pre-service or in-service training to be prepared to meet the needs for EBs). Beliefs about language value in home country contains belief rating items (i.e., beliefs) that probe science teachers for their beliefs about English and its priority and importance in American society (e.g., to be considered a citizen of my country, one should speak English).

Within the attitude towards science pedagogy for EBs there are two belief clusters: (a) beliefs about integrating language and culture into science instruction, and (b) beliefs about allowing EBs to use their native language during science instruction. Beliefs about integrating language and culture into science instruction contains belief rating items (i.e., beliefs) that probe science teachers for their beliefs about the feasibility of various research-based instructional strategies that have shown to be efficacious in supporting science achievement for EB students

(e.g., does incorporating EBs culture and background help them learn during science instruction). Beliefs about allowing EBs to use their native language during science instruction contains belief rating items (i.e., beliefs) that probe science teachers for their beliefs about the specific pedagogical tenet that students should be encouraged to utilize their first, native or heritage language during classroom instruction (e.g., does allowing EBs to use their first language to clarify their understanding of English during instruction help their understanding of the content in science).

Research Questions

First, I will probe the attitudes and beliefs of science teachers towards EB students and validate that these teachers have experienced transformative learning. Then, I will expand on those initial quantitative results by interviewing purposefully selected participants with positive attitudes towards emergent bilinguals to understand the unique transformative learning experiences which have influenced them. My inquiry is driven by two major research questions:

RQ1: How do science teachers describe the transformative learning experiences which influenced their attitudes and beliefs towards emergent bilinguals?

RQ2: How do science teachers describe both the structural and institutional barriers that worked, or continue to work against their transformative learning and the resources that supported or continue to support their transformative learning?

Significance of the Study

The professional development to promote equitable science learning for EBs is diverse both in terms of duration and fidelity, but quite homogenous in terms of aims, structure and assessment. The aims and structure of these professional development intervention studies are geared towards producing a coherent curriculum which addresses science achievement for all

students. In certain studies, such as August et al. (2009) & August et al. (2014), where researchers enact the professional development interventions called Quality English and Science Teaching (QuEST) 1 & QuEST 2 respectively, there is no focus on supporting teacher change in terms of their knowledge, attitude, and practice (KAP). Instead, a great deal of emphasis in these interventions is put into measuring the degree to which teachers in the study implement the curriculum with fidelity. Each of these large-scale studies report no increase in science achievement for EB students. In contrast, principal author Alexandra Santau (2010, 2011) has already shown that professional development interventions with a focus on teacher change in terms of their KAP is possible. Studying the same sample of teacher and student participants and using the same curriculum-professional development intervention they published on both teacher focused questions and data (Santau et al., 2010) and student focused questions and data (Santau et al., 2011). In their student focused publication, they empirically narrowed down the effectiveness of their intervention to affect student achievement of all students, including EBs; in their teacher focused publication, they explored the ways in which teachers discussed their growth and change in terms of both knowledge and practices with their EB students.

Recent interventions such as Llosa et al. (2016) and Maerten-Rivera et al. (2016) were somewhat successful in attaining science achievement gains for the student population being supported in their professional development studies. These two studies in particular show a maturation in this domain of research for excluding rigorous attention to fidelity in terms of the application of the curricular materials the researchers seek to employ. Rather these studies show a shift in focus on supporting teachers through the key features of professional development proposed by Desimone (2009). Features such as active learning and collective participation help promote the development of KAP which are constructs not promoted historically in this domain

of research. Llosa et al. (2016) describe these professional development features of the teacher workshops in the following way,

> Teachers actively applied the knowledge and strategies they acquired in the workshops throughout the year; they implemented the intervention components in their teaching, reflected on their instructional practices, and shared their experiences and insights with other teachers from the same school and across the schools within the same district. (p. 404)

Reflection during the process of collective participation and after active learning is aligned with the reflective learning required in Mezirow's (1991) transformation theory. I will purposefully select science teachers for this study utilizing quantitative measurements to determine those who have positive attitudes towards emergent bilinguals and who also self-identify as having had those beliefs influenced by a TLE. Then, I will explore their unique TLEs, along with both the barriers working against and the resources supporting their transformation. The results from this study inform professional development for science teachers supporting EBs in the following ways: (a) the themes that emerge in terms of transformative learning can be considered and integrated in the design of future professional development, (b) the themes that emerge in terms of both barriers and resources involved in their TLEs can be both mitigated and enhanced respectively to help teachers overcome barriers and utilize resources. While fidelity is an important aspect of curricular professional development, the energy consumed in this way is wasted. Rather than focus on helping teachers execute the curriculum as designed, future research should instead focus on supporting teacher change in terms of KAP. In these ways, professional development can better and more holistically address the needs of EBs. In the chapter that follows I will provide a synthesis of the literature which frames this proposed study.

CHAPTER 2: LITERATURE REVIEW

In this chapter I synthesize the salient literature; it is organized into three major sections. The first section is an overview of Mezirow's theory of transformative adult learning. This section explores how Mezirow (1991) conceptualizes adult learning, and the process through which adult learners can transform their meaning making perspectives. It also provides a clear connection between transformation theory and belief. The second section provides the theoretical foundations of the belief construct. It serves to operationally define belief which is a construct measured in this study. Additionally, it clarifies the relationship between belief and many other related psychological constructs such as knowledge and attitude. The third and final section is a review of the research which expounds upon the two major attitudinal dimensions measured in this proposed study: (a) science teacher attitudes towards linguistic diversity, and (b) science teacher attitudes towards science pedagogy with EBs.

Mezirow's Transformative Adult Learning Theory

In his book, *Transformative Dimensions of Adult Learning*, Mezirow (1991) presents a theory for how adults make meaning from new experiences while accounting for their existing set of expectations, and further how these set of expectations can be transformed to generate new forms of meaning making. For Mezirow, making meaning is fundamental to what learning is all about. Meaning is obtained when adult learners make sense of or give coherence to new experiences. In his own words, "learning always involves making a new experience explicit and schematizing, appropriating, and acting upon it" (Mezirow, 1991, p.11). Essentially, adult learners schematize new experiences through meanings that have already been made to guide the way they think, act, or feel about their new experiences. In his theory Mezirow (1991) refers to this first dimension of meaning structures as a meaning perspective. A *meaning perspective* is "a

habitual set of expectations that constitutes an orienting frame of references that we use in projecting our symbolic models and that serves as a (usually tacit) belief system for interpreting and evaluating the meaning of experience" (Mezirow, 1991, p. 42). Meaning perspectives often lead to distorted views of reality because they tend to be prerational, unarticulated presuppositions. They serve as frames of references or perceptual filters for new experiences. Mezirow provides three sets of meaning perspectives which significantly shape sensation and delimit perception, feelings, and cognition: the epistemic perspective, the psychological perspective, and the sociolinguistic perspective (Mezirow, 1994; Mezirow, 1991).

The sociolinguistic meaning perspective is particularly relevant within the context of this study. It captures concepts such as social norms/roles, cultural/language codes, language/truth games, common sense as cultural system, secondary socialization, ethnocentrism, and philosophies/theories (Mezirow, 1991). When discussing the cultural aspects or codes of the sociolinguistic meaning perspective Mezirow (1991) writes,

> [C]ultural codes are the tacit regulatory principles that establish power relationships and the nature of appropriate discourse both within a given body of knowledge or area of specialization and among such bodies and areas. They also are the principles behind the assumptions implicit in our social norms. (p. 57)

Mezirow (1991) recognizes that language shapes, limits, and distorts the beliefs of adult learners especially in terms of the taken-for-granted codes they operate under. In his theory of transformative learning, Mezirow (1991) also seemingly anticipates the phenomenon of translanguaging which has recently captured the attention of linguistic scholars in the domain of multilingual language users when writing,

> It has frequently been observed that because our reality is prestructured by our linguistic symbol systems, we do not live through language so much as language lives through us. Through language we find concepts with which to punctuate the flow of experience, to locate it in time and space, and to identify objects, events, feelings, circumstances, and contexts. Indeed, language does not merely describe things and events that we experience but constructs them. (p. 58)

The practical theory of translanguaging also views language as an embodied variable process of sense and meaning making rather than an obtained organism-centered entity (Li, 2018). Li (2018) and Mezirow (1991) view language as something capable of altering our perspectives of what is possible. This view of language has major educative and emancipatory implications, and begs the question: how can teachers alter their sociolinguistic codes, that is fundamentally their sociolinguistic meaning structures, which may "shape, limit, or distort" their instructional practices with EBs (Mezirow, 1991)?

The Transformation of Meaning Structures

The previous section introduced the concept of the meaning perspective, the first dimension of Mezirow's (1991) meaning structure. The second, equally vital, dimension of the meaning structure is the meaning scheme. The *meaning scheme* is,

> The particular knowledge, beliefs, value judgments, and feelings that become articulated in an interpretation. Meaning schemes are the concrete manifestations of our habitual orientation and expectations (meaning perspectives) and translate these general expectations into specific ones that guide our actions. (Mezirow, 1991, p. 44)

Meaning perspectives generate specific meaning schemes. Together the meaning perspective and meaning scheme are two interrelated dimensions which make up the entirety of what is a meaning structure. Mezirow (1991) posits that these meaning structures, which distort our view of reality, can be transformed through specific forms of adult learning. According to Mezirow (1991) adult learning can take one of following forms:

- Learning through meaning schemes: learning that takes place within preexisting meaning structures which further differentiate or elaborate on that meaning structure.
- Learning new meaning schemes: learning which creates new meaning that is sufficiently consistent and compatible within a broader preexisting meaning perspective but that nonetheless extends and complements the existing meaning structure.
- Learning through transformation of meaning schemes: learning which occurs through reflection on our assumptions and expectations. This reflection is driven by a sense of inadequacy in prior ways of meaning making due to specific beliefs becoming dysfunctional.
- Learning through transformation of meaning perspectives: emancipatory learning which requires reflection and critique of "specific presuppositions upon which a distorted or incomplete meaning perspective is based and then transforming that perspective through a reorganization of meaning" (p. 94).

Mezirow (1991) defines transformative learning as learning through transformation of meaning perspectives. In his view, transformation theory emphasizes the value of moving towards reflectivity in adulthood as it represents a function of intentionality towards learning. Thus, educational interventions, such as professional development for teachers, can influence this

process of transformation by reinforcing the practice of reflectivity. Transformative learning occurs through a process of reflection on one's own beliefs. Mezirow (1994) describes this process in the following way, "reflection involves a critique of assumptions to determine whether the belief, often acquired through cultural assimilation in childhood, remains functional for us as adults" (p. 223). Reflective action is at the forefront of transformative learning. *Reflective action* is "making decisions or taking other action predicated upon the insights resulting from reflection" (p. 108). Mezirow (1991) articulates the process of transformative learning in the following way:

> Transformative learning involves an enhanced level of awareness of the context of one's beliefs and feelings, a critique of their assumptions and particularly premises, an assessment of alternative perspectives, a decision to negate an old perspective in favor of a new one or to make a synthesis of old and new, an ability to take action based upon the new perspective, and a desire to fit the new perspective into the broader context of one's life. Perspective transformation involves (a) an empowered sense of self, (b) more critical understanding of how one's social relationships and culture haves shaped one's beliefs and feelings, and (c) more functional strategies and resources for taking action. Taking an action is an integral dimension of transformative learning. (p. 161)

Mezirow (1991) further indicates ten phases through which adult learners can transform their existing meaning perspectives. These ten phases were first established inductively by Mezirow (1975) through a national study of women reentering college after a hiatus, and then confirmed in a later study by Morgan (1987) which examined a group of displaced homemakers. The ten phases of transformation are as follows:

1. A disorienting dilemma.
2. Self-examination with feelings of guilt or shame.
3. A critical assessment of epistemic, sociocultural, or psychic assumptions.
4. Recognition that one's discontent and the process of transformation are shared and that others have negotiated a similar change.
5. Exploration of options for new roles, relationships, and actions.
6. Planning of a course of action.
7. Acquisition of knowledge and skills for implementing one's plans.
8. Provisional trying of new roles.
9. Building of competence and self-confidence in new roles and relationships.
10. A reintegration into one's life on the basis of conditions dictated by one's new perspective. (Mezirow, 1991, p. 168)

In more recent work, Nohl (2015) empirically identifies five distinct phases of the transformation process when analyzing biographical narrative interviews (90-180 minutes in length) of approximately 80 individuals from 2001 to 2013 in Germany. These interviews include participants from a variety of diverse backgrounds who have undergone transformations in disparate ways. These phases are:

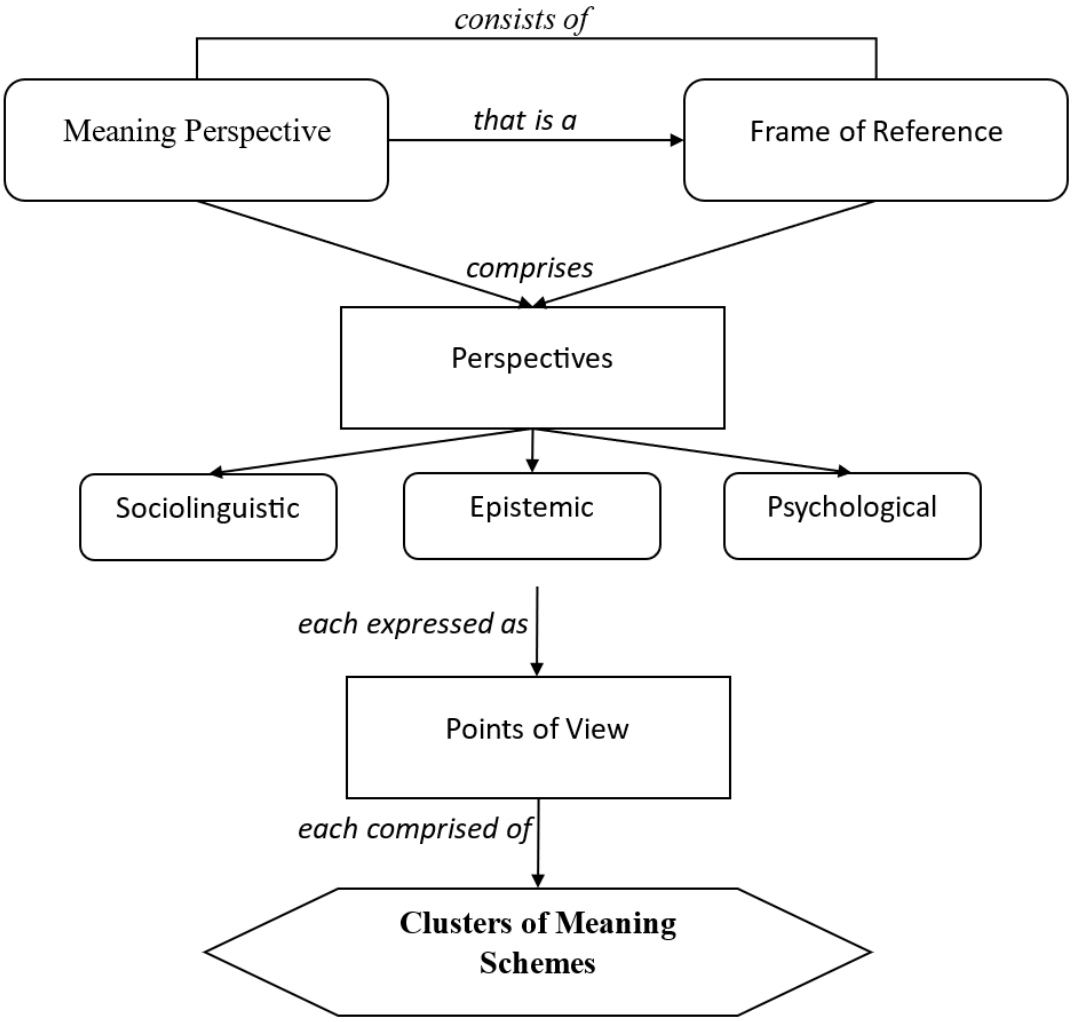
1. The nondetermining start
2. Phase of experimental and undirected inquiry
3. Phase of social testing and mirroring
4. Phase of shifting relevance
5. Phase of social consolidation and reinterpretation of biography (Nohl, 2015, p. 44)

The greatest distinction in Nohl's (2015) model of transformation is the deemphasis on the disorienting dilemma, the self-examination of guilt or shame, and the critical self-assessment of meaning perspectives. Instead, this model describes the onset of transformation as nondetermining and difficult to pinpoint causality even though a transformation can be said to have occurred. The initial process of transformation in their analysis can occur seemingly innocuously or without too great of a perturbation. The rest of the phases in Nohl's (2015) model map very closely to the ten phases outlined originally by Mezirow (1991).

During the first interview within the second phase of this study, I will explore how science teacher participants describe the features, aspects, and attributes of their own unique TLEs. These TLEs have influenced a major shift in their sociolinguistic meaning perspective and its ancillary beliefs. With this understanding it may be possible to organize future educative experiences for teachers, so that they may also transform their own beliefs towards EB students. This will enable science teachers to better enact linguistically and culturally appropriate science instruction in their classrooms. The second interview will enable science teachers to describe the institutional and structural barriers which worked against their transformation and the formation of positive beliefs towards EBs. This understanding is equally as important since the transformation of these beliefs may be stunted or unmade by explicit or implicit factors. Just as important is how these participants describe the systems and structures of supports which have sustained their transformation in beliefs towards EB students.

The following figure summarizes the relationship between meaning schemes and meaning perspectives as described by Mezirow (1991).

Figure 1. *Transformation of Perspectives*



Defining Teacher Beliefs

There is little consensus for an epistemic definition of what constitutes a belief (Bryan, 2012; Gail Jones & Leagon, 2014; Huerta et al, 2019; Shim, 2014). Recognizing this long-standing state of affairs is not just an honest and accurate portrayal, but it is also a useful platform for examining the many definitions, models, and frameworks that have been proposed and then further adapted. In the words of Frank Pajares (1992), "...defining beliefs is at best a game of player's choice" (p. 309). He goes on to write,

> They [beliefs] travel in disguise and often under alias – attitudes, values, judgements, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertoires of understanding, and social strategy, to name but a few than can be found in the literature. (Pajares, 1992, p. 309)

With the goal of reforming teacher practice, and ultimately enacting positive development for our science students, researchers have long pondered the role of beliefs in causing or preventing changes in teachers' instructional practices (Fang, 1996; Flores & Smith; 2009; Nespor, 1987; Pajares; 1992; Pettit, 2011; Rokeach, 1969; Song & Samimy; 2015; Woods, 1996). "Science for all," is a sentiment which still requires many reforms to be acknowledged as either sincere or legitimate.

Whether we consider its role in pre-service preparation or in-service professional development, the literature has shown that belief is a powerful force which affects and intersects with many other teacher factors. These factors include context, self-efficacy, practice, experience, knowledge, Habitus, identity, and attitudes to name just a few. In the field of EBs researchers have studied the various teacher experiences which will most strongly affect these factors (Flores & Smith, 2009; Pettit, 2011; Reeves, 2006). A pair of researchers (Youngs & Youngs, 2001) informed by social contact theory hypothesized that cultural exposure through studying abroad or learning a foreign language would greatly affect the beliefs of teachers working with EBs. They found no such relationship. Instead, their results imply that reform to university education programs is the most effective way to influence teacher beliefs regarding EB students. Experience in specific university courses geared towards diversity training proved

to be the greatest predictor of positive beliefs. The following sections will: (a) synthesize the existing literature on the topic of belief, and (b) operationally define the constructs of belief along with delineating its connection to other related constructs such as knowledge and attitude.

Teacher Beliefs and Knowledge

Perhaps the greatest hurdle in defining belief is in its common conflation with knowledge. Robert Abelson (1979) dedicated an entire manuscript to differentiate between the two types of systems. He proposed seven unique characteristics which distinguish a belief system from a knowledge system. When enough of these characteristics can be ascribed to a particular system, then in his view the system was sufficiently distinguishable as a belief system. One of the most salient, and persistent characteristics of belief systems is that they rely heavily on evaluative and affective components. This characteristic in particular influences Frank Pajares (1992) more than a decade later, as he distinguishes between belief and knowledge by writing, "belief is based on evaluation and judgement; knowledge is based on objective fact" (p. 313). These researchers tend to view belief as subjectively emotive while viewing knowledge as objectively stoic.

Another inextricable characteristic of beliefs is that they do not exist in complete independence of one another; they often exist as systems. These mutually dependent beliefs are psychologically organized and are prioritized in accordance with their relationship to other structures. Some beliefs are more central than others, which make those beliefs harder to change or altogether dispense with. If a core belief is challenged, it will incur major repercussions for the entire interconnected system. This reality is reflected most saliently in the arena of science education when science teachers are apprehensive to enact reform-based practices which contradict their own beliefs. Milton Rokeach (1969) describes it this way, "a belief system may

be defined as having represented within it, in some organized psychological but not necessarily logical form each and every one of a person's countless beliefs about physical and social reality" (p. 2). Even though knowledge is similarly arranged into systems of organization, these systems are largely considered more hierarchical as opposed to the weblike, interconnected structures of beliefs. As such, knowledge systems tend not to have central or core tenants; teachers can learn new pieces of information and not necessarily internalize those facts. This lack of internalization leads to a lack of fidelity in terms of implementing research-based instructional practices with EBs. Perhaps this is why research indicates that beliefs are much stronger predictors of behavior as compared to knowledge.

Dochy and Alexander (1995) proposed some helpful models of possible relations between belief and knowledge. In their study they asked respondents to choose which of these models best represented their own conceptualization of knowledge and beliefs. Here are two of the four competing models: (a) knowledge and beliefs are two separate, unrelated constructs; (b) knowledge and beliefs are overlapping and indistinguishable from one another. These two models exist on either end of a spectrum, and as such are likely to be furthest from an actual representation of how these constructs manifest in education as the findings in their study reveals. Their data from 54 American respondents indicates this as zero respondents conceptualize the two as being entirely unrelated, and only 6% consider the two as indistinguishable. Here are another two competing models: (a) knowledge is one of many, subsumed components of belief; (b) belief is one of many, subsumed components of knowledge. Similarly, their data suggests these conceptualizations are not widely held as 15% and 19% respondents respectively selected these models. Instead, the bulk of American respondents (52%) conceptualized the relation as overlapping, or that knowledge and beliefs share "integrated

aspects while maintaining other distinct and separate constructs" (231). Perhaps the reason for such messy definitions and distinctions between the two is due to our own collective conceptualized duality of knowledge and belief in which they are simultaneously integrated and independent.

Much like the dual nature of fundamental particles, perhaps when observed under particular conditions what is presumed to be a belief behaves more as knowledge and vice versa. These fundamental constructs are each capable of expressing themselves through actions sometimes in seemingly indistinguishable ways. While in other circumstances, it is more straightforward discerning whether a belief or knowledge influenced certain teacher practices. For the purposes of this proposal, I will consider this duality the nature of these constructs. This will require me to carefully select conditions to probe and examine teacher beliefs so as not to erroneously measure knowledge.

The belief rating survey utilized in the first phase of this proposed study was developed by Huerta et al. (2019) and has its roots in Byrnes & Kiger's (1994) Language Attitudes of Teachers Scale. This survey measures two science teacher attitudinal constructs: (a) attitude towards linguistic diversity, and (b) attitude towards science pedagogy with EBs. Conceptually, each of these attitudinal constructs are made up of multiple belief systems, and each of those belief systems are made up of individual beliefs. In the following subsection, I will further clarify the relationship between belief and attitude.

Teacher Beliefs and Attitudes

Untangling the construct of belief from the construct of attitude has proved to be a befuddling task for many (Huerta et al., 2019; Jones & Leagon, 2014; Rokeach, 1969). Never mind their often-interchangeable use in the literature, it is further complicated by their conflation

with other constructs such as “perception”, “views” and “theories of actions” (Kane, Sandretto, & Heath, 2002). As early as 1947, psychology researchers like Doob and Blumer suggest dispensing with the attitude concept altogether for its ambiguous nature. Blumer in particular claims the difficulty to “...ascertain what data to include as part of an attitude and what to exclude…” (Rokeach, 1969, p. 110). However, we know the attitude construct persists to this day as an important factor of education research for its influence on teacher practice. Therefore, it is paramount for this proposed study that I develop a well-defined operational definition of attitude.

In early publications on this topic the relationship between belief and attitude was conceptualized as a difference of psychological composition: belief tied to cognitive aspects while attitude to affective ones. However, this distinction was quickly dispensed with, and currently almost no contemporary model of belief is devoid of affect. Indeed, Rokeach (1969), and then decades later Nespor (1987), attribute “emotions”, “feelings”, “moods” and “subjective evaluation” as inextricable affective aspects of beliefs. Rokeach (1969) proposed a model for a structure of belief systems which consist of: (a) a cognitive component, representing or pertaining to aspects of knowledge; (b) an affective component, representing or pertaining to aspects of emotion; (c) a behavioral component, representing or pertaining to aspects which require action.

