The third space: The use of self-study to examine the culture of a science classroom

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DEDICATION

To all those risk takers in the world, I salute you.
ACKNOWLEDGEMENT

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THE THIRD SPACE:
THE USE OF SELF-STUDY TO EXAMINE THE CULTURE
OF A SCIENCE CLASSROOM

An Abstract of a Dissertation
Submitted
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

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ABSTRACT

Science educators are in the position to create bridges between their students and the world of science (Aikenhead, 1996, 1999). This connection has often been described as the third space (Bhabha, 1994; Moje, Collazo, Carrillo, & Marx, 2001; Wallace, 2004), which is represented as a combination or a meeting of the students’ world and the world of science. In this study, I examined my role in creating the third space through the use of self-study. Self-study is a form of research, educators use to understand their practice (Austin & Senese, 2004; Loughran, 2004; Northfield & Loughran, 1996). It is a means of describing, analyzing, and interpreting a teacher’s actions within his or her classroom (Tidwell, 2002). The focal point of this self-study is to understand my actions found within my past and present teaching experiences and the underlying beliefs that are expressed through those actions.

In this self-study, I collected data from my life history, classroom observations, and member check interview. My life history described my influences that shaped my philosophy of teaching and learning, while the classroom observations provided a means of understanding my interactions with the science curriculum and my English Language Learner (ELL) students. And finally, a member check focus group interview occurred to confirm the results occurring in the classroom observations. Once the data were collected, I used grounded theory methods to analyze my results and answer the research questions.

This self-study became the means of exploring my philosophy of teaching and learning and my teaching practices as they occurred in an ELL science classroom. I examined my own practice through a comparison between my past experiences and my
current teaching situation and through this exploration, I identified my actions and the beliefs associated with those actions as they informed my teaching practices.
CHAPTER 1
INTRODUCTION AND SOURCE OF MY INTEREST

Introduction

Culture is a means of identifying the values, beliefs, and ways of knowing of a particular group of people (Banks, 2007; Nieto, 2004; Stewart & Bennett, 1991; Ting-Toomey & Chung, 2005). It creates the structural framework for viewing the world and assigning meaning. The scientific community has its own perspective of how the world operates. Its culture can be found in the field, the laboratories, and even the science classroom. Thus, science educators can become cultural representatives of the scientific community and create bridges between aspects of the culture of science and their students. In the science education literature (e.g., Moje, Collazo, Carrillo, & Marx, 2001; Wallace, 2004) this connection has been described as the third space, where the two worlds, the world of the students and the world of science, combine to create this new space. The creation of the third space occurs in the classroom, and is the bridge between those two worlds or cultures.

In this study I examined my role in creating the third space through the use of self-study research. Self-study is a form of research educators use to understand their practice (Austin & Senese, 2004; Loughran, 2004; Northfield & Loughran, 1996). It is a means of describing, analyzing, and interpreting a teacher’s actions within his or her classroom (Tidwell, 2002). The focus of this self-study is to understand my actions in the classroom and the underlying beliefs that are expressed through those actions.
My research questions considered in this study are:

1. What are my underlying beliefs about teaching science to students and how are they expressed in my classroom?

2. What is the third space created in my classroom?

Overall this study seeks to examine and understand a teacher in her science classroom. This goal was accomplished by collecting data from primary sources, which included my life history, classroom observations, and member check interview. My life history described the influences that shaped my philosophy of teaching and learning. The classroom observations were conducted through videotaping five different lecture periods and analyzing my teaching practices. And finally, a member check focus group interview with my previous students occurred to confirm the interpretations made from the classroom observations. Secondary sources included journal entries, Power Point slides, and classroom handouts and laboratory activities. Once the data were collected I used grounded theory methods to answer the research questions.

This dissertation is divided into five chapters. In Chapter 1, I will examine my life history, providing an overview of my interest in using the inquiry method to help students understand the culture of science. I will also describe my experiences working with students from diverse linguistic and cultural backgrounds and how these experiences have shaped my philosophy of teaching and learning in a science classroom. In Chapter 2, I will review the literature providing an overview of the culture of science and its reflection in a science classroom, specifically in a setting that has a culturally and linguistically diverse student population. The third chapter provides a description of the
methodology used in this self-study, including a description of the grounded theory methodology used to answer the research questions. In Chapter 4, I discuss the results of applying grounded theory analysis to the data and I also answer the research questions that guide this study. And finally, in Chapter 5 I will discuss the conclusions and implications of this self-study.

In this self-study, I was both teacher and researcher. At times, the juggling of both responsibilities proved to be difficult. Making sure the video camera was set up and running properly, answering students questions about the study and the overall process of the dissertation research, setting up the computer for the lecture notes, and preparing the activities for the class period, all had to occur during the 5 minute transition period.

Source of My Interest: My Life History

Who am I

I am an African American female raised in a middle class suburb in Tacoma, Washington. My interest in science began when I was chosen in ninth grade to participate in the M.E.S.A. (Mathematic, Engineering, Science, Achievement) club. In this club, we played a variety of math and science games. The advisor brought in guest speakers who talked about the different types of careers in math and science. And every summer, all of the M.E.S.A. students from across the state met and learned more about math and science careers.

Once I graduated from high school, I went to a large university where I majored in Environmental Health. I was interested in working with the public, but once I had completed an internship at the Public Health Department, I decided that pursuing a career
in environmental health was not the path I wanted to take. Therefore, I went to graduate school and received a master's in education, with an emphasis on science education. Over the past ten years, I have taught biology, chemistry, ecology, earth science, and physical science to ninth, tenth, eleventh, and twelfth graders in California and in the Midwest.

The Use of Inquiry Based Science Methods

I began teaching high school science in Los Angeles and was fortunate to be in a supportive and nurturing environment. I taught during a period of strict standards and benchmarks; yet I was free to explore a variety of teaching methods. As a faculty, we were asked to move beyond lectures and worksheets to more non-traditional teaching approaches in an attempt to raise their students' test scores on the state standardized test. Many of the school administrators believed in and supported the use of inquiry within our science classes. Thus, I began using this method within my science classroom. The National Research Council (NRC; 1996) defined inquiry as a:

Multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence, using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (p. 23)

Four major stages of inquiry have been identified: structured inquiry, guided inquiry, open inquiry, and the learning cycle (Colburn, 2000). Structured inquiry involves the science teacher providing the problem, procedures, and materials for student investigation. With guided inquiry, the teacher provides only the materials and problem, while students create their own procedures for solving the problem. Open inquiry is
analogous to scientists working in their field, where students design their own experiments in order to solve a scientific problem. Lastly, Colburn described the learning cycle as students “engaged in an activity that introduces a new concept. The teacher then provides the formal name for the concept. Students take ownership of the concept by applying it in a different context” (p. 42). Although it may seem like the inquiry method is a fixed, agreed upon approach, this is in actuality not the case. There are a variety of versions that science educators use within their classrooms.

I led students through this inquiry continuum, progressing from a highly structured environment to a less structured experience, allowing them to design and conduct their own experiments. When I employed this continuum of stages in my science curriculum, students were not only slowly introduced to the various scientific concepts, but they were also provided the means of understanding the culture of science through their own experiences with the inquiry method. My role in their endeavors was to provide students with the opportunity to explore this new world.

In my science classroom I believed the use of inquiry reinforced scientific concepts, while introducing students to the nature of science. Through inquiry, my students began to explore the methods scientists use to solve problems. My interest in the inquiry method did not begin in California, however, but started with my first job in science education during my time in college.

Down and dirty with science. When I was an undergraduate, I had a part-time job working at a large science museum in the Pacific Northwest. This was an interesting position because I had the opportunity to teach science to both adults and children. My
duties varied, ranging from sitting at the tide pool to answering questions at the information desk. My favorite assignment, however, was the electricity cart, which contained all the materials needed to explore electricity. I would place a piece of wire, a light bulb, and a battery on the top of the table and in a matter of minutes a visitor would stop and ask what I was doing. I would reply, “Hey, can you make this bulb work?” Some of them would simply stare, and I would either repeat myself or take a long pause, allowing them to understand my question. Many of the visitors knew exactly how to make the bulb work, while others needed more guidance. Once they were able to make the bulb light up, I would take out other materials and invite them to explore electricity in more detail. These guided inquiry lessons provided an opportunity for me to experience connecting the visitors’ world to the world of science. In this cart activity, we, the visitors and I, would discuss not only electricity, but also how lights work in one’s home, what happens when a circuit breaks, being struck by lightning, and a host of other topics.

At the museum, science was informal, interesting and fun. It was not an abstract idea floating around in space; rather it had relevance to the visitors’ lives. There was meaning behind the ideas generated about electricity. These guided inquiry experiences created “an opportunity for the learner to create meaning from an experience” (Llewellyn, 2002, p. 31). Electricity was explored through the visitor’s world and we were getting down and dirty with science, using materials to explore and understand a topic, and as their guide, I was hooked. This was my first experience teaching science, and by the time I had my first practicum as a pre-service teacher, I was excited about using inquiry with students.
My next encounter with the inquiry method involved a field experience where I observed a sixth grade physical science classroom, Mrs. Baker’s room 107. I was enthralled with this woman. She had energy and spunk, and was never very far from her large 32-ounce Diet Dr. Pepper. Her students were motivated to create wonderful and interesting science projects that stemmed from an energetic passion for science. At the science museum, I had experienced using guided inquiry on a small scale, while in Mrs. Baker’s room I observed a teacher engaging an entire classroom in this method of teaching.

While I was in Mrs. Baker’s classroom, her students were in the process of designing a container that could protect an egg from falling off the top of the building at school. They were also creating posters describing their design, prototypes, trials, and observations. This class devoted a great amount of energy and time to their projects, and it showed. I would overhear conversations centered on force, gravity, and inertia. For me, this became another example of down and dirty science. Her students were exploring the abstract world of physical science grounded in their experience with actual materials, procedures, and observations.

Mrs. Baker’s school was located in the middle of the city, an area known for its violence and poverty. In fact, this section of town had been featured on the police show Bad Boys. Many of her students were labeled at-risk and/or special needs students stereotypically destined to become dropouts and drug addicts. Yet there they were discussing and debating the properties of a good egg container, actively engaging in science. I witnessed how the teacher orchestrated her classroom, creating an environment
through the use of structured and guided inquiry lessons that fostered the learning of science.

My experiences at the science museum and in Mrs. Baker's classroom provided an opportunity to explore the inquiry method within a constructivist framework (Adams & Hamm, 1998; Etheredge & Rudnitsky, 2003; Llewellyn, 2002). Constructivism is a learning theory based on the idea that students construct meaning from their experiences with the world (Barba, 1998; Llewellyn, 2002). Llewellyn states:

Through exploration and “messing about,” the student uses present cognitive structures, ideas, theories, and beliefs to act on and interpret the experience. The individual can also make predictions about the phenomenon by applying prior learning to the new experience. Often, the experience matches the individual’s past experience, and the new information is assimilated into the learner’s understanding. (p. 31)

The cart activities in the science museum required me to begin an exploration using the visitors’ prior understanding of electricity. In Mrs. Baker’s classroom, the egg container activity was initiated with students brainstorming what they knew about force and gravity, and how these forces related to their world. Her students’ prior knowledge was key in creating and shaping the curriculum. The ideas generated through their discussion became the foundation of her lesson (cf. Llewellyn, 2002). The use of inquiry provided her students with an opportunity to explore science while also exposing them to how scientists operate in their field. The inquiry method became the means of illustrating to her students the cultural practices found within the scientific community. What I discovered in Mrs. Baker’s class was that the beliefs, values, and ways of doing found within the inquiry method provided students access to understanding how scientists operate in their field. Students learned vocabulary related to the science content under
investigation, while also learning the process scientists use to solve a problem. My experience with the inquiry method at the science museum and in Mrs. Baker's classroom formed the foundation of my philosophy of science education. The science museum taught me how to use inquiry and Mrs. Baker modeled effective incorporation of inquiry within a science classroom. I was able to use both of these experiences as the basis for my teaching in Los Angeles. When I had my own classroom, I felt comfortable exploring the world of science with my students.

Cultural Competency and the Third Space

The five years I spent in Los Angeles teaching science at the high school level provided experience in working in a diverse environment. I not only taught a variety of science classes, but I also spent time with students who had a range of needs. These classes were a mixture of students labeled gifted and talented to at-risk.

My classroom was also diverse in the traditional sense of having students of color. The current school population in the U.S. consists of 43% ethnic and racial minority students (National Center for Education Statistics, 2005), and it has been estimated that by the year 2050 24% of the U.S. population will be Hispanic (Diller & Moule, 2005). This school in California had already surpassed these statistics. The majority of the student population and many of the faculty members were Hispanic. I worked with people whose culture was different from my own. Our cultural differences included the food we ate, the holidays we celebrated, and the languages we spoke.

In Los Angeles, I was both living and working in a culturally diverse area, which, fortunately, offered opportunities to explore this new environment. I started taking
Spanish lessons, learned how to salsa, and spent time getting to know my students and their world. I got to know my students through the conversations we had about our lives. At times I was the only African American teacher, and the students appeared to be interested in knowing about my life. They would ask questions concerning how I was raised, what I did for fun, and why I moved to Los Angeles. Their questions led to opportunities for me to ask them about their own lives. Our conversations became my foundation for understanding their culture, building my knowledge of their world.

I applied my newfound cultural knowledge to the curriculum. I was becoming a culturally competent educator, congruent with Diller and Moule’s (2005) view of cultural competence as:

the ability to successfully teach students who come from cultures other than your own. It entails developing certain personal and interpersonal awareness and sensitivities, learning specific bodies of cultural knowledge, and mastering a set of skills that, taken together, underlie effective cross-cultural teaching. (p. 2)

I used examples, analogies, and metaphors within my classroom that came from my students’ lives. I also developed an awareness of how students interacted with their other teachers, particularly their Hispanic teachers, becoming conscious of the appropriate student-teacher relationship and cultural expectation of the role of a teacher. My overall goal was to relate to my students and to teach them science effectively using their culture as the connecting piece between the scientific concepts and how those concepts related to their everyday lives.

I was able to connect with my students and they with me. This was especially important because I taught science, a subject with a reputation for exclusivity. Science educators who are submerged within the perspective of science tend to perpetuate the
cultural values found in this particular community (Lee, 2003; Lemke, 1990). The culture of science can often conflict with the culture of the students, particularly students from diverse backgrounds (Aikenhead, 1996; Costa, 1995; Lee, 2003; Lee & Fradd, 1998). This conflict can manifest itself in a variety of ways. Relevant literature has identified a tension between students' academic and personal identities (Brown, 2006; Costa, 1995; Lee & Fradd, 1998), cognitive understanding and language development (Aikenhead & Jegede, 1999; Lee & Fradd, 1996; Ninnes, 1994), and the differences between everyday knowledge and scientific knowledge found in various cultures (Aikenhead, 1996; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001).

Science educators are in the position to create bridges between the everyday world of the students and the world of science (Aikenhead, 1996, 1999). This connection has often been described as the *third space* (Bhabha, 1990, 1994; Moje et al., 2001; Wallace, 2004), which is represented as a combination or a meeting of the students' world and the world of science (see Figure 1). The everyday world of the students and the world of science are synonymous with the culture of students and the culture of science. Both encompass the values, beliefs, and ways of knowing found in each group. Specifically, in my teaching experience, students' understanding of science can be connected with an educator's ability to understand students' respective beliefs about the natural world and then use this information to help students understand science and develop an appreciation for how it fits within a society.
These "in-between spaces" (Bhabha, 1994, p.1) connecting the two worlds provide the learner and the teacher with a location within which they can negotiate a new world. As their science teacher, my goal was to use my students' cultural framework as the basis of the science curriculum to create a common ground. My classroom became the third space, a place where students could begin their journey in understanding science.

Teaching in Los Angeles was an exciting time in my career. I was working in an environment that was noncompetitive, collaborative, and active in pursuing a variety of teaching methods in an attempt to reach the students. I was developing as an educator, connecting the two worlds, the students' world and the world of science, to create a third space. This connection was established by embedding students' inquiry experiences within their culture. I did this through designing projects that related to their culture and their experience with science.
Overall, my experiences exemplified what I believed was good science teaching, where a teacher understands her students' culture and incorporates it into the science curriculum. I believed this approach could work in any environment, thus when a job opportunity for my husband arose and a move to the Midwest became a possibility, this culturally curious and inquiry-based science educator was ready to explore a new environment.