Settling for parsimony in their study, Flores & Smith (2009) adopted the term “attitudinal beliefs” in a seeming concession to the fruitless effort of determining an exact meaning of “belief system” (Abelson, 1979). In a similar concession, Huerta et al. (2019) define an “attitudinal construct” as a cluster of beliefs organized around an object. This model is supported by Pajares (1992) who writes, “when clusters of beliefs are organized around an object or situation and

predisposed to action, this holistic organization becomes an attitude" (p. 314, 1992). Rokeach (1969) also conceptualized attitudes in a strikingly similar manner. To him an attitude is not a fundamental element within the personality, "...but represents a cluster or syndrome of two or more interrelated elements" (Rokeach, 1969, p. 112). He considers belief the underlying, fundamental element which composes an attitude. In this study, I also concede to organize belief as a fundamental construct several of which constitute an attitude. So, for the purposes of this study the construct of attitude (henceforth interchangeable with attitudinal construct) will comprise several belief clusters which themselves comprise several belief statements.

Teacher Beliefs and Practice

The relationship between belief and action is complex. Overall teacher behavior comprises many teacher practices which in turn require specific action in and outside of the classroom. Rokeach (1969) conceptualized belief systems as requiring a behavioral or actionable component. Additionally, he formulates that "...behavior is a function of the interaction between two attitudes - attitude-toward-object and attitude-toward-situation" (p.127). Nespor (1987) dedicates an entire manuscript examining the role of beliefs in the practice of teaching. She argues that belief systems are pivotal in the processes of task and problem definition as well as memory facilitation. The first process of task and problem definition has had lasting implications in science education and for EBs. Indeed, what teachers believe to be best language practices strongly influence the way they define tasks within the classroom. The second process of memory facilitation has implications for the way we train pre- and in-service teachers. In her view, the affective and emotional components of belief can influence the ways in which teachers retrieve and reconstruct memory during recall. This means that regardless of teachers knowing that certain practices may benefit their students, their own contradictory beliefs can influence

even the way they recall that knowledge. More recently there has been a trend in research developed web-based video analysis tools to assist teachers with reflecting on and then refining both their beliefs and practices (Bryan & Recesso, 2006; Yerrick et al., 2005). This trend is in part a response to the complicated nature of changing or influencing beliefs to ultimately impact teacher practice.

It is also important to reference the divide in the literature between studies that find evidence to support the direct effect of beliefs on practice, and those that find evidence to refute it. The congruity thesis posits that beliefs directly affect the actions teachers take in their practice. This was the case in Laplante's (1997) study where he investigated the teaching strategies of teachers with didactic beliefs. The teachers viewed themselves as consumers of science and science itself as a body of knowledge. These beliefs are in stark contrast to constructivist reforms in science education which promote science as a process of inquiry. These teachers enacted those didactic beliefs into action by practicing teacher-centered strategies through closely controlled investigations and students as receivers of decontextualized knowledge. While on the other hand, the incongruity thesis posits that espoused beliefs bare little to no effect to instructional practices utilized in the classroom. Consider the studies in which teachers claim to believe in constructivist ideals yet provide no opportunities for students to define problems, design investigations and create explanations (Simmons et. al., 1999; Wallace & Kang, 2004). Both theses have numerous studies to indicate some degree of validity, so perhaps it is most accurate and most useful to state that some beliefs affect certain actions more strongly than others.

Transformations in Teacher Beliefs and Practice

Teacher beliefs exist in a system where individual beliefs are interconnected to one another. Thus, it is difficult to influence these belief systems much less transform them. It has already been discussed how central beliefs are particularly persistent, regardless of the acquisition of new knowledge. The research indicates that it is easier to dispense with new information than it is to restructure an entire belief system (Reeves, 2006). Perhaps this is why the literature indicates that longitudinal interventions are required to effectively change teacher practice. Lee (2004) examined the patterns of change in both belief and practice for teachers who shared elements of culture and language with their culturally and linguistically diverse students. She attempted to instill "instructional congruence" within her teacher participants which maintains that "...effective subject area instruction should combine consideration of students' cultural and linguistic experiences with attention to the specific demands of academic disciplines" (p. 67). Her goal was for the teachers to integrate effective science and literacy instruction with EBs. Her findings indicate that gradually after three years of intervention she was able to detect changes in their espoused beliefs and observe changes in their science teaching practices. Fang (1996) reviewed over a decade's worth of research examining teacher beliefs and practice. A striking aspect of his findings which has been missing from this discussion thus far is the effect beliefs have on teacher expectations. Studies have long shown the significant impact teacher expectations have on both students' behavior and academic performance (Good, 1987). Each of these reviews also indicate the role time plays in establishing sustained changes to teacher practice. Just as beliefs and practices are persistent, so too must the interventions attempting to influence them.

Mezirow's theory of transformative adult learning is an excellent candidate for understanding how teachers' beliefs towards emergent bilingual students can be transformed. Through reflective action on the premises of meaning perspectives, teachers can transform their sociolinguistic meaning perspective and the ancillary beliefs that inform that perspective (Mezirow, 1991). Science teachers can transform their sociolinguistic meaning perspective to align with linguistically and culturally appropriate instruction by engaging in professional development that leverages the ten phases of transformation (Mezirow, 1975; Morgan 1987). Certain professional development interventions aimed at supporting science teachers in their instruction of EBs have reported only modest gains in both student science achievement and fidelity of the curriculum (August, 2009; August, 2014). This is due in part because the researchers have made no effort to attend to aspects which facilitate sustainable teacher transformation. Transformative learning, when embedded within these curriculum-based professional development interventions, may be the process through which that sustainable transformation of beliefs can occur. Those new orientations in beliefs may facilitate the enactment of linguistically and culturally relevant pedagogies within science classrooms and effectively support EB students.

Kumi-Yeboah & James (2012) provides findings from a qualitative, narrative study exploring the transformational journey of an award-winning novice teacher. After only four years in the classroom this teacher was distinguished and recognized by their school district. From their two in-depth interviews with the teacher the researchers uncovered several emergent themes. The teacher: (a) described the challenges they faced in their new teaching career and provided strategies for others to overcome them, (b) emphasized the need for preparation and organization in order find success in their early teaching career, (c) discussed the value of hard

work and dedication and traced these values to professional development they had experiences, (d) shared their perspective on the importance of getting involved in extracurricular activities to establish meaningful relationships with students outside the classroom, (e) linked their early success in teaching on the mentoring relationship his mentor fostered, and (f) expressed the important responsibility of continued learning through professional development. In closing the authors write,

> [E]ducators experience how new ideas and information can affect and unbalance their beliefs, values, and ways of understanding. These factors serve as a disorienting dilemma, a trigger event to stir their self-examination and critical reflection on their teaching. With time, the new teacher began to shift meaning perspective to understand his experiences and world changes. (Kumi-Yeboah & James, 2012, p. 176)

Teacher preparation and continued training through professional development should meaningfully implement features of transformative learning to support adult learners in making meaning perspective shifts (shifts in their beliefs). In a different study Boyd (2009) provides an excellent example of the impact a transformational teacher can have on the students they interact with in their case study of an effectual first-year teacher. They write, "[t]ransformational teachers use individual consideration by listening to students' needs and helping them become self-actualized" (p. 55, 2009). The author leveraged transformational leadership theory to analyze the practices this teacher utilized in their classroom and the impact of these practices on student outcomes and classroom climate. In closing they write, "[b]y modeling transformational leadership in the classroom, educators can both transform the lives of their students and deepen their understanding of leadership" (Boyd, 2009, p. 56).

Beliefs in Transformation Theory

Mezirow (1991; 1994) makes ample use of the term belief and does so in a variety of ways throughout his book, *Transformative Dimensions of Adult Learning*, and throughout his subsequent response to critique of transformation theory in the peer-reviewed article, *Understanding Transformation Theory*. Candidly, Mezirow provides no clear definition of this psychological construct, so understanding the role of belief in transformation theory is conceptual at best. This subsection will provide one clear example of the ways in which Mezirow leverages the term belief to define the most salient aspects of his theory.

Perhaps the most significant use of belief by Mezirow (1991) is when he articulates that meaning perspectives serve as a belief system for interpreting and evaluating the meaning of experience. The meaning perspective is one of two dimensions which comprise the overall meaning structure, and when the beliefs which support that meaning structure are reflected upon the process of transformative learning begins to take place. Beliefs are central to the way Mezirow (1994) describes this transformation process,

> Our meaning structures are transformed through reflection, defined here as attending to the grounds (justification) for one's beliefs. We reflect on the unexamined assumptions of our beliefs when the beliefs are not working well for us, or where old ways of thinking are no longer functional. (p. 223)

In other words, to transform one's meaning structure is to transform one's beliefs. This conceptual claim is critical within the context of this proposed study as the initial quantitative phase will include two sequential batteries of measurement:

1. The belief rating survey will determine which science teachers hold positive attitudes towards EB students (Huerta et al., 2019).

2. The Learning Activities Survey will determine whether those beliefs were influenced by a transformative learning experience (August 1998).

Thus, it is pivotal to conceptually consider science teachers' positive beliefs, that have been influenced by TLEs as evidence that their sociolinguistic meaning perspective has been transformed.

Science Teacher Attitudes towards Emergent Bilinguals in Science Education

Numerous studies have been published on understanding teacher attitudes, beliefs, and practices regarding their EB students (Fradd & Lee, 1995; Huerta et la., 2019; Lee, 2004; Lee & Fradd, 1998). The research conducted specifically on science teachers is small compared to the work done more broadly on mainstream teachers. Still, there is great value in learning about mainstream teacher attitudes and informing the methods of preparing and developing our science teachers. Informing this proposed study is the research conducted by Youngs & Youngs (2001), in which they constructed and tested a model of predictors that are likely to explain mainstream teachers' attitudes toward emergent bilingual students. They offer five categories for examination with their participants:

- general education experiences
- specific EB training
- personal contact with diverse cultures
- prior contact with EB students
- demographic characteristics (Youngs & Youngs, 2001).

Their findings support that factors like personal experience with foreign cultures, specific courses dealing with foreign language or multicultural education, professional training with EB

students, and having lived outside of the US among others, are statistically significant predictors for mainstream teachers to have positive attitudes towards EB students.

Another informative study is the work done by Shim (2014), in which they interview five "ESL teachers" about their beliefs regarding academic challenges faced by EBs. From their responses one alarming theme which emerged was that they considered the use of EBs' first language troublesome, and that it directly interfered with EBs' ability to learn English. All five teachers in their study held this belief. This finding would be more palatable if the participants were mainstream teachers with less training on educating EBs, but it is important to recognize that even teachers who are tasked specifically with teaching EBs English are erroneous in their beliefs. Studies in the arena of linguistics tout the importance and value of not just maintaining but instead continuing to develop EBs native or heritage language (Cummins, 2000; Lee & Oxelson, 2006). This practice has been shown to not just help EBs learn English more efficiently, but as discussed previously in the content area of science it also contributes to an increase in achievement. Oddly, another emergent theme among the participants of Shim (2014) was their belief that unprepared teachers adversely affect EBs' learning. Some participants desired more "ESL" training for all teachers, and that EB students would benefit from learning from better trained mainstream teachers.

The first phase of this study measured two science teacher attitudinal constructs: (a) attitude towards linguistic diversity, and (b) attitude towards science pedagogy with EBs. The literature synthesized in the next several pages will provide an understanding of the research done in these areas.

Science Teacher Attitudes Towards Linguistic Diversity

Attitudes towards linguistic diversity include beliefs about emergent bilinguals' use of their native language within the classroom or at home. On a larger scale, they encompass beliefs concerning federal legislation setting forth English as the national language. A particularly informative study is Reeves' (2006) wherein she investigates teacher attitudes toward inclusion, coursework modification, professional development, and language and language learning. Four findings emerge from secondary content-area teachers responding to a Likert-scale survey: (a) discrepancy exists between teachers' general attitudes and specific attitudes towards EBs inclusion, (b) concern exists about the equitability of coursework modifications for EBs, (c) ambivalence exist toward participating in professional development for teaching EBs, and (d) misconceptions exists about how second languages are learned. Many studies support the fourth and final finding concerning misconceptions about how second languages are learned (Karabenick & Noda, 2004; Lee, 2004; Lee & Oxelson, 2006; Pettit, 2011). Some find that teachers believe a student's native language interferes with the learning of English (Reeves, 2006; Lee & Oxelson, 2006), while others find that teachers believe EBs should learn English within one to two years (Pettit, 2011; Reeves, 2006; Walker et al., 2004). The reality of linguistics research contradicts each of these beliefs. For one, beyond simply maintaining and instead developing EBs' native or heritage language actually facilitates the development of English proficiency (Cummins, 2000; Karathanos, 2009; Lee & Oxelson, 2006). Second, linguistic research indicates that it takes one to three years to develop conversational English and up to seven years to fully acquire academic English (Cummins, 1981). The consequences of these erroneously held beliefs manifest themselves in teachers prohibiting the use of EBs' first language in the classroom (thus further hindering their development in both English and

science), and teachers correcting the pronunciation of single words (rather than focusing on aspects of three-dimensional learning as outlined in the NGSS).

Reeves' (2006) first emergent theme is another salient factor: discrepancy exists between teachers' general attitudes and specific attitudes towards EBs inclusion. Her study along with others, indicates that teachers would generally agree with the statement "I would welcome the inclusion of 'ESL' students in my classroom," but have specific concerns about EBs with very low English proficiency joining their classrooms. This attitude may be connected to another attitude reported by Flores & Smith (2009) where the authors note ambivalence in the the belief that being an American requires knowing English. The belief that English language proficiency is emblematic of citizenship is prevalent in the literature (Flores & Smith, 2009; Huerta et al., 2009; Karathanos, 2009; Reeves, 2006).

Science Teacher Attitudes Towards Science Pedagogy for Emergent Bilinguals

Effective teaching practices with emergent bilinguals are predominantly influenced by what teachers believe. In Fang's (1996) words, "teachers teach in accordance with their theoretical beliefs" (p. 53). Specifically discussing the role of actions in relation to EBs, Harklau (2000) writes, teacher actions "not only serve to teach language but also serve to shape students' attitudes toward schooling and their very sense of self" (p. 64). Thus, without the belief that certain instructional practices are effective such as:

- Integrating oral language development strategies during science instruction help EBs understand science content and develop English proficiency.
- Allowing EBs to use their first language during science instruction help them understand science content.

- Incorporating EBs' culture and background help them learn during science instruction.

Then science teachers are unlikely to enact those practices during instruction, even if they know those practices will enhance their learning (Huerta et al., 2019). Generally, attitudes regarding pedagogy are divided between whether teachers believe the practices themselves are effective, and whether they believe the practices are feasible to enact in their classroom. Negative beliefs within either attitude will likely keep the practices most supportive to EBs from being enacted within the science classroom.

Summary of Literature

This chapter provided an overview of the relevant literature supporting this study. First, Mezirow's (1991) transformation theory offers an excellent foundation for understanding how adult learners, such as teachers, can alter their beliefs regarding both linguistic diversity and pedagogy with linguistically diverse students. This theory provides evidence as to why certain beliefs can distort the ways in which teachers interact with their linguistically diverse students and the importance of reflective action in amending those circumstances. Second, Rokeach (1969), along with many others, provides clarification of the admittedly messy belief construct. This has ultimately enabled me to operationally define belief, and further conceptually connect belief to Mezirow's (1991) transformation theory. Third and last, this chapter provides an overview of the research published in the domain of the two attitudinal constructs measured in the purposeful selection of participants.

CHAPTER 3: METHODS

The purpose of this study is two-fold: a) to explore the TLEs which have influenced the positive attitudes and beliefs of science teachers towards EBs and b) to explore the barriers and resources involved in their transformations. Through this study, I seek to answer the following research questions:

RQ1: How do science teachers describe the transformative learning experiences which influenced their attitudes and beliefs towards emergent bilinguals?

RQ2: How do science teachers describe both the structural and institutional barriers that worked, or continue to work against their transformative learning and the resources that supported or continue to support their transformative learning?

I used an exploratory multiple case study design to answer these research questions and conducted the study in two distinct phases after completing a pre-phase pilot. I conducted a pilot pre-phase ahead of the formal study to revise and refine both the survey instruments and the interview protocols with a convenience sample of five teachers. After completing the pilot pre-phase, I began the first phase of the study by administering a two-tier survey to a purposeful sample of science teachers in a school district within a southeastern state in the U.S. Then, I tested the data from this survey for normality and utilized a normal distribution to identify the science teachers who hold positive attitudes and beliefs towards their EB students across two science teacher attitudinal constructs: (a) attitude towards linguistic diversity and (b) attitude towards science pedagogy with EBs. Science teachers who self-identify as having had a transformative learning experience influence their beliefs towards EBs proceed to take the second tier of the survey to quantitatively validate that experience as transformative learning.

During the second phase of this study, I purposefully selected science teachers utilizing the results from the two-tier survey. These were science teachers that have: (a) positive attitudes towards EBs, and (b) validated transformative learning experiences were selected for two follow-up in-depth interviews. The first interview explored the ways in which these science teachers described the ten phases of their transformation (Mezirow, 1991); the aim of this interview was to ascertain the attributes, features and aspects of their TLEs. The aim of the second interview was to explore the institutional and structural barriers that worked against their transformation as well as explore the resources which enhanced their transformation.

First, this chapter begins with a brief description of my philosophical worldview, and a discussion of how this worldview has influenced the research methods proposed, followed by a statement of subjectivity. Second, the rationale for utilizing qualitative methods as a research approach is described; this description includes an analysis of the specific typology, the exploratory multiple case study design, for the purposes of answering the research questions of this study. Finally, the details of the data collection methods and data sources are described.

Philosophical Worldview

The dispute between qualitative and quantitative research paradigms has a long and tumultuous history in social science research; the decades-long debate during the 1970s and 1980s has been most aptly characterized as the paradigm wars. The postpositivist worldview continues to be the philosophical underpinning which guided the quantitative methods and their respective typologies. This approach to research assumes the ontological nature of reality as both objective and singular and the epistemological nature of knowledge as independently obtainable. In contrast, the qualitative research approach is underpinned by a social constructivist worldview. This approach to research assumes the ontological nature of reality as both subjective

and plural and the epistemological nature of knowledge as obtained interdependently. Quantitative methodologies typically require the researcher to maintain distance from participants to attain impartiality; meanwhile qualitative methodologies typically require the researcher to maintain closeness to participants to attain saturation. The strand of quantitative research is most concerned with collecting numerical data which can then be analyzed statistically to make deductive or inferential conclusions. In contrast, the strand of qualitative research is concerned with collecting descriptive data which can then be analyzed through coding to make inductive conclusions. The chasm between these strands of research is great, but there are several worldviews that attempt to bridge the gap between them.

One such worldview is the transformative one which is not to be confused with the transformative nature of Mezirow's (1991) theory of adult learning. Mertens et al. (2010) establishes a clear rejection of the post-positivist and interpretivist ontological assumptions that reality is relative. In their view, the transformative paradigm creates a new definition of what is real with the defining feature being social justice. They write, "thus, what is taken to be real needs to be critically examined via an ideological critique of its role in perpetuating oppressive social structures and policies (Mertens et al., 2010, p. 198)." The transformative paradigm also rejects standard notions of the nature of knowledge. Mertens (2012) describes it this way,

> The transformative epistemological assumption raises questions about the nature of relationships between researchers in terms of who controls the investigation, not only when it is conducted by nonmembers of marginalized communities, but also when the researchers are community members or teams of members and nonmembers are used. It also raises questions about the nature of knowledge in terms of power and privilege. (p. 6)

The defining feature of what is knowledge is that which challenges the status quo. To acquire this particular type of knowledge, the transformative researcher must develop trusting relationships with community members to determine ways in which the study can be more culturally responsive. Adopting the transformative worldview means integrating these novel ontological and epistemological assumptions in a meaningful way. Ontologically this study rejects cultural relativism and recognizes that the educative differences that exist between EBs and those who speak English natively as very real. Targeted and research-based approaches to teaching and learning are required to best support EB students (Llosa et al., 2016), and this study asserts that positive beliefs towards EBs influences the application and efficacy of these practices. This study also recognizes that teachers may experience tension in their institutions when attempting to enact culturally and linguistically relevant science instruction. This study further recognizes the devaluation of EB students' native or heritage language, especially in terms of the emblematic nature of speaking English as citizenship in the U.S. Thus, the power difference in whose cultural knowledge matters, and even further, whether some forms of knowledge even qualify as such is also very real.

Mertens (2012) also makes clear the methodological consequences of adopting the transformative worldview. They describe these consequences in the following way,

> Inclusion of a qualitative dimension in methodological assumptions is critical in transformative research and evaluation as a point of establishing a dialogue between the researchers and the community members. Mixed methods designs can be considered to address the informational needs of the community. However, the methodological decisions are made with a conscious awareness of contextual

> and historical factors, especially as they relate to discrimination and oppression. (Mertens, 2012, p. 808)

Although quantitative data was collected and analyzed in this study to triangulate results, develop implications, and select participants to interview, I recognize the value of the qualitative methodological dimension and emphasize the collection and analysis of qualitative data. In essence, the aim of this study is to enable my participants to describe their experiences throughout their transformational journey, and my role is to capture and convey those experiences to the educational research community.

Subjective Lens of the Researcher

I am a Latin American immigrant who learned English as a second language in American public schools. My family immigrated to the U.S. when I was only 18 months of age. I have always described Nicaragua as my native country, but that the U.S. is my home country. While I will always have an interest in supporting the people of my native country, my research in education is geared towards supporting the students in American public schools. My identity as an immigrant, and as a linguistically minoritized individual has shaped my interest in supporting science educators to teach their EB students more effectively. I maintain that teacher beliefs towards EB students strongly influence the pedagogical approaches teachers enact within their classrooms. While a strong understanding (i.e., knowledge) of the linguistically and culturally appropriate instructional strategies is important, I believe teachers are more likely to enact these targeted and research-based instructional strategies when they hold positive attitudes and beliefs about the linguistically diverse students those strategies are intended to support (Huerta, 2019).

With this study, I aim to understand the types of transformative learning science teachers have experienced which influenced their positive attitudes towards EB students. My research

goals are to learn from these teachers about the attributes, features, and aspects of their experiences which generated what Mezirow (1991) calls a meaning perspective shift, and just as importantly to learn about the forms of institutional and structural barriers they had to or continue to overcome as well as the resources which enhanced their transformation and continues to sustain it. As a racially, linguistically, and culturally diverse education researcher with many years of experience in educative environments both as a student and practitioner there are many biases I bring into this specific line of work. To mitigate these biases and overcome the limitation of my subjective lens, I will discuss my strategies to develop rigor in this study further in the manuscript (section titled Establishing & Maintaining Rigor in Chapter 5).

Rationale for Qualitative Methods Research Approach

In planning this study, I adopted the transformative worldview which underscores the need to develop rich descriptions of phenomena and give voice to marginalized participants (Mertens, 2012). Creswell & Poth (2018) write that, "[q]ualitative research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem" (see Chapter 3). The attitudes and beliefs of science teachers working with EB students is not well understood (Huerta et al., 2019). The qualitative approach to research is appropriate for developing a rudimentary understanding of the underlying patterns and themes that are observed (Creswell & Poth, 2018).

Exploratory Multiple Case Study Design

There are a multitude of qualitative research designs (also referred to as typologies) available for education researchers to utilize in answering their exploratory research questions. Creswell & Poth (2018) propose five major approaches to qualitative research: (a) narrative

research, (b) phenomenological research, (c) grounded theory research, (d) ethnographic research, and (e) case study research. Creswell & Poth (2018) also provide insight on how to determine if the case study research approach is appropriate to investigate certain research questions; they write, "[a] case study is a good approach when the inquirer has clearly identifiable cases with boundaries and seeks to provide an in-depth understanding of the cases or a comparison of several cases" (see Chapter 4). The teacher participants in this study are intended to be special cases; the participants are science teachers with positive attitudes towards EBs which have been influenced by a TLE. According to Yin (2018), "[t]he more that your questions seek to *explain* some contemporary circumstance (e.g., "how" or "why" some social phenomenon works), the more that case study research will be relevant" (p. 4). The research questions guiding my investigation are entirely framed as "how" questions and are based in the subjective and personal descriptions of my teacher participants.

Other important design aspects to consider when employing a case study is to determine whether to examine a single case or multiple cases, and whether to seek a holistic or embedded analysis. When deciding to examine a single case or multiple cases Yin (2018) writes,

> The first word of advice is that, although all designs can lead to successful case studies, when you have the choice (and resources), multiple-case designs may be preferred over single-case designs. If you can do even a "two-case" case study, your chances of doing a good case study will be better than using a single-case design. (p. 61)

Based on Yin's very clear advice, I examined multiple forms of data for five selected cases. Additionally, I treated each of the five selected cases together in a holistic manner during

data analysis. In other words, I analyzed the results from survey and interview data for each of the five cases utilizing cross-case themes after I generated within-case themes.