**A New State, A New School.**

When I moved to Iowa, I was confident, based on my previous teaching experience, that I would eventually find a teaching position. The principal and my department chair in Los Angeles both had written outstanding letters of recommendation, and I believed all of this would lead to a teaching position.

In addition to my knowledge and skills in science education, I felt my ethnicity would also enhance my job opportunities. This Midwest community, in which I now live, has a diverse student population with a significant percentage of African American students. Unfortunately, this diversity is not reflected in the school district's faculty.

Thus, when an African American female science teacher comes to town there is a significant amount of talk, especially when she can teach physical science, biology, chemistry, and earth science. It becomes only a matter of time before she is offered an appointment. Thus, after a few months of working a variety of odd jobs, I was asked to teach biology at one of the local high schools.

Once I accepted this position, friends, family, and even complete strangers offered advice on dealing with the type of students I would encounter in my classroom.
Unfortunately, none of their advice prepared me for what I faced in this new setting. In addition to teaching general high school biology, I was asked to teach biology to English Language Learners, ELL-biology, a class that did not exist in my previous school.

When I was initially approached about teaching ELL-biology, I was very hesitant. In Los Angeles, I had worked primarily with Hispanic students. Some of my students were labeled ELL, but there was a realized assumption that they were fluent in English, either as their first or second language. My instruction did not include preparing lessons to work with students who were in the process of learning English. In my Los Angeles experience, if students were not considered to be fluent in English, they were enrolled in the bilingual program at the high school employing bilingual teachers. These educators not only had the knowledge and skills to educate this population, but many also shared their students’ language and culture. My tenure in California had not involved working with bilingual students who needed language support. I knew such students existed, but my encounters with them were minimal.

Discussion with another ELL science teacher. During my interview with the principal at my new school, she recognized my trepidation about working with ELL students and had one of the other ELL science teachers, Nancy, talk with me about the position. Through our discussion, I discovered I would be teaching students who originated from a variety of places throughout the world. A significant number of immigrants from all over the world have been working and living in this community, coming from Mexico, Guatemala, the Marshall Islands, Honduras, China, and Bosnia. I would also have students from the U.S., but who either had lived most of their lives in
Mexico or lived in insular communities where English was not their primary language and thus not a necessary tool for their survival.

Through our conversation, I conveyed to Nancy that I was uncomfortable teaching the ELL class because of my lack of formal preparation and experience working with the ELL population. This was a major concern because I did not have any idea what I would do once placed in front of the ELL students. I did not know what their needs were or how to adjust the curriculum to accommodate those needs. I knew they were not fluent in English, but what did that mean for the classroom? Would I have to speak slowly and loudly, being the stereotypical American tourist in a foreign land? However, this was not a foreign land; it was my own classroom. It was a place where I was supposed to feel comfortable using effective teaching strategies, such as the inquiry method, to help students learn science. Yet, the ELL students, because of our inability to communicate with one another, were in another realm, occupying a land I had not visited. I was nervous because my teaching methods were based on sharing the same language. Where would I begin to create that third space and teach them science if we did not occupy the same realm?

Nancy was able to address some of my questions and misgivings by describing what occurred in her science classroom. She had been teaching ELL- physical science for the past five years, and through her experience she believed the best way to teach was to use a modified version of the general physical science curriculum. In this case, modification meant using materials designed for the middle and elementary school.
In regard to the ELL-biology class, Nancy explained that there was no set curriculum, and I could use any methods, materials or tools that I thought would be most effective for my students. I was free to create, modify and adjust the biology curriculum as needed. But I still wanted a starting point from which to begin teaching science to the ELL students. Additionally, I had a difficult time viewing Nancy’s advice as valid. She was not certified to teach ELL. Like me, she just happened upon the position. After our conversation, I was concerned about the methods she used within her classroom. Were they grounded in research, or were they only based on her experience in working with ELL students? I only had one course in bilingual education in my master’s program and knew watering down the curriculum was not an effective teaching approach.

I was also concerned because Nancy and I did not discuss ways she incorporated her students’ culture within the science curriculum. She had been working with ELL students for many years and I wondered if she thought culture was important, or if she even recognized the difference between the culture of science and the culture of her students. I wanted to give Nancy the benefit of the doubt, believing she may not have the vocabulary to express her beliefs about culture and her experience working with culturally diverse students. But throughout our discussions, I felt uncomfortable because there were times when her words had racial overtones. Nancy kept referring to the ELL students as these students. “These students need this,” “these students need to do that,” or “these students just cannot do that” became her trademark phrases in our phone conversations. I am very sensitive whenever someone uses the phrase these “fill-in-the-blank.” It causes a jolt of lightning to go through my body, because it is usually
associated with negative connotations and stereotypes. "These people do this" and "these people do that" implies that what they are doing or who they are is not only different but also abnormal or wrong. It separates the speaker from the specified group, signaling that the latter is the group that is different. As an African American, I have sat in many education classes where my fellow classmates (and even professors) used the term these people to make reference to ethnic and racial minorities and all the problems and issues associated with them. Thus, my ears prick whenever someone uses that term to describe a particular population. I thanked Nancy for her time and began the process of deciding whether or not I would accept the teaching position offered to me.

I ultimately found myself saying "yes" to the teaching appointment because I needed a job. I also believed I could successfully face this new challenge. I saw myself as a champion of all students, particularly racial and ethnic minority students. I was an educator who believed she could work with anyone and be successful, regardless of the obstacles. As the school year progressed, however, I realized my previous experience did not provide the necessary background for understanding and addressing the issues involved when working with ELL students and I began my own education on how to teach science to ELL students.

My education began by discussing my concerns with the ELL resource specialist employed at the high school. She helped me by listening and commenting on my ideas and providing me with books about teaching ELL students. I also enrolled in a series of workshops sponsored by the school district that were specifically designed for science teachers. By the end of the school year, I felt more comfortable working with ELL
students, but I was still not able to understand my students' cultures. Teaching in Iowa provided me with a new experience working with culturally and linguistically diverse students. In Los Angeles, I was concerned solely with understanding the role of culture within my classroom. In Iowa this understanding changed and developed into an understanding of how language and culture combine, creating a new perspective from which to view my teaching of science.

Language differences, cultural differences. I lived in Los Angeles for five years, spending time and working with people from a variety of cultures. I was able to communicate with my culturally different students because we shared the same language. Because of a shared language we could describe our worlds and how we operated within these worlds. This process became a symbolic exchange between verbal and nonverbal symbols, where the overall goal was to obtain a shared meaning (Ting-Toomey & Chung, 2005). In Iowa, I found I had more difficulty understanding my ELL students' culture because I did not speak their language. I did not know how to share my world of science or connect their world with mine because we did not share language. Because of language, I felt that I could not begin the process of making my curriculum culturally relevant, creating that third space.

Language and culture are intertwined, woven together like a tapestry. If one string is pulled, the entire piece can unravel. This interconnection is a way of viewing language within the framework of culture. And I saw that addressing issues derived from language differences became a way for me to make cultural connections. Agar (1994) wrote:

Communication in today's world requires culture. Problems in communication are rooted in who you are, in encounters with a different mentality, different
meanings, a different tie between language and consciousness. Solving the problems inspired by such encounters inspires culture. (p. 23)

Culture is the frame in which language is found within a society, and more specifically, within my classroom. Language is connected with not only what we say, but how we say it and why we say it. Thus language and culture combine to create a “languaculture” (Agar, 1994, p. 60), informing one’s behavior, motives, identity, and language choices.

The languaculture found in my classroom was at times disorienting. A myriad of languages and cultures created a singularly unique environment. Because of the language barrier, this was my first teaching experience where I did not share the same reference points as my students. We could not begin the process of understanding one another, as I had in my previous teaching experience in Los Angeles, because we were seriously limited in our communication with one another. I did not understand their cultures nor did they understand the culture of science and its representation in the classroom. This created a dilemma within the classroom, but it also became the starting point for me, as the teacher, to understand the role of language and culture in a science classroom. In my ELL science classroom, I found an alternative to helping my students understand science, and this self-study is an examination of my teaching practices used in this classroom.

Significance of the Study

This self-study became the means of exploring my philosophy of teaching and learning and my teaching practice. I examined my own practice by comparing my past experiences and my current teaching situation, and through this exploration I identified
my actions and the beliefs associated with those actions as they informed my teaching practices.

My self-study is significant because it can be used as a model for professional development for pre-service teachers in teacher education, and practicing teachers in the field. Pre-service and in-service teachers can benefit from exploring their past as reflected in their present teaching situation, developing a life history that reflects the influences that shape their pedagogical beliefs and practices within their own classroom. Examinations of such life history data can help teachers better understand their own individual contexts for their teaching. They can also make classroom observations, then use grounded theory methods to find the discernable patterns found within their own classrooms that can help teachers come to understand their role in creating a learning environment that helps all students understand science. And finally, this self-study can be used as a model to share how one teacher explored her own approach to working with students who were culturally and linguistically different from herself.

Conclusion

Culture is a means of identifying the values, beliefs, and ways of knowing of a particular group of people (Stewart & Bennett, 1991). Culture creates the structural framework for viewing the world and assigning meaning. The scientific community has its own perspective of how the world operates, whether in the field, the laboratories, or even the science classroom. Thus, science educators become cultural representatives of the scientific community. Many scholars (Aikenhead, 1996; Bryan, 2003; Bryan & Atwater, 2002; Kang & Wallace, 2005; Moje, 1995) argue for research that focuses on
understanding the role that teachers play in expressing the culture of science and its reflection within the classroom. My self-study does just that, examining my own practice through the lens of culture.

Notes

1. All names have been changed.

2. The term "Hispanic" is a broad term used to describe people whose primary language is Spanish or English, but whose culture and heritage originated in Spain. In the United States, these groups consist of mainly Mexican Americans, Puerto Ricans and Cubans. It is also used as a classification marker in the school district in question.
CHAPTER 2
LITERATURE REVIEW

Overview

Culture, as defined within the literature, can be conceived as a group of people bound by the same set of values, beliefs, symbols and meanings in their society (Banks, 2007; Nieto, 2004; Stewart & Bennett, 1991; Ting-Toomey & Chung, 2005). Ting-Toomey and Chung wrote of culture as a:

learned system of meanings—a value-laden meaning system that helps you to make sense of and explain what is going on in your everyday intercultural surroundings. It fosters a particular sense of shared identity and solidarity among its members. (p. 27)

Scientists have a particular point of view on how to interpret the world (Gooding, 1992; Hacking, 1992; Maddock, 1981; Pickering, 1992). This view can be found in laboratories, in the field, as well as within the science classroom. Thus, science educators become important cultural representatives of the scientific community (American Association for the Advancement of Science [AAAS], 1993; NRC, 1996). Therefore, it is important for teachers to understand and become aware of how the culture of science influences their actions (Moje, 1995; Moore, 2007; Yerrick, 2000) and their students (Aikenhead, 1996; Costa, 1995; Lee, 2003; Lee & Fradd, 1998).

The purpose of this chapter is to provide an overview of the literature regarding the culture of science and its expression within science classrooms. The first section will identify aspects found within the literature regarding the culture of the scientific field. The second section will address the relationship between language and culture within classrooms. The third section will examine the language of science and its implications.
for science classrooms. The last section will examine the conceptual framework of a third space.

**Culture of Science**

Western scientists have a particular viewpoint about the natural world (Gooding, 1992; Hacking, 1992; Pickering, 1992; Stanley & Brickhouse, 2000). Natural science is approached through a realist's or a universalist's perspective (Stanley & Brickhouse, 2000) whereby reality is seen as ordered, knowable, causal and explanatory (Cobern & Loving, 2001; Stanley & Brickhouse, 2000). These perspectives entail viewing science as "universal and invariant across time and place" (Stanley & Brickhouse, p. 37). These assumptions allow scientists to observe, interpret, and study natural occurrences regardless of where they are occurring in the world. Scientists are also depicted as curious and inventive (Hacking, 1992), creating and employing technology to meet the needs of society. These traits have become the hallmark traits of successful scientists in the Western world (Lemke, 1990; Moje, 1997; Stanley & Brickhouse, 2000).

Scientists are also depicted as objective, and reality is viewed to be independent of one's personal beliefs and values, thus endorsing an impartial view of the world (Aikenhead, 1996; Cobern & Loving, 2001; Gooding, 1992; Lee, 2003; Maddock, 1981; Pickering, 1992). Nature is observed from the outside, and the researcher takes the vantage point of God (Smith, 1989), viewing material things from different perspectives. Objectivity is not only a goal, but also an underlying assumption made by scientists (Pring, 2000). Pring sees objectivity as having various meanings:

First, it signifies that what is said is in tune with the world as it really is; it is not the product of (purely subjective) whim or wishes. Second, an enquiry is
“objective” in that it takes the necessary and appropriate steps to get at that objective state of affairs. That is, one sticks to the proper procedures, which are likely to arrive at the correct conclusions. (p. 62)

Objectivity becomes an important issue in believing the truthfulness in a scientific investigation (Maddock, 1981). It implies a sense of distance and control of the natural world (Cobern & Loving, 2001). This belief in objectivity is taught, preserved, and reinforced in the field (Hacking, 1992). The previous description of the culture of science may not be universal, but still provides insight into how some scientists operate in the scientific community.

These ideas are found not only within the scientific community, but also within many science classrooms (Maddock, 1981). Science educators are implicitly trained within the cultural backdrop described above. The NRC (1996) wrote, “[teachers] model and emphasize the skills, attitudes, and values of scientific inquiry. Certain attitudes, such as wonder, curiosity, and respect toward nature are vital parts of the science learning community” (p. 50). Science educators view these as the hallmark of not only a good science teacher, but also a good science student.

Science educators perpetuate the cultural values found in the scientific community. They engage in the instruction of illustrating the “habits of mind” (AAAS, 1993, p.190), which include problem solving, reasoning, communicating, and making connections. Problem solving involves asking questions, making accurate observations, collecting and interpreting data, and drawing conclusions from the data. Reasoning “stresses the use of data and logic to draw conclusions, create interpretations, and make decisions” (Georgia Department of Education, n.d., p. 1); communication deals with
graphic interpretations and the written and spoken word. Finally, making connections is concerned with how different branches of sciences relate to each other using “the universal scientific process skills, laboratory techniques, and reasoning” (Georgia Department of Education, n.d., p. 1). Pervasive across these habits of mind is the umbrella concept of objectivity.

Another important aspect of teaching science is enculturation, the process of becoming part of a community (Aikenhead, 1996). Some teacher education programs have created internships for pre-service science teachers in order to encourage and support enculturation by providing opportunities to better understand the world of scientists. Schwartz, Lederman, and Crawford (2004), for example, observed pre-service teachers placed within a laboratory setting to give them experience with the daily life of scientists. The intended goal of the internship was for the prospective teachers to have an authentic scientific inquiry experience and be explicitly instructed in the nature of science. The researchers found the internship strengthened the pre-service teachers’ understanding of the process involved with using inquiry in a laboratory setting. Furthermore, many of the teachers believed they would incorporate their experience into their own science teaching. This suggests a strong enculturation or indoctrination into the scientific community. Science education becomes a rite of passage for students interested in this academic field (Costa, 1995; Hawkins & Pea, 1987). Scientists and science teachers can become gatekeepers, allowing students access to specific pathways of knowledge and enculturating them within this community (Brown, 2006; Lemke, 1990; Maddock, 1981; Moje, 1995).
Another important aspect of enculturation into the science community involves understanding and engaging in the inquiry method. Colburn's (2000) description of the inquiry method as a learning cycle incorporates both direct instruction from the science teacher and application by the students. Through this method of learning students are enculturated into the science world. Colburn (2000) also provides guidelines for the different stages of inquiry. The process begins with structured inquiry, whereby the science teacher provides problems, materials and procedures and the students engage in closely monitored scientific exploration grounded in objectivity. Once the students have adopted these ways of conducting scientific inquiry, they progress to guided inquiry where a problem and materials are provided but the students must determine the procedures independently. With success in this guided process, students advance to open inquiry, creating solutions to problems through their use of correct scientific procedures. It is at this point in the inquiry method that students identify themselves and are identified by others as members of the scientific community. Students engaging in the inquiry method are essentially acting as little scientists in the classroom. As Etheredge and Rudnitsky (2003) write:

The notion that students should learn science by behaving like scientists has always had great appeal to educators. The notion that children, especially young children, are [authors' italics] scientists, engaged in building theories about the world, adds to the cachet of inquiry. (p. 6)

Science educators use the inquiry method to provide students with the skills, procedures, attitudes, and beliefs needed to understand natural phenomenon (Etheredge & Rudnitsky, 2003). Students are asked to use their natural curiosity to lead them through
the process of inquiry, employing the same skills scientists use while working within a laboratory setting.