Study Context and Participant Description

Most of the science teachers sampled for this study work in a public school district situated within a southeastern state in the U.S. This school district is diverse not only in terms of its geographical descriptors as it serves urban, suburban, and rural families, but also in terms of its ethnic, racial, and linguistic student population. According to this state report card, in 2021 (the year in which participants were selected) this school district served 10,900 EB students. That means EBs make up 14.7% of their total student population which is above the national average (NCES). The school district included 96 schools in total (52 elementary schools, 25 middle schools, 19 high schools).

In this section, I describe the teacher demographics within this school district, and then describe in detail the boundaries of each case within this study. The 2020-2021 state report card indicates that this school district employed 5,032 teachers during that school year. Teacher data hosted by the State Department of Education provides some insight into the race and gender of the teachers employed in this school district during the 2019-2020 school year. Some metrics and accountability requirements were waived by the federal government in response to COVID-19. Thus, I am using data from one year prior to my participant recruitment. The table below presents this data:

Table 1. School District Teacher Demographics

Race	Gender[1]						**Population Total**
	Female		Male		Not Reported		
	n	%	n	%	n	%	
Black	268.60	5%	69.30	1%	0.00	0%	337.90
Indian[2]	14.20	0%	1.00	0%	0.00	0%	15.20
Hispanic	100.40	2%	18.00	0%	0.00	0%	118.40
Asian	36.80	1%	10.00	0%	0.00	0%	46.80
White	3420.50	70%	783.30	16%	4.00	0%	4203.80
Not Reported	117.70	2%	12.60	0%	32.40	1%	130.30
Population Total	3958.20	81%	894.20	18%	36.40	1%	4888.8

Further, the state report card indicates that 61% of teachers have advanced degrees, and that only 0.4% of teachers are teaching out-of-field in their core classes.

This school district granted me limited access to their teachers. In other words, they did not allow me to recruit across the entire school district. Using publicly available data from the state School Report Card website, I developed a list of 12 schools (six elementary, three middle and three high schools) each representing schools with the highest population of EB students. I

[1] Surveys inquiring about gender identity should provide respondents the opportunity to self-identify their gender beyond binary male/female options.
[2] The district data does not make clear the definition of Indian. It is unclear if they intend for this represent indigenous people of the Americas.

chose a higher number of elementary schools, as they tend to have smaller populations of students which feed into few middle and high schools with larger student populations. This decision enabled me to have a better likelihood of finding teachers with positively oriented attitudes and beliefs towards EB student.

From these 12 schools, I generated a convenience sample by requesting school-level science leaders such as principals, science department chairs, and instructional coaches identify three science teachers within their building who enact culturally and linguistically relevant teaching strategies with EB students. I shared the following tool with science leaders to help them in identifying appropriate teachers for this study:

Table 2. Convenience Sample Identifying Items

Please select three science teachers from your building which most strongly:
• Enact teaching strategies which effectively support emergent bilingual students
• Develop meaningful and sustained connections with emergent bilingual students
• Have positive attitudes towards linguistic diversity

Due to challenges from the COVID-19 pandemic, I faced difficulty recruiting participation for my study solely from sampling within this school district. After two months of pursuing additional participants within this school district, I only received responses from 15 science teachers. A dissertation committee member supported me in finding additional participants for the main study. This member leveraged their social media to find science teacher participants from across the nation to participate in the two-tier survey. Approximately half (n=18) of my participants were recruited through this method. Since these participants varied widely in terms of geographic location (no two teachers shared even the same school district), I

did not provide demographic contextual data for their learning environments. This additional recruitment brings the total number of survey participants to 33. I did not collect demographic data of any participants in this study, as it was not directly linked to any of my research questions.

Next, I distributed a staggered, two-tier survey to this convenience sample of science teachers. The first tier of this survey probed the attitudes and beliefs of science teachers along two dimensions: (a) attitudes towards linguistic diversity, and (b) attitudes towards science pedagogy with emergent bilinguals (Huerta et al., 2019). The final item of this tier asked teachers if they have arrived at their attitudes and beliefs towards EBs by way of a learning experience they would describe as transformative; if so, teachers were prompted to continue to the second tier of the survey. The second tier validated whether these teachers have experienced transformative learning (King, 2009; Mezirow 1991).

Next, I generated a purposeful sample of science teachers by selecting teachers who validated transformative learning experiences, and who scored at least an average score on the belief-rating survey tier. Finally, from this purposefully selected sample, I invited multiple participants from a wide range of survey results to participate in two, hour-long interviews regarding their TLEs. I invited teachers who scored: a) approximately at the mean, b) between 1 standard deviation (SD) and 2 SD above the mean, and c) between 2 SD and 3 SD above the mean. Five science teachers responded to this invitation and participated in my interviews.

Research Design

This section and its constituent subsections serve as the case study protocol which is an essential feature of the exploratory multiple case study methodology (Yin, 2018). This exploratory multiple case study was conducted in two distinct subsequent phases along with a

pilot pre-phase. My goal during the initial phase was to identify as many cases as possible that scored at least an average score and above; I detailed this case selection process in the preceding section.

The pilot pre-phase, or the instrumentation refinement phase, was conducted in Fall 2021. Phase 1, or the case identification phase, began in Fall 2021 and continued through Spring 2022. Phase 2, or the TLE exploration phase, began in Spring 2022 and continued through Summer 2022. My goal during the second phase was to interview as many science teachers as possible to explore two major topics: (a) the unique attributes, features, and aspects of their TLEs, and (b) the barriers and resources involved in their transformation. The table below provides a timeline for the overall study:

Table 3. Study Timeline

Date	Step
late May 2021	Submitted Clemson IRB
mid-June 2021	Piloted surveys and interviews
mid-July 2021	Submitted school district IRB
late August 2021	Contacted school level science leader
mid-September 2021	Contacted and surveyed science teacher convenience sample
mid-November 2021	Recognized limitations in recruitment numbers
early December 2021	Pivot recruitment strategy with faculty support
early February 2022	Completed quantitative data collection
mid-February 2022	Began recruitment for interviews based on quantitative data analysis

mid-May 2022	Completed qualitative data collection
November 2022	Completed qualitative data analysis
2023	Completed dissertation manuscript

Data Collection Methods and Data Sources

In this section, I provide an overview of the data collection process which is organized in two distinct subsequent phases. The collection of multiple forms of data from multiple sources enabled me to evidence triangulation and allowed me to converge upon findings (Yin, 2018). Phase 1 resulted in the identification of several participants to recruit but also generated several forms of quantitative data from each of the participants including: (a) their ratings on belief statements towards emergent bilinguals along two attitudinal dimensions, and (b) insight into their meaning perspective shift (change in beliefs) as well as minor insight into the attributes, features and aspects of their TLE.

Phase 2 generated two sets of qualitative data from each of the two in-depth interviews. The first interview followed up on the results from tier two of the survey (transformative learning) and sought to explore the unique and specific attributes, features, and aspects of their transformation. The second interview followed up on the results from tier one (belief ratings towards EBs) and expanded on tier two (transformative learning) of the survey by exploring how teacher beliefs manifest into supportive teaching practices for EBs. I explored the manifestation of these practices through the lens of the barriers and resources involved in transformation. The proceeding sections provide details into each of the two phases as well as the pilot pre-phase.

Pilot Pre-Phase

To refine the data collection instruments, and to develop experience in conducting semi-structured interviews, I piloted both the two-tier survey and the interview protocols with a small (n=5) convenience sample of educators. These educators were not all science teachers; they varied in terms of the ages of students they taught. The instruments I refined in this phase are detailed in the following Phase 1 & Phase 2 subsections.

The two-tier survey pilot was conducted utilizing an interview hybrid method. I interviewed participants after completing their survey. I asked a series of questions to gauge any issues they may have encountered while completing the survey via Qualtrics. Their input was invaluable, as a few key changes were made to the original survey. Particularly, that one half of the first-tier questions had Likert-scaled responses ranging from 5 to 1 (strongly agree to strongly disagree), and the second half was oriented 1 to 5 (no to yes, all of the time). The final survey shared with participants in Phase 1 was revised to reverse the scoring for consistency across surveys.

During the second part of this Pilot Pre-Phase, I interviewed the same 5 convenience sample of educators using the semi-structured interview protocols. At the end of the interview, I prompted participants to discuss any questions, concerns, or feedback they may have about the protocol itself. Although few meaningful changes resulted from this process, this experience allowed me to better structure and order questions and resulted in the development of specific probing or follow up questions which were not anticipated during the proposal stage. I also developed notes which I used when conducting my interviews in Phase 2.

Phase 1

The online survey instrument is two-tiered; the first tier consisted of 31 items and took approximately 15 minutes to complete. Each of the two attitudinedl constructs were measured in the first tier using 13 Likert scale items. Another four items asks for participants name, email, school and specific subject area (i.e. general science, biology, chemistry, etc.). The last item on this tier asked participants to self-identify whether a transformative learning experience has influenced their beliefs towards EB students.

The second tier of this survey which participants opted into with the self-identification item, consisted of 11 questions and took approximately 15 minutes to complete. Perspective transformation was identified using four items while the learning activities which may contribute to this transformation was identified using items three items. This survey also included a definition of how the term emergent bilingual is being used in this survey along with a brief description of what is meant as a TLE in this study.

To measure science teacher attitudes towards linguistic diversity, I utilized Huerta et al.'s (2019) 13 Likert scale items. These authors adapted their instrument from Byrnes and Kiger's (1994) Language Attitudes of Teachers Scale (LATS). Huerta et al.'s Chronbach's alpha measure for internal consistency was equal to the original instrument (.81) from Byrnes and Kiger (1994) after making changes to the language used in their items.

To measure science teacher attitude towards science pedagogy for emergent bilinguals, I used Huerta et al.'s (2019) 13 Likert scale items. The authors anchored their items around, evidenced-based practices for teaching academic content and literacy to EBs recommended by *What Works Clearinghouse* (U.S. Department of Education, 2014):

1. Teach a set of academic vocabulary words intensively across several days using a variety of instructional activities.
2. Integrate oral and written English language instruction into content-area teaching.
3. Provide regular, structured opportunities to develop written language skills.
4. Provide small-group instructional intervention to students struggling in areas of literacy and English language development.

Beyond these recommendations, the authors looked to research leaders in the domain of EB research which promote practices such as: (a) allowing EBs to use their first language to clarify their thinking in the classroom, and (b) using EBs' home culture in the science classroom as ways to facilitate learning. These items are scored on a 5-point scale (5 = yes, all of the time and 1 = no). Higher scores represent more tolerance and acceptance towards EBs and linguistic diversity. Out of 26 items measuring the two attitudinal constructs, 11 required reverse scoring.

My intention was to use a principal components analysis (PCA) to analyze the content validity of the instrument once responses were received from participants. However, due to sampling limitations brought on by the partnering school district along with the unique challenges brought on by COVID-19, I was unable to reach the five minimum response per variable to run this test. 26 items would require approximately 130 participants which would have been possible with my original sampling strategy. A PCA would have enabled me to determine if the 26 items could be meaningfully reduced into two major groups, thereby independently confirming the grouping of items into measuring two independent attitudinal constructs.

Lastly, to identify that a participant has experienced transformative learning which influenced their positive attitudes towards EBs I utilized an adapted version of the Learning

Activities Survey (King, 2009). Three items guided participants "to reflect on an experience of change and delve into what exactly it was, how it happened, and what contributed to its occurrence" (King, 2009). Another three items identified from a broad number of categories the types of transformative experience the participant had undergone.

The complete two-tier survey is provided in Appendix A; however, the table below provides a summary of the major sections of the belief rating survey (tier one of the two-tier survey):

Table 4. Summary of the Belief Rating Survey

Teacher Attitudes Towards Linguistic Diversity	
Belief Constructs	Summary of Items
Beliefs about EBs and Learning	These items measure science teachers' beliefs regarding EBs and their schooling such as their motivation to learn English, and whether their presence inhibits the learning of other students.
Beliefs about External Supports for EBs	These items measure science teachers' beliefs regarding EBs and the support they receive institutionally such as PD for teachers and targeted programs.
Beliefs about Language Value in Home Country	These items measure science teachers' beliefs regarding EBs and the role government should play in promoting English in the US.
Teacher Attitudes Towards Science Pedagogy with Emergent Bilinguals	
Belief Constructs	Summary of Items

Beliefs about Integrating Language and Culture into Science Instruction	These items measure science teachers' beliefs regarding EBs and the specific science instructional strategies that best support their learning.
Beliefs about Allowing EBs to use their Native Language during Science Instruction	These items measure science teachers' beliefs regarding EBs' use of their native language in the science classroom.

The table below provides an overview of Phase 1:

Table 5. Phase 1 Overview

Step	Procedure
1) Generated convenience sample of schools	• Identified school level science leaders • Requested leaders with identify science teacher participants based on criteria
2) Surveyed convenience sample	• Contacted convenience sample (n=36) and invite them to join study • Tasked participants with submitting two-tier survey
3) Surveyed additional convenience sample	• Contacted convenience sample (n=20) and invite them to join study • Tasked participants with submitting two-tier survey
3) Generated pool of special cases	• Selected participants one standard deviation at or above mean score on belief rating survey • Validated transformative learning experience

4) Selected 5 cases	• Invited all participants which meet criteria to interview and select 5 participants at random

Treatment of Quantitative Data. Testing the distribution of the survey data was essential because it was necessary to invite participants to interview who scored at least a mean score as well as those scoring one and two standard deviations above the mean. After reverse scoring the 11 negatively worded items, I calculated the Attitude Sum Score which reflects the degree of positive attitude a science teacher has towards EBs (below mean sum scores reflect negatively oriented attitudes, while at or above mean sum scores reflect positively oriented attitudes). The table below presents the descriptive statistics of all the participants who provided a response to the two-tier survey; the table only includes descriptions of the 26 items measuring the attitudinal constructs:

Table 6. Descriptive Statistics

			Statistic	Std. Error
Attitude Sum Score	Mean		97.9091	2.33402
	95% Confidence Interval for Mean	Lower Bound	93.1548	
		Upper Bound	102.6633	
	5% Trimmed Mean		98.4242	
	Median		99.0000	
	Variance		179.773	
	Std. Deviation		13.40794	
	Minimum		60.00	
	Maximum		123.00	

Table 7. Tests of Normality

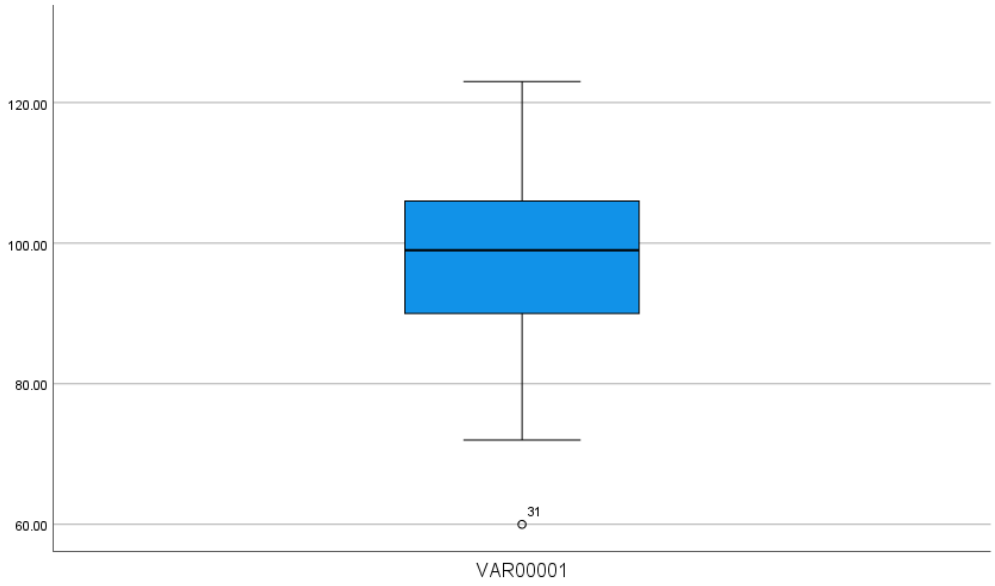
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Attitude Sum Score	.077	33	.200*	.973	33	.557

	Range	63.00	
	Interquartile Range	18.50	
	Skewness	-.512	.409
	Kurtosis	.939	.798

The table above shows that the mean and median scores were very similar, as well as the skewness and kurtosis being within the acceptable range of -1 to 1. The table below presents the results of the tests of normality:

The *p* value for the Shapiro-Wilk test is .557 which is greater than the acceptable value of .05. This value indicates that the distribution of my sample is not significantly different from a normal distribution. Lastly, the median score is nearly perfectly centered within the box plot shown below, as well as there being only a single outlier data point outside of the whiskers (participant 31).

Figure 2. Box Plot of Attitude Sum Scores



Based on the validated assumption that my data set was approximately normally distributed, I invited five participants to interview from a pool of science teachers who scored an Attitude Sum Score which was at least: a) at the mean and below one standard deviation, b) at one standard deviation and below two standard deviations, c) above 2 standard deviations. Maria, Amy, Amanda, Kelly, and Shelby (all pseudonyms) met these criteria and agreed to participate in interviews to further explore the nature of their TLEs. Their Attitude Sum Scores are presented in the table below:

Table 8. Attitude Sum Scores for Purposefully Selected Participants

Participant Name	Attitude Sum Score	Standard Deviation
Maria	96	Approximately 0
Amy	106	Between 0 and 1
Amanda	110	Between 0 and 1
Kelly	97	Approximately 0

Shelby	119	Between 1 and 2

Phase 2

During the first in-depth interview, I explored the attributes, features and aspects of the TLEs of my science teacher participants. King (2009) provides an interview protocol which can be used as a follow up interview to the initial Learning Activities Survey. This protocol was a great starting place for the types of questions I wanted to ask, but I made several changes based on the committee's feedback during the proposal stage. King's (2009) follow-up interview protocol is provided in Appendix B, and generally requires participants to reflect on the ten phases of transformation listed in Chapter 2. The protocol I utilized during the interview is also provided to display the differences in my approach.

During the second in-depth interview, I explored the barriers and resources involved in transformation. Mezirow (1991) writes that *empowerment* could be an outcome of perspective transformation and described three features of *empowerment*:

- A more potent and efficacious sense of self (p. 210).
- A more critical understanding of social and political relations (p. 210).
- More functional strategies and resources for social and political action (p. 210).

Thus, it is reasonable to believe that these critically sampled science teachers may be empowered due to their transformation to describe these barriers and resources, especially considering that my purpose in interviewing them was described as part of my invitation. I added a critically minded committee member to assist in the development of this protocol and sought their assistant to develop face and content validity. Additionally, I piloted this interview protocol with

a small convenience sample of teachers (n=5) during the Summer 2021. This protocol is also provided in Appendix B.

Treatment of Qualitative Data. I first began treating the qualitative data by listening to each interview while cleaning the interview transcript generated by Otter.AI software. Then, I listened to each interview a second time, while generating memos and notes of salient information pertaining to each of the two research questions. After combining my memos and notes from during the interview, with the memos and notes of my second listening, I began open coding the interview transcripts based on Yin (2018). Yin (2018) suggests that the process of open and axial coding to inductively uncover emergent themes is appropriate for multiple case studies although it is often utilized in grounded theory research as well. Thus, I coded the interview transcripts openly and independently, then I proceeded to code axially within each interview of each case to develop code groups. Lastly, I identified themes within each interview of each case to compare those themes to each of the other 4 cases (5 cases total each with 2 interviews).

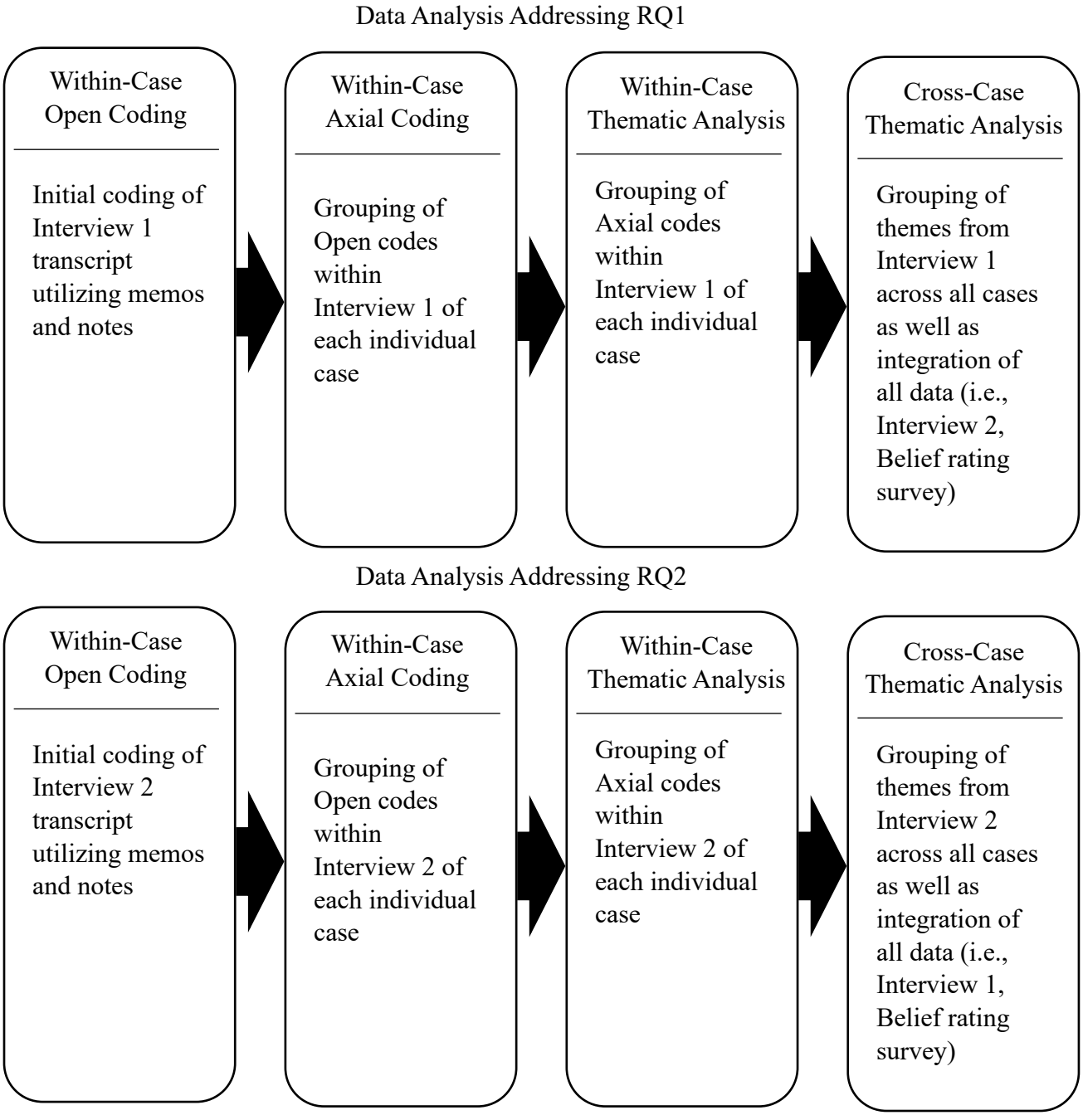
I then proceeded to employ a case-based cross-case synthesis of the within-case emergent themes from axial coding. Yin (2018) writes, "[i]n a case-based approach, the goal is to retain the integrity of the entire case and then compare or synthesize any within-case patterns across the case" (p. 196). Yin (2018) further outlines guiding principles of analysis:

- The cross-case analysis should attend to and account for all the evidence gathered throughout the study (p. 199).
- The cross-case analysis should investigate all plausible rival interpretations to findings (p. 199).

- The cross-case analysis should address and focus on the most significant aspect of the study (p. 199).

To attend to Yin's (2018) first suggestion, I analyzed all the data collected from each case (10 individual interviews, and 10 individual surveys) to determine ways in which the data either converges or diverges in relation to the research questions. Yin's (2018) second suggestion is addressed in Chapter 4 when discussing the dual nature of barriers and resources. This finding emerged not necessarily as rival to any interpretation, but it was entirely unexpected and emergent only because the data was analyzed across cases rather than simply within. Lastly, to address the most significant aspect of this study which is exploring the types of transformative learning these exceptional teachers have experienced, I presented the findings thematically rather than through a presentation of each individual case. These themes are presented and discussed in the following chapter. The figure below provides a summary of the qualitative data analysis.

Figure 3. A Summary of Qualitative Data Analysis



Summary of Data Collection Methods and Data Sources

To summarize the overall exploratory multiple case study methods utilized in this study to answer the stated research questions, I developed a case study protocol. This case study protocol also serves to fight threats to reliability of the findings. The table below serves at the protocol for this exploratory multiple case study.