In a study conducted by Krajcik, Blumenfield, Marx, Bass, Fredricks, and Soloway (1998), the researchers observed some of the obstacles and challenges faced when using inquiry within a seventh grade classroom. The study involved two teachers who had developed three inquiry projects. The first lesson was an introduction to the inquiry method, providing students with the vocabulary and group experience needed to be successful with this method of learning science, while the other two lessons consisted of small group projects that students conducted in class. Both of these projects allowed students to understand and to engage in the inquiry process.

Throughout the course of the year, Krajcik et al. (1998) found that students generated two types of questions: descriptive and relational. Both of these were developed by the students, allowing them to design experiments while exploring “key scientific ideas related to curriculum goals” (Krajcik et al., 1998, p. 323). The researchers observed that some of the students were creating questions that were worthwhile and thought provoking, while at other times, their questions were lesser of quality and were based simply on information the students were familiar with either at school or at home. For example, one group wanted to study the amount of fecal coliform found in pond water only because one of their group members had seen the test done at home. This then became the basis of their question directing their entire project.

Krajcik et al. (1998) found that some of the students understood some key concepts important to science, but were unable to relate their results to the final
conclusion in their research papers. Additionally, some students were able to use the vocabulary of the scientific method, but were unable to create an environment that allowed for the experiment to occur within the rules of the scientific method. Students saw how important controls were to an experiment, but had difficulty creating designs that would actually address these problems. Krajcik et al. (1998) reported:

For instance, Dave’s group was interested in exploring whether the water cycle could help in water purification. However, because they lacked understanding of states of matter and of the water cycle, they were not able to develop a design to test out their ideas. (p. 331)

The researchers found students’ initial attempts at inquiry promising, but more work was needed for them to go beyond the superficial level of understanding what and how scientists do what they do. Krajcik et al. (1998) wrote:

[For the teacher, there is] difficulty selecting an overall driving question that can encompass small scale, student-designed investigations and, at the same time, both open windows to the complexity of the science and reflect larger issues. Such driving questions also must be sensitive to science content that is appropriate for the level of knowledge and understanding of the students. (p. 343)

Krajcik et al. (1998) concluded that students needed more experience with the inquiry process in order to create successful projects. They also needed to receive timely and informative feedback from teachers, peers, and experts in the field. This study also illustrated that using inquiry within a classroom requires a large amount of time. Students needed time to reflect, revise, and even redesign their ideas; they could not simply jump into this type of learning and be productive.

For many students, inquiry is a unique learning approach within the science classroom. In research on students’ perceptions of science as a subject matter, Brown (2006) found students’ perceptions of science revealed a distinction between the
scientific field and other subjects. Brown’s participants described science and the activities used to understand science as unique. Many viewed science as being so distinct from other school subjects that it required behavior not normally used in school. The students in Brown’s study believed scientists were “detailed, laborious, and exhaustive in their pursuit of information” (p. 114). The students’ perception created a barrier, which distanced many of them from science. They believed they did not and could not belong to this community.

Inquiry can also pose a challenge for students whose cultural backgrounds are not congruent with practices involved in the inquiry method (Lee, 2003). Ninnes’ (1994) work in the Solomon Islands illustrated how the culture of his students influenced not only their perception of science, but also their engagement in and use of the activities found in the science classroom, specifically the inquiry method. The purpose of his study was to examine and understand the learning styles of the Melanesian Solomon Islanders. The information he collected was then incorporated into his teaching, enhancing the overall performance of his students’ ability in his science classroom.

In the Melanesian culture, knowledge is passed down from expert to novice; it is thought to be “externally derived, principally from authority figures and peers” (Ninnes, 1994, p. 681). Ninnes allowed his students to work in groups, and he quickly was able to identify the expert within each group. This role was implicitly assigned, given to the student with the most perceived science experience. This person controlled the participation levels of each group member. The expert decided who did what and when, controlling every aspect of the project. Ninnes reported the following:
During 4R’s lesson today the students were finding the density of various objects by first finding their volume and then dividing by their measured mass. CR, AT, and CQ [students] were working as one group. The latter two are ex-Provincial Secondary School students. In the group CR was clearly in charge, doing most of the manipulation of equipment, directing the others’ efforts and recording results. AT and CQ watched CR as she worked, and assisted from time to time. (p. 686)

Ninnes (1994) also found that the informal learning style of this culture focused on the gradual progression “from observation to partial participation to full participation” (p. 686). He believed if he reduced the group size from five to two, many more of his students would have a greater opportunity to participate in the laboratory experiments. Through this small manipulation of classroom practices, Ninnes was able to use students’ cultural values to enhance his teaching. This resulted in more students actively participating than before, giving all of his students an opportunity to learn science.

Ninnes (1994) also realized from his study that observation and imitation are highly valued by the Melanesian Solomon Islanders. Both of these practices were used as teaching devices within this community. The process involved watching someone complete a task and then imitating the same task at a later time. Ninnes observed this within his classroom, where many of his students would rather watch and copy their peers than follow instructions found in the textbook. Students did not participate within the inquiry method as traditionally defined, and because of this, Ninnes believed it was important to use his knowledge of their culture to change his teaching practices. He used their cultural framework as a guide to shape his own teaching practices in order to help his students better understand science.

Fradd, Lee, Sutman, and Saxton (2001) also examined how culture influences students’ perception and ability to work within the cultural framework of the scientific
field. The researchers worked with fourth grade teachers and students to promote inquiry-based science. Their overall goal was to help their students succeed and become interested in this community. The first phase of their project was to introduce the inquiry method to teachers and students. Fradd et al. found many of their participants, teachers and students alike, were having difficulty engaging in inquiry because of the cultural differences between their world and the world of science. One teacher commented:

Remember, many of us come from backgrounds where science was not taught. In our children's homes inquiry was not acceptable way of learning because families don’t want children asking questions, debating, or challenging authority. Children are expected to learn by watching. (p. 422)

The researchers found that changing the way inquiry was presented could make science more accessible to teachers and students. Through the use of instructional scaffolding, building on concepts slowly over time, and making the implicit rules of the inquiry method explicit, Fradd et al. (2001) found those involved were able to use inquiry as a means of exploring science. Both Fradd et al. and Ninnes (1994) illustrate that science educators can learn to recognize and to understand not only the culture of science, but also the culture of their students. They can become bridge builders, providing a link between the world of science and the world of their students (Aikenhead, 1996, 1999).

Inquiry can become a means of exposing students to this new world of science. When used effectively, the inquiry method becomes a positive learning experience for students, as Llewellyn (2002) wrote:

Inquiry helps us connect our prior understanding to new experiences, modify and accommodate our previously held beliefs and conceptual models, and construct
new knowledge... learning through inquiry empowers students with the skills and knowledge to become independent thinkers and lifelong learners. (p. 16)

The inquiry method reflects the constructivist’s view of learning (Llewellyn, 2002). In a constructivist classroom, students’ prior knowledge becomes the foundation of the lesson (Llewellyn). Their understanding is an important key in creating and shaping the curriculum. Inquiry becomes the tool that links students’ prior knowledge with experience. Llewellyn described this process as a way of providing “an opportunity for the learner to create meaning from an experience” (p. 31). Inquiry, through the constructivist framework, helps students climb the ladder to understanding new information, while building on the old.

The use of inquiry within a science classroom stands in contrast to a traditional classroom (Llewellyn, 2002). In such an approach, teachers are seen as facilitators rather than informants. Their role is to guide students through the process of understanding scientific concepts (Fox, Grosso, & Tashlik, 2004). The classroom shifts from teacher-centered, where the teacher and the textbook control the curriculum, to student-centered (Llewellyn, 2002), allowing students to “observe phenomenon and understand the realities of the universe” (Adams & Hamm, 1998, p. 1). This student-centered approach encourages students to use their knowledge of the world to develop questions of investigation, while simultaneously learning the same skills scientists use to solve problems involving the natural world (Adams & Hamm, 1998; Fox, Grosso, & Tashlik, 2004; Llewellyn, 2002). Inquiry, if used effectively, appears to be a powerful tool to help students succeed in science while taking an active role in their own education (Adams & Hamm, 1998; Fox et al., 2004; Llewellyn, 2002).
Language and Culture

Language, as defined by Ting-Toomey and Chung (2005), is an “arbitrary, symbolic system that names feelings, experiences, ideas, and objects, events, group, people, and other phenomenon... governed by multilayer rules developed by members of a particular sociocultural community” (p. 141). Language and culture are connected; in other words, in order to understand an individual culture, one has to first understand the language and how it is used within the community (Nieto, 2004; Ting-Toomey & Chung, 2005). Agar (1994) described this connection as a “languaculture” (p. 60), where culture surrounds language, becoming the fundamental way of expressing one’s values and “the lens through which one views the world” (Nieto, p. 208). Trueba (as quoted in Nieto, 2004) wrote:

Whatever knowledge we acquire, it is always acquired through language and culture, two interlocked symbolic systems considered essential for human interaction and survival. Culture and language are so intricately intertwined that even trained scholars find it impossible to decide where language ends and culture begins, or which one of the two impacts the other most. (p. 208)

Thus culture becomes an important underlying aspect of the language used in a community, where “culture erases the circle around language that people usually draw. You can master grammar and the dictionary, but without [author’s italics] culture you won’t communicate” (Agar, 1994, p. 29). The interconnection of language and culture has implications within the school setting (Delpit, 1995; Nieto, 2004), where “the language practices that children bring to school inevitably affect how and what they learn” (Nieto, p. 208). Therefore, understanding the culture and discourse of students becomes an important area of research (Moje, 1995).
Interactions among students and teachers shape and develop students' overall learning in school. For example, Ballenger (1992), who is both teacher and researcher, found that when "the adult does not share the same cultural background and the same experience of socialization as the children, one becomes very aware of learning how to enter and manage the relevant conversation" (p. 200). Overall she wanted to understand why she was having problems in her Haitian classroom. She wrote:

The children ran me ragged. In the friendliest, most cheerful, and affectionate manner imaginable, my class of four-year-olds followed their own inclinations rather than my directions in almost everything... My frustration increased when I looked at the other classrooms at my school. I had to notice that the other teachers, all Haitian women, had orderly classrooms of children who, in equally affectionate and cheerful manner, *did* [author's italics] follow directions and kept the confusion to a level that I could have tolerated. The problem, evidently, did not reside in the children, since the Haitian teachers managed them well enough. Where then did it reside? What was it that the Haitian teachers did that I did not do? (p. 200)

Through a series of dialogues between Haitian teachers and North American teachers and through her observations of their classrooms, Ballenger (1992) began to answer her research questions. She found that one of the differences between these two cultures involved how teachers and students interacted with one another. For instance, the Haitian teachers commented on how North American teachers refer to the students' emotional states and suggest those emotions lead to their misbehavior in class. For example, the teachers used terms like, "you [referring to the student] must be angry; it's hard for you when your friend does that" (p. 203), while the Haitians teachers did not make reference to the feelings of their students.

Ballenger (1992) also found differences between the teachers in their use of consequences. She wrote:
North American teachers typically present the particular consequences of an act of misbehavior. For example, Loften say something like, “He’s crying because you hit him” or “If you don’t listen to me, you won’t know what to do.” Haitian teachers are less likely to differentiate among particular kinds of misbehaviors; they condemn them all, less in terms of their results than as examples of “bad” behavior. Clothilde is typical of the Haitian teachers in that the immediate consequences are not made explicit; she does not explain why she is against biting or punching. She instead refers to such behavior as “bad,” and then explains to the children the consequences of bad behavior in general. (p. 204)

Through her research, Ballenger (1992) began to understand the complex nature of how student-teacher interactions affected what occurred within the classroom. The author observed the discourse patterns of the North American and Haitian teachers, concluding that their styles of communication were distinct. As the teacher, she incorporated the styles of both Haitian and North American student-teacher interactions. Ballenger emphasized the importance of understanding students’ cultural and linguistic backgrounds in order to effectively work with culturally different students.

Lee and Fradd (1996) also observed and identified the interactional patterns used by students and teachers from three different cultures. Their study was conducted in two elementary schools examining six teachers’ classrooms, representing the three language groups. The groups consisted of bilingual Spanish, bilingual Haitian-Creole, and monolingual English speakers within a science classroom. The teachers within these classrooms were from the same culture and used similar discourse patterns as their students. The bilingual teachers and students used both of their languages to engage in each science activity and interact with one another.

Lee and Fradd (1996) identified three distinct interactional styles. The Spanish speakers used overlapping speech patterns, where while “one member of the triad began
speaking, the others completed thoughts and followed up on ideas, even within the same sentence” (p. 280). The bilingual Spanish speakers also used verbal and nonverbal communication styles, and the teacher linked their prior observation with theory, while rewarding students’ efforts through social rather than academic means. In the Haitian-Creole classroom, the teacher dominated the interactions between students and teachers. The nonverbal communication styles included the use of facial expression and the physical space between students and teacher. The researchers found “the lack of student-initiated responses and their restrained behavior appeared as a sign of respect for teachers, rather than a lack of interest” (p. 288). This was in direct contrast with what was found in the monolingual English science classroom. The authors observed a lack of nonverbal communication and found instead that verbal communication dominated the interactions between the teacher and the students. “Each member in the triad spoke individually, one at a time, usually in one to three complete sentences” (p. 288). The monolingual English speakers’ teacher expected students to perform independently, using statements such as, “Now, I want you to think about this,” “I’m going to ask you about,” and “I see that you are thinking about this” (p. 289). Lee and Fradd concluded:

Interactional patterns that promote cultural congruence may sometimes be incompatible with the norms of discourse and task engagement in science as they are currently presented in national documents... As a result, students unfamiliar with the science discourse may have difficulty deciding when to talk, how to present their ideas, and how to demonstrate their understanding. (p. 293)

The studies by Ballenger (1992) and Lee and Fradd (1996) both illustrate the importance of understanding not only the cultural background of students, but also the interrelatedness of culture and language. This becomes especially important for students
engaging in science, because science, as Gee (2005) contends, “makes demands on students to use language, orally and in print... that are at the heart of higher levels of school success” (p.19).

Language of Science

Science educators use language as the way of expressing and promoting the culture of the scientific community (Lemke, 1990; Moje, 1995). Roth (2005) argues language is an important aspect “of the human condition that... provides resources for conducting everyday affairs, including doing [author’s italics] of science” (p. 1). Lemke found that student participation in science activities occurs through the medium of language, where one is “observing, describing, comparing, classifying, analyzing, discussing, hypothesizing, theorizing, questioning, challenging, arguing, designing experiments, following procedures, judging, evaluating, deciding, concluding, generalizing, reporting, writing, lecturing, and teaching in and through the language of science” (p. 1).

Two distinct views regarding the type of discourse used within science classrooms can be found in the literature. One, the traditional objectivity view, separates the person from nature and the personalized from the scientific. Lemke (1990), through his observations of science classrooms, found it was important for teachers and students to be as “explicit and universal as possible. This means that verbal, rather than gestural or other nonverbal signs are required, and that implicit forms of grammar... are not fully acceptable” (p. 133). He observed the “correct” or “stylistic norms” (p. 131) of how science should sound within the classroom. If a teacher deviates from this norm, students
comment directly or indirectly on it, insisting that the teacher should conform to the
norms of the language used in science. Lemke, even though he personally does not agree
with these ideas, found that students and teachers believed that in order to learn science,
they should not use colloquial forms of language including paraphrasing, personification,
or the use of human attributes, including metaphors and figurative language. He is
especially concerned about being serious and dignified when expressing scientific content
as well as avoiding any reference to historical figures or events, particularly avoiding
fiction or fantasy. This is in stark contrast to Treagust and Harrison (1999), who
investigated the quality of scientific explanation by research scientists and science
educators, and strongly encouraged the teachers to use:

rich and creative metaphors, analogies and models containing anthropomorphism
and teleological expressions. Classroom science explanations... are a unique form
of explanation that amalgamate expert scientific and expert pedagogical
knowledge.... The latter expression emphasizes the fluid, dynamic, and adaptative
nature of teacher’s expert teacher knowledge. (p. 40).