Table 9. Case Study Protocol

Phase	Stage	Activity	Reason
Pilot Pre-Phase	1. Recruited participants	I leveraged my own network of science teachers to participate in the refinement of my instrumentation	The survey had only been used in one published study, and the interview protocol was newly developed
	2. Interview 1	I interviewed participants after they completed the survey	To gather information regarding issues with the survey
	3. Interview 2	I practiced the interview protocol, and then asked participants about the protocol itself	To gather information regarding issues with the interview protocol
	4. Refining instrumentation	I took feedback from participants to refine the instruments	To refine instruments for Phase 1 and Phase 2 of the study
Phase 1	5. Recruited participants	I utilized specific guidelines to request building science leaders to nominate teachers for the survey	Rather than collect data from all science teachers, this enabled me to have a high likelihood of finding science teachers with positive attitudes towards EB students

	6. Surveyed first convenience sample	I disseminated refined two-tier survey to teachers identified in prior step	To collect data about science teacher beliefs towards EBs as well as data about their potential TLEs
	7. Recruited additional participants	I reached saturation with survey with few participants, so I received help in recruiting more participants	COVID-19 created unique challenges for recruiting teachers through my original strategy
	8. Surveyed second convenience sample	I disseminated refined two-tier survey to teachers identified in prior step	To collect data about science teacher beliefs towards EBs as well as data about their potential TLEs
	9. Descriptive analysis of quantitative data	I analyzed survey data descriptively	This analysis enabled me to identify science teachers with positive beliefs who also self-identified as having those beliefs influenced by a TLE
	10. Identified cases	I utilized the analysis from the prior step to identify participants for Phase 2	These participants would serve as the cases explored in Phase 2
Phase 2	11. Interview 1 with each case	I interviewed the five science teacher participants to explore their TLEs	To collect data to answer RQ 1

12. Interview 2 with each case	I interviewed the five science teacher participants to explore their TLEs	To collect data to answer RQ 2
13. Treatment of raw qualitative data	I cleaned the interview transcripts generated by software utilizing audio and field notes	Clean transcripts would enable me to thematically analyze the qualitative data
14. Cross-case thematic analysis	I utilized a cross-case thematic analysis detailed in Figure 2	This form of analysis would provide findings to RQ1 & RQ2

CHAPTER 4: FINDINGS

The purpose of this exploratory multiple case study was to explore the Transformative Learning Experiences (TLEs) of science teachers who identify those TLEs as having influenced their transformation in beliefs towards Emergent Bilingual (EB) students. Five critical cases were examined in this study; they were purposefully selected from a broader population of science teachers. Maria, Amy, Amanda, Kelly, and Shelby each hold positive attitudes and beliefs towards EB students, as determined by their responses to the two-tier survey during Phase 1 of this study. This chapter is organized into three major sections, two of which presents findings to answer the two research questions guiding this study:

RQ1: How do science teachers describe the transformative learning experiences which influenced their attitudes and beliefs towards emergent bilinguals?

RQ2: How do science teachers describe both the structural and institutional barriers that worked, or continue to work against their transformative learning and the resources that supported or continue to support their transformative learning?

The first section focuses on introducing the five science teacher participants whose TLEs were explored during this study. The second section focuses on describing the salient aspects of these science teachers' TLEs, while the third section focuses on describing both the barriers and the resources which made these science teachers' TLEs either more or less challenging respectively. The findings in these two sections are presented thematically.

Case Profiles

In this section, I present profiles for each of the five science teacher participants that serve as the bounded cases for this study. The five science teachers purposefully selected based

on specific criteria described in the previous chapter, agreed to participate in two in-depth interviews to explore the nature of their TLEs. During those interviews, I asked each of them about the circumstances surrounding their TLEs such as: a) years of experience, b) training and education leading into teaching, and c) demographics of their first teaching assignments. Additionally, as our conversations evolved over the more than two hours in which we talked, they shared many other aspects of their professional and personal lives which helps develop of richness of their characters and their stories.

Maria

Born in the United States to Cuban immigrant parents, Maria is the only EB who participated in this multiple case study. She went to college and earned a bachelor's degree in elementary education which was her dream career since high school. Her teacher preparation program (TPP) poorly prepared her for the first teaching assignment she would find herself in. Her placement during her undergraduate training placed her in a predominantly White serving elementary school which was nothing like the predominant Latin-American and Spanish-speaking student population she would end up teaching in. Maria was in her 15th year of teaching in the same elementary school by the time we spoke, and certainly considered herself a veteran who made herself available to newer teachers in her school. Identifying as Cuban-American influenced her views regarding the EB students she taught. For example, she made it very clear during our conversations that EBs were not a monolith. She understood well and enacted practices in her classroom which celebrated the diversity in culture that exists among the Spanish-speaking community in her classroom and school. Maria highly valued her relationship with her mentor Shannon (pseudonym) who supported her in a vital way throughout her

transformative learning experience during the very early stages of her teaching career. The positive impact Shannon had on Maria's career and success is something that Maria made very clear.

Amy

A high school science teacher with 10 years of experience, Amy taught in a predominantly Latin-American and Spanish-speaking community. Amy has a bachelor's degree in biology and earned her teaching certification through a graduate TPP. She taught very briefly at another high school immediately after earning her master's degree, and experienced transformative learning in her current school where she has spent most of her teaching career. Amy highly valued receiving support from EB experts, and she lamented the fact that despite the large proportion of EBs in her high school that she never once has received PD directed towards enhancing her instruction with them. She shares a great number of insights throughout our conversations of ways to restructure the supports they have currently, and how to best expand the resources they have now to make the most impact on the achievement of EBs throughout her school.

Amanda

A 20-year Elementary school teaching veteran, Amanda had mainly been teaching in self-contained gifted & talented settings by the time we met. She has taught many different subjects throughout her career but has focused on teaching science in recent years. Amanda had approximately 17 years of teaching experience by the time she experienced transformative learning. Her TLE was catalyzed by teaching the first EB in her gifted & talented classroom

ever. Although she had taught this group of students for many years, she had never taught an EB in that setting until the 2018-2019 school year. Amanda also taught in a refugee city prior to moving to her current elementary school. She describes this experience as also being transformative for her in so far as exposing her to people from starkly different backgrounds and cultures. This unique teaching opportunity in a major metropolitan city provided Amanda what she describes as an excitement to celebrate diversity. Amanda's TLE has culminated in her advocacy of EB students to be permitted the same rights as other students in her state: to be able to test in their home, native or heritage language to have an opportunity into the gifted and talented program. She is often at school district meetings as well as the state house to advocate for EBs.

Kelly

A high school science teacher in her fifth year of teaching, Kelly became a teacher through an alternative certification program. This means that Kelly's pedagogical training began roughly on her first day on the job. Unsurprisingly, her TLE occurred during the first few years in her school as she was adjusting not just to teaching EB students but adjusting to teaching in general. Kelly moved thousands of miles from her home state to take this opportunity to become a high school science teacher. The result was teaching in a community, city, and state with a Latin-American and Spanish-speaking community vastly more diverse than the one she grew up in. Kelly has had to develop her teaching strategies rather quickly and leans a lot on the support of her fellow teachers. Particularly, Kelly mentions an individual who had expertise in supporting EBs who was just a few doors down the hall during her first year of teaching. She

laments that this person moved across the building during her second year, and longs to have that type of support even now during her fifth year of teaching.

Shelby

A Midwest transplant living and teaching in the rural south in a state bordering Mexico, Shelby had been teaching high school science for 14 years by the time we spoke. The major metropolitan city she grew up in exposed her to a great deal of diversity which helped her quickly become enculturated in her new home city. She teaches in a school serving mainly North American indigenous students as well as Latin-American, Spanish-speaking EBs. Although she no longer teaches there, the principal at her first school was incredibly influential in her development as a teacher and particularly in her development with teaching EB students. Shelby has developed incredibly strong bonds with her EBs, and speaks openly about advocating for teachers to receive more and better PD at her school which connects back to the excellent PD she received at her first school.

Salient Aspects of Transformation

One purpose of this study was to explore how Maria, Amy, Amanda, Kelly, and Shelby each describe their individual TLEs. Through the two-tier survey and the first in-depth interview, I had the opportunity to probe the circumstances surrounding their transformation. My exploration during this first interview was broad to create space for my teacher participants to describe in as authentic a way as possible all the aspects of their transformation. After coding each individual interview transcript both openly and axially, I was able to derive themes within each critical case. The themes presented in the following subsections emerged from a cross-case analysis between all the individual themes derived from each of the five science teachers. They

represent the most salient aspects of transformation among the multiple cases explored in this study. I chose to describe these themes as salient aspects intentionally. Aspect is referential to the appearance of an object to the eye or mind; referring to these themes as aspects is a way of acknowledging my limited position as a biased observer. Salient is referential to the most noticeable and significant observations of an object; referring to these themes as salient is a way of acknowledging my limited position as a biased interpreter. As a result of this study, I present three salient aspects of transformation: a) the disorienting dilemma of inexperience, b) the role of mentorship in the transformation of beliefs, c) the essential presence of EBs in transforming the sociolinguistic meaning perspective.

The Disorienting Dilemma of Inexperience

A key phase of transformative learning theory (1991) is the confrontation of disorienting dilemmas at the onset of the transformative process. As discussed In Chapter 2 the ten phases of transformation begin when an adult learner confronts a challenging situation in which their held beliefs are insufficient for helping them overcome it. This confrontation is often disorienting and acts as the impetus for adult learners to negotiate new beliefs and seek support in enacting them in their practice. All five of the science teachers participating in this study described confronting a very similar dilemma at the onset of their TLE: inexperience.

Maria, Kelly, and Shelby each shared with me that they were in their first year of the teaching profession when they had their TLE. Kelly became a teacher through an alternative certification program. She became a secondary science teacher through a program available outside of the state she grew up and went to college in. She said, “When I first started teaching, I actually didn't have a teaching degree. I came in with a degree in geology; I had no teaching background. And so, I never really had any experience with English as a second language”

(Interview 1, March 2022). Learning to teach on the job is challenging enough, but Kelly also had to confront a major lack of experience simply interacting with people who are learning English. Kelly describes growing up in a rural and agricultural part of the U.S. where her high school had approximately 30 EB students. In her words, “I came here, and it was like whoa, culture shock. Like, excuse me? Like, I was not used to this at all” (Interview 1, March 2022). This culture shock is a major part of what was disorienting to Kelly, in addition to learning how to become an effective teacher without any prior training. She further describes her first-year teaching in a school with a predominant EB student population, “when I first started teaching, I didn't know how to even approach those students because I didn't really know what to do besides the little helpful tools that they give you at the beginning” (Interview 1, March 2022). The dilemma of inexperience would push Kelly to seek others in her building for support, as well as push her to find her own way in the instances no one was available.

Maria had a much more conventional approach to the teaching profession. She earned a Bachelor of Arts degree in elementary teaching and became a certified elementary teacher in the same state where she went to college. She went on teach in the same city she graduated from and has been there for over 15 years. However, she shared with me that her TPP did not adequately prepare her for teaching in a school with a predominantly EB student population. In her words,

> I went to [a local university] and they were very heavy oriented with Caucasian percentages. There wasn't a lot of Hispanics that went to that school in the first place. And then when I was placed, and of course, they always placed teachers in some sort of practicum. And every school I was placed in was a heavy, heavy Caucasian school. It would be like if there was for example, there's a population have 600 in the school, there would be maybe two Hispanics in the whole school.

> Or I would have a school that was way, way out in the country and there was very little African Americans or Hispanics out there whatsoever. (Interview 1, December 2021)

Maria did not get any exposure to linguistically diverse students throughout her undergraduate program and this inexperience caused quite a dilemma for her during those first few years in her new elementary school. Maria identifies as Hispanic, and a lot of her beliefs surrounding the EB student population stemmed from her own life experiences. She assumed the EB students in her classroom would be like her: they would have a strong grasp of both languages in terms of speaking, reading, and writing. The reality was much different. She said,

> So, there was a point where my beliefs at the beginning while I was in college, I was like, okay, since they're not teaching me how to teach Hispanics, I'm assuming that whenever I go into the field, they're going to be just like, what I grew up where they're going to have these skills and these two languages underneath their belt and ready to go, but it wasn't like that at all. (Interview 1, December 2021).

Several of her students were brand new to the country, had little to no English proficiency, and had very little understanding of American culture as a result. She describes part of her transformation in the following way,

> It was transformative in the sense of I had to figure out not how to water it down, but how to make it visually representative of what I was teaching. And also in a way, how do I explain it to where this child's mindset can adapt? Because they have not been in the States, they have not had outside classroom experiences. If they were from Honduras or Costa Rica that they had to figure out, okay, I have

> not been in the United States, so I don't know how this applies in science, I don't know how this applies in English grammar. (Interview 1, December 2021)

Maria had to discover how to help her culturally diverse students connect to the curriculum which was not designed with them in mind. Her beliefs had to change to incorporate and eventually enact the types of teaching strategies that would best support her linguistically diverse student population.

Shelby, much like Maria, had a conventional approach to the teaching profession. She earned a bachelor's degree in teaching, but she emphasized on teaching secondary science instead. She studied at a university not far from her home in a highly urban city which she describes as very diverse in terms of both race and language. She says, "It's one of the best things I actually really liked about [this city] is that it is so diverse, because there's not just you know, homogenous groups of people around" (Interview 1, March 2022). Upon graduating she moved to a very small town many states away and took a position during her first-year in a Title I school with "mostly Hispanic and Native American students" (Interview 1, March 2022). She says that from her first day teaching the experience was disorienting, "it was not the same populations in terms of diversity. And the first experience was very early on, like, day one of teaching, like, you know, like right in the door that was like, boom" (Interview 1, March 2022). Shelby's expectations were shattered when she entered her classroom. Like Maria, Shelby believed her EB students would have a certain amount of English proficiency, at least enough to enable communication between teacher and student. Those beliefs were confronted with reality in those first few weeks of teaching,

> In terms of like, the transformative in terms of language, I think, like - this is going to sound like I said, very naive, but I kind of had an idea of like, oh, people

> know, some English, you know? A little bit, you know? Like, hi, hello. And my expectations were that there would be a little bit of communication that could happen. And that was not the case at all. So that was very reflective of like, how can I talk to this kid? Like, when I don't know the language? They don't know, my language. Like, how do you communicate? And how do you like, let them know, like, I'm going to try, I don't, I don't want to leave you behind. And so that was really, really reflective for me. And that was, like I said, within, like, the first week after I got to know the names. (Interview 1, March 2022)

Her beliefs about EB students began changing from those very first few weeks and according to her have continued to progress and change every year since then.

Unlike Maria, Kelly and Shelby, Amy was in her fifth-year teaching when she began her TLE. Amy did not have inexperience in terms of teaching, but she did express a sense of inexperience teaching linguistically diverse students. Amy had only taught "three or four ESOL students over five years" in her first school (Interview 1, December 2021). In her words,

> I originally for the first five years of my career taught at [a school with a predominantly White student population], very different demographic. So, I had several ESOL students, but they were far and few. Four - going on five years ago, I transferred to [my current school], which was a complete shift in our ESOL population going from [this school to my new school with a predominantly EB student population], very different demographics. And so, the little experience I had in [in my first school] really changed my perspective. (Interview 1, December 2021)

Even with five years of teaching experience, the inexperience of teaching EB students and the inexperience of learning effective strategies for supporting them was disorienting enough to catalyze a change in her beliefs. She goes on to say,

> So, I definitely think the jarring part goes back to the inexperience with the population. So, the lack of how to be able to navigate that situation with the student being able to support the students, I definitely had to tap into some resources here. (Interview 1, December 2021)

Amy, like many of the teachers in this study who struggled with inexperience, sought others in her building to support their teaching practice and were influential individuals in her transformation. Amy reflected on the fact that as a teacher of five years, she did not have to "reinvent whole new lessons" and instead could focus on growing more as a "holistic teacher" (December 2021, Interview 1). In reflecting on this time of her career she says, "I think that time in my life in my teaching career lined up to start allowing me to look outside. Just the instructional part and more about the development of my students" (December 2021, Interview 1). This five-year teaching experience is a key difference between Amy and several of the other science teacher participants in this case study.

No teacher had more experience than Amanda, who was in her 17th year of teaching when she had her TLE. Despite this wealth of experience, Amanda did not have a great deal of experience teaching students who were developing basic English proficiency. Amanda is a self-contained, gifted and talented (GT) elementary teacher. This means that she teaches her students every subject, including science, at a higher pace and covering more topics beyond the standard curriculum. As the GT teacher in her grade level, Amanda rarely taught EB students, and when

she did those students were almost “tested out” of the ESL program (March 2022, Interview 1). She explains why so few EB students enter her classroom,

> As far as the GT teacher, oftentimes, I get students who've already have a, uh, I guess, a pretty well-established command of English because to be able to be identified for gifted and talented, the tests that we give in [state] are all in English. (March 2022, Interview 1)

Amanda described this disparity in her student population to me and laments how little racial and linguistic diversity exists in her classroom. Her disorientating dilemma came in the form of a transfer student from another state, late into the 2018-2019 school year. This student was able to test into gifted and talented in this other state utilizing her native language, Russian. In Amy’s words, “So, when she took her gifted and talented testing to be qualified, in [the state she moved from], all of the tests were done in Russian” (March 2022, Interview 1). Without this exceptional circumstance, Amanda may have never taught a student who was still developing basic English proficiency.

Even after 17 years of teaching, Amanda was confronted with inexperience due to the inherent institutional barriers that exist for linguistically diverse children. This student was the first EB that she had taught in this specialized setting. In Amanda’s words,

> And I think for me - I never had that experience before - having student with limited English in the gifted classroom, and again, speaking Russian. I have decent knowledge of Spanish. But so, this was a language that I'm not familiar with. (March 2022, Interview 1)

Amanda had a very different approach to being confronted with this inexperience, compared to the other teachers in this study, since she was a veteran of 17 years. She was able to take agency

of her own transformation in beliefs. Amanda negotiated and enacted these new beliefs within a matter of weeks. Even though the same catalyst of inexperience was affecting her at the onset of transformation, her TLE was much different to the other four teachers.

Amanda grappled with the beliefs in her school district that EB students should be required to take the gifted and talented identification tests in English. In some ways, these beliefs had become her own. Yet this EB student challenged every notion of incapability due to limited English proficiency. As Amanda described it, this student thrived in her GT classroom,

> So, she came in, in March, by the end of the year, when she did the end of year state testing, she got meets grade level expectations in science. She took that test in English, and she had limited English, but yet she scored, you know, meets grade level expectations, which was pretty impressive. I could see she was really catching on quickly. You know, there's a lot of vocabulary there. But she was able to pick it up. (March 2022, Interview 1)

Through her transformation she has become an advocate for linguistically diverse students, to the point where she has sought out conversations with her superintendent to fix this disparity in the GT program. The inexperience of working with EB students in the GT classroom environment set the stage for her beliefs to be challenged.

Summary of The Disorienting Dilemma of Inexperience. All five of these teachers describe inexperience as a major dilemma which caused a disorientation of their held beliefs going into their TLEs. For Maria, Kelly and Shelby, the inexperience of teaching EB students was exasperated by the inexperience of teaching altogether. These three teachers were new to the profession, and Kelly was entirely out-of-field and had not had practicum or student-teaching experience. Maria and Shelby did have these practicum and student-teaching experiences in their

TPP, but their student populations did not serve any EB students which created a major gap in experience when it came time to enter the classroom as a certified teacher. Amy considers herself a veteran teacher after five years in the profession. This experience enabled her to largely navigate her transformation without much support, but still was confronted with the inexperience of only having taught three or four EB students in her first placement. This inexperience served as the disorienting dilemma to begin her TLE. In a unique learning environment, Amanda also confronted inexperience in terms of teaching EB students. The institutional and structural barriers in her school district prevented many EB students, especially those still developing English proficiency, from entering her GT classroom. This inexperience of teaching EB students with more limited English proficiency created quite the disorienting dilemma when an almost entirely Russian-speaking student entered her GT classroom. Inexperience in each of these cases enabled transformation to occur. Each of the five science teacher participants in this study described the same essential aspect of their TLE: the presence of their EB students. During our interviews I would ask each of my teacher participants if there was a particular person who was influential during their TLE; without failure, in each of my interviews I had to clarify that I meant someone other than their EB students. Unsurprisingly, Mezirow (1991) states that the social dimension is central to transformation,

> Perspective transformation is a social process: others precipitate the disorienting dilemma, provide us with alternative perspectives, provide support for change, participate in validating changed perspectives through rational discourse, and require new relationships to be worked out within the context of a new perspective. There is evidence, however, that “significant others” may not always be central to perspective transformation. (p. 194)

In just these two sentences, Mezirow (1991) captures largely what I found in this study: the social interactions the teachers experienced with their EB students facilitated their disorienting dilemma, and for some (but not all) there was a "significant other" in the form of a mentor which provided alternative perspectives, supported change, and engaged in rational discourse with these science teachers. This aspect of transformative learning theory is evidenced in the findings, and I discuss this further in the following section.

The Role of Mentorship in the Transformation of Beliefs

One of the key aspects of Mezirow's (1991) theory of transformative learning is the role other individuals play in supporting the transformation of meaning perspectives. Each of the teachers described people who influenced the transformation they were undergoing. These influential people varied widely in terms of their roles. For example, all five teachers specifically shared that their EB students were pivotal in their transformation. The linguistically diverse students in their classrooms serve as part of their disorienting dilemma like Mezirow (1991) posits. However, when pressed further to recount any other individuals that may have been important during that transformative period, each teacher also provided other adults which influenced their transformation. The degree of influence of these individuals varies from participant to participant.

Two of my teacher participants, Maria and Shelby, each vehemently expressed the importance of their mentors in both influencing and facilitating their transformation of beliefs. When I asked Maria if there was anyone who had supported her transformation, she had this to say,

> Yes, I have a mentor that I'm actually still really good friends with - she is now retired. She was the one that I actually started my practicum at [current school]

> here, and she basically told me and, again, it's fascinating because she's Caucasian - and she said, there is a large problem with us being able to relate to children of other - the sense of other cultures. (Interview 1, December 2021)

Maria comments on the fact that her mentor is White in reference to part of her disorienting dilemma earlier in our conversation. Maria was disoriented when she discovered that their ESOL support in the building was a White person with no training in learning other languages and little training in cultural diversity. However, the influential person Maria chose to share about is a White individual which indicates that race itself is not a barrier for someone to be influential in her teaching practice. It seems the greatest factors that influenced her mentor relationship are the knowledge and skills someone possesses in terms of sociolinguistics. On the topic of this mentor, Maria goes on to say,

> She pretty much said: this is the time to speak up, this is the time to express yourself and say, something has to change, we have to do a different - whether it be a different schedule at a different class or have a discussion with my administration about the change in the ESOL program. (Interview 1, December 2021)

This mentor is clearly providing Maria with alternative perspectives. She pushed Maria almost 16 years ago to challenge the status quo at her school when she started her first teaching position at [current] Elementary. Maria had a lot more share about her mentor,

> So this mentor, her name's Shannon (pseudonym), she won't mind. But Shannon was very, she told me, she goes, if you want a change to happen, you have to speak up, you're going to have to take these extra classes, she would guide me to, we have something called a portal here. So she would guide me to the course

> portal, and that would tell me okay, there are more divergent classes, she influenced me and impacted me enough to get my Master's in divergent learning. So she said, in order to go further, you have to research more and learn more. So this mentor would tell me, okay, get your courses done, get your Masters in this. Research what this is about, and it'll help you and to be able to talk to administration more and get the wheels turning on making the change towards that. (Interview 1, December 2021)

Shannon influenced not only Maria's beliefs about EB students, but also influenced her trajectory in terms of both PD and ongoing formal education in divergent learners. Shannon's mentorship is an example of the impact a mentor can have on the outcome of a teacher's beliefs and the massive influence someone can have on the outcome of a TLE. Maria, like some of my other participants, have become a strong advocate for her EB students and not just in her classrooms but beyond to her entire building and across the school district.

I followed Maria's response with an important question: would her transformation in beliefs be possible without the influence of her mentor Shannon? Unequivocally, Maria said it would not be possible. In her own words,

> Because if I wouldn't have had a mentor that was open minded to emergent bilingual learners, and I was placed with somebody that had, "oh, I need them to be taken out instead of included into the classroom" mindset, it would have definitely changed my mindset. (Interview 1, December 2021)

In Maria's experience her mentor Shannon was pivotal in the outcome of her belief's transformation. She wondered if perhaps her beliefs would be negatively oriented depending on who would have guided her during this complicated time in her teaching career.