Lemke (1990) and Treagust and Harrison (1999) illustrate the complex nature of
language within science classrooms. At one end of the spectrum, science teachers are
expected to embrace and promote the type of discourse found in the scientific
community. Yet science teachers are also expected to use their pedagogical practices to
make science accessible to their students. Duschl (2005) also discussed the incongruence
found within the science education community. He surveyed teachers about the language
used in science classrooms and found a variety of perspectives about the language of
science:

Some teachers’ points of view will be wedded to the language of content learning,
knowing what [author’s italic], while some will be committed to that of process
learning, knowing *how* [author’s italic]... For some teachers, the language of science classroom will be one associated with asking questions or designing and reporting experiments. Yet other teachers will embrace ideas that the language of science classroom teach the discourse of power and authority inherent in science rhetoric. (p. ix)

This tension regarding language within science classrooms was illustrated in two studies of a high school chemistry classroom conducted by Moje (1995, 1997). The overall purpose of both studies was “to understand how language is used in a secondary science classroom and to discuss implications of such uses for the meanings constructed by teachers and students as they use language in their science classroom interactions” (Moje, 1995, p. 352).

Moje (1995, 1997) observed a chemistry classroom from 1995 to 1997. Her data sources included audiotape transcriptions, field notes, and informal interviews. Initially, the author found the teacher’s discussions about science, scientists, and ways of knowing science centered around three major aspects:

(a) focusing on accuracy and precision, (b) distinguishing between science and other disciplines, and (c) using personal pronouns to promote her own authority as a science expert and to bring students into the classroom and science community. Through the teacher’s talk, students could began to hear about the importance of studying scientific concepts, and they were inducted into the community of science with an expert professional who encouraged them to participate cooperatively in the classroom science community. (1995, p. 364)

In a subsequent study, Moje (1997) reexamined the data sources using critical discourse analysis, a type of research methodology used to examine the discourse used by a participant. She wanted to analyze the language of the chemistry teacher to uncover the hidden meanings and implications of the teacher’s discourse. Moje found the educator focused on using the “right” (p. 4) word, which resulted in the students concentrating...
their attention on using the correct definition. The chemistry teacher "inadvertently reinforced a notion of foundational knowledge... suggest[ing] that knowledge in science was layered and hierarchical, that one must know the exact definition in order to make sense of the concepts" (p. 4).

In both studies, Moje (1995, 1997) found the discourse of the science teacher involved a merging of multiple discourse communities that included the scientists, science teacher, and classroom manager. She wrote, "these merged discourses tended to emphasize organization, accuracy, and precision, and thus reproduced or constructed particular assumptions about what counts in science" (Moje, 1997, p.4). Therefore, science educators negotiate the various discourses found within the science classroom. All of these studies presented above demonstrate how the language of science becomes the means through which students can learn the culture of the scientific community.

The Third Space

One of the ways science educators can make science more accessible is through building connections between students and science (Aikenhead, 1996; Fradd et al., 2001; Lee & Fradd, 1998). This connection, or the third space, has been primarily used within educational research to discuss issues of literacy, specifically with math and science, and how students' everyday discourse and content literacy can merge to create a hybrid or a third space.

Lee and Fradd developed a conceptual model entitled instructional congruence theory for making these connections. The authors defined this as "the process of mediating the nature of academic content with students' language and cultural
experiences to make such content accessible, meaningful, and relevant” (p. 12). Lee and Fradd developed this theoretical concept in regard to science and literacy instruction for students who are in the process of learning English, but their ideas can be expanded to include all students in the process of learning science.

Instructional congruence is accomplished by first recognizing students’ cultural backgrounds, second by understanding how students acquire literacy, and finally by becoming knowledgeable about the nature of science and its relationship to the learning process. All of this is done “to guide and enable students to understand science” (Lee & Fradd, 1998, p. 13).

In Lee and Fradd’s (1998) framework, science teachers are encouraged to recognize and appreciate their students’ cultural background. The educators are then asked to create connections between the lives of their students and the particular scientific concept under investigation. For example, Lee and Fradd wrote:

In introducing the use of the thermometer, an Hispanic teacher wanted students to learn to read the Celsius and Fahrenheit scales. He posed the following questions: “When you have a fever, what temperature does your mother look for? What number does she expect to see on the thermometer?” Student responses varied from 38 to 40 and 98 to 100 degrees. While the students appeared puzzled by the range of numbers, the teacher responded, “Yes, that’s right! Your mothers are taking your temperatures using two different scales, Celsius and Fahrenheit. Let’s look at our thermometers. See the two scales? Our thermometers are bilingual, just like you.” (p. 18)

In the example above, Lee and Fradd (1998) claimed that the teacher encouraged the students to recognize the two different ways of representing data. The teacher also created an analogy, relating the “measurement system with the students’ language
systems, the teacher linked students’ experiences with big ideas of distinct but comparable systems” (p. 18).

The examination of students’ discourse is also an important concept in Lee and Fradd’s (1998) model. In their research, they found students “initially lacked the necessary language to express their ideas clearly” (p. 18). Yet as students’ experience in science grew, their language became more complex and represented “the intersection of language development and science learning” (p. 18). Lee and Fradd concluded that this intersection becomes a key component in understanding how to make a connection between the world of students and the world of science.

Moje et al. (2001), using Lee and Fradd’s (1998) concept of instructional congruence, examined the discourses of students engaging in inquiry-based research projects. Their data consisted of participant observations documented in field notes and interviews of the teacher and students in one 7th grade science classroom. Their data “focused on both the teacher’s and student’s literacy and language practices, the classroom environment, and the teacher-student interactions” (p. 475). Their analysis revealed the teacher and the students engaged in multiple discourses within the classroom that at times competed with one another. They wrote:

In both the written curriculum and Maestro Toma’s enactment of it, multiple Discourses and experiences coexisted with little integration... the various Discourses at play in this classroom and curriculum were in competition or conflict with one another, rather than in a productive interaction. (p. 476)

Moje et al. concluded that these discourses could be integrated, creating a “congruent, hybrid third space” (p. 476). The authors believe this third space is only constructed “when disciplinary, classroom, and everyday Discourse inform one another and build
new knowledge and Discourse” (p. 490). Gutierrez, Baquedano-Lopez, Alvarez, and Chiu (1999) also examined literacy, but these scholars were interested in investigating the third space from a perspective of collaboration, where the third space becomes an event of co-learning, a hybridity of language and literacy.

Wallace (2004) explored the conceptual idea of the third space. She contended that the use of language to learn science is “an abstraction of a space/time location” (p. 908) in which the meaning of the utterance becomes a place for a co-construction or a new hybrid of meaning. Wallace wrote:

Thus, we may interpret the Third Space as an area in which neither one of two different languages are dominant, but the meaning of both may be transformed according to new experiences... We are compelled to accept children’s authentic understandings, even if they are not in accord with scientific authority... In the Third Space, multiple discourses may be woven together without sacrificing or dismissing the importance of their speakers’ experiences and ways of knowing the world. (p. 908)

Flessner (2009) also discussed the idea of hybridity, but used the concept of the third space as a form of reflection in teacher education. In his study, Flessner examined his reflective work as a teacher educator navigating between an elementary classroom and a university mathematics methods course.

Whether the researchers used the third space as a framework for understanding literacy practices (Moje et al., 2001; Gutierrez et al., 1999), examining the language of science in the classroom (Wallace, 2004), or reflecting on the negotiation between elementary classes and university courses (Flessner, 2009), their use of the term hybridity provides them with a way to describe the new environment created within the third space.
This notion of hybridity, created by the confluence of two often very distinct environments, provides a useful perspective for thinking about teaching and learning.

The theory of the third space stems from the work of Bhabha’s (1990, 1994) and Soja (1996). Both of these scholars discuss the third space from a cultural-political perspective. Educational researchers use this as a framework for examining the literacy practices and reflective teaching practices as a basis for their understanding of what occurs in a classroom.

Science educators can reconfigure their classrooms in order to encompass students’ culture and the culture of science to provide the learner with a location to create a new world (see Figure 1 in Chapter 1). And as Moje et al. (2001) state:

In many ways, the construction of congruent third space in classroom requires the deconstruction of boundaries between classroom and community, especially for students who are often at the margins of mainstream classroom life... we can find ways to negotiate our boundary crossing work so that youth will be always learning, but learning in places where their everyday Discourse and knowledge are valued, integrated with others, and expanded. (p. 492)

The creation of the third space can begin with the understanding of the world of science and the world of one’s students. Lee and Fradd (1998), Moje et al. (2001) and Wallace (2004) have begun the discussion about the third space, yet more research in this area is still required to help science teachers understand its dimensions in science classrooms (Lee & Fradd, 1998; Moje et al., 2001).

**Conclusion**

The language and beliefs of a specific community constitute the cultural framework of the members in it. Scientists have a distinct culture and discourse that is reflected and promoted by science educators through the use of the inquiry method, and
this method provides a means to expose students to the world and culture of the scientific community. However, for some students the process of using the inquiry method is difficult. Thus science teachers, through their understanding of the inquiry method and the needs of their students, can provide a bridge between the world of science and the world of their students.

Ballenger (1992), Brown (2006), and Ninnes (1994) are researchers and classroom teachers who have used their research to encourage growth in their classroom practices. Other scholars mentioned previously in the chapter have investigated the inquiry method and its influence on the language and culture in a science classroom. Their research stems from the perspective of a classroom observer and not a classroom teacher (Duschl, 2005; Etheredge & Rudnitsky, 2003; Fradd et al., 2001; Krajcik et al., 1998; Lee & Fradd, 1996, 1998; Lemke, 1990; Llewellyn, 2002; Moje, 1995, 1997; Moje et al., 2001; Schwartz et al., 2004; Treagust & Harrison, 1999). Many of the concepts posited by these classroom observers remain a matter of theoretical practice rather than actual experience. The purpose of my research is to explore my science classroom both as an observer and as a participant to reinforce the perspective of the insider in the ever-changing world of science pedagogy. As Moje (1995) notes, “It is crucial that we investigate questions regarding how the shared cultural perspectives between the teacher and her students influence the students’ willingness to engage in the language necessary to succeed in the classroom...” (p. 368). My self-study is integral to my understanding of my beliefs about teaching and learning and how these beliefs inform my actions in the classroom. My research questions regarding this study are:
1. What are my underlying beliefs about teaching science to students and how were these beliefs expressed in my classroom?

2. What is the third space created in my classroom?

This self-study puts me in a position to provide answers to these questions through examining my own practice and the ways in which I interact with my students in creating the third space.
CHAPTER 3
METHODOLOGY

Overview

The aim of my research is to understand my own practice within my classroom for the sake of becoming a better science teacher of English Language Learners (ELL) and of contributing to others' similar endeavors. I am using self-study as a vehicle for developing this understanding. This method of investigation is designed so that an educator can examine his or her own teaching practices. This self-study is also more than just a personal story for self-improvement; others can use this investigation as a way to inform educational reform for both secondary teachers and teacher educators through the examination of their own practices and also using what they learn to improve the education of all students.

The overall study becomes a reflection on the beliefs and values found within one's philosophy of teaching and learning as it is reflected within a classroom. In my self-study, I am not introducing a new teaching strategy; rather, I am examining my own beliefs and values as they are expressed within my science classroom. This chapter contains three sections. The first is an introduction to self-study, specifically addressing its major components and how it differs from action research. The second section presents research within the field of self-study that provides a theoretical grounding in understanding how one's culture is enacted in a classroom. And finally the last section describes the specific procedures used in my self-study.
Self-Study Defined

Educational researchers use a variety of methods to understand what occurs within a classroom setting. Those who are interested in analyzing their own teaching practice engage in a type of research known as self-study. Loughran (2004) notes:

[Self-study] has emerged from the work of teachers and teacher educators themselves. That is, that their attempts to better understand the problematic worlds of teaching and learning have led to an increasing focus on their work so that researching their practice better inform them about their teaching and enhancing their students’ learning. (p. 9)

Self-study is a reflective process providing educators with the means of coming into closer proximity with the contradictions and complexities found within their own practice (Austin & Senese, 2004; Loughran, 2004; Northfield & Loughran, 1996). The overall goal of self-study is to improve one’s classroom practice (LaBoskey, 2004) and to add to the overall knowledge in teacher education (Loughran, 2008).

The focus of self-study is the self. This focus is not the self in isolation, but rather entails a connection between the educator and the academic world (Ham & Kane, 2004; Samaras & Freese, 2002). The knowledge gained through self-study research is used to challenge not only those involved in the research, but also extends to those within the institution of teacher education (Loughran, 2004) by challenging how teachers and teachers educators view and understand their experiences in the classroom.

A critical component of self-study is the examination of the values and beliefs found within one’s practice (Allender, 2004; Austin & Senese, 2004; Northfield & Loughran, 1996; Tidwell & Fitzgerald, 2004). This is different from action research, another type of research educators use to observe and analyze their practice. Action
research is viewed as a practical means of determining the effectiveness of a teaching style or curriculum program (McNiff & Whitehead, 2002). It involves studying a particular teaching approach, and through the examination of students' behaviors, assignments, and test scores, determining its effectiveness in helping students be successful in the classroom. Action research focuses on the what and the how of classroom practice. In self-study, the focus is primarily on the educator and his or her role in the overall classroom environment. Austin and Senese (2004) provide an overview of the differences between action research and self-study:

In my mind, action research is more about what a teacher does and not about who a teacher is. When I reframe my research as self-study, I enter through another door, the door of the self. Self-study is much more challenging for me because it requires that I put myself, my beliefs, my assumptions, and my ideologies about teaching (as well as my practice) under scrutiny. (p. 1235)

Action research and self-study are two methods employed by educational researchers to understand their practice within the context of the classroom. Unlike self-study, action research is broad in scope, encompassing many different types of research agendas. It can be found within the social sciences, administrative studies, and business management (McNiff & Whitehead, 2002). While self-study encompasses a variety of disciplines as well, this study looks more closely at self-study research primarily from teacher education, and the research agenda focuses on the educator, teacher educator or classroom teacher, investigating his or her own practice within his or her own educational setting.
Understanding Teachers’ Values and Beliefs

Educational researchers have used self-study to explore and understand how the values and beliefs of teachers influence their practice within a classroom (Capobianco, 2007; Kuzmic, 2002; Loughran & Northfield, 1998; Samaras & Freese, 2002; Senese, 2002; Waters-Adams, 2006) and their interaction with students (Allender, 2004; Loughran & Northfield, 1998; Tidwell, 2002). Some scholars have suggested that self-study research could be carried out on the values and beliefs of educators in order to transform practice (Capobianco, 2007; Kuzmic, 2002; Loughran & Northfield, 1998; Tidwell, 2002), to determine the relationship between the nature of science and teaching (Waters-Adams, 2006), and to incorporate different ways of knowing from either the students’ perspective (Tidwell, 2002) or an teacher educator’s perspective (Senese, 2002). All of these studies point to the importance of the ongoing examination of how one’s values and beliefs affect one’s pedagogical decisions. These studies also highlight the complexity of attempting to understand one’s practice within an educational setting, and they provide a conceptual framework for my research agenda.

Self-study is a means educators use to understand their practice. As Austin and Senese (2004) explain “in self-study, the focus of the research becomes [author’s italic] the person of the teacher: who the teacher is, how the teacher acts, what the teacher says, how the teacher thinks and responds, and how the teacher decides” (p. 1236). Therefore, educators become the focal point in the examination of their practice.

Much of the self-study research regarding science education involves teacher education. For instance, Bencze and Bowen (2002) evaluated their framework for science
teacher education examining student-teachers' epistemological, ontological, and pedagogical perspectives regarding the nature of science. Loughran and Northfield’s (1998) research in science classrooms involved examining Loughran’s experience in a one year teaching position in a seventh grade mathematics and science classroom. The authors depicted the aim of their study as “to understand the schooling situations for which we are to prepare and support teachers” (p. x). They believed there was a gap in research, one that needed to be filled from the perspective of a teacher, and they wanted to demonstrate how their teaching practices could be improved through the use of self-study.

Research Methodology

The purpose of my research is to use the techniques of self-study to examine my practice, specifically the underlying beliefs of my teaching found within the third space created in my science classroom. My investigation will also provide further insight into the theory of the third space. In the following section, I outline the methodology involved in my self-study. When I speak of the third space, I am shifting the focus from literacy (Gutierrez et al., 1999; Moje et al., 2001; Wallace, 2004) to culture, which includes the literacy practices, language, values, beliefs, everyday knowledge and everyday discourse found in one’s culture. My investigation will also provide further insight into the theory of the third space. In the following section, I outline the methodology involved in my self-study.
Research Questions

My self-study involves exploring my own practice, specifically focusing on my beliefs underlying not only my actions within my classroom, but also my philosophy of teaching and learning. The inquiry was guided by the following research questions:

1. What are my underlying beliefs and how do I express these beliefs in my classroom?
2. What is the third space I created in my classroom?