Mentorship also played a key role in Shelby's transformation of beliefs during her first years as a teacher. Shelby worked in a small, rural school, and described herself as "the science teacher in the building". For Shelby, her mentor did not come in the form of another more experienced teacher in the building but was instead the principal of the school. In her words,

> My principal at the time as well was a big influence, because he helped me figure out like, how do we start? Like, how do we find stuff? Where do we even begin, and how we can communicate with (one) another? (Interview 1, March 2022)

Shelby goes on to mention some other important people during her transformation like her co-workers (other subject matter area teachers), and the EB students themselves. However, when I asked why she mentioned her principal first, above all these other individuals, she went on to share a lot about why her principal was pivotal in her transformation. She says,

> His name was Albert (pseudonym). I am still friends with him even now, because it's been almost 15 years now. Albert, he set up like some of the best PD I have ever done. And I know like PD in the education media is a big giant joke. Like, I know that. However, Albert, like he gave us really good PD. (Interview 1, March 2022)

Albert provided Shelby and her colleagues with specific and targeted PD for developing skills for working with a racially, culturally, and linguistically diverse group of students. Shelby's principal would also regularly schedule observations with his teachers to provide feedback and insight into how his teachers were implementing their new knowledge. According to Shelby, he would also bring experts in diverse teaching strategies to work closely with his teachers and provide specific, detailed feedback on their teaching.

Beyond providing PD to Shelby and her colleagues, her principal also had what Shelby described as a true “open door policy”. Shelby says, “I know a lot of principals say they do, but - like Albert actually did”. Albert’s mentorship to Shelby was key to her transformation, particularly in his willingness to support her in teaching linguistically diverse students. His direct involvement in the development of Shelby’s knowledge, attitude and practice was crucial. Shelby says, “So he was very involved in very - very into like, supporting his teachers and making sure that we could be good for our kids” (March 2022, Interview 1). While Albert may not have motivated Shelby to continue her formal education, his mentorship guided Shelby to find the right path in supporting EB students in her science classroom. When I asked Shelby if her score on the belief ratings portion of the survey would have been lower prior to her first year of teaching when she had this TLE and mentorship from Albert, she said the following,

> So I think if I had started out and hadn't had this experience with having support with, you know, my colleagues and my principal and all this other stuff, I think - I think it would have taken a dark left turn there, and probably been a lot worse. Because like, if you don't have the support to overcome the dilemmas and challenges, you know, people can tend to get a little bit more negative. (Interview 1, March 2022)

Shelby feels that the support to overcome the challenges of teaching EB students, especially as an inexperienced first year teacher, is crucial in the transformation of her beliefs. She scored two standard deviations above the mean score of all participants surveyed in this study, and she scored the highest among the five teachers in this case study report.

For Kelly and Amy mentorship also played a role in their transformation of beliefs, but to a much lesser extent than it did for both Maria and Shelby. Kelly and Amy mention individuals

in their respective buildings who supported them during their first year of teaching. Kelly is an out-of-field teacher with no experience teaching so she was paired with Tricia, a veteran "teacher mentor," during Kelly's first year on the job. Tricia provided Kelly with answers to her burning questions regarding how to best teach her students that were still developing English proficiency. She says,

> Tricia was really great because she helped answer questions that I had. And then she was also just really great giving advice when helping ELL students – telling me to only do like, a lot of the same accommodations for SPED [special education]. So only like chunking a lot of the information, making sure that the really important words, the vocab words are the words that they know. (Interview 1, March 2022)

Tricia really helped guide the teaching strategies that Kelly implemented during her first year, and according to Kelly is now a teacher mentor to all first-year teachers working in their building. Kelly also mentioned a SPED teacher that worked down the hall from her as being someone who supported her during that period of transformation. This teacher would also provide her with several strategies for supporting diverse learners when Kelly asked, "Well, even though she taught special education. A lot of the same tools for SPED are also used for ELL students. So to kind of give them that little bit of help that they need. (Interview 1, March 2022)." Perhaps because Tricia was not yet a dedicated mentor teacher, meaning she had other duties to fulfill beyond mentoring new teachers, Kelly had to supplement her support from someone in closer proximity.

Amy on the other hand pointed to the bilingual translator in her building as someone who was supportive during her own period of transformation. This bilingual translator, who Amy did

not name, helped Amy overcome the challenges she faced with an EB student in her first-year teaching. Amy said, “We actually have a bilingual translator on our staff who heads several of the organizations in our community for Hispanics. And so I would seek her help a lot and started sending him to her as well for resources (Interview 1, March 2022).” Amy, like 4 of the 5 science teachers participating in this case study, had little experience teaching and no experience in working with EB students prior to their first teaching placement. For Amy it was very helpful to have someone in the building to discuss how to best support this particular student and also other EBs in her secondary science classroom. She said,

> …being able to have those conversations, she grew to know the student really well too, since I would send him to her as well to be able to walk through some of the processes. So I think she is a really big support, and I think a lot of that just drives from her passion [for] the Hispanic community here - all the organizations she leads. So I think her passion very much rubbed off onto me creating part of my passion. (Interview 1, March 2022)

According to Amy, this mentor did play a role in her transformation and particularly in helping her develop a passion for supporting her linguistically diverse students. It was important for Amy to see someone develop strong, supportive relationships with these EB students which eventually became one strategy Amy used to support her own students in her classroom. In her words,

> The students that I've had these experiences with are the ones that would have those conversations with me before class after class - that we really developed a relationship that opened the door for me to be able to experience this with them. (Interview 1, March 2022)

Here she recounts the importance of her relationship with certain EB students throughout her entire teaching tenure which have been the essence of her transformation in beliefs. However, the skills to develop and maintain these relationships seem to stem partly from observing this bilingual translator in her building.

Interested in this relationship between Amy and her bilingual translator, I further pressed by asking if the presence of this person's support was pivotal to her transformation in beliefs; in other words, would her transformation have occurred without her bilingual translator? Amy responded by stating that although the translator was important, and certainly helped with her transformation, she would not say her transformative journey hinged upon their presence. In her words,

> So I definitely think I would have shifted to some degree. You know, if, if the resource isn't there, you're going to figure out how to navigate to get the resources and support that you need. So I'm not going to say that it was make or break without her. But she certainly enhanced the experience. (Interview 1, March 2022)

Amy truly felt that her EB students were at the center of her transformation which echoes what all five of my teacher participants had to share regarding their TLEs. In Amy's case however, her relationships with her EB students were especially significant. When asked what advice she might give to another teacher negotiating a transformation in her beliefs, she said "I definitely think the listening aspect, and building relationships of trust between each other has been key (Interview 1, March 2022)." She continues,

> If I were to mentor another teacher in opening their beliefs and being willing to adapt to change… You have to be able to build the trust and be able to be the

> learner in the environment, even though technically you're the teacher. (Interview 1, March 2022)

It is interesting that Amy recognizes that she learned a great deal from the bilingual translator, in terms of how to build and maintain these relationships, yet she does not feel their presence was "make or break it." Especially considering how important the bonds to her linguistically diverse students have been. Perhaps, as she states herself, the real teachers have been her students.

Of all the teacher participants, Amanda was the only one that did not point to another colleague as someone influential during her transformation. Amanda is the most experienced of all the teachers included in this case study; she had taught for 17 years when she had the TLE she recounted during our interview. Amanda is likely a mentor to newer teachers in this period of her career, rather than being mentored by others. Her TLE revolved around a particular student that had little English proficiency and was placed in her gifted and talented elementary classroom. However, Amanda said that this student's mother was an influential person during this transformative period. Amanda says,

> You know, it was her mom. I got it. I understood that she knew - and I felt like sometimes teachers or educators don't always listen to parents. Sometimes parents really know: my child needs more and they're not getting what they need. I could see how important it was for that mom that she was giving up these extra English language instructions so that she could be in gifted. And I really got that. (Interview 1, March 2022)

The EBs mother was especially influential to Amanda because she is now a mother of two, who has had to advocate on behalf of her children to be placed in the gifted and talented track. Observing this parent struggle to convince building administrators to allow her Russian-speaking

daughter to participate in the gifted and talented classroom had an impact on Amanda. She says, “so it's her, it wasn't another colleague” (Interview 1, March 2022). I curiously asked about their relationship: what were some of the interactions or collaborations you had with this student’s mother throughout the school year? Amanda replied that they did not spend a great deal of time together, but that instead it was her advocacy for her daughter which was influential.

Summary of The Role of Mentorship in the Transformation of Beliefs. For these five science teachers the role of mentorship existed on a spectrum. For Maria and Shelby, mentorship was pivotal and their TLEs would not have been the same without their mentors. For Kelly and Amy, mentorship played a role, but not a central one and perhaps the transformation would have occurred despite their mentor’s presence. For Amanda, mentorship was nonexistent, likely because she is a veteran teacher and instead was influenced by the mother of her EB student. The other four science teachers were just beginning their teaching careers, and at least one of them had a mentor assigned to them. Each of these four teachers had the self-awareness of inexperience which led them to seek others for support during their TLEs.

The Essential Presence of EBs in Transforming the Sociolinguistic Meaning Perspective

The previous section presented findings on how social interactions, particularly mentorship, provide the necessary support for changes to occur in beliefs. In this section, I will present findings for social interactions which precipitated belief transformation to occur in all five of my participants. Each of the five science teacher participants in this study described the same essential aspect of their TLE: the social interactions with their EB students.

No teacher is more emblematic of this phenomenon than Shelby. She never hesitated to discuss the important role her EB students played in the transformation of her beliefs. Like some

of the other teachers I will discuss, Shelby did seem to focus on one student and the social interactions they shared throughout this students' high school career.

> When I actually like, got into teaching, like out of school, I had this student who was like no, no English at all whatsoever. I mean, like, not even emerging on like the AZELLA scale or anything, which AZELLAs is what Arizona uses. But like barely any exchanging, and so it was really, really challenging to communicate back and forth, because like, I don't speak Spanish. The student happened to speak Spanish, and so then I was like, trying to find something that we could actually communicate to each other - and it's so isolating. I mean, if no one else can speak your language, you know, you're just on your own. Everyone else is around you talking - in something that you don't understand and like, it was just one of those like, "oh my gosh, this poor child." Like eight hours a day, you know, you're in here that you don't know what's happening. (Interview 1, March 2022)

Shelby felt it was essential for her to transform the teaching practices she enacted to best support students such as the one she is recalling here. She had little to no experience supporting students developing English proficiency, much less students who as she describes were not emerging on the scale of English proficiency they use in her state. Even as I asked if any people had influenced her transformation during those first pivotal years in teaching, she first listed this student as being influential. In her words,

> I don't know if that was a transformative experience you were looking for, but that was like the first like, big moment where I was like, "oh, no, you poor thing." Like, I have to make this work for you in some way to get you to be not even just

> like learning the content, but just to be part of the classroom community. (Interview 1, March 2022)

Her beliefs towards EB students began changing due to the presence of this particular student, as well as others that she engaged with throughout the course of her teaching career. Shelby was beyond motivated to create and foster a classroom environment that enabled these students to thrive academically (Interview 1, March 2022).

Kelly placed the least emphasis on her social interactions with EB students, although they were still central to her transformation. During our interview she reminisced about a student who was influential during her first year teaching in this predominantly EB school environment. She said,

> Learning her background really helped me understand like, my beliefs and thinking, "Okay, I know not every student has the same household," but she was trying to make an effort and like trying to be better - in not just bettering her life, but like bettering herself. And so that made me want to like better myself and you know, learn more. (Interview 1, March 2022)

Recognizing the effort this student was making to be successful in her classroom motivated Kelly to challenge her beliefs and develop her strategies to best support EB students in her classroom.

Maria, Amy and Amanda each placed a lesser, yet significant degree of importance on the interactions they experienced with their EB students, and the influence these interactions had on their belief transformation. Maria confidently asserted that if she had not been placed in her EB populated school that she would not have experienced transformative learning. She said,

> If I was not placed in [in my school] - if I had not chosen to do my career at [my school], I would not - I personally don't think I would have had the transformative experience unless I would have also been in the Hispanic population like [my town]. (Interview 1, December 2021)

In other words, her transformation was precipitated by the fact that she had an opportunity to engage with and interact with EB students.

Amy also reminisced about her EB students, and how the survey she had taken weeks before our interview caused her to reflect on her experiences with them. She said,

> I have several students that as I filled out the Google form, I immediately started thinking about one of them - in particular (there) was a student I worked with my first year here, who was an undocumented student who we really had a change (together). (Interview 1, December 2021)

During our conversation, Amy lamented how several of her EB students throughout her tenure had self-limiting perceptions about their future careers. From her experience, many of her students only saw specific type of work such as in the service industry and discounted the possibility of trade school or higher education entirely. These types of conversations with her EB students challenged Amy to shift her beliefs of what she felt was possible for her EB students in their future which required that she shift her beliefs for what was possible for her EB students within her science classroom. She goes on to say about this one particular student,

> He was probably my first student that I think I had a huge shift in my mentality as a teacher of helping him understand like, “Oh no, you still have a lot that you're able to achieve here. Regardless of what, whether or not you're documented, whether or not your moms from here.” (Interview 1, December 2021)

This shift in her beliefs goes beyond teaching strategies and appears to be a shift in unmaking self-fulfilling prophecies by advocating for her EB students. Amanda's entire TLE was precipitated by one specific student who transferred into her school during the year, so it comes as no surprise that her focus was on this child.

Amanda had never taught another EB student in her gifted and talented program. Her beliefs were shaped by the understanding that perhaps these students could not achieve in this environment due to a lack of experiencing otherwise. Amanda discusses the change in her beliefs that her interactions with this EB student helped influence,

> I guess what was changed for me was realizing that language - it didn't matter where the student was with their attainment of English, they still needed to be served in that gifted classroom. For me, what I was unsure of was the better place for her - in a regular classroom getting more support through with the ELL teacher, or what she had been better off, which I feel like she was being in my gifted classroom, with other students receiving that higher level of curriculum. And I guess that (is what) was the transformative thing for me is that yes, she was better off with the gifted services. (Interview 1, March 2022)

Amanda needed to see this EB student be successful in this unique environment to begin to shift her beliefs. Her more negatively oriented beliefs came from a place of caution: would this student be better served in a typical learning environment where she would have access to ESOL services? That was the tradeoff required in this situation, as the student being placed in the GT class meant a conflict with the ESOL teacher's schedule. Amanda recognizes that she was wrong for being worried, and as a result of this experience with this EB student now advocates on

behalf of testing students in their native or heritage language to determine if they should be placed in the GT track.

Summary of the Essential Presence of EBs in the Transformation of the Sociolinguistic Meaning Perspective. Although the presentation of findings in relation to this salient aspect appears to be organized and grouped in terms of my perceived importance of their description, it is clear that their social interactions with EBs played a pivotal role in each of their transformations. Another clear interpretation from these findings is that for several teachers the recollection of transformation appears to converge around specific students rather than the general population of EBs. Regardless, whether it is participation during class or an extended private dialogue after class, the social interactions that these teachers experienced with EBs was essential for the transformation of their sociolinguistic meaning perspective to occur. As a result of these social interactions with EBs, these science teachers began the challenging process of transforming their beliefs, ultimately orienting those beliefs in a more positive manner as evidenced by their survey results as well as the teaching practices they described during our interviews. To the question, would your beliefs be positively oriented today without ever having taught EB? Their answers were resoundingly: no.

Barriers and Resources Involved in Transforming the Sociolinguistic Meaning Perspective

The second purpose of this study is to explore the barriers and resources these science teachers encounter during periods of transformation in their attitudes and beliefs towards EB students. When articulating his theory of transformative learning, Mezirow (1991) appears to have a blind spot for describing the factors that could inhibit transformation. In fact, mentorship is implied rather than explicitly stated as a factor that could enhance transformation. To expand on that theory as well as recognizing that transformation is not an individual but rather social

process, I aimed to explore the factors which enhanced or inhibited the transformations of Maria, Amy, Amanda, Kelly, and Shelby. As a result of this study, I present three themes representing the barriers and resources involved in their transformations: a) the barrier of time, b) the barriers of language and culture, and c) the resource of expert guidance.

The Barrier of Time

Throughout our conversations the topic of time was either explicitly or implicitly addressed by four of the five science teachers I interviewed. When discussing the barriers and challenges they faced in implementing teaching practices that best support their EB students, these teachers expressed the positive difference it would make for their students if they had more time. One distinction some of these teachers made was between instructional (or classroom) time and preparatory (or planning) time. In truth, certain teachers described being constrained in one if not both areas.

The instrument that was used to measure the attitudes and beliefs science teachers hold towards EB students probed in one major portion the feasibility of implementing certain teaching strategies. Maria responded in her survey very positively towards the feasibility of many instructional strategies that are supported by research to best support EBs in the science classroom. However, during our interview, I asked Maria to share her thoughts on why she believed small group instruction was either unfeasible or rarely feasible in the classroom. She said to me,

> It's not feasible because we have so many students in the classroom. So, to have to, to have to focus on a small group of ESOL students - while you have all these other students at different levels, it is completely difficult, because you want to give those ESOL students more than - just because a typical small group in our

> grade level would be about 15 to 25 minutes. But when it comes to ESOL students you need about that 35 to 45 minute block, you're really not getting much with 15 or 20 minutes, because if you consider settling down, introducing the lesson, and you're really not focusing on the apply and practice stage, and when you're doing the lesson. So, with the small groups, it's so hard because one time is a factor, and two, you're not actually letting the ESOL students apply and practice what they learned. (Interview 2, December 2021)

With more time within the classroom, and perhaps with less of a focus on standardized testing, Maria would be more inclined to view small group instruction as more feasible to implement within her classroom. However, she finds herself having to prioritize other forms of instruction which better enable her to meet the demands of the district. Maria expressed frustration towards the focus on standardized state and national testing within her elementary school; especially for how this drives instructional time away from science and towards tested subjects like English and mathematics. In her words,

> If there weren't so many benchmark tests that basically forced you to teach a certain thing, I'd have time to be able to do the teaching practice I want. Right now, I'm told on what to teach. It's practically like teaching to the test. (Interview 2, December 2021)

While she recognized that small group instruction would best support EB students, she must also balance that this form of instruction may not be the most efficient and effective way of impacting the benchmarking scores.

Amanda similarly expressed concerns regarding standardized testing during our conversation. She implied that a focus on testing and scores, especially how they reflect the

effectiveness of a school or a district, takes away focus from the type of instruction which may best support certain students. In her words,

> We can always go back to standardized testing, right? When we think about the things that - whatever the test is assessing are the things that get the most focus. And, you know, we can hear so much about bubble students, those are the students who are close to moving up to the next level. And we'll have conversations about how much a student could be worth on a test, you know, students who move up this much, are worth this much toward our scores and schools. And I think so often a focus for any student, when our focus is so strong on standardized testing, that can take away the focus from what each student might need, personally. (Interview 2, March 2022)

While Amanda did not discuss the specific instructional strategies standardized testing may interfere with, it seems that with less of a focus on testing she would have more time to implement focused and strategic instructional strategies to best support individual student needs.

On the other hand, Amy explicitly describes time as barrier in best supporting her EB student population. However, Amy teaches students in high school who face unique challenges in their personal lives, such as holding jobs, compared to the younger students Maria teaches. There are many opportunities Amy regularly offers her EB students, but they require time outside of normal classroom instruction. She talks about these challenges during our conversation,

> I don't know if this would technically be a barrier, [but it] would be like time. So, a lot of our emergent [bilingual] students are not just students, but they are working pretty much full time after school, on the weekends to help support their

> family. And so oftentimes, I'm like, “hey, can you come into tutoring? Let's set up a time - like what day works for you?” [The students say,] “I'm working every single day after school, I can't be here.” So just having time together is a barrier finding the time to be together to work more on stuff that needs more time and dedication would be a barrier. (Interview 2, December 2021)

Regular instruction time does not appear to be sufficient for the type of instruction Amy wishes to implement. At the very least, it appears that more dedicated and focused instructional time in smaller groups would greatly benefit the linguistically diverse learners in her classroom. Amy did not elaborate on the specific challenges she faces in incorporating small group instruction within her classroom.

Of the four teachers which expressed time as a barrier, only one explicitly discussed the challenges with developing instructional materials for EB students outside of regular instructional time. Shelby discusses the constraint of time in terms of preparing instructional materials for her EB students and describes the challenges in preparing specific materials for this population of students which is highly represented in her classroom. She says,

> So, I think within the classroom, sometimes time would be a constraint but outside of the classroom, like you think it'll take, like 45 minutes to do something to get it prepared. And it actually takes like two hours. So, like that sort of time constraint exists as well, because like, how long do you think it'll take to be prepared is completely underestimated. You think it'll be “oh, so fast, so easy.” No, it's not. (Interview 2, March 2022)

Shelby also describes other forms of documents, beyond curricular materials, that she has to prepare for students which require additional time to prepare for her EB students. She describes

having to develop multiple iterations of various forms that she sends home for parents, and the challenges that exist when trying to ensure those forms are accurately translated and convey the meaning she intends.

Although not explicitly tied to the constraint of time two of the four teachers also expressed frustration in the distribution of their classroom populations. One described an irregular distribution of EB students throughout her classes, and how this varying distribution of students creates an unintended barrier of additional planning time. In one class Maria teaches four EB students and in another she teaches over 10. This makes it challenging to create one lesson to deliver the same science instruction in both learning environments. She assured me that leadership at the building level is supposed to attempt to make that distribution more uniform throughout each class of students to mitigate these strains placed on planning. Shelby expressed frustration in having to teach class sizes as large as 38 with over 50% of her student population still developing English proficiency to some measured extent. Without explicitly mentioning time in this scenario, it is easy to infer how these classroom structures can create additional time outside of the classroom in terms of planning, while simultaneously constraining time within the classroom. Managing student behavior for example in the case of teaching nearly 40 students may well make small group instruction unfeasible for someone like Shelby.

Time within and outside of the classroom was a barrier these teachers faced throughout their transformation. These constraints not only limited the forms of instructional strategies they would implement with their EB students, it also constrained their planning and developing of lessons, curricular materials and other important documentation. A few of these teachers expressed ways of overcoming this barrier by altering the structure of their class, or simply leveraging alternate forms of instruction which are less time intensive such as small group

instruction. Still when asked if they could have more time, either by extending class time, reducing class size, or moving away from a focus on testing, all these teachers agreed that more time would benefit their transformation.

Summary of the Barrier of Time. Time consistently emerged as a significant barrier in the effective teaching of EB students, as discussed by four out of five science teachers interviewed. Two dimensions of time were identified: instructional time and preparatory time.

Maria emphasized the challenges of incorporating small group instruction due to large classroom sizes and the time constraints this creates. In a standard classroom setting, there's limited time to support EB students effectively, especially considering that working with EB students often requires additional time. Further, the overwhelming focus on standardized testing means that instead of tailoring instruction to student needs, teachers feel compelled to teach students how to maximize their test scores. Amanda echoed Maria's sentiments, lamenting how the emphasis on test scores overshadows individual student needs. Benchmarking tests, in particular, dictate what is taught, thereby hindering the implementation of teaching practices that best support EB students.

In contrast, Amy, who teaches older EB students, highlighted the unique time challenges they face. Many of these students work full-time jobs outside school, limiting the additional time they can dedicate to tutoring and additional practice outside of the classroom. Shelby spoke about the underestimated time it takes to prepare specialized materials for EB students. These preparations are not quick fixes but often require extensive effort. Additionally, she discussed the challenges of accurately translating materials for parents and guardians, ensuring clarity and correct conveyance of information.

An underlying issue highlighted was the irregular distribution of EB students across classrooms. For instance, having four EB students in one class and over ten in another presents planning challenges. Larger class sizes, with over half being EB students, further complicates the teaching process, potentially making certain methods, like small group instruction, impractical. In essence, time works as a barrier towards the transformation of attitudes and beliefs in a variety of ways. Despite various strategies to mitigate these challenges, the unanimous sentiment was clear: more time, be it through extended class durations, reduced class sizes, or lesser focus on standardized testing, would significantly benefit the learning outcomes and educational experiences of EB students in their science classrooms.

The Barriers of Language and Culture

Each of the five science teachers interviewed for this study expressed some degree of difficulty in overcoming the barriers of language and culture when managing their transformation in beliefs towards EB students. The barriers are present in many different forms as described by the participants. For some it was a straight-forward as a challenge in terms of communication with both students and parents who were still developing English proficiency. For others the barrier of culture was a challenge in how to best incorporate EBs' culture into the curriculum to draw from their wealth of knowledge and support students in making those connections with the science content. Regardless, these barriers had to be overcome and first acknowledged for these transformations in belief to take place.