Embedded within the question regarding the third space is an examination of the role of the teacher, as well as the beliefs and values that are brought to the classroom. My research questions provided a basis for understanding my values and beliefs and how these values and beliefs informed the third space.

Educational Setting

My self-study occurred within my English Language Learners (ELL) biology classroom. At the time of the study, I had taught this class for the past four years and had established a relationship with many of the students, their parents, and the other ELL teachers within the program. For this one class, I was both the full-time teacher and researcher.

The larger ELL program in the school district is located in a large urban high school in the Midwest. Using the racial identity categories of the high school administrators, the student population is 1,440 and consists of 76% White, 17% African American, 4% Hispanic, 2% Asian, and 1% Native American. The ELL population is
composed of primarily Hispanic and Bosnian students, but there are also students from China, the Marshall Islands, and Honduras.

The ELL students enrolled in this program take courses in ELL English, ELL reading, and ELL vocabulary. The district also offers other sheltered content courses. For example, besides ELL biology, other ELL courses offered include ELL physical science, ELL world history, ELL US history, ELL pre-algebra, and ELL keyboarding.

My ELL biology class provided an opportunity for me, as the researcher, to understand how language and culture influence my teaching practices. My curiosity about my practice began with my work with the ELL students. Both my students' learning of science and my teaching of science impacted my awareness of the issues surrounding language and culture. My frustration with using my prior classroom techniques and cultural references in my teaching led me to reevaluate my curriculum and the manner in which I was presenting the information. My research thus represented a path to a better understanding of my own beliefs and their effect on my teaching in an ELL science classroom.

My Methodology.

The self-study included multiple sources of data. My life history (see Appendix A), classroom observations (see Appendix B for an example of a videotape transcription of a classroom observation), and member check interview constituted the primary sources of data. My life history described the influences that have shaped my philosophy of teaching and learning, while the classroom observations provided a means of observing my interactions with the class as a whole and with individual students. And finally, the
member check focus group interview was used as a device to evaluate my interpretation of what occurred during the classroom observations.

The secondary sources of data consisted of Power Point slides (see Appendix C for an example of the Power Point slides), laboratory activities, and student worksheets. Such a use of multiple sources of data increased the validity or truthfulness of my research (Bullough & Pinnegar, 2001). Also, the use of multiple sources provided a basis for determining the various themes or patterns found within my practice (Ryan & Bernard, 2003), thus engaging "the readers in a genuine act of seeing the essential wholeness of [my] life" (Bullough & Pinnegar, 2001, p. 16). My story becomes the connection between my world and the world of others, thereby adding to the body of knowledge found not only in self-study, but also in the field of science education.

Life history. I began Chapter 1 with an exploration of my teaching experiences through the use of life history. My life history provided a context for understanding the development of my philosophy of teaching and learning science. Samaras, Hicks, and Berger (2004) view life history as a means of uncovering and unveiling "a soul searching truth about the self" (p. 910). I placed myself within the context of my own history. This led to a creation of my own story, allowing me to uncover my own truths, my own self as a science educator.

My self-study involved identifying the beliefs informing my pedagogical identity. The life history became an inward reflection of my life as an educator so far, beginning the process of understanding my practice and the way in which it can be improved for my students and for me.
The life history was first constructed through the use of a timeline, creating an overview of my beginning interest in teaching to my present teaching position (see Appendix A). It depicts my past in chronological order, providing a historical outline of the major events that led to my current professional context. Once this was created, I focused my inquiry on answering three guiding questions: (a) what was occurring during each event in my life? (b) what were my actions in response to each event? and (c) how did the event contribute to my teaching philosophy? These questions became the basis of understanding my history in relation to my philosophy of teaching and learning.

Throughout the writing of my life history, I continued to use these questions to understand my everyday language that “[laid] bare our [my] taken-for-granted assumptions, casually or unthinkingly revealing deep differences in the stances and values... of [myself] ourselves” (Mitchell & Weber, 2005, p. 5).

In the summer of 2007, I began the depiction of my life history. This involved revisiting the science museum and the middle school where I did my practicum with Mrs. Baker. Both places evoked the memories of the past in order to understand the present. I did not have the opportunity to visit with Mrs. Baker, but fortunately during my visit at the science museum, I was able to reconnect with some of my co-workers. Through our informal conversation, I was able to reconstruct my experiences teaching science to visitors.

The final source of data for my life history involved re-examining past journal entries from my time in Los Angeles and here in Iowa. These diary accounts highlighted some of my frustrations and accomplishments in working with students from a culture
different from my own. It also provided an opportunity to re-explore my past through my own words.

The use of life history allowed for an unveiling of myself as an educator. The data obtained also provided an opportunity to “engage [in] history forthrightly” (Bullough & Pinnegar, 2001, p. 16). Thus I retraced my past in order to take an honest look at my future.

The classroom observation. In the spring of 2008, I made classroom observations of my teaching by videotaping five lectures that occurred over a two-week period, each ranging from ten to sixteen minutes in length. The video “recreate[d] both the voice and the behavior, the physical content, the direction of gaze” (Tochon, 2007, p.53) of my lived experience as the science teacher. It also provided the context for understanding what occurred within my classroom.

Videotaping not only recorded the verbal, but also the non-verbal messages communicated between my students and me. By using video, I was able to view myself within the context of the teaching situation to become better aware of my interaction with the students. The data provided a means of understanding my practice and contributed to the overall improvement of my practice (McNiff, Lomax, & Whitehead, 2003).

In the field of self-study, the use of video is not unique. Farren and Whitehead (2005) and other scholars (McNiff & Whitehead, 2002; Whitehead, 2000) have used this form of data collection to understand their practice and their overall interactions with students.

The visual narratives, in the form of digital video clips, of our educational practice, include our engagement with practitioner-researchers as we seek to
understand our educational influences in their learning... In studying our own education practice, with the help of digital video, we hope to influence the education of social formations so that others will begin to question their underlying values, assumptions and epistemologies that inform their practice. (Farren & Whitehead, p. 1)

Videotaping is a tool researchers use to observe a teacher in her natural environment. It provides an opportunity to explore the activities and interactions found within a science classroom. As Kelly and Crawford (1997) contend, videotaping "allow[ed] us to better understand the situation and contexts of particular events and how they relate to the practices of this classroom" (p. 538).

**Critical friend and the member check interview.** In the field of self-study, colleagues are employed to help establish the validity of one’s research. They become one’s *critical friends*, providing feedback to and support for the self-study researcher (Loughran, 2004; Northfield & Loughran, 1996; Tidwell & Fitzgerald, 2004). Collaborating is an important tool, offering a means of checking data and interpretations and providing an alternative viewpoint (Bullough & Pinnegar, 2001; Feldman, 2003; Loughran, 2004). I asked three people to become my critical friends. Two were classmates, also enrolled in the doctoral program, and the other was a former colleague from the high school. My critical friends examined my transcripts and helped to develop the codes and categories. My critical friends also read drafts of my analyses and my interpretations of my results, providing feedback on what I found in my teaching practice. Key events from these conversations and feedback were recorded in a journal.

Another source of data was a member check interview with my students. Their perspective provided a means of determining the accuracy of my analyzed data. My
students were in constant contact with my work and were most familiar with the educational settings and practices found within the classroom. In the fall of 2008, I asked these former students open-ended questions about my teaching practices. We also observed the video of the classroom observations and they read the transcription.

**Analysis of the Collected Data: Grounded Theory Methods**

The collected data were analyzed by means of the grounded theory method (Ryan & Bernard, 2003). Grounded theory is a type of qualitative research method that uses the data collected to construct an interpretation or theory (Charmaz, 2006; Corbin & Strauss, 2007). The data shapes the conceptual framework upon which the theory is based. Charmaz (2006) describes grounded theory methods as being a set of “systemic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories ‘grounded’ in the data themselves” (p. 2), and becomes a method of generating theory (Atkinson, Coffey, & Delamont, 2003). A theoretical framework is not applied to the data, and then analyzed; rather a framework emerges from the data and a theory is then developed and the data is re-examined within that framework to understand the overall research experience. Clarke (2005) provided an overview of a grounded theory analysis:

In this method, the analyst initially codes the data (open coding), word-by-word, segment-by-segment, and gives temporary labels (codes) to the particular phenomena. The analyst determines whether the codes generated through one data source also appear elsewhere, and elaborates their properties. Related codes that have endured are then densified into more enduring and analytically ambitious ‘categories,’ and these are ultimately integrated into a theoretical analysis of the substantive area. (p. xxxi)

Using methodology similar to that developed by Clarke (2005), I created a grounded theory from my collected data. The overall process first entailed assigning
initial codes to the data. These provisional labels were then used as a guide for
developing more specific and well-defined codes that better described the data. These
codes were next densified. This part of the process involved examining all of my codes
and grouping them into categories according to the similar themes or patterns found
within the codes. These categories were then used as the basis for answering my research
questions and generating my grounded theory. My grounded theory analysis was a
recursive process that required re-organizing and re-examining the data until I could
better discern the various patterns and themes found within my classroom.

Overall, my analysis consisted of transcribing the five video recordings of the
classroom observations and then re-reading the transcripts, highlighting key words and
creating codes based on the underlying meaning of those highlighted sections. I then
created global codes to look at specific aspects, and then redeveloped more specific codes
that better reflected the meaning represented in the text. The codes were then densified
into categories and used to generate open-ended questions for the focus group interview,
which I used for the member check. Once the focus group interview was conducted, I re­
examined all of the collected data, which included my life history, classroom
observations, lecture notes, transcription notes, focus group interview, and critical friend
discussions, to develop a grounded theory. In the subsequent section, I will describe the
process of generating a grounded theory in more detail, specifically describing the
recursive nature of the entire analytical process.
Analysis

At the beginning of my research process, I wanted to analyze the data in two distinct phases. The first phase would involve coding the video transcriptions of the classroom observations and the second phase would entail examining the focus group interview and comparing that data with the transcription data. However, because of the recursive nature of the process, I continued to re-examine my life history, classroom observations, and the focus group interview throughout the entire process. Thus, I did not have a distinct phase one and phase two. Rather, the recursive analysis merged together into one continuous process.

I began analyzing the data by first transcribing the video recordings of the classroom observations made in the spring of 2008. The classroom observations consisted of five videotaped teaching sessions, ranging in length from ten to sixteen minutes. In the transcription, I assigned each student a number, to help identify him or her within the transcription.

During the initial transcription, I documented any aspects of the lesson that I found noteworthy or interesting during the observations. For example, I noticed my recurring use of gestures while I was lecturing in class. I observed that gesturing with my hands was part of my instructional style. These gestures were found throughout the classroom observations. I documented each occurrence in my research notebook and decided to include in the transcription, in as much detail as possible, a description of the gestures that accompanied the words spoken in class. (See Appendix B for an example of a transcribed video taped teaching session with gesture descriptions.)
In addition to gesturing, I also observed that laughter permeated my lectures. It is interesting to note that the nature of our (my student’s and my own) jokes was not directed at a student; rather our laughter was directed at the science material. In other words, we (the students and I) made jokes about the science material. I also documented these occurrences of playfulness in my notebook. Instead of just describing them, I made a connection between the use of laughter and the ability to show students how to relate to science through the use of play. I wrote about my playfulness in the classroom in the form of a memo. According to Corbin and Strauss (2007), memos are a “specialized type of written record... that portray possible relationships between concepts” (p. 117). All of my entries in my research notebook were then later used as the basis for developing the codes, the categories, and the overall grounded theory.

Once the transcriptions were complete, I used a methodology created by Kelly and Crawford (1997) in their video examination of a science classroom. Their process involved developing initial codes and then using these codes to construct a timeline showing a “visual comparison of the range of activities over time as well as the approximate length of each” (Kelly & Crawford, 1997, p. 538). Below is a list of the initial codes developed from the transcription:

1. Getting Ready and Settling Down
2. Personal Examples
3. Discussion
4. Question and “Story Time”
5. Explanations using Analogies
6. Confusing One Word for Another

7. Their World and My World

Kelly and Crawford’s (1997) transcription analysis method was used only as a starting point in analyzing my data. The reason for this was the visual timeline and initial codes developed were not specific enough to encompass all of the data. Also, many of the different codes identified in the classroom observations were intertwined within the transcriptions, making it nearly impossible to construct a timeline. I found I needed additional codes that would describe the data in more detail. After discussing this concern with my critical friends (my classmates and my former colleague) I was able to develop different codes that better fit my data:

1. Plan
2. Directive/Statement of Desired Action
3. Teacher Confirmation
4. Student Confirmation
5. Teacher’s Examples
6. Student’s Examples
7. Teacher’s Questions
8. Student’s Questions
9. Teacher’s Jokes
10. Student’s Jokes
11. Teacher Clarification
12. Student Clarification
13. Lecture

14. Material Review

Each of these new codes were described and then densified into categories (see Table 1). I next examined my secondary sources to confirm my categories and these sources were then used as evidence for each of the categories. Once this was complete, I analyzed each category to determine the types of beliefs expressed in the collected data. After this examination was accomplished, I used that information to answer my research questions and determine the grounded theory of this research study.
Table 1

*Densified Codes and Categories*

<table>
<thead>
<tr>
<th>Initial Codes</th>
<th>Codes</th>
<th>Categories</th>
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</thead>
<tbody>
<tr>
<td>Getting Ready and Settling Down</td>
<td>Plan</td>
<td>Plan</td>
</tr>
<tr>
<td>Personal Examples</td>
<td>Directive/Statement of Desired Action</td>
<td>Directives</td>
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<td>Discussion</td>
<td>Teacher’s Questions</td>
<td>Questions</td>
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<td>Question and “Story Time”</td>
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CHAPTER 4

DESCRIPTIONS AND DISCUSSION

Overview

The purpose of this chapter is threefold. First, I will provide a description of each of the categories found in the collected data. Next, I will discuss my beliefs that were represented in the classroom, based on the categories. Lastly, I will discuss my research questions. My descriptions and answers to my research questions provide snapshots of my teaching practices and the means to understand the underlying beliefs found within my philosophy of teaching science to English Language Learners.

One aspect of my self-study involved examining my practice within the context of my science classroom. Specifically, this task was accomplished through video recording my teaching in my English Language Learners' biology classroom. Through the use of video, I was able to understand my teaching practices "as they are lived in practice with students" (Farren & Whitehead, 2005, p. 1).

The classroom observations only recorded me within the context of my teaching, what I have termed the teaching sessions. My analysis of the teaching sessions was generated through grounded theory methodology. In this type of research, the collected data is used to generate the theoretical framework and becomes the basis for understanding my teaching practices and the underlying beliefs that are found within that practice.

An initial step in my analysis process was a three-tiered code development system that resulted in the final categories described in this chapter (see Chapter 3 for
information on initial coding). The following list provides the seven categories that emerged from the data:

1. Lecture
2. Review
3. Examples
4. Questions
5. Directives
6. Plan
7. Playfulness

Description of Categories

Lecture

The lecture category consists of occurrences from the classroom observations when I was presenting new science material to my students. Through the collected data, this category is defined as a teacher, standing primarily in front of her classroom, introducing science concepts to her students. During this study, the students and I were engaged in a unit on heredity. Specifically, we were studying chromosomes, mitosis, fertilization, and meiosis. In each of my lectures, I used Power Point slides to highlight the content information I deemed important for students to know. They would copy this information into their science notebooks. The slides were also used to provide illustrations and models of the various concepts under investigation. (See Appendix C for an example of the Power Point lecture slides.)
From the transcription, the lecture generally followed after I had reviewed material covered in the previous class. Below is an example of a typical lecture found in the classroom observations:

Okay let’s keep going. We don’t have a lot of notes/ So chromosomes. So see I’ve got one, two, three, four, five different pictures of chromosomes. So chromosomes can come in various stages. [Gesture- expands her hands sideways.] Well this one. Here is our DNA. So chromosomes have different names... Before we go through mitosis, it is called chromatin. Chromatin. That is our loose [strands]. ... Chromosomes have two different names. One name is called chromatin. [Gestures to board with hand, to show the things she wants the students to copy down.] You have chromatin and chromatid. So chromosomes. We can call chromosomes, chromosomes. We can call chromosomes, chromatid. And we can call chromosomes, chromatin. (5/16/2008)

In the classroom observations, I would frequently stop lecturing to provide students with opportunities to ask questions about the science material. The unit on heredity is one of the most complex topics found in the biology curriculum. It contains many unfamiliar vocabulary words, and time is spent during my lecture repeating the topic-specific vocabulary words and allowing students an opportunity to practice using those words and the definitions associated with them. The following is an example from the transcripts of one such occurrence where I am pointing to the board discussing the difference between homozygous and heterozygous alleles:

Teacher: So alleles, if you are a big “B” and big “B” or little “b” and little “b,” we call you homozygous.

Student 3: Homo[zygous]?

Teacher: Hmmm. Homozygous.

Student 3: [Como?] Homozygous?

Teacher: Uh huh. Big “B”, big “B” or little “b”, little “b”.
Student 8: Homo-zy-gous. [Student is trying to sound the word out, phonetically.]

Teacher: Homozygous. See how they are the same. The same, the same. While heterozygous is one big and the other one is little. That is heterozygous. [Teacher is pointing to the screen, showing the difference between the two different types of alleles.] (5/27/2008)

During the lecture category, there were times when students' attention would waiver, and instead of interrupting the lecture, I used a simple classroom management technique, so as not to disrupt the flow of the lecture. “Okay last thing I want to talk about today is genotype. Genotype is when you write the letters of the alleles [Teacher taps on the desk of a student.] and phenotype is what you look like.” Instead of stopping my lecture and interrupting class, I walked over to the students and quietly tapped their desk. The students recognized this cue to stop talking and began to focus on the lecture.

From the classroom observations, my lectures became an opportunity to introduce students to science concepts. I would discuss the lectured material after I had reviewed the previously discussed material. It is interesting to note that the classroom observations were conducted during the lecture period of my daily classroom activities, yet the actual lecture only constitutes a small portion of the total teaching session.

Review

The review category is composed of occurrences where I discuss the science material that was previously discussed during the teaching session. Through the classroom observations, reviewing is used as a means of re-examining the science concepts before new material is introduced in class.
The following is an example of a review that occurred in the teaching session:

Okay here we go. So this is a review. Heredity. So you know this already. You guys know this already. Meiosis. In meiosis each parent gives parents half of its chromosomes to offspring. Okay. And the way that happens is/they form gametes. And remember gametes are sex cells. If you’re boy/ sperm, and if you’re a girl/ egg. (5/23/2008)

The review generally occurred before any new information is discussed in class. But there are a few instances when I lectured and then reviewed information from previous lectures. This type of review sequencing was employed to make connections between the new lecture material and the previously lectured science content.

So mitosis is controlled in the nucleus. Okay the nucleus, [Teacher points to image of nucleus on the board.] remember our nucleus. Small dark region we called it the brain of the cell. It holds these chromosomes. (5/16/2008)

In the transcriptions I found that I use two terms, “remember” and “yesterday” throughout the teaching sessions. I use these terms to remind students that the information has already been discussed in class. Thus, I expect them to listen and then be able to recall what was discussed the previous day. The following is a list that illustrates the terms used to help students recall the information:

1. Remember there are two types of reproduction. (5/19/2008)
2. We did this yesterday. (5/23/2008)
3. Remember when we did the babies and eye color/where’s eye color. (5/23/2008)

In the classroom observations, reviewing became a category that illustrated how I discuss the previously covered science material. The teaching in this category provides
students with an opportunity to re-examine the content presented in class, and my intent was to use the reviews as an opportunity to check their understanding of the material.

Examples

In the teaching sessions, the use of examples was found throughout the classroom observations. This category consisted of examples provided in class either by my students or by me. I have divided this category into two sections, teacher examples and student examples. Below is a description of both sub-categories.

Teacher examples. In the classroom observations, I would sometimes use my personal life as a backdrop for understanding science. I would use examples to provide a connection between science and the world in which they live through examples of my life. For example, a student asked if cells stop growing, and I provided the following narrative to illustrate my point:

We do stop growing. Okay. Usually people. [Student: I mean, but] Like I, personally, I've been the same height since I was in fifth grade. So in fifth grade, I was really tall. Okay. I was really tall. Boys we are like this. [Gesture: Puts hand up to shoulder to indicate a height.] Then what happened? In high school I stopped growing, but what happened to boys? They kept growing [Gesture: Raises hand over head to show growth.] and so I become short. Just like that. Nothing happened to me, but the people around me grew. So our cells do stop growing, and they do stop growing. (5/16/2008)

My examples became a means to help the students understand that science is not merely abstract theories, but is at work in the context of our own lives. For example, when I discussed how a fertilized egg has different combinations of chromosomes, I used my family as an example.

What I mean by different, they all have different chromosomes. You know how we got 46 chromosomes. They all have different pieces of those chromosomes. Okay. That's why you don't/ like I have a little sister and we look/ I don't think
we look that much alike. 'Kay. I look more like my dad, and she looks more like my mom. (5/19/2008)

Both of the previous teacher examples show the connection between science and the actual world, in this case my personal world. My stories also included using stories from the lives of my friends. The following example describes how complicated fertilization is and how couples, through the use of science, have found ways to have children.

Remember how I told you how my friends were trying to get pregnant, and they couldn't get pregnant... and they did the in vitro. Where they took the eggs out... got the sperm in a Petri dish, and they fertilize them. You can tell which sperm is "y" and which sperm is "x." So when they fertilize them, umm, eh Scott and Laura didn’t care if they had boys or girls. So they did half girls and half boys. ... She ended up having three. They implanted four eggs in her womb, but only three survived... fertilization is really complicated, and if one part of your body is a little off then that whole system gets off. It doesn’t work out as well....So it is not 100%. And actually when they did that invitro, this was their second try. They had already tried once and didn’t work. The eggs didn’t umm survive... Then they tried it again and it worked. I think she even... did shots to regulate her menstrual cycle. ... they tried to have... babies naturally. But it just didn’t work. And so this was their last try. (5/23/2008)

Besides using examples from my personal life, I also used examples found in popular culture, such as commercials. In reference to cells, particularly how brain cells do not reproduce, I commented:

You've seen those commercials with the frying pan and they crack the eggs... "this is your brain on drugs." Because once you kill your brain cells, they're gone.

All of the examples are meant to make science relevant to my students’ lives. For some students, science is viewed as abstract and disconnected from their own reality (Brown, 2006), but by using personal examples, my intention was to make a connection between science and the real world.
Student examples. Students discussed their understanding of science by making a connection between their understanding of science and the examples found in their own lives. This category occurred throughout the teaching session and illustrated their ability to make these connections. When we were discussing heredity, particularly fertilization, one of my students described what he saw on a televised science program in relation to what we were discussing in class:

Student 10: Cause I heard…from [the] TV program, … (5/23/2008)

Students would also provide examples of what occurred in their own lives. For instance, when we were discussing how obstetricians make mistakes when identifying the sex of a child in the womb, one student commented that this had occurred in her family:

Student 8: Same with my mom. All nine months, it’s [a] boy, but when I came out it’s like a girl. (5/23/2008)

This also occurred when we were discussing how traits are passed down from parent to child. Two different students made comments about their family and eye color:

1. Student 4: … I have a cousin and she has green eyes and her parents have… brown eyes. (5/29/2008)

2. Student 1: … My sister and dad and mom have brown eyes and I have hazel. (5/29/2008)

Students also shared their own experience with science in their lives. In this particular example, two students discussed how they raised tadpoles in their back yard.

Student 1: …. His [referring to his classmate] little brother and me/we put um like mud/it’s like mud from a lake [teacher: uh-huh] and these seed like grass in the lake you know and water and like/we made little tadpoles/and then just threw them away and we couldn’t [take them home]…Like we made these little ones threw them away like/they were a lot of little tadpoles.

Teacher: Were they alive or dead?
Student 1: Yeah alive.

Teacher: And like you like literally threw them garbage away or you threw them [away.]

Student 5: No, the lake. [Teacher: Oh okay] We created them.

Teacher: Wow, that's pretty cool.

Student 1: Like you need a leaf or [?] like a few days, and they start growing.

Teacher: Were did you get the mud?

Student 5: This one creek by my house.

Student 1: You know the creek that goes by Adams [local grocery store]


Student 1: I didn’t know it was going to work, but like/his little brother had a book of science.

Teacher: And that was from the book?

Student 1: Yeah...It was way cool.

Student 5: Down in Mexico [there’s lots of tadpoles].

Teacher: Tons of little tadpoles.

Student 1: I don’t know how we created them. But like they somehow...

Teacher: They were probably/ the eggs/probably eggs were in the mud you picked up.

Student 5: The sand.

Teacher: Er the sand. [So they might] eggs were already there, and you just gave them enough light, heat, water, and let them grow.

Student 1: We took water from like the house you know/put in there and put some mud like and grass and stuff and [layered]. We didn’t think it was going to work. And like if this doesn’t work, throw it away [and start over]. (5/19/2008)
These two students discussed their experience with science using terms from their own everyday language and they also described this event not as an outsider, but as people actively engaged in science outside of the classroom. From these examples, students made connections between the science content and their own experiences. They expressed their knowledge through sharing their stories and examples. Often the flow of discussion would begin when I provided an example and they would respond with their own, creating rich discussions of how science was connected to their everyday life. At times, our class would move away from being teacher-centered, to being more a group of equals sharing their knowledge of the science through storytelling. We became a community of learners, sharing and expressing our ideas.

Questions

From the classroom observation, I found questions, asked by my students or me, occurred throughout the teaching session. This happened so often that these questions became a category. The type of questions found within this category revolve around clarifying the lecture material, confirming students' knowledge of science, reviewing the previous material, and checking their understanding of what was discussed in class. I have divided the question category into three sub-categories: clarification questions, confirmation questions, and recall questions. The questions are found throughout the teaching session and are meant to enrich the discussion and students' learning of the science material.

Clarification questions. The clarification category consists of instances when the information was clarified and further explained to students. Questions were generated and
asked during the lecture or when we were reviewing the previous material. I used this as an opportunity to describe in further detail the science content under investigation as illustrated in the following example.

Student 10: What does that little blue thing called?

Teacher: The little blue thing is called chromosomes. The chromosomes are found inside the nucleus. (5/16/2008)

I also tried to clarify any issues that emerged during the teaching session.

Students’ questions arose from the science content itself or from other problems they might have had about school procedures or their personal life. The following is an example of a student asking questions about fertilization:

Student 9: Okay, how could it fertilize like that, but not inside? It is still going to be the same cause you put the sperm in there, how come...

Teacher: Oo, because they’re probably there fertilization is really complicated, and if one part of your body is a little off then that whole system gets off. It doesn’t work out as well. (5/23/2008)

The students also asked questions about school policies and procedures. The teaching session involved spending time in class answering those questions.

Student 7: Are we/When [is] our semester schedule test?

Teacher: No. You will not have a semester final. What you will have/ [Student: Thank God.] heredity will be your final. We are going to talk about hopefully this week.

Student 7: But what when/ when our test?

Teacher: When our test? Our test...

Student 7: Not next week.
Teacher: No. No. No. It is either/ I think you guys are on Wednesday. June 5\textsuperscript{th}.

(5/19/2008)

As mentioned previously in the Examples category, the students provided examples and asked questions based on their examples. The following represents a student’s embedded clarification question found within her example:

Student 8: Okay, Ms. Magee those little spermy thingy. They are not wiggley?

Teacher: They are not wiggley?

Student 8: No, they’re just like white. (5/23/2008)

The students also discussed their personal lives, and based on what they said I would ask questions regarding their experiences. They clarified their previous comments by providing more details about what had occurred in their lives.

Teacher: So trait is a type of characteristic that is passed down. And when I say passed down that means from parent to child. [Teacher waits and goes to her gradebook to look at something, and students are talking waiting for others to finish.]

Student 6: Ms. Magee [I think I am not going to have kids]

Teacher: You think you are? You’re not going to? Let me know.

Student 6: I am not going to have anything?

Teacher: You are not going to be married?

Student 6: I’m not going to get married. Oh my God, I am so scared. I’m not going to have kids. And I’m not going to have sex. (5/23/2008)

The students also helped their fellow peers, clarifying any problems they might have with the science material in class. For example, when they were describing a person who is a monk, students made comments to help their fellow students understand:
Teacher: Okay so. Mendel/Mendel he was a monk. What's a monk? [Student: monk?] A monk.

Student 10: It's on TV. He does stupid things. [He's referring to the TV show, Monk.]

Teacher: Uhhh different type of monk. Not the TV show, Monk.

Student 1: A monkey. A science.

Teacher: Like a church.

Student 9: Oh the monk.

Teacher: The monks like priest. [Student: And they can't cuss.] They wear the big brown robes. They don't swear. They...

Student 7: They love animals/little crickets and stuff. They don't get married. They don't like girls.

Teacher: Exactly. So Mendel was a monk and he was also a gardener... (5/27/2008)

In the classroom observations, student clarification did not occur as frequent as did my clarifications. Nevertheless, their questions helped to ascertain what they did not understand in class, and my intentions in using clarification questions was as a tool to help them comprehend the science content.

Confirmation questions. This sub-category consists of questions made by either my students or myself that confirmed the other’s responses. Students asked different types of confirmation questions concerning the various topics: the science content, classroom activities, and school procedures.
Students would check their understanding of the material through asking questions:

Teacher: They broke down just one part of the chromosomes to show that it is DNA.

Student 13: Chromosomes are DNA?

Student 12: That’s how they find out?

Teacher: Chromosomes are DNA. That’s how the whole my baby’s daddy. [Gestures to the board, touching the screen.] This is how you find out.

Student 12: That’s Mom and Dad right there?

Teacher: [Nodding her head.] That’s Mom and Dad right there... (5/16/2008)

In the example above, students are confirming that chromosomes consist of DNA, but also that DNA comes from our parents, and how doctors check for the paternity of children, “...that’s how the whole my baby’s daddy” (5/16/2008), a topic found in many different television talk shows. Students also checked their understanding of any specific details that are brought forth from the lecture. In the following example, two students are determining the correct number of chromosomes a person has to have in order to be considered a normal human being:

Student 10: So you have to [have] 44 [chromosomes]?

Teacher: You got to have 46.

Student 10: 46?

Student 13: Normal?

Teacher: 46 to be quote unquote normal. (5/16/2008)
Both of these confirming questions are examples that illustrate their understanding of heredity and its connection to real life situations.

As discussed previously in the example category, students also asked confirming questions to check their understanding of the connection between science and their world.

Student 10: Yea, Cause I heard/like/ from like TV program, that/ that most of the girls/ I mean it’s the father and [and not the mother].

Teacher: Yea, it is the sperm. (5/23/2008)

Students also asked confirming questions about the activities that occurred within the teaching session. What follows is an example that involved examining the various parts of a chromosome. I had asked students to draw, in their science notebook, the picture on the board.

Teacher: ...And we are going call it the centromere. It is what we are going to focus on. Draw a picture of it. It doesn’t have to be pretty.

Student 1: Draw it?

Teacher: Yeah. Draw your picture of a chromosome. (5/16/2008)

And finally, confirmation questions occurred when the students did not understand school procedures that affected their academic world.

Student 10: This is for our final. Ms. Magee, isn’t this for our final?

Teacher: Yes. This is our last thing to talk about. This is your final stuff. So heredity yes/that’s the title of this? Heredity.

Student 6: This is going to be our final?

Across the transcriptions, I also asked students confirmation questions when I did not understand their questions. For example:

Student 4: No I mean. But/when is/the cell is like/When the cell is inside a baby?
Teacher: Oh. How does it know to be a boy or how does it know to be a girl?
Student 4: Yeah. (5/23/2008)

In my ELL class, there also were moments when I asked confirmation questions because of the language differences found between my students and me. In the following, a student provided an example of a trait and I asked a confirming question:

Student 13: Color hair
Teacher: You want to put hair color? [Student: Yep.] Give me one more.
(5/23/2008)

In this example, I re-stated her answer in the grammatically correct form in English as a way to check my understanding of what she had said and as a way to indirectly model the correct way to say it in English. The confirmation category included ways in which my students or I confirmed our knowledge of the science topic and science activities, confirmed procedural knowledge, and confirmed the meaning of language used.