Several of these science teachers expressed a sense of frustration or helplessness in their lack of proficiency in their students' native language. For all but Amanda the non-English language their students spoke was Spanish. One of the first barriers Shelby discusses is her gap in knowledge about Spanish,

> I think an obvious barrier is that I didn't have a strong enough background in Spanish to like, even begin to start, you know, outside of like counting to 10, and "hello," I had literally no knowledge prior to that. So, I think that my prior knowledge was definitely a barrier to overcome. (Interview 2, March 2022)

Shelby grew up in a major metropolitan city in the United States where she often encountered people either in school or in the wider community who spoke Spanish. However, this was not a language she had ever studied formally. Meanwhile Kelly, who is also in a similar secondary setting, also expressed some difficulty with basic communication in Spanish. She said, "also like the language, because I am not fluent in Spanish, I know some things, and I know a lot of the swear words, which works now [she laughs], but like, a lot of it was just like the language barrier was like the big one (Interview 2, March 2022)." Even Maria, who shared during our first conversation that she had some level of fluency in Spanish expressed that communicating science specific vocabulary in Spanish was a barrier for her. In her words,

> So, I find tools a lot that help because there's certain terminology that I wouldn't be able to translate, because I didn't know about that, because I'm like, oh, gosh, how do I talk about weathering and erosion in Spanish, so it's difficult. (Interview 2, December 2021)

The fluency of these content and context specific terms is often referred to as register in the language development literature; Maria while having developed fluency in conversational Spanish had yet to develop this science specific register in Spanish. Many of these examples of a barrier due to language can be overcome through novel technologies which Maria and Kelly leverage to gap that bridge in communication between them and their students. Sadly, one science teacher shared an experience with language as a barrier which could not be overcome.

The greatest expression of helplessness due to a language barrier came from anecdote shared by Shelby. She shared a story with me about one specific student who spoke a unique dialect at home from continental Africa. Unfortunately, even after working with EB supports within her building, they were unable to find a single resources to help this student translate between English and their native language. This is what she said,

> I'll be honest with you, in some situations, it was impossible to overcome. Like there's – there's just nothing that we can get access to that has his language in it. And it's the worst, the absolute worst, because it's just, I mean, even from just a linguistically, like a linguistic preservation aspect, like that's devastating because of the culture and the language. In education setting, it's terrible, because like, maybe the student does need something and says it in his home language. (Interview 2, March 2022)

Although Shelby did share some interesting strategies such as using images to try and bridge this gap in communication, she still expresses that this specific example of a language barrier was not one she was able to overcome.

Differences in terms of culture was a barrier that was closely related to the barrier of language. Some teachers expressed that differences in culture created a barrier between themselves and their EB students, while others shared that their lack of understanding of diverse cultures was their own internal barrier. Interestingly, a few teachers discussed bridging the gap between home culture and school culture; the barrier that exists between those worlds is especially great for EB students according to the experiences of these science teachers. They expressed a desire to create new opportunities for EB students' home and native culture to be

celebrated within the school community. Maria became particularly excited when sharing an idea to celebrate EB students' home culture at the school. She said,

> Like a world International Day, we don't really have stuff like that. It would be awesome if we had that and say, "hey, there are not just Mexicans. There are people from Guatemala, and Costa Rica here." If we had that at least, and even not just once a year - we had that at least once a quarter so that people can realize, "hey, this is another bit that we have," but right now we're not really fostering "a come into the building kind of atmosphere," we're fostering a, "you need to have this, this, this this this before you register your child," and we don't have any events for you right now, and it scares a lot of parents off. (Interview 2, December 2021)

She expressed that this barrier that exists between home and school culture is further strengthened by anti-immigration laws. From her perspective these laws create an innate fear which keep the parents of EB students from engaging as freely, openly, and often as the parents of non-EB students. In her words, "a lot of the parents that don't speak English, they're scared because one, they have a lot of their fear that oh, 'if I come into the building is someone going to call Immigration on me,' because a lot of them don't have documentation (Interview 2, December 2021)." This fear of lack of proper documentation seems to be a specific barrier subset within the greater culture barrier.

The anecdote Amy was willing to share sheds light on how creating opportunities for the parents of EB students to engage with the school community helps bridge this barrier of culture. At her secondary school they can offer specific resources to support the Spanish-speaking community her school serves. She said,

> So, we tried to do a lot with getting our bilingual parents into the building, or Spanish speaking with a bilingual child. So at the beginning of the year, we host our, you know, normal, meet the teacher night, Open House night, where our bilingual translator does stay late to do just a Spanish version, separate from the English version. (Interview 2, March 2022)

This resource provided to Amy at the school level highlights the difference these types of events and pointed resources like bilingual presentations can have at the classroom level. Despite sharing that language presented a barrier, Amy expressed the most confidence of all teachers participating in this study that she does overcome the barrier of culture in her classroom. Her greatest culture barrier is in terms of a gap in generational knowledge which she admits is not unique to EB students. However, she shares that it is perhaps a greater barrier for this group of students as compared to non-EB students. In her words,

> And I often find, especially with just the generational education, whether its parents have the gap, which then leads to their children having the gap, that very similar to me, they just have a lack of knowledge of expectations - of what we can offer resource wise. And I would say I think this is the same with any parent that's not necessarily involved with this school. But I think it's more at a deeper level with our emergent [bilingual] students, because we can't just send a phone blast home saying, “hey, you know, your child needs glasses, let them know, they're, you know, to talk to their guidance counselor, we've got a program that can pay for them.” (Interview 2, December 2021)

The generational gap that exists between parents and students which creates a limited understanding of the resources provided by the school is further exacerbated by differences in

both language and culture. This barrier prevented Amy from supporting her EB students to the full extent she knew was possible.

One of my teacher participants had a unique TLE many years prior to the transformation we focused on discussing for the purposes of this study. Amanda worked in a major metropolitan city in the US before working in her current role and location. While she lived there it became a refugee city for Sudanese refugees, and she took every opportunity to support her new students and their families. This experience informed her future transformation when she encountered a linguistically diverse student for the first time in her gifted & talented classroom. She shares at length how this experience working within a refugee city had predisposed her to being more open to leverage and celebrate differences in culture to better teach her EB student. In her words,

> I do have some experiences that other teachers have not had. And some of the professional development I've had has been very supportive of culturally relevant teaching. And I know that's not specific necessarily to languages, but oftentimes they do go together. Because sometimes having you know, not a native English language might also mean a different culture. And I have seen teachers in the past, with their emergent [bilingual] learners speak differently about them. And I think sometimes there is that idea that if someone's learning English, maybe they're not understanding at the same level other students are. And I don't think people overtly think these things, you know, I'm always - I think, because of some of the training I've gone through. And I'm always constantly thinking about what are my perceptions and what are my biases? And I think right now, we're in a place where there's a lot of pushback with that kind of teacher instruction. I think you

> know, if we could find a way to help teachers be more comfortable with examining our own biases, about, you know, all of our students and the cultures they come from would go a long way to help students. (Interview 2, March 2022)

Her statement gets at the heart of the purpose of this study: our beliefs influence our practices. Amanda clearly communicates that while some of her colleagues may not overtly "think these things" there is an underlying belief that EB students are "not understanding at the same level other students are." A certain set of Amanda's beliefs predisposed her to limit the learning capacity of her linguistically diverse student, while a separate set of beliefs influenced her to consider that students' difference in both language and culture as an asset. Ultimately, her TLE with this student in her gifted & talented classroom caused her to entirely question the process through which students are selected and invited to participate in the gifted & talented track. This TLE provided her a guiding question which she still carries forward: why are we not able to test for gifted & talented students in languages other than English? The constructive interference of multiple TLEs has made Amanda into the most vocal advocates for EB students out of all the teachers interviewed in this study. Her testimony underscores the enormous value of overcoming the barrier of language and culture for science teachers.

Differences in language and culture present a major barrier to these teachers while also creating a wonderful opportunity for connection. As is the case with Amanda, when the differences are believed to be an opportunity then the capacity for what science teachers believe EB students are capable of in the classroom grows. As is the case with all five of my teacher participants, even the teaching strategies they elect to implement in their classrooms with EB students also grows as the barrier of differences in language and culture is overcome.

Summary of the Barrier of Language and Culture. One of the aims of this study is to explore the barriers science teachers face while instructing EB students. Language barriers, often related to Spanish proficiency, varied among teachers in this study. Shelby, with minimal Spanish skills, and Kelly, who felt overwhelmed despite some knowledge, exemplify this variety. Maria, conversant in Spanish, struggled with specialized science content specific terms. A poignant instance was Shelby's inability to find resources for a student speaking a unique African dialect, emphasizing the crucial role linguistic resources play in the success of EB students within science classrooms.

Culture is intrinsically tied to language. The divide between home and school culture was a recurrent theme, compounded by concerns like anti-immigration sentiments discouraging EB students' parents from school engagement. Amy emphasized proactive integration, highlighting her school's efforts, such as bilingual meetings, to engage the Spanish-speaking community. Yet, she identified a generational gap in understanding educational expectations, which is more pronounced among EB students due to linguistic and cultural differences.

Amanda's transformative experience in a refugee city shaped her unique approach to EB students. Exposed to culturally relevant teaching and consistently challenging her own biases, she offers a perspective distinct from common misconceptions about EB students' comprehension levels. Her experiences have led her to question traditional methods of identifying gifted students, advocating in her school community for multilingual assessments. Through her journey, she champions the importance of acknowledging and embracing linguistic and cultural differences. In essence, when educators see these differences as assets rather than barriers, it enriches both the teaching methodologies and learning outcomes for EB students.

The Resource of Expert Guidance

Nearly all the teachers interviewed in this study expressed the value of receiving guidance from both individuals and groups that have expertise in teaching EB students. In fact, the absence of expert guidance within the specific area of linguistic diversity was often described as a barrier by the same teachers. When these teachers could regularly rely on support from EL coordinators, ESOL teachers, and even bilingual teachers on how to best address the needs of this special population of students, they felt more capable of teaching EB students. This increase in capacity manifests into the enactment of specific teaching strategies such as the development of register within the science classroom.

Expertise in linguistic diversity was of utmost value to Kelly, who shared with me at length the value of the support she received from her ELL department. While she did mention the department was small, only comprised of a total of three ELL teachers for the entire building, Kelly worked just down the hall from one of them and was consistently going to them for support. She said, “she's been a lifesaver. If I need help with specific students, I go to her because I'm like, ‘Oh, I know she's had them,’ so I'll go to her and I'll ask questions and get advice (Interview 2, March 2022).” Kelly struggled to think of many other resources or assets that supported her transformation, so it speaks volume to the importance of having individualized and targeted support. Although this support was not structured, Kelly had to go this support in between class changes or schedule time for chats before or after school. It provides insight into the type of support which may be structured into other highly EB populated schools.

Amy also speaks to the potential value of her ESOL department which will soon provide more individualized and targeted support for content specific teachers such as herself. She said,

> So, we do have our ESOL department for sure. So, it's comprised of, I think we just hired a fifth ESOL teacher to be able to support us, and I know in January, when we return, our ESOL teachers will actually be joining our department meetings to work more one-on-one with gaining ESOL support within our classes. So, I think it's kind of directed like one teacher will work with each of the cores. So, we definitely have support there. (Interview 2, December 2021)

Amy's ESOL department as it currently functioned unfortunately did not have the structure or capacity to provide much support to individual teachers. Many of these teachers, including Amy, described the main purpose of their ESOL/ELL departments as supporting EBs in developing English language proficiency. Some of these departments did provide content area specific instructional support in terms of creating a space for EB students to catch up on missing assignments, however in each of the instances described by my teacher participants, EBs received a letter grade affecting their GPA for progress in their ESOL/ELL class. Thus, this creates an environment geared mainly towards the learning goals and objectives of that class (i.e., English language acquisition), and the content area specific instructional supports are provided when there is extra time. Amy was not the only teacher to speak enthusiastically about the potential to work closely with ESOL/ELL experts.

With the prompt of, "what resources or supports would best enable you to support EB students in your science classroom," Amanda also converged on the idea of receiving guidance from linguistic experts in her building. She said,

> Talking about our [grade level] planning, how we plan together, that's not a purposeful planning that we do. And the person who would have a vast knowledge of this [subject is] our ELL teacher. She doesn't have the time - like

> when I think about the people who come to our grade level plannings, so we will try to have these common grade level plannings. And, you know, a technology person may come, the literacy and math coaches are always there, usually, the Special Ed person is there, and oftentimes, our media center person will be there too. But the person I think about who's always missing is our ELL teacher. And that's our person who'd be a wealth of knowledge on how to support our [emergent] bilingual students, and, you know, our students who are being served by her, and she's not there at our meetings, and she couldn't be at our meetings. You know, I think about - because she served so many students, and I think we talked about this before, too, she has so many students, she has to serve and pool that if she were to be at all the grade level meetings, they would need a sub for her. (Interview 2, March 2022)

Amanda clearly acknowledges that the ELL teacher is someone with a "wealth of knowledge" in supporting EB students, as well as acknowledging that she and her content specific colleagues would benefit from their guidance in instruction. It is also fascinating all the various forms of support units that are present during these grade level planning meetings such as the instructional coaches across several subject areas, the media center specialist, a special education specialist, and even some to provide support with learning technology. It is also clear that the role of this ELL teacher is strictly different from the role of instructional support some of these other individuals play within their school. It would be of great benefit to Amanda and her colleagues for someone with expertise to provide regular coaching within the domain of linguistic diversity, especially considering the high number of EBs in this school and school district. Amanda adds to this discussion on EB coaching by saying the following,

> When I think about the coaching, so like we have instructional coaches, like we have a literacy coach and a math coach - we're also supposed to have science and social studies coaches, but I'm trying to think about when we have meetings together, and they help us plan. You know, I'm thinking we don't really have conversations about how to help those ELL students. You know, some but not as in depth as we do when we have conversations about helping students that are below grade level, and that can be two very different conversations, you know, just because they're, you know, learning English doesn't mean they're below grade. (Interview 2, March 2022)

Conversations and guidance in terms of supporting her EB students from an expert is a resource Amanda would greatly leverage if it were provided. I link this desire to have more expert guidance to her admission her training in teaching gifted and talented students involved no training in best supporting linguistically diverse students.

The kind of directed and specific guidance Amy and Amanda desired as a resource, is something that Shelby had afforded to her at her school. Shelby described an individual in her school building whose role was to move from classroom to classroom and support content specific teachers with their EB students. In her words,

> For me, though, my district supports us by having those positions available for our ELL floaters who go around to the classrooms. And they actually like help the teacher with stuff. So, my support comes directly from like, the ELL aide who comes around. (Interview 2, March 2022)

Throughout her transformation, which Shelby described as ongoing, these "ELL aides" played a pivotal role in providing targeted and specific expertise to support her EB students' unique

needs. Those needs change and vary as students change and vary from school year to school year; however, Shelby could count on this resource provided to teachers within her building. From the way Shelby described it though, these "ELL aides" also served as the ELL/ESOL teachers my other participants described. Meaning these aides also teach their own classes on English language development and acquisition while also having an opportunity to "float" throughout the building. I asked Shelby what other resources would have been helpful during her TLE and she stated that PD targeted at enacting and implementing strategies to best support EB students would have been ideal. In her words,

> I think I would actually go the PD route. And I know that my colleagues would just – I can see them rolling their eyes already. I can imagine. But PD that is effective and it meets the standards of being effective and taught teachers how to, like actually do stuff to like, I don't know how to say it, but to actually be effective teachers, for emergent [bilingual] students, like whatever those strategies are, and more than just like, what we technically we have to do. I think that would actually be really, really great for all of us teachers to actually experience and not just the stuff that they've tried in the past, because the stuff they've tried in the past, I'm going to be honest, is not all that helpful, it's not nothing new. And it's a lot of just like, okay, yeah, but "how do I actually do this in a real science classroom, not in just this, you know, idyllic setting that you've created for PD?" (Interview 2, March 2022)

Even Shelby who celebrated the expert guidance she was provided in her building still stated that more guidance from experts would be a major resource and asset in better supporting EB students as well better supporting her transformation. Her statement gets at the heart of the

implications of this study which is to generate professional development geared towards supporting teachers in making holistic changes in their practice by targeting not just curricular and instructional changes but also changes in attitudes and beliefs.

Summary of the Resource of Expert Guidance. For the science teachers interviewed in this exploratory multiple case study, expert guidance emerged as an essential element in effectively addressing the unique needs of EB students. Rooted in linguistic diversity expertise, this guidance appeared pivotal in shaping their instructional approaches and bolstering their confidence.

Kelly's narrative underscores the personal significance of having accessible and specialized support. With only a small ELL department in her building, she often leaned on a neighboring ELL teacher. Her frequent, albeit informal, interactions with this expert were clearly beneficial, suggesting potential advantages if such support was systematically structured in similar educational settings. Amy's feedback aligns with this sentiment. She mentioned that her school's ESOL department is growing, indicating a hopeful shift towards collaboration between ESOL teachers and content-specific educators. Presently, the ESOL/ELL setup at her high school mainly focuses on English language development, occasionally providing content-specific aid. Yet, Amy's excitement for future collaboration underlines the potential value of such integrative efforts for teachers like her.

Amanda emphasized in her interview the need for including ELL experts in planning sessions. At her school, while various specialists take part in grade-level meetings, the noticeable absence of ELL experts, despite their potential contributions, stood out to her. Amanda highlighted the difference between linguistic challenges and academic performance, suggesting that mastering English is not requisite for developing content specific mastery. Amanda also

lamented the missed opportunities in her teacher preparation program, as they didn't focus enough on supporting linguistically diverse learners. Shelby, on the other hand, detailed a somewhat different experience. At her institution, "ELL aides" float between classrooms, providing real-time assistance. However, even in this environment, Shelby recognized a gap in the quality of professional development (PD). She expressed a wish for grounded PD sessions that offer actionable strategies rather than ones that work in theory but not necessarily in practice.

It is evident that while the teachers in this study come from varied backgrounds and have different perspectives, a common thread is the value they see in expert guidance for teaching EB students. It is clear from my conversations with these teachers that expanding this expert guidance in a systematic way, that is, one that is incorporated from planning and designing lessons all the way through to the enactment of specific teaching strategies would have enhanced their transformation of beliefs.

Summary of Findings

Analysis of my first interviews with these science teachers revealed the answer to the first research question (RQ1) of this study which inquired about their TLEs which influenced their attitudes and beliefs towards EBs.

Inexperience working with EB students served as the catalyst for the TLE of all five science teacher participants in this exploratory multiple case study. Compounding that specific form of inexperience, Maria, Amy, Kelly, and Shelby all had inexperience in the teaching profession altogether. Kelly, in particular, had no teaching background or training prior to walking into the science classroom. Mezirow (1991) refers to this catalyst at the onset of transformation as the disorienting dilemma; an experience which causes one to recognize the

limitation of one's own beliefs to manage a present and imminent crisis. All my teacher participants described their inexperience as the dilemma which caused their transformation in beliefs to begin.

As mentioned previously in this chapter, mentorship is something Mezirow (1991) alludes to implicitly in his theory of transformative learning. He posits that for transformation to occur, that it requires sharing one's own discontent with the limitations of their current beliefs with, as well as receiving understanding and support from someone else who has negotiated similar changes in their beliefs in the past. Maria and Shelby are excellent examples of how pivotal this mentoring relationship is. They both describe the extent to which their beliefs are positively oriented almost entirely to the guidance provided by their mentors who they recall by name even years after receiving their support.

The presence of EBs at first appeared to me as a non-finding. In my view, it is self-evident that for one's own beliefs to change in relation to a specific group of people, that it would require at the very least sustained social interactions with that group of people. Through my analysis of the data, I found this aspect of their transformation to be anything but self-evident. First, it emerged as a theme for each case during the within-case analysis. Second, it was something shared by all the teacher participants without requiring further probing. My interpretation of this is the following: they each recognized that working with EBs was essential to transforming their beliefs towards them and described it as such.

Analysis of my second interviews with these science teachers revealed the answer to the second research question (RQ2) of this study which inquired about the barriers and resources they faced during their transformation in attitudes and beliefs towards EB students.

Time constraints, both in terms of instruction and preparation, stood out as a major barrier working against their transformation. The pressing demands of standardized testing combined with the unique requirements of teaching EB students meant several of these teachers found it hard to tailor their instruction effectively. Additionally, logistical challenges, like irregular distribution of EB students across classrooms, further complicate both the planning and enacting of teaching strategies that would best support EB students.

The barrier of language varied significantly across all five teacher participants. Some teachers grappled with basic Spanish proficiency, while others, even those conversant in Spanish, struggled to convey specialized science terms. Shelby's testimony highlights the challenges faced when limited linguistic resources are available, as seen in her search for materials for a student speaking a unique African dialect. The cultural aspect is another inextricable layer of complexity. A few teachers found it challenging to bridge the divide between home and school cultures, especially in an environment affected by political issues like anti-immigration sentiments. However, there are transformative insights, like Amanda's, which emphasize the potential benefits of viewing linguistic and cultural differences as assets rather than barriers in their teaching methodologies.

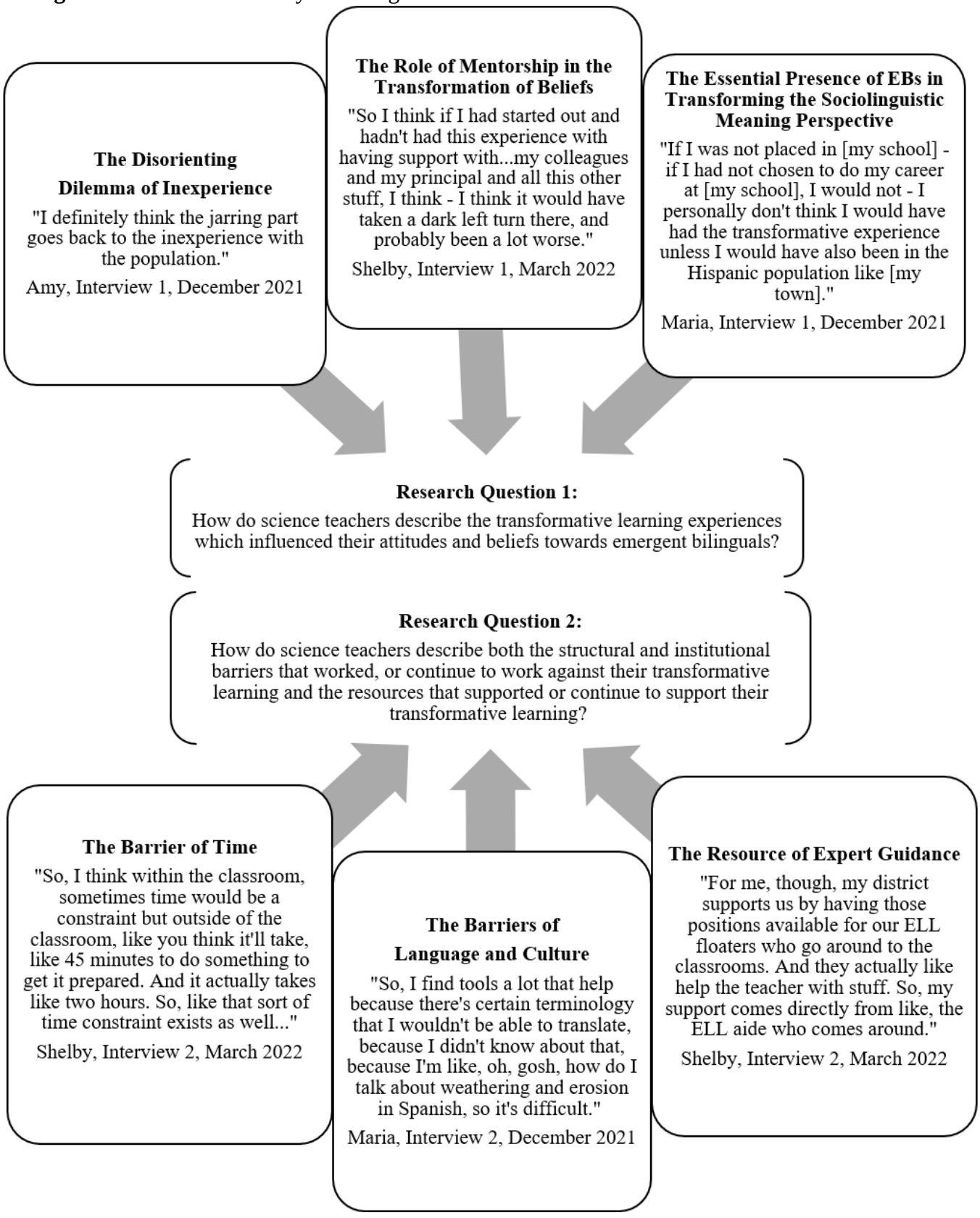
Amid these barriers, expert guidance emerged as a resource for the teachers in this study. Their interactions with linguistic diversity experts were often invaluable. For instance, Kelly derived significant benefits from her interactions with a neighboring ELL teacher. Amy indicates that better educational environments for EB students could stem from more collaboration between ESOL teachers and content area teachers. Amanda, similarly, stresses the importance of incorporating ELL expertise right from the planning stages. Shelby's experiences underscore the

necessity for professional development from experts working with linguistically diverse student populations that helps content area teachers develop tangible, actionable teaching strategies.