Recall questions. In the transcription, the recall questions are used to help students remember the previous information taught in class. The questions involve students responding in one- or two-word answers, demonstrating their understanding of the science material.
Following is a list of the different recall questions asked throughout the teaching sessions:

1. Yesterday we talked about cell division. What’s happening to these cells? (5/16/2008)

2. Also yesterday I talked about how these cells, we call the original cell the parent cell and then once it splits they become, we call them the daughter cells. You have the parent cells and the daughter cells. The parent cells is the original and the daughter cells is what? (5/16/2008)

3. Remember there are two types of reproduction. There is asexual, and there is sexual. What type do humans go through? (5/19/2008)

4. Okay we have different types of cells. We have somatic cells. And they deal with mitosis. And then gametes. Quick, what are gametes? (5/19/2008)

5. When I say traits, what sort of things get passed down from child, parent to child? (5/23/2008)

My recall questions were part of the review phase and asked before any new information was discussed in class. I have designed the curriculum so that new material builds upon previously learned material. The following are three examples of recall questions that were designed to help students remember the information previously taught in class:

1. Then what happened… You know what I am talking about? (5/16/2008)

2. Now remember mitosis/ remember mitosis. What were the steps called?

Remember that little saying that we had of the steps? (5/19/2008)
3. Yeah. But these things are super small. They are microscopic. 'Kay/ Can you imagine this little tiny thing traveling seven inches? (5/23/2008)

The third question from the list above was a prompt that required more creative and critical thought for the responses. Most of the recall questions required responses with a known right or wrong answer. Nevertheless, all my recall questions were meant as a tool for reviewing the information and for checking students' understanding of the science material before proceeding with the new material.

Directives

The directive category consists of statements made by my students or by me in order to explain the various tasks or actions we wanted each other to perform during the teaching sessions. Different types of directives occurred in class, ranging from students stating their need for classroom materials to the teacher giving directives for the purpose of obtaining students' attention during the lecture. In the transcriptions, these directives occurred primarily in the beginning of a teaching session, but were also found scattered throughout the session.

The classroom observations revealed that, as their teacher, I used directives in my teaching more often than the students used directives for their own purposes. I used the directive statements in three different ways: managing classroom behavior, teaching the science content, and planning the various activities that occurred in class. These directives described the desired behavior and/or actions that I wanted to occur during the teaching sessions. These directives were important because these explicit statements allowed students to clearly understand what I expected of them. But more importantly, it
revealed to me an aspect of my teaching where the directives for managing, for teaching, and for planning suggested my need and interest in the organization of my science classroom.

**Managing students’ behavior directives.** One of the ways I used directives was for managing students’ behavior in class. These occurred primarily in the beginning of a teaching session in order to initiate student note-taking in class. The following are examples of the ways I would manage student behavior, the first three being direct imperatives:

1. Take out your notes... (5/16/2008)
2. Hurry up. (5/19/2008)
3. Have a seat... (5/29/2008)

These statements I made to students were direct and conveyed that I wanted to begin the teaching session, and their own behavior needed to reflect my urgency in beginning the class activities.

I also used the managing directives to maintain students’ focus during the lecture. For instance:

1. Mary wake up come on, come on, come on. (5/29/2008)
2. Okay, so now we need to stop talking. (5/16/2008)
3. Maybe you should write this down. (5/23/2008)
These directives were used to keep the students’ attention focused on the lecture notes. What follows are examples of managing directive statements that were stated in the form of questions.

1. Jorge, are you ready? (5/16/2008)

The managing behavior directives were stated as questions that did not necessarily warrant an answer. These pseudo-questions were used as a means of directing the students’ attention back to the lecture and away from their off-task behavior that I found unacceptable during class at that time. My questioning was used to let students know that I wanted them to discontinue their behavior and focus on taking notes.

Teaching directives. In the transcription, directives were also used as a form of teaching, specifically directing students’ attention to the science content found in their lecture notes. My instructions involved asking them to perform a specific activity using the notes as a means to more closely examine the science material under investigation. For instance, I would say to them:

1. Draw a picture of a chromosome... label the dot centromere. (5/16/2008)
2. Let’s do some more punnett squares and I’ll show you what I mean... (5/29/2008)

I used teaching directives to help students better understand the content being taught through their note taking.

Planning directives. The planning directives were used to provide students with an explicit statement of expectations. These planning directives were often embedded within the larger plan category (see below) where I would outline the planned activities.
scheduled for that day. I spent time during the teaching sessions clearly describing what I wanted them to accomplish during my lectures and explicitly stated when I wanted these activities to be completed:

1. You are going to finish the coloring... and then you are going to answer questions based on your coloring. (5/16/2008)

2. So I have two things I want you to work on (plan)... Venn diagram and the questions on the front (directive)... then (plan) I want you to look at this transparency (directive). (5/19/2008)

In the examples above, I spent time telling the students what I wanted them to do and when I wanted them to do it.

My students also used directives to describe the action they wanted me to perform in class. Their solicitations were a way of stating their needs and managing their teacher by trying to plan the class activities. The needs of my students varied and changed depending on the context of the situation. Their directives did not occur as often during the teaching session, but were still significant in terms of expressing their needs to me, their teacher. Sometimes they simply asked for classroom materials, for instance, “Hey Ms. Magee I need a pencil.” At other times their needs corresponded to my teaching of the science material. In the following example, I told students to draw a picture of a chromosome (as a directive) and a student responded with a directive informing me that he needed more time to complete his drawing:

Teacher: Yeah. Draw your picture of a chromosome. It is pretty much an “x” with a dot in the middle. Yes a “x” with a dot in the middle of it. And that /Label that dot centromere. Label the dot centromere....
Student 1: Hey what - I am not done with the picture.

Teacher: You have five seconds. [Teacher starts a silent countdown with her fingers.] Ding.

Student 1: Seriously, seriously hold on. [Teacher pauses until the student is done with his drawing.] (5/16/2008)

In this example, the student directive indicated that he could not keep up with my pace during the lecture. He was providing me with the necessary information that would help him to be more successful in class by expressing his need for more time to complete the task.

My students also made directive statements as a means of planning the actions of their teacher. They explicitly stated such management by telling me what they wanted me to do and when it needed to be accomplished. The following are two examples that illustrate their handling of their teacher:

1. Student 7: Okay let's keep going. (5/16/2008)


Management directives also occurred during the class discussion, particularly when I was using a personal example to illustrate the connection between science and the real world. This form of management could possibly indicate students' boredom with the material or my discussion of that lecture topic, as they were trying to redirect my attention to continue the lecture. Also some students may feel uncomfortable with personal disclosure (Diller & Moule, 2005). The students' use of management directives could indicate their embarrassment for their teacher, particularly when I discussed my personal life, something that many of their teachers do not do while they are lecturing to
their students. Such discussion in the classroom of a teacher’s personal life may not fit the students’ expectations of the role of a teacher. In either case, it is easier to request that I finish the lecture, rather than discuss my personal life and how it relates to science.

Plan

In the plan category, I describe the activities that will occur during the class period. This category is associated with time and the sequencing of each activity in class. In the classroom observation, I would plan the activities according to the amount of time we would spend on each activity: “We are going to talk a little bit, then like six, seven minutes, and then we’ll finish the babies and then we’ll be through for the day.” The difference between this category of plan and the sub-category of Planning Directives is in the manner in which it is presented and the intent behind that presentation. In the Planning Directive, I provided specific declarative statements to students regarding a specific task with the intent of them completing that task within that time frame. In a sense, the Directive Planning is really an order to perform. The plan category is broader in nature and encompasses the events of an entire class period with the intent of providing an overview, a foreshadowing of the activities for the day. Embedded within this overview is an outline that can be shaped and changed as the events occur in class.

My outlining of the events occurred primarily in the beginning of each teaching session, but was also found throughout the teaching session.

Okay so today/ today, today, today we are going to um review our notes, from what we did yesterday. And what I mean by review we are going to talk through it. You are going to finish up the coloring if you have not already finished and then you are going to answer questions based on your coloring. (5/16/2008)
The activities were stated in chronological order and explicitly described the events for that class period. These plans also included time expressions that made references to the previously lectured science material, to the present science content under investigation, and to the future science curriculum activities. For example, in the transcription when I referred to the past I said:

1. We already had notes on this... (5/19/2008)

2. You see yesterday. (5/16/2008)

The plans I made in the present moment were used to discuss what I expected from the students. This category is similar to the directive category discussed previously, and there is overlap between the two. In the transcriptions, present directives were embedded within the plans. I stated to my students when I wanted them to engage in an activity and what I expected them to do. In what follows are two examples of my plans:

1. Like I said I want you guys just to listen (directive). And then when we are through I’ll go back and you can take notes (plan)... (5/16/2008)

2. So I have two things I want you to work on (plan)... Then (plan) I want you to look at this transparency (directive). (5/19/2008)

When I spoke of future plans, I described to the students what would occur in the classroom for the class period. The future plans described the activities students would do for the rest of the day, week, or the school year and below are three examples of those future plans:

1. Teacher: ...And we are going to talk more about genetics. After we finish mitosis, we’ll talk more about genetics. (5/16/2008)

2. Teacher: ...I wanted us to go the computer lab on Wednesday. Tomorrow. But we’re not, I want us to at least get through mitosis....We’ll go on Friday. (5/16/2008)
3. Teacher: Yeah. I want to push it up, because I want us to get to Heredity. And heredity is the really is/really interesting fun stuff. And I want to make sure we have enough time to do all heredity stuff, before the end of the year. Because we are almost out of time. (5/19/2008) Most of my plans were expressed orally, but I also wrote them on the white board at the front of the room. Unfortunately, due to lack of physical space, these notes were written in a form of shorthand that were used more as a tool to remind me of the previous classroom activities and less as an aid to inform students of my plans for their class. Nevertheless, the plan category represents interactions in my classroom that were used as a constant reminder of where we currently are, where we had been, and where I planned to go in the course of the semester.

Playfulness

The playfulness category is composed of moments when laughter occurred in the classroom observation. Both my students and I made jokes about a variety of things, but our jokes typically concerned the science topic addressed in class.

Teacher: Mitosis. Not your “toe-sis”

Student 7: I said your “toe-sis” my-toe-sis.

Teacher: My-toe-sis not your- toe-sis. Ha-ah. [Students and teacher laugh.] (5/16/2008)

From the transcriptions, the data showed that I used jokes as a means of capturing the attention of students and of getting them excited about learning heredity. For instance, in this unit, one of the science activities involved flipping a coin to determine the traits of a baby and then drawing a picture based on those obtained traits.

Teacher: [Laughs at student’s joke.]...After we finish mitosis, we’ll talk more about genetics. Genetics is fun. We will make babies in here.
Students [All at once.]: How ya goin’ to make babies? We’re going to make babies. How are we going to make babies? [Laugh.]

Teacher: They’re not real.

Students: [All laugh.] [More discussion on how to make babies.](5/16/2008)

This was how I introduced the topic of genetics, and many of my students made comments about it, so much so that it was difficult to transcribe the video because students were speaking all at once, expressing their interest in this topic.

My students also expressed their sense of humor in class. Most of their jokes were about the science material. The following are two examples of jokes students told in class:

1. Student 10: Man that was like two hours in the video, you need like tiny microscopes. [Teacher and students laugh at his joke.](5/19/2008)

2. Student 4: Eh, so umm my sperm looks like me, kinda of... [All laugh.] Cause you know how the boys look like their dad. (5/23/2008)

The two examples above illustrated students’ comfort level in discussing serious matters in a joke-telling way. These examples demonstrated how students stayed on task in the discussion, while at the same time being creative with how they expressed their understanding of science with humor. These examples also reflected the climate of the classroom, where students felt comfortable expressing themselves to others.

There were only two moments when the jokes were made at another person’s expense. This occurred while we were discussing how many chromosomes a Downs Syndrome person has in their genetic makeup.

Student 7: Lisa got like 100 [chromosomes].
Teacher: Oh Mary.

Student 7: Lisa started it. Okay let's keep going.

The other occurrence was made at my expense, making fun of my routine of answering any of the students’ questions put forth; the student used that knowledge at my expense:

Student 11: What's etcetera?

Teacher: It means...

Student 11: I know. [Students and teacher laugh at her joke.] (5/16/2008)

In this instance, when the student asked “What’s etcetera?” she was aware of the value I placed on addressing all students’ question as valid and real. She found this joke to be funny, because to her the answer to this question was obvious. And yet she knew, that even though it appeared obvious, I would still answer it. Even though this joke was at my expense, the overall tone of the interaction was playful and not intended to be hurtful. This was another example of the classroom environment where the student felt comfortable enough to engage in a playful interaction with the teacher.

Research Questions and Discussion

In this self-study, I observed my science classroom by videotaping my teaching. These observations provided the means of examining my practice and developing an understanding of my actions in the classroom and my interaction with students. This study was guided by the following research questions:

1. What are my underlying beliefs about teaching science to students and how are they expressed in the classroom?
2. What is the third space created in my classroom?

In this section, I will answer each question and follow with a discussion of each of those questions.

Research Question #1: What Are My Underlying Beliefs about Teaching Science to Students and How Are They Expressed in the Classroom?

My beliefs were derived from the categories developed from the collected data from my classroom observations (See Table 2). From the data, four different beliefs emerged and I stated each of them using Rokeach's (1973) "I believe..." (p. 2) format:

1. I believe I need to be highly organized in my science classroom.

2. I believe all students can learn science.

3. I believe I need to make science relevant to my students.

4. I believe in building a positive relationship with my students.

My beliefs illustrate what I found important, which becomes the framework for how science was taught in my classroom. These beliefs also provided a snapshot of my teaching in a science classroom populated with ELL students.
Table 2

Beliefs and Categories

<table>
<thead>
<tr>
<th>Beliefs</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe I need to be highly organized in</td>
<td>Plan</td>
</tr>
<tr>
<td>my science classroom.</td>
<td>Directive</td>
</tr>
<tr>
<td>I believe all students can learn science.</td>
<td>Lecture</td>
</tr>
<tr>
<td></td>
<td>Questions</td>
</tr>
<tr>
<td>I believe I need to make science relevant to</td>
<td>Examples</td>
</tr>
<tr>
<td>my students.</td>
<td></td>
</tr>
<tr>
<td>I believe in building a positive relationship</td>
<td>Playfulness</td>
</tr>
<tr>
<td>with my students.</td>
<td></td>
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I believe I need to be highly organized: As a science teacher, I was responsible for many different activities that occurred during a class period. For instance, I was held accountable for presenting the science content to my students, assessing their learning of that content, answering any questions posed, helping them conduct laboratory activities, and performing the administrative duties. All of these needed to be completed in a forty-nine minute class period.

My organization skills are seen within the Plan category and the Directives category. The collected data found in the Plan category and the Directive sub-category planning represent how I organized the class period and how I expressed my plans to my
students. My outlining of the events occurred primarily in the beginning of each teaching session, but can also be found throughout the lecture. The activities were provided in chronological order and explicitly stated what the students were going to do for that class period. Most of my plans were expressed orally, but I did write them down on the white board at the front of the room.

It was clear in the way I used directives that I found order an important aspect of my organization. While the planning provided the framework for the lessons themselves, it could be argued that the management of students' behaviors organized students' actions through re-direction, while the teaching directives served organization in that it provided clear guidance for the activities students completed during the teaching sessions. The directive category in general reflected my need to control students' actions to maintain classroom order.

I believe all students can learn science. In my science classroom, I provided multiple opportunities for students to learn science. In the science curriculum, students listened and participated in the teaching session. This belief was illustrated in the lecture and questions categories. In the lecture category, whenever I presented new information to students I explained the concept in a variety of ways. I also provided multiple visual representations of the concept in the Power Point slides. For example, when I was explaining the difference between homogenous and heterogeneous and how they were seen in the traits of an organism, I used the Power Point slides to visually illustrate the concept's meaning. In the question category, the clarification and confirmation questions were used to help students understand science. In the ELL class, I found I spent time
answering questions students had about the material. Their questions helped to illustrate their understanding and also their confusions. A tenet that emerged from the questioning data was the value I placed on student questioning in the classroom. For me, all of their questions had value and required a sincere and honest answer from me.

Part of the evidence of my belief that everyone can learn science is the manner in which I make science accessible to students. My curriculum contained different activities that provided multiple ways for students to learn the information and be successful in class. My lesson plans revealed that the ELL classroom was rich in activities. Students completed worksheets independently, with partners, and in groups; they conducted labs, such as a guided inquiry into the different traits found in the classroom and a lab activity that used a flipped coin to determine traits; and they took oral quizzes and oral exams. But students also had traditional paper and pencil scantron tests, and completed research projects involving research in the library culminating with a presentation. Another aspect of this access to success for my students was weighting the value of the assignments equally.

I believe I need to make science relevant to students. Science has a reputation for being irrelevant to our everyday lives because of the various abstract theories and formulas found in science. One of the responsibilities of being a science teacher is to illustrate to students how science is not only an important aspect of our society, but can also be used as a way to solve problems found in our environment. Thus, I believe science teachers need to make science relevant to their students. In the classroom observations, this belief is most richly expressed through the example category.
At times, the examples were used as a forum to illustrate how science was not limited to abstract theories that exist in a vacuum, but are found within the context of their own lives. For example, when I discussed how a fertilized egg has different combinations of chromosomes, I used my family as an example, demonstrating the connection between science and my own life. In the example category I also described how complicated fertilization was and how couples, through the use of science, have found ways to have children.

The use of my own personal stories happened again and again in my teaching. I often would ground the explanation of a scientific phenomenon within the context of daily living, especially daily living that would mean something to my students. These personal examples that I shared used my own life as a way that modeled for my students how to make the connection of science with the personal – how one’s own life is embedded in science and is integral to who they are and what they do.

All of the examples were used as a means of making science relevant to my students’ lives. I felt they needed to see the purpose of science and its importance in a society. Sometimes science is viewed as abstract, disconnected from what really occurs in people’s lives. By using personal examples, however, I was making the connection between science and their everyday experiences found inside and outside of the classroom.

I believe in building a positive relationship with my students. In the classroom observations, I found my actions often led to building relationships with my students by finding out about their lives, not just their lives in relation to science but also their lives
as human beings. This belief emerged in the way I interacted with students. For instance, I valued the importance of relating to students on a personal level through observing the students’ behaviors in class. I noticed when they were not participating in class, if they were sick, or even when they were dressed well, as expressed in the following three examples:

1. Teacher: Liza, you are not going to be with us today? (5/19/2008)
2. Teacher: Do you need to go to the restroom? (5/23/2008)
3. Teacher: Don’t you look snazzy. (5/16/2008)

I also discussed with my students issues or problems that were occurring in the community. In my teaching, the class interactions showed that I would take the time from the planned curriculum to discuss problems that occurred outside of the classroom. In the following example, we had a discussion of the tornado that came very close to our town.

Student 8: Did you see the tornado?

Teacher: I did not see the tornado. Did you see the tornado? Do you guys know Mr. Smith?

Students (All in agreement): Yea. (5/23/2008)

Teacher: ... He drove in right after it hit and he said the town/ the town was all messed up and then there was nobody around and slowly people started to get out of their houses and he said it was scary freaky like/ a zombie like.

Student 1: They said like 5 people died or something.

Student 10: No 7 people died.

Teacher: Yeah, which was/I mean/ pretty low fatalities/which was good/ it was too bad that those 7 people died.
Student: Did you hear on the news/about that/how there was/there was a car accident/and then um there like were two girls in the car and one died and like she was somewhere in the ditch and like these people came to get her?

Teacher: You can be sucked up by the tornado or the debris...you’ll have to worry about the tornado but also the desks are flying around, the computers, books, chairs/all these things flying around could hit you.

Student 6: They say it was by the airport.

Teacher: Yea. It was north of Waterloo.

Student 10: Yeah it was close to my house.

Our conversations about the community played an important part in creating a positive relationship between the students and the teacher. These conversations about the community enabled students to connect their lives outside with the classroom community. This seems to enable students, as members of the class community, to feel comfortable in speaking their thoughts. These moments in class, when we brought in events from outside the curriculum, created a context for students to speak about what they knew and what they have experienced. Such conversations helped establish an environment for sharing that often led to students discussing ideas, expressing their humor, and talking with each other and with the teacher in a more familial manner. In examining these interactions across my teaching sessions, this speaking to each other is with warmth and with a sense of being connected together through this class and through their experiences in the class. It is this familial way of speaking, this comfort level of the students, that seems to enable them to feel comfortable with expressing their ideas. This is also realized in the way in which they addressed their understanding of the concepts of science through their own expressions of meaning.
Discussion of My Beliefs

When I began my self-study journey, my beliefs were based upon my past experience teaching science to culturally diverse students. I believed it was important to use my students’ cultural background as the basis for my teaching. I designed my curriculum to encompass aspects of their world. My analogies, metaphors, and examples were developed from their cultural background and then incorporated into the science curriculum. Developing a culturally relevant science curriculum was a value that I held dear to my heart (Ting-Toomey & Chung, 2005), so much so that I made a serious effort to understand the culture of my students. According to Lee and Fradd (1998), developing an understanding of my students’ culture is a means of creating an instructionally congruent classroom. They defined this type of teaching as “the process of mediating the nature of academic content with students’ language and cultural experiences to make such content [science] accessible, meaningful, and relevant” (p. 12). My use of culture was an important aspect of my teaching in Los Angeles. I believed this approach was valuable, and I felt successful in my teaching of science.

My beliefs about teaching science were also influenced and shaped by my experience with the inquiry method. I began my career in science education at a science museum, where using inquiry was a job requirement. I witnessed how excited and interested visitors became whenever they experienced science through the inquiry process. My belief in the power of the inquiry method became even stronger during my practicum. I observed Mrs. Baker’s students in the midst of an inquiry project. Thus, when I began teaching science to students in Los Angeles, I felt equipped to help all of my
students learn science. During my tenure in California, I found that my beliefs about teaching science were constantly reinforced in my science classroom.

When I moved from Los Angeles to Iowa, I held onto the ways I had actualized my beliefs in a science classroom, disregarding the change in my teaching situation. I was now teaching science in an ELL classroom, where my new students came from a variety of cultural and linguistic backgrounds. My frustration with my new situation and my inability to reach my students gave me impetus to find an alternative method of teaching science to ELL students. My self-study has provided a means of exploring my beliefs about science education and how they have developed to incorporate this current teaching situation.

Research Question #2: What is the Third Space Created in My Science Classroom?

Originally, I interpreted the third space as a combination of the students’ world and the world of science (see Figure 1). My role, as their teacher, was to create a bridge between my students and their understanding of science. The concept of the third space became one of the ways teachers educated their culturally diverse students through a bridging of these two worlds (Bhabha, 1994; Moje et al., 2001; Wallace, 2004). Moje et al. (2001) found teachers could create the third space by having students’ knowledge of science and their everyday discourse inform one another. My students and my own everyday experiences were used as a means of exploring their understanding of science. This was accomplished through providing students with examples of science not only in everyday terms, but also through how it was found in everyday experiences. This connection to everyday experiences occurred when I discussed how infertile couples used
science to successfully have a child. And it also occurred when I referenced popular
culture, specifically commercials (e.g., “this is your brain on drugs”), and cell renewal.

According to Wallace (2004), the third space can also occur when students’
language is accepted during the class discussion, regardless of accuracy of the terms they
use to describe science. When we were discussing mitosis, the process of cell division, a
student confused the term cell growth for cell multiplication. I did not correct his mistake,
but rather repeated his statement and then stated: “They do stop reproducing” as a way to
imply that growing and reproducing did not have the same meaning. I addressed the
specific differences found between growth and multiplication, at the same time accepting
the student’s hybrid meaning in the classroom discussion.

The literature regarding the third space was concerned with creating a connection
between students and science (Moje et al., 2001; Wallace, 2004), but what I found
through my self-study is that the teacher influenced the creation of the third space. In my
research, I found I was responsible for creating the bridge between my students and
science; but also I was responsible for participating in the creation of the actual third
space. I had a played a role, a pivotal place in the actual third space.

The world of the teacher became an important aspect of the third space. This
world is composed of my experience with science in terms of having exposure in this
field. It includes my interest in science and the continuation of my own education in the
field of science. The teacher’s world also contains the beliefs held by the individual and
how these beliefs emerge through that individual’s actions in the classroom and in
interactions with students.
My new image of the third space incorporates the world of the teacher. It becomes a combination of all three worlds (see Figure 2). The world of the students, the world of science, and the world of their teacher all combine to create the third space. This new depiction illustrates the complexities found within a science classroom. Students have a relationship with science and with their teacher, while I, as their teacher, have a connection with science and my students. Students also have a relationship with science without their teacher, and I have an association with science without my students. Yet when all three combine it creates the third space.

Figure 2: The Modified Third Space
My first visual representation of the third space (see Figure 1) was developed when I began the process of writing my life history. At that time, I believed there was a disconnection between my students and science. My responsibility as their teacher was to help connect them to science. Students needed to be pushed, pulled, and even dragged into the world of science. I became the person who did the pushing, pulling, and dragging in the science classroom. I created the bridge, and once students crossed over, we together would learn science. But from my classroom observations, I found students had their own connection with science that did not include me. For example, two students began class by sharing a story of how they raised tadpoles in their backyard. They did this because their little brother had a book about it and they were curious to try it.

These two students offered this story without any encouragement from me, their teacher. All I did was listen to their story, and show interest in their after school activity. In fact, I tried to listen whenever students had something to share that dealt with science. I tried to create a classroom that provided students with opportunities to express their knowledge of science, enriching the overall understanding of science and creating the third space.

The modified third space also becomes a negotiation of meaning among the three areas. It is not unidirectional, which the bridge metaphor implies, but rather the teacher, student, and the meaning of science all come together. An aspect of the complexity of this triadic relationship is the value the scientific community places on having a right or wrong answer. The negotiation of scientific concepts is not a fluid symbiotic relationship. Students cannot make up their own definitions of the meaning of science, but teachers
and students can co-construct their understanding of science. This negotiation focuses on what is known and what is misunderstood. The reframing in this process helps confirm the known and unknown, and helps the teacher in making decisions for instruction.

Discussion of the Third Space: Self-Disclosure

In my classroom observations, I provided students with many different examples that illustrated the connection between science and our everyday world. Self-disclosure was an important facet of my teaching. My stories were used to help students understand the relevance of science and also provided grounding to the vocabulary found in the unit under investigation.

In Los Angeles, I did not use my personal life as a way to enhance the curriculum, and the culture of my students became the connecting piece. Yet in Iowa, working in an ELL classroom that contained a myriad of cultures and first languages, I could not incorporate the various cultures of my students into the class lessons in any cohesive manner. Initially, this inability to incorporate their cultures into any teaching seemed a problem in my ability to reach students. My solution to this problem was to use my own life and its connection with science as a medium to help students connect with and understand science. This process was accomplished by telling stories of how science impacted my own personal life. My sharing of my world became a bridge I used to help students understand science and its importance in our society. None of my stories made reference to my students' cultures, and yet these personal real life scenarios were successful in teaching science concepts. When I began to share my life and its connection with science, I provided my students with a common experience, albeit through my own
experiences with science. Even though some of the students resisted my sharing of personal stories initially (expressed when students tried to manage their teacher), my self-disclosure created groundwork of commonalities for my students. They could use my experience to leverage their own understanding of science. Through my personal stories, I also provided students with a discourse style to model. From these shared experiences, students began disclosing aspects of their lives and their own connections to science. Given the model of a third space, when my students engaged in discussions of their connection to specific concepts in science, they used this process to cross the bridge into the world of science through the use of their own stories.

When I first moved to Iowa, I believed that understanding my students' culture and integrating this information within the science curriculum was the only way to help them understand science. But I have found, through the classroom observations in this self-study, that once I began to share aspects of my life and its relation to science, I created a new way of helping students from diverse cultures. In so doing, I enabled my students and myself as well to create that connection to science framed within a triadic approach to the concept of a third space.
CHAPTER 5
CONCLUSIONS AND IMPLICATIONS

Conclusion

My experience in self-study research was beneficial to my overall teaching practices. I investigated my philosophy of teaching and learning, examining how my experiences influenced and shaped how I taught science in my classroom. I also became conscious of my teaching practices through witnessing my actions while teaching science to ELL students. From these observations I uncovered the underlying beliefs that influenced those actions. Before this study, I theorized about how I help students learn science, but it was grounded in a classroom dynamic with a minority culture representing a majority of my students within the context of a monolingual English setting. Through this self-study I have been able to understand my role in creating a learning environment within a more diverse linguistic and cultural classroom context. I also became aware of the complexities of a classroom with students of diverse linguistic and cultural backgrounds interacting with one another and with their teacher. Through this self-study I have also realized the potential of a modified third space incorporating a negotiated dynamic across the three perspectives.

One of the aims of this research study was to explore my philosophy of teaching and learning. This goal was accomplished through examining my life history and the influences that shaped my ideas concerning teaching science to students. Another aim of this study was to examine my current teaching situation, specifically investigating the underlying beliefs that were expressed through my actions in the classroom. And finally
through this study, I compared my ideas concerning the third space (Bhabha, 1990, 1994; Moje et al., 2001; Wallace, 2004), deepening my understanding of my own teaching practices and the complexities of a science classroom.

The purpose of this chapter is fourfold. First, I will provide a summary of my results. I will then discuss the implications for teachers and for professional development opportunities. I will also address the implication for the theory of the third space. Finally, I will highlight further research opportunities that could be developed from this self-study.

**Summary of My Results**

My self-study involved examining my teaching practices in order to understand my beliefs as they were expressed in my teaching and also to understand my role in creating a learning environment for my students. My research study began through the development of a life history. This aspect of my study highlighted how my experiences with using the inquiry method and working with culturally diverse students shaped my philosophy of teaching and learning. My life history also led to the use of the third space theory. From the literature, I originally envisioned this concept of a third space as a meeting between the world of the students and the world of science. My role in the third space became a bridge between those two worlds. My life history provided an opportunity to explore my teaching experiences, and to relate a theory developed from the literature to other teachers' experiences. Once my life history was complete, I then began to observe my teaching in a science classroom.
In the spring of 2008, I videotaped five of my lectures. These teaching sessions ranged in length from ten to sixteen minutes and recorded my actions in my science classroom populated with ELL students. The videotapes were transcribed and included descriptions of what was occurring in the classroom including the gestures made while I was talking. Once the transcriptions were complete, I used grounded theory methodology to analyze the collected data and to provide answers to my research questions.

Throughout this entire self-study, I asked two of my doctoral classmates from the university and a colleague from the high school to discuss my results. These critical friends provided insights into what I was finding throughout the research process. Our discussions were used as a sounding board to help work through my analysis of the transcriptions and also aided in the development of the modified version of the third space and how it was represented in the classroom.

This self-study was guided by the following research questions:

1. What are the underlying beliefs found in my classroom and how do I express them in my classroom?
2. What is the third space created in my classroom?

These questions guided my analysis of my collected data, determining my underlying beliefs found in my science classroom. These questions also helped to further develop the theory of the third space. The overall process was recursive in nature. I would analyze my data, then re-examine my data through what I found in my previous analysis, while continuously discussing with others what I found throughout the entire process. My underlying beliefs developed from this analysis were:
1. I believe I need to be highly organized in my science classroom.

2. I believe all students can learn science.

3. I believe I need to make science relevant to my students.

4. I believe in building a positive relationship with my students.

I also found that my understanding of the third space had changed to include the teacher’s world, the student’s world, and the world of science.

Implications for Teachers and Professional Development Opportunities

In the fall, I will no longer be a high school teacher. I am moving to another state, on the East coast, teaching at a university. I will be working with pre-service science teachers, teaching a course in science methods. This research experience will provide knowledge and understanding of my own practices that can be used within my new teaching environment. Building upon the work of other self-study researchers, my own self-study could be used as a way to further my own professional growth and provide a model for professional development for in-service and pre-service teachers.

Science teachers, and all teachers in general, can witness their own practices first hand through the process of self-study. Like me, they can explore the relationship between their ideas and what occurs in their actual classrooms. Specifically, teachers can develop a life history describing their philosophy of teaching and learning. In their life history, they can explore their experiences in teaching and how that in turn shapes their philosophy. Through their life history, teachers could ask specific questions about what they perceive to be important and determine how their past experiences influenced their beliefs. These teachers undergoing the journey developed from this exploration could use
their life history to investigate their current teaching situation, comparing and contrasting what they knew initially in their life history and what they learned from their experiences in the classroom. Once their life history is developed, these teachers could also create a personal narrative that describes their experiences, sharing with others what they have come to know and understand about their life history and their beliefs about teaching and learning.

Another aspect teachers can examine in their classroom is observing their own teaching practices. Their self-study could involve videotaping their practices. After each videotaped session, teachers could, depending upon the time available, transcribe each session or they could simple watch their tapes. In either case, while they are observing their teaching, they could determine the patterns and themes that develop from their observation of their classroom and from this information describe what occurs in their classroom. They could use this information to compare what occurs in their classroom to their beliefs