Each of the barriers and resources discussed here are two sides of the same coin. In other words, given the proper conditions and contexts any barrier could be considered a resource and any resources considered a barrier. For example, the barrier of class time created by both a high number of students and a high proportion of EB students present in each class, could be a resource if class sizes were small and if the number of EB students created a more manageable proportion. Suddenly, in these conditions, time is a resource which could enable a science teacher to implement teaching strategies like small group instruction. This dual nature of resource and barrier is perhaps the most salient finding from my second interview with my five teacher participants. Specific underlying conditions, perhaps most affected by larger societal factors (e.g., socioeconomics, immigration, racism), manifest as either a resource or barrier.

In closing this chapter, the figure below provides a visual summary of the emergent themes presented in this chapter. Each theme is accompanied by an exemplar quote pulled directly from the interview transcript with my teacher participants:

Figure 4. A Visual Summary of Emergent Themes



CHAPTER 5: DISCUSSION & CONCLUSION

Overview

In this chapter, I discuss the findings presented in Chapter 4, and present conclusions based on a synthesis between the two dimensions explored in this study: a) the salient aspects of transformation, and b) the barriers and resources involved in transformation. I then discuss the limitations of these conclusions as well as the strategies utilized to establish and maintain rigor throughout this exploratory multiple case study. In closing, I discuss the implications this study has on the professional development of science teachers, as well as the implications this study has on future research in science education.

Mentorship: Leveraging Expert Guidance to offset the Disorienting Dilemma of Inexperience

All five of the teacher participants in this study described facing similar dilemmas at the onset of their transformation: inexperience with teaching Emergent Bilingual (EB) students. As discussed in Chapter 2, Mezirow (1991) claims that Transformative Learning Experiences (TLEs) follow a linear process which begins with adults facing a disorienting dilemma. Although Mezirow's (2000) later work described the process as potentially recursive, as well as Nohl's (2015) work in the transformative learning space contradicting this particular inception to transformation by presenting findings to suggest that TLEs typically have non-determinant starts, the teachers in this study identified their inexperience as the dilemma which caused them to begin questioning their prior beliefs towards EB students. Furthermore, it was through mentorship that Maria, in one example, began to externally process her feelings of guilt and shame regarding her prior beliefs. This is a stated phase in the theory of transformative learning (see Chapter 2). Her transformation maps closely to the steps theorized by Mezirow (1991), as

she continued to critically assess her sociocultural assumption. In Maria's case, she erroneously assumed that her Spanish speaking students would be proficient in both English and Spanish as she had been throughout her childhood. Maria's transformation also closely mapped the fourth and fifth phase of Mezirow's (1991) transformative learning theory, as she began to negotiate her changes with her mentor, Shannon, as well as receiving help from Shannon in exploring new roles and actions. Maria was not alone in describing the importance of mentorship, Shelby, Amy, and Kelly also shared the importance of mentorship in their transformation albeit to varying degrees of importance. This finding aligns well with the established literature in science education pointing to the role of mentors in helping shape the beliefs of their mentees. Bradbury (2010) writes in the discussion of their study,

> Since the inception of mentoring in the field of education, ideas about the role of the mentor have changed. No longer is it sufficient to think of a mentor as only an 'emotional supporter' or 'expert advice giver.' Rather, mentors working with novice science teachers play a critical role in shaping evolving beliefs about teaching in reform-minded ways. (p. 1066-1067)

Bradbury (2010) argues for a reframing of mentoring in science education that emphasizes meeting the learning needs of students in the classroom which would ultimately facilitate learning opportunities for both students and novice teachers.

Unsurprisingly, the only teacher participant in this exploratory multiple case study that did not discuss the importance of mentorship was Amanda, who experienced transformative learning much later in her career and served as mentor herself at that point in her career instead. Thus, my findings suggest that an emphasis on providing mentorship to less experienced or novice science teachers would prove to be most efficacious. Synthesizing the findings between

the salient aspects of their transformation and the barriers and resources involved in transforming their beliefs, a key point of discussion is the following: highly EB populated schools should consider providing mentors with expertise in effectively teaching and supporting EB students to science teachers who identify as being inexperienced educating EBs or those that are novices to the teaching profession. The characteristics of mentors selected to participate in such a program are of utmost importance; in other words, not every veteran teacher is suitable to provide the mentorship necessary to support science teachers through their TLE. Garza & Harter (2016) present findings on the characteristics of effective mentors: a) mentor praxis, b) mentor-mentee relationships, and c) mentoring context. Garza & Harter (2016) also reference Johnson's (2002) much earlier work which identified the following traits of a good mentor:

a) must be sensitive to the needs of the beginning teacher;

b) be able to transmit effective teaching strategies;

c) be a good listener;

d) be able to communicate openly with the beginning teacher;

e) understand that teachers may be effective using a variety of styles;

f) refrain from being judgmental; and

g) model the philosophy that education is an ongoing process (p. 17).

Utilizing this literature on mentorship, as well as the data collected and analyzed throughout this study, I uncovered several ideal characteristics these individuals should have that would facilitate transformative experiences for all science teachers. Especially for those science teachers at the beginning of their teaching careers. I express the essence of being a "good listener," and developing strong "mentor-mentee relationships" as collegiality. The process of building community among colleagues in a professional field. I express "mentor praxis," as well

as “understanding that teachers may be effective using a variety of styles” as expertise of mentorship developed through years of experience in the teaching profession. Lastly, I express the “mentoring context,” and “refrain from being judgmental” as mentors who are accessible at meeting their mentees where they are as well as being available to them when they are needed. The following sections will outline the three major characteristics of such a mentor, and how these characteristics converge or diverge around existing literature in science education.

Collegial

Despite the number of years that had passed since they had been mentored, both Maria and Shelby identified a mentor by name: Shannon and Albert, respectively. In fact, Maria and Shelby still regularly maintain contact with their mentors and seek their advice to this day albeit more sparingly as their own expertise has developed. Regardless of how meaningful the relationship these teachers developed with a mentor was, every participant interviewed with the exception of Amanda, mentioned a specific person they would turn to for support. This support varied in form, but included forms such as: conversations/dialogues, modeling, instructional strategies, curricular materials, translation tools and resources, and guidance regarding relationship and community building. Based on these findings, the first key characteristic an expert mentor should embody is collegiality. Collegial captures the shared power and authority among colleagues. This shared power and authority helps create a sense of camaraderie and goodwill in the workplace while capturing some elements of the qualities Garza & Harter (2016) as well as Jonhson (2002) discussed in their work of teacher mentorship. For the science teacher participants in this study, it was valuable to feel empowered to have authority over what ultimately occurred within their own science classroom. Shannon and Albert empowered Maria and Shelby through conversation, modeling, and all the forms outlined above to enact reform-

based practices in their science classroom. These mentors did not use punitive means to ensure efficacy of certain practices, but rather empowered Maria and Shelby to exercise their agency and develop their own expertise through collaborative means.

Individuals serving in this mentorship role will ideally develop meaningful and lasting professional relationships with younger and inexperienced science teachers. This longitudinal approach to mentorship especially beneficial for transformative learning to occur, and the mentor would need to develop a sense of camaraderie and community among these teachers to maintain sustained support over 3-5 years. This timeframe is referential to both Maria and Amy's TLEs that while they are described as ongoing are also described as not requiring dedicated mentorship after becoming experienced themselves. Michailidi & Stavrou (2021) emphasize the importance of collaborative conversations between colleagues (mentors and mentees) for the implementation of innovative teaching of in-service science teachers. Individuals selected to be mentors of inexperienced science teachers in highly EB populated schools should be those that can create the space for constructive dialogue to occur which in turn will create collegial mentoring relationships.

Expert

All five teachers also expressed the value of having experts in their building who could guide them in best supporting EB students. Based on the findings this expertise would be concentrated in two major areas: academic and sociocultural. Both Maria and Shelby expressed the value of sociocultural expertise in a similar way: those supporting the teachers with EB students should have some degree of Spanish language proficiency. The non-English language which would require proficiency would vary based on the school context, but whether the language is Chinese Mandarin or Russian, proficiency in the prominent non-English language

was highly valued as well as signified expertise to both Maria and Shelby. In other words, having some degree of proficiency in that relevant non-English language, signified to Maria and Shelby that their mentor was someone whose advice was to be valued. Other forms of sociocultural expertise include an understanding of how to build bridges between school community and EB home community. Amy would benefit from an expert in Latin American culture who understands the distinction between Mexican, Central American, and South American cultures. With this understanding, the expert could guide someone like Amy to best connect with their EBs family and/or guardians and create opportunities for them to participate in school functions. Again, this cultural knowledge expertise would vary based on the specific school context. Amanda lacked this type of expertise and viewed this as a barrier (more on this duality in the following subsection).

The academic form of expertise refers to the reform-based teaching practices that will best support EBs in the science classroom. Practices such as: a) empowering EBs to use their native or heritage language to clarify science instruction, b) utilizing small group instruction to maximize the opportunities for EBs to engage in meaningful discussion surrounding science topics, c) creating opportunities for EBs to explore science content rather than explaining it. The forms of academic expertise that were relevant to the science teachers in this study included: a) strategic approaches to teaching science specific vocabulary, b) the development of alternative forms of assessment to accommodate EBs, and c) how to deliver instruction on procedural knowledge (such as solving an equation) through modeling. The specific forms of expertise that are relevant to this discussion are linked to the personal experiences of the science teachers in this exploratory multiple case study, but the literature shows that recognition of expertise is valuable in building a meaningful mentoring relationship (Forster et al., 2022; Oliver, 2009).

That is to say, a veteran teacher selected to mentor in this capacity should evidence both academic and sociocultural expertise.

Accessible

Both Maria and Amy celebrated how accessible their mentors were to them throughout the beginning years of their teaching tenure. This accessibility to their mentors meant that they would regularly receive support on how to best address the needs of their EB students, as well as receive timely feedback and input on implementations of novel teaching strategies. Mathur, Gehrke & Kim (2013) write the following when discussing their results on a study investigating the impact of a teacher mentorship program,

> our research supports previous findings that the effectiveness of mentoring partnerships depends on (a) the frequency of contact with beginning teachers and (b) the matching of new teachers to veteran teachers with similar teaching assignments who are located in the same school building (Fletcher, Strong, & Villar, 2008; Parker et al., 2009; Strong, 2005; Whitaker, 2000).

As evidenced by Mathur, Gehrke & Kim (2013), as well as evidenced by many other education researchers they cite, regular and timely interaction is a hallmark of any quality mentoring program.

Veteran teachers selected to be mentors of inexperienced science teachers working with EBs should have systematic and organized time in their regular schedule to meet regularly with the teachers they mentor. Too often these mentoring relationships are relegated to support being received outside of regular school hours, but a school interested in the success of their EBs should invest in building a mentoring program that prioritizes time for these interactions to occur intentionally rather than arbitrarily. Another important aspect of organization is that the mentors

be located within the same school building as the teachers they mentor. This would enable meetings to occur more frequently, and would inhibit the likelihood for novice science teachers to simply choose not to ask for the support they need.

Time, Language & Culture: Acknowledging the Barriers Linked to the Presence of EBs

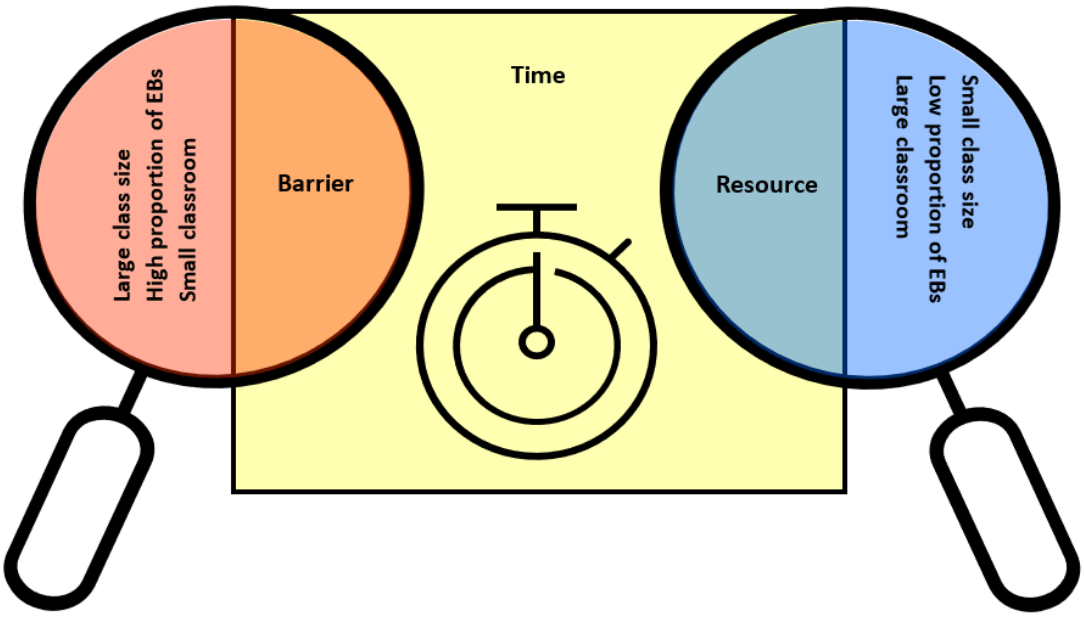
Of all the findings, the analysis most clearly evidenced the following: the transformation of beliefs towards EBs requires their presence in the classroom. The presence of EBs, according to my teacher participants as well as according to the literature (Knox & Salinas, 2019; Cervetti, Kulikowich, & Bravo, 2015; Cho & McDonnough, 2009), also carries with it unique challenges to instruction. The barriers of time, language and culture emerged as themes as a result of analysis. In other words, these were barriers that inhibited the transformations of Maria, Amy, Amanda, Kelly, and Shelby. From their perspective, these barriers made it challenging to enact the reform-based teaching practices that would be support their EB students. They viewed the enactment of those practices as evidence of their transformation in beliefs. Tolbert, Knox & Salinas (2019) quote Rodriguez & Kitchen (2005) in writing, "we understand that secondary science teachers have few or no opportunities to become well prepared for socially and culturally contextualized instruction since science teacher preparation often privileges Western science content and skills over social and cultural contexts (p. 1070)." Tolbert, Knox & Salinas (2019) present an instructional framework, Secondary Science Teaching with English Language and Literacy Acquisition (SSTELLA), to frame, adapt and apply effective science teaching strategies within an appropriate sociocultural context. This work is an effort to provide an effective resource to science TPPs in supporting novice science teachers to overcome barriers when teaching EBs.

In the following subsections, I will discuss these inherent barriers, time, language, and culture, through two perspectives: a) the individual, b) the collective. Through the discussion of the individual perspective, I will identify the actions which science teachers have agency over controlling, changing, and adapting to these particular barriers. In other words, the first section will discuss the power of the individual teacher to overcome the barriers of time, language, and culture. Through the discussion of the collective perspective, I will identify the actions which science teachers have no agency over controlling, changing, and adapting to these particular barriers. In other words, the second section will discuss the lack of power of the individual teacher to overcome the barriers of time, language, and culture created by systems and policies.

Resource and Barrier as Duality: The Individual Perspective

The most unexpected finding throughout this study was the duality of resource and barrier. In fact, the original design of this study only explored the barriers involved with transformation, and it was through guidance of a fellow critical researcher that I ultimately decided to also explore the resources involved with transformation. During the between-case analysis, the duality of resource and barrier emerged. It appeared to me, that each of the emergent themes answering RQ2 could be interpreted as either a barrier or a resource depending on the specific context and conditions through which the barrier or resource is being experienced. The figure below provides a visual representation of this concept for the barrier of time.

Figure 5. The Duality of Time as a Resource and Barrier



Time, represented by the yellow box, is a value neutral construct; it is inherently neither a barrier nor a resource. When time is viewed through a specific lens (e.g., the red lens on the left of the Figure 3) like large classroom size by population, a high proportion of EBs, and a small classroom, then it is likely to perceive time as a barrier. This interpretation of duality also applies to the barriers of language and culture. Language and culture are both value neutral constructs which observed through specific lenses can appear to be either barrier or resource by any given science teacher.

There is power in the recognition of this duality that the individual science teacher can claim. Recognizing that a lens causes the appearance of an object or construct as barrier enables one to begin the process of investigating the specific conditions which give rise to that lens. Through this investigation, a science teacher may discover that there are actions, adaptations and changes they can take to alter those conditions thereby changing the lens. In other words, through their own agency and power, science teachers may be able to change a barrier into a

resource. The limits of the individual to act, adapt and change conditions vary widely across contexts, but it is true that many of the barriers the science teachers in this exploratory multiple case study faced eventually became resources they leveraged later in their teaching careers. One salient example is that of Amy. Amy viewed culture as a major barrier at the onset of her transformation[3]. The gap which existed between her culture and that of her EBs was vast, and she found it challenging not only to connect with her students but also to support them in meaningful ways. This barrier initially worked against her TLE. Through mentoring, exposure, and exploration, Amy began to apply a different lens to bridge the gap in culture between herself and her EBs. In approximately three years, Amy began to perceive culture as a resource which she could leverage to better connect with her EBs and their parents or guardians. Amy began to reflect on the limitations her school and her state and country (both collective entities) imposed on EBs on a systematic and political level. For her, it was challenging to get EB parents to participate in registration nights and open house due to their fears of policing and deportation. Thus, ultimately bridging that cultural gap remained a barrier she could not entirely overcome through her own power.

Systems & Policies: The Collective Creation and Perpetuation of Barriers

Time emerged as a barrier as a result of cross-case holistic analysis. After analyzing all the relevant data, I define time within this study as: a) the minutes and hours teachers have available to them with students for instruction, and b) the minutes and hours teachers have available to them with students for extracurricular activities such as tutoring, and individual

[3] Although outside of the scope of this study, there is an inextricable link between race, ethnicity, language, and culture which should be acknowledged by all professionals working in highly EB populated learning environments. This tension is present, but not addressed, in Amanda's case where her EB student which catalyzed her TLE is a European, White-presenting student. It is unclear whether or not this students race and ethnicity played a role in their TLE.

conversations, c) the minutes and hours teachers require for planning both materials and strategies to most effectively teach EBs, and lastly d) the minutes and hours teachers invest in developing their practice, attitude and knowledge to become more effective science teachers for all students. As mentioned in the previous section, time perceived through specific lenses causes it to appear as a barrier. The ways in which time manifested as a barrier for the teachers in this study varied widely. For several of them time became a barrier through the lens of a large class size which was then compounded by a large proportion of EBs. These conditions create a time barrier which is not within the power of the individual teacher to effectively overcome it. Policies such as state or national funding create limitations such as the number of teachers hired to serve a given school. Without greater funding to hire more teachers, there is no physical way of decreasing the number of students in a given classroom. By increasing the total number of teachers and classrooms, it is possible to address both the high overall population of students per classroom, but also address the high proportion of EBs by strategically scheduling and placing those students. It is most often beyond the scope of the individual power and agency of any science teacher to affect the conditions of classroom size.

Similarly, both language and culture each emerged as a barrier as a result of cross-case holistic analysis. After analyzing all the relevant data, I define language as: the method through which teacher and student communicate via speech, writing or gesture; and I define culture as: the customs, norms, knowledge, and beliefs socially transmitted to teachers and students. These constructs manifested as barriers in these teachers' TLEs in the following ways: a) differences in culture between science teacher and student making it challenging to connect, b) lack of proficiency in EBs native or heritage language as well as lack of proficiency in English making it challenging for science teacher and student to communicate. These barriers extend beyond EBs

themselves, but also to their parents or guardians. Nakagawa (2000) analyzed both the discourse and educational policy surrounding the creation of the involved parent in education. They aptly describe part of the problem as the double bind; they write, "[p]arents do not do enough, and without parental support, nothing else matters (Nakagawa, 2000)." They reference Jamieson (1995) in writing that the double blind is a historically leveraged strategy by those with power against those without; regardless of the action taken by parents in their involvement they will appear to be wrong. The concept of the double bind is salient to the parents in Amy's school community who feel the right choice is to remain free of incarceration but appear wrong in not participating in school functions such as registration and open house.

On the barrier of language, Gandara (2010) explores the effects of restrictive language policies on educational outcomes for the students in the states of California, Arizona, and Massachusetts. For teachers like Maria, who speaking Spanish fluently, the ability to provide instruction or even to clarify instruction in a non-English language is limited due to policy in the state she teaches in. While as an individual teacher, Maria has the power and authority to provide translated resources to her EBs, she cannot overcome the collective barrier of policy to provide science instruction in Spanish. Out of all the teachers in this study, Amanda was the only one who identified that her transformation involved action in the politically. As a result of her TLE, she could no longer support the educational policy in her school district that restricts students from taking the GT placement test in their native or heritage language. The TLE with her student who spoke and placed into GT placement in Russian provided her with experiential evidence that students could be successful in that advanced track while still developing English proficiency. Amanda's case exemplifies the limitations of the individual to overcome barriers created by the

collective, while also exemplifying the potential of every individual to work towards collective change.

As a result of this study, I encourage school boards and elected officials to create educational policy and systems that create conditions where time, language and culture appear as resources rather than barriers. Additionally, I encourage that mentors of novice science teachers who work with EBs, support their mentees in becoming political advocates[4] like Amanda who use their individual power to transform the collective systems which create a perpetuate barriers.

Limitations

One limitation of this study is the use of critical-case sampling in purposefully selecting participants to interview for Phase 2. This form of sampling bares many similarities to extreme case sampling. In fact, Morgan (2014) subcategorized both extreme and critical case sampling as variants of sampling participants with "special information" (see Table 7.1). According to Teddlie & Yu (2007) extreme case sampling involves determining a dimension of interest, identifying a distribution of individuals along that dimension, and then finally locating extreme cases. Extreme data points in the domain of statistical analysis are typically ignored because they strongly influence the overall analysis of most data samples. This tends to lead to a deductive misinterpretation of the outcome. However, extreme data points can lead to uniquely insightful inductive interpretations from which we can derive general principles. By understanding the simultaneous risk and value of extreme data, I can mitigate its harm while amplifying its benefit. The participants in this study represent critical cases: science teachers who have experienced TLEs that have influenced their positive beliefs towards EBs.

[4] There exists tension between the conclusions drawn in this section. On one hand, I think it unreasonable to expect our public-school teachers to become political advocates for large scale reforms, yet it was the something Amanda was very capable of achieving. Perhaps it is best said that the aims of such a transformation would be sustained effective practice with EBs, and that transformation into advocacy is very real but should not be the aim of PD.

Another limitation in this study is in the process of validation that science teacher participants have experienced transformative learning. The research which utilizes King's (2009) Learning Activities Survey typically perform some type of learning intervention (i.e., professional development, university course, workshop, etc.), and then subsequently provide their participants this survey to understand whether or not their intervention functioned as transformative learning experience. In this study, I utilized the survey much differently. The survey is instead validating that a prior TLE has taken place unrelated to the present study. For many of the participants, the transformations began many years ago, while for others the transformation began four years prior to our interview. This maturation for three of the Phase 2 participants can create a limitation in the reliability of their recounting their TLE.

There is also some limitation associated in generating an initial convenience sample based on the recommendation of building level science leaders rather than probing the entire population of science teachers from the school district. To some extent the guiding prompts to identify a convenience sample provided to building leaders mitigates some of this limitation. However, even school level science leaders are limited in their perception of their science teacher colleagues, and who they selected to nominate have had a great impact on the five cases selected for analysis. There is also limitation associated with the emergency convenience sample generated due to the recruitment challenges created by COVID-19. A broad invitation was shared via the social network of a committee member, and thus there is no parity between this recruitment strategy and the original strategy for recruiting Phase 1 participants.

Lastly, I want to discuss the limitations involved in the implicit challenge involved in transformative learning research. As the researcher, I am inquiring from my participants about the positive beliefs and attitudes they hold towards a marginalized group of learners. Beyond

this, transformative learning by definition implies that if a teacher holds positive attitudes and beliefs towards EBs now, that there was a time in the past when they held negatively oriented beliefs towards that same group of students. There is a limitation to the extent to which a teacher would openly express their once held negatively oriented beliefs and attitudes, although several of my science teacher participants did speak candidly about their past.

Establishing & Maintaining Rigor

To establish rigor and mitigate both the effects of subjectivity and the effects of limitations in research design, I leveraged Yin's (2018) tactics for managing each of the four prominent tests in social science research: (a) construct validity, (b) internal validity, (c) external validity, and (d) reliability. These tactics are detailed in the following sections.

Construct Validity

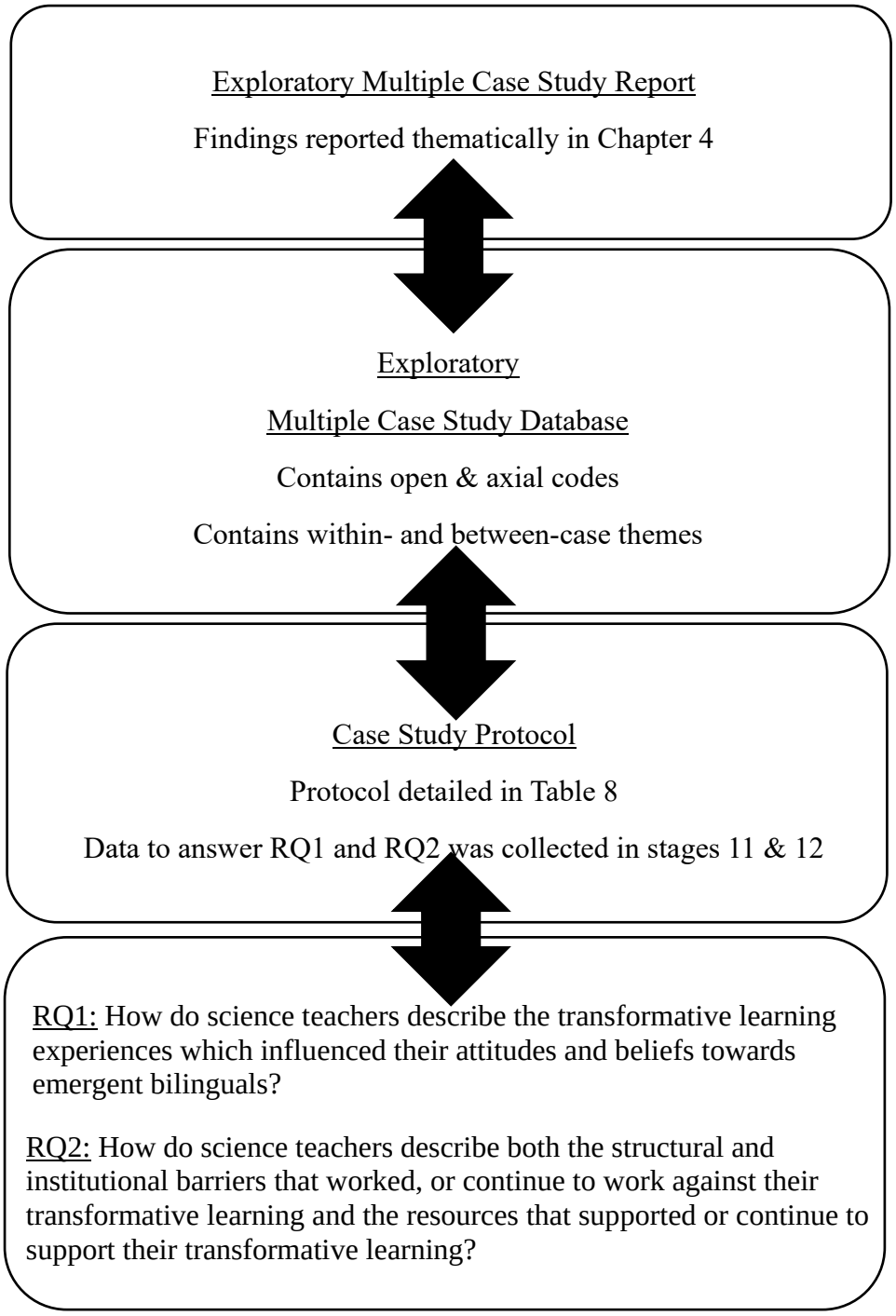
The belief construct is pivotal in the discussion of findings in this study. When discussing the test of construct validity Yin (2018) writes that,

> People who have been critical of case studies often point to the fact that a case study researcher fails to develop a sufficiently operational set of measures and that "subjective" judgments – ones tending to confirm a researcher's preconceived notions [Flyvbjerg, 2006; Ruddin, 2006] – are used to collect data. (p. 43)

To overcome these potential criticisms, I collected multiple sources of evidence as suggested by Yin (2018). My data includes more than 30 belief rating items across both tiers and six interview items across both protocols each addressing the construct of belief. During the final stages of qualitative data analysis, all data sources were analyzed to uncover emergent themes between cases.

Yin (2018) also suggests that a chain of evidence detailing how findings are linked sequentially throughout the study back to the original research questions, can help mitigate threats to construct validity. The figure below depicts the chain of evidence for this study.

Figure 6. Chain of Evidence for Exploratory Multiple Case Study



Internal Validity

Threats to internal validity mainly concern case study designs in terms of their ability to make inferential claims. Conclusive inferential or causal links between phenomena cannot be made as a result from this study. I have carefully conceptualized and written that transformations influence teacher beliefs (i.e., do not create or cause them). In other words, TLEs can help explain some degree of the variance in changes to beliefs, but do not paint the entire picture. Some of the limitations discussed further below detail how some of the phenomena explored in this study (such as transformations) are not directly observed and have potential for maturation since their initial occurrence. To handle these threats, I: (a) attended to all the evidence gathered and discussed areas in which the findings diverge, (b) addressed all plausible rival interpretations part of which is discussed above, and lastly (c) addressed the most significant aspect of this exploratory multiple case study – the transformations in beliefs of the science teachers interviewed.

External Validity

To address threats to the generalizability of this study's key findings, I have framed the study in Mezirow's (1991) theory of transformative adult learning. Yin (2018) claims that while case study designs may not be able to assert statistical generalizations, that initial theory in design can support case study researchers in claiming analytic generalizations. The claims in this study are that transformations in the sociolinguistic meaning perspective (and its ancillary beliefs) result in teachers who are more effective in enacting culturally and linguistically relevant science instruction, as well as science teachers more inclined to transform policies and systems which create barriers for EBs. Thus, this case study (rather than the individual cases) provide inductive insight into the TLEs of teachers with positive beliefs towards EB students which

could be analytically generalized to inform the structure of both professional development, mentoring programs, and educational policy.

Reliability

The repeatability of this study is maintained in two ways: (a) the detailed case study protocol which outlines the process of data collection and provides specific sources of data, and (b) the development of a chain of evidence essentially linking the case study findings directly back to the case study questions. This chain of evidence is supported through the establishment of a case study database where the data sources for each individual case has been ethically organized. The case study protocol is detailed in Table 8 (Chapter 3), while the chain of evidence is depicted in Figure 4 (Chapter 5). Utilized in tandem, the study's repeatability is maintained.

Implications for Future Research and Professional Development in Science Education

As a result of this study, there are new questions and directions for research to explore and attempt to explain. There are two main directions that most interest me at the conclusion of this study: a) exploring how positive beliefs towards EBs manifests into the enactment of specific instructional strategies in the classroom, b) explaining the mechanisms through which a teacher transforms their beliefs to be empowered to pursue political and systemic changes. The first direction of research may be best accomplished through a longitudinal ethnographic study of a science teacher exceptionally positive attitudes towards EBs. The identification of such a science teacher could leverage similar strategies to the ones I utilized in Phase 1 but could discover alternative methods for identifying such a critical case. Observing such an exemplar teacher over months could provide novel insights to link particular sets of beliefs to the enactment of specific instructional strategies. Another, equally interesting direction for future research comes from my conversations with Amanda. Multiple TLEs throughout her teaching

career have empowered her to advocate for political and systemic changes in her school district. These changes would remove barriers for EBs attempting to place in GT classes. A sequential explanatory mixed-methods study could help provide insight into how such a unique transformation occurs, and provide useful information for helping teacher educators, administrators and mentors best develop leaders in science education.

The past two decades have seen the establishment of novel research in the arena of professional development to support science educators. This new body of research focuses on supporting EB students. Lee & Buxton (2013) pointed to growth trends in the population of EBs in the U.S. as a major motivating factor. They cite the National Center for Education Statistics in writing that, "the number of school-age children (ages 5-17) who spoke a language other than English at home rose from 4.7 to 11.2 million between 1989 and 2009, or from 10% to 21% of the population in this range." Additionally, of all K-12 students in the U.S., 11% are categorized as limited-English proficient which mandates additional support from schools seeking state funding. This expansion in the EB population coincides with greater demands placed on all science teachers.

As mentioned in the introduction, the NGSS require higher linguistic expectations of all students, particularly in science and engineering practices such as: (a) asking questions, (b) constructing explanations, and (c) engaging in argument from evidence. Even before these broad reforms in science education, the 2009 National Assessment of Educational Progress, which serves as the nation's pulse for science achievement levels, indicates the low achievement rates of EBs (NCES, 2011b). In response to this reality, science education researchers began to apply exploratory results from instructional case studies and design-based interventions on small

student samples to increasingly broader professional development interventions aimed at improving science instruction.

The professional development to promote equitable science learning for EBs is diverse both in terms of duration and fidelity, but quite homogenous in terms of aims, structure and assessment. There exists a gap in research on positively affecting teacher knowledge, attitudes, and practices (KAP) towards EB students. The aims are geared towards producing a coherent curriculum which addresses science achievement for all students, and in this regard the most recent publications are quite successful (Llosa et al., 2016; Maerten-Rivera et al., 2016). In contrast, principal author Alexandra Santau (2010, 2011) has already shown that this type of research is possible. On the same sample of teacher and student participants and using the same curriculum-professional development intervention they published on both teacher focused questions and data (Santau et al., 2010) and student focused questions and data (Santau et al., 2011). In their student focused publication, they empirically narrowed down the effectiveness of their intervention to affect student achievement of all students, including ELLs; in their teacher focused publication, they explored the ways in which teachers discussed their growth and change in terms of both knowledge and practices with their ELL students. While fidelity is an important aspect of curricular professional development, it is my opinion that the energy consumed in this way is wasted. This exploratory multiple case study provides the foundation for designing such a professional development intervention; one which aims to positively influence the attitudes and beliefs of science teachers towards EB students.

Such an intervention would require other major pillars such as curricular resources as well as instructional strategies, but the novel approach would be the addition of a third pillar focused on creating opportunities for transformation to occur within science teachers'

sociolinguistic meaning scheme (i.e., a transformation in their beliefs towards EBs). As stated in a previous section, maximizing the capacity of expert guidance through carefully selected mentors would facilitate opportunities for these transformations to occur. They would enable science teachers with negatively oriented beliefs to engage in challenging conversations and begin to process their disorienting dilemmas. By both acknowledging the barriers of time, language and culture and providing teacher participants with the expectations of those challenges as well as strategies for how to overcome them as individuals, such a PD intervention could minimize attrition in terms of transformation and again facilitating environments where transformations in beliefs are more likely to occur. This PD could also help strengthen transformation, by elucidating the barriers created by policies and systems which could help inspire science teachers to become leaders in pursuing collective transformation of their schools, students, colleagues, as well as the advocating for changes at the district, state, and national level. The implementation of this third PD pillar would take into consideration the findings from this study and operationalize them. My proposal for such a PD will be organized and discussed utilizing the following key aspects of PD: a) aims, b) structure, and e) duration.

First, PD which integrates the novel utilization of a third pillar of transformation in terms of attitudes & beliefs should articulate aims towards science teachers: a) teaching EBs, b) practicing reflexivity, c) and developing communities of practice (COP). The presence of EBs was essential to the TLEs of all five science teacher participants in this study, it is also true that their presence is linked to the barriers of time, language, and culture. Therefore, it should be an aim that participants of this proposed PD work directly with EBs. If it is not possible for participants to teach EBs, then a shadowing or co-teaching opportunity should be created for them to experience this firsthand in a highly populated EB learning environment. Reflexivity is

something that should be practiced throughout the PD experience but is also something that should be taught to be sustained after the PD is delivered. Reflexivity is something highly encouraged by Mezirow (1991) as he defines the theory of transformative learning and is also central to the ways in which my participants describe their TLEs. Lastly, designing, establishing, and supporting participants in maintaining COPs is an excellent method to ensure these participants receive expert mentorship throughout their transformation and beyond. In turn, participants who are at the onset of transformation may one day become mentors themselves, as was the case for participants like Maria and Amy.

Second, I recommend that the PD be optimally structured by being delivered throughout an entire school year in a monthly series split evenly among the three major pillars: a) transformation, b) curriculum, and c) instruction. In a 9-month school year, this would mean three sessions delivered on each of the three topics. Focusing on transformation, which is at the heart of this present study, I recommend that the first session of three be focused on something we in science education refer to as a discrepant event which can help learners recognize the limitation of their current understanding or worldviews (Ruiz & Whitworth, 2023). One thought is to deliver the first 15 minutes of the PD in a non-English language to model and demonstrate the challenge of learning in a language you do not yet understand. This can serve as the disorienting dilemma which is the first phase of a TLE as theorized by Mezirow (1991). This should lead into individual reflection on science teachers' on held beliefs of EBs; researchers and practitioners can utilize the instrumentation from this study to create reflection guides on the practice's teacher participants may feel EBs are limited in. The first session should end with the grouping of participants with expert mentors who they can schedule individual time for discussion and dialogue regarding their reflection responses and providing guidance on how to

make changes. The second session would be focused on working directly with EBs. Ideally, this would take place within each participant's own classrooms and those delivering the PD can shadow the teachers along with their newly established mentor. Here they can provide reflection questions and challenge participants to engage in practices they may have negatively oriented beliefs about. By having the opportunity to observe these practices being successful, science teachers can begin to imagine and explore new roles and new actions. The final session can be focused on authentically discussing the barriers of time, language, and culture in teaching in highly EB populated environments. This would not be the time to provide meaningful strategies to overcome them, as many of the curricular and instructional strategies in the other well-established pillars will accomplish that goal. Instead, this would be an opportunity to address the reality of the systems and policies that help create these barriers and begin discussing the ways in which individual teachers can make meaningful changes in their classroom to overcome them.

Third and last, the duration of this PD should be longitudinal and not delivered in a one-off workshop modality. Instead, as mentioned in the previous paragraph, the PD should be delivered over a school year. Many of the existing PD aimed at supporting science teachers working with EBs tend to last no longer than a semester at most, and at worst involve the delivery of a handful of workshops in a short amount of time (Santau et al., 2010). Deep reflection on one's own deeply held beliefs requires time. Many of the participants in this study mention that their transformation is ongoing to this day, 10 years or more after their disorienting dilemma. It is important that PD acknowledges this and provides multiple opportunities throughout a long duration of time for science teachers to reflect openly on about their beliefs as they are transforming.

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APPENDIX A. SURVEYS

Transformation & Attitude Two-tier Survey

Tier one: Teacher Attitudes towards emergent bilinguals (Huerta et al., 2019)

Participants respond with Likert scale responses of 1= strongly disagree, to 5=strongly agree.

Table 10. Teacher Attitudes Towards Linguistic Diversity

Belief Constructs	Items
Beliefs about EBs and Learning	Having an EB in the classroom inhibits the learning of the other students. (Reverse-scored)
	Most EBs are not motivated to learn English. (Reverse-scored).
	It is unreasonable to expect a regular-classroom teacher to teach a child who does not speak English. (Reverse-scored)
	At school, the learning of English should be a priority for EBs and should take precedence over learning subject matter. (Reverse-scored).
	EBs often use unjustified claims of discrimination as an excuse for not doing well in school. (Reverse-scored)
	The rapid learning of English should be a priority for EBs, even if it means they lose the ability to speak their native language. (Reverse-scored)
	It is important that people learn a language in addition to English.

Beliefs about External Supports for EBs	I would support the government spending additional money to provide better programs for EBs.
	Regular-classroom teachers should be required to receive pre-service or in-service training to be prepared to meet the needs for EBs.
Beliefs about Language Value in Home Country	To be considered a citizen of my country, one should speak English. (Reverse-scored)
	English should be (if it is not) the official language of my country. (Reverse-scored)
	Local and state-regional governments should require that all government business (including voting) be conducted only in English. (Reverse-scored)
	Parents of EBs should be counseled to speak English with their children whenever possible (Reverse-scored)

Participants respond with Likert scale responses of 1= no, to 5=yes, all of the time.

Table 11. Teacher Attitudes Towards Science Pedagogy with Emergent Bilinguals

Belief Constructs	Items

Beliefs about Integrating Language and Culture Into Science Instruction	Is it feasible to provide regular, structured opportunities for EBs to develop written language skills during science instruction?
	Is it feasible to incorporate oral language development strategies help EBs learn during science instruction?
	Is it feasible to incorporate a set of vocabulary words intensively across several days into science instruction?
	Is it feasible to provide small group instructional intervention for EBs in science instruction?
	Is it feasible to incorporate students' culture and background into science instruction?
	Does providing regular, structured opportunities for EBs to develop written language skills help them learn during science instruction?
	Does integrating oral language development strategies help EBs learn during science instruction?
	Does incorporating EBs' culture and background help them learn during science instruction?
	Does providing small group instructional intervention for EBs belong in science instruction?
	Does teaching a set of vocabulary words intensively across several days help EBs learn during science instruction?

Beliefs about Allowing EBs to use their Native Language during Science Instruction	Does allowing EBs to use their first language to clarify their understanding of English during instruction help their understanding of the content in science?
	Does allowing EBs to use their first language during instruction help them understand content in science?
	Does allowing EBs to use their first language during instruction confuse their understanding of content in science? (Reverse-scored)

Tier two filter item. Thinking back on your responses have you encountered a learning experience you would describe as ***transformative*** which has influenced your beliefs towards emergent bilingual students?

Transformative learning experiences involve disorienting dilemmas which make you question and self-examine your own beliefs towards things such as linguistic diversity. These experiences then encourage us to explore entirely new ways of thinking and seek guidance from others who have negotiated similar changes in perspectives. These experiences culminate in developing competence and confidence in your new beliefs, and acting in accordance to them.

If yes, please continue to the next item.

Table 12. The Learning Activities Survey

(King, 2009)

	Items
Meaning Perspective Transformation	Thinking about the transformative learning experience which influenced your beliefs about emergent bilingual students check off any statements that may apply: a. I had an experience that caused me to question the way I normally act. b. I had an experience that cause me to question my ideas about social roles. (Examples of social roles include what a mother or father should do or how an adult or child should act.) c. As I questioned my ideas, I realized I no longer agreed with me previous beliefs or expectations. d. Or instead, as I questioned my ideas, I realized I still agreed with my beliefs or role expectations. e. I realized that other people also questioned their beliefs. f. I thought about acting in a different way from my usual beliefs and roles. g. I felt uncomfortable with traditional social expectations. h. I tried out new roles so that I would become more comfortable or confident in them. i. I tried to figure out a way to adopt these new ways of acting.

	j. I gathered the information I needed to adopt these new ways of acting. k. I began to think about the reactions and feedback from my new behaviors. l. I took action and adopted these new ways of acting. m. I do not identify with any of the statements above.
	Thinking back on this transformative learning experience, do you believe you have experienced a time when you realized that your values, beliefs, opinions or expectations had changed? a. Yes. *If "Yes," please go to question #7 and continue the survey.* b. No. *If "No," please go to question #6 to continue the survey.*
	Briefly describe what happened.
	Thinking back to when you first realized that your views or perspective had changed, what did your being in school have to do with the experience of change?
Facilitating Learning Activities	Which of the following influenced this change? (Check all that apply) a. Was it a person who influenced the change? Yes or No. b. If "Yes," was it… (check all that apply) a. Another student's support.

	b. Your classmates' support. c. Your advisor's support. d. A challenge from your teacher. e. Your teacher's support. f. Other: _____ c. Was it part of a class assignment that influence the change? Yes or No. d. If "Yes," what was it? (check all that apply) a. Class/group projects. b. Writing about your concerns. c. Personal journal. d. Nontraditional structure of a course. e. Internship or co-op. f. Deep, concentrated thought. g. Personal learning assessment (PLA). h. Verbally discussing your concerns. i. Term papers/essays. j. Self-evaluation in a course. k. Class activity/exercise. l. Lab experience. m. Personal reflection. n. Assigned readings. o. Other:_____

	e. Was it a significant change in your life that influenced the change? Yes or No. f. If "Yes," what was it? (Check all that apply) a. Marriage. b. Birth/adoption of a child. c. Moving. d. Divorce/separation. e. Death of a loved one. f. Change of a job. g. Loss of a job. h. Retirement. i. Other: _____
	Would you characterize yourself as one who usually thinks back over previous decisions or past behavior? Yes or No. Would you say that you frequently reflect upon the meaning of your studies for yourself, personally? Yes or No.
	Did any of the following experiences occur while you were undergoing your transformative learning experience? (Please check all that apply) a. Another student's support. b. Your classmates' support. c. Your advisor's support.

	d. Class/group projects. e. Writing about your concerns. f. Personal journal. g. Nontraditional structure of a course. h. Internship or co-op. i. Deep, concentrated thought. j. Personal learning assessment (PLA). k. A challenge from your teacher. l. Your teacher's support. m. Verbally discussing your concerns. n. Term papers/essays. o. Self-evaluation in a course. p. Class activity/exercise. q. Lab experiences. r. Personal reflection. s. Assigned readings. t. Other:_____

APPENDIX B. SEMI-STRUCTURED INTERVIEW PROTOCOLS

Semi-structured Interview Protocol 1. (adapted from King, 2009)

This interview is part of research that included the survey you took. This research is about the learning experiences of adult learners. I believe that some teachers who have highly positive beliefs towards emergent bilingual students arrived at those beliefs by influence of learning experiences which are transformative. In other words, sometimes our beliefs are oriented in one particular way, and there are learning experiences which can transform their orientation in a completely different direction. You have indicated that your beliefs may have been transformed by a learning experience. The following questions are intended to understand the unique features of your transformative learning experience.

1) Thinking back on your beliefs towards emergent bilingual students, have you experienced a time when you realized that your values, beliefs, or expectations had changed?

   Probe: can you recall a distinct period of time in your teaching career as a student or practitioner where your beliefs towards emergent bilinguals changed dramatically?

2) Describe that experience.

   Probe: what was the duration of this experience?

3) Do you know what caused it? If so, please explain.

   Probe: did you experience a dilemma in which you questioned your own beliefs towards linguistic diversity?

4) Was there is a person or people who influenced this change?

   Probe: was there another student, teacher, mentor, advisor, etc.

5) Would you describe this experience as being educational?

   Probe: was this part of a college course, professional development, etc.

6) Was there a significant change in your life during this time which may have influenced the change?

   Probe: changes such as marriage, divorce/separation, death of a loved one, loss of a job, change of a job, retirement, moving, addition of a child, etc.

7) Perhaps it was something else that influenced the change. If so, please describe it:
8) You have mentioned (recount features the participant has mentioned) as features or aspects of this learning experience. Can you describe how (mention each feature as separate question) influenced the change in your beliefs?
9) What could have been done differently in these learning experiences to better help you in this change? What specific activities?
10) Thinking back to when you first realized that your beliefs or perspective had changed:
    a. When did you realize this change had happened? Was it while it was happening, mid-change, or once it had entirely happened (retrospective)?
    b. What made you aware that this change had happened?
    c. What did your being in school have to do with it?
    d. What did you do about it?
    e. How did/do you feel about the change?
11) Is there anything else you would like to share about your transformative learning experience?
12) Do you have any questions?

Semi-structured Interview Protocol 2. (developed with committee faculty member.)

This interview is part of research that included the survey you took. This research is about the learning experiences of adult learners. I believe that some teachers who have highly

positive beliefs towards emergent bilingual students arrived at those beliefs by influence of learning experiences which are transformative. In other words, sometimes our beliefs are oriented in one particular way, and there are learning experiences which can transform their orientation in completely different direction. You have indicated that your beliefs may have been transformed by a learning experience. We have already discussed the unique features of your transformation, and the specific circumstances which influenced the changes in your beliefs. The following questions are intended to understand the barriers and challenges you have faced in your transformation, and in enacting culturally and linguistically relevant instruction in your classroom.

1) Thinking back on your learning experience which transformed your beliefs towards emergent bilingual students, do you recall any resistance, or barriers working against your transformation at that time?

   Probe: during what period of your career did this occur?

2) In what ways do your beliefs towards emergent bilingual students influence your teaching practices with them in your science classroom?

   Probe: you mentioned (recount specific belief item and rating), how does this influence your teaching practice?

3) In your current practice as a science teacher, what resources are available to you in enacting teaching practices which effectively support emergent bilingual students?

   Probe: which resources do you leverage most often?

4) In your current practice as a science teacher, what barriers do you face in enacting teaching practices which effectively support emergent bilingual students?

   Probe: which barrier is the greatest or impossible to overcome, and why?

5) You mentioned (recount each specific barrier) as a barrier to your teaching practice, can you describe ways in how you might overcome this?

   Probe: what would be required for you to overcome this barrier?

6) Please describe the support you receive from your building (i.e., administrators, instructional coaches, department chairs, ESOL coordinator, etc.), or from your school district (i.e., district science coordinator), in effectively supporting your emergent bilingual students in your science classroom.

7) Broadly speaking, what changes would best enable you to effectively teaching emergent bilingual students?

   Probe: changes at school, district, state or national level.

8) If you were speaking to another science teacher struggling with their transformation in beliefs towards emergent bilingual students, what advice would you give them?

   Probe: what has helped you sustain this transformation in beliefs?

9) Is there anything else you would like to share about the barriers you have faced in supporting emergent bilingual students?

10) Do you have any questions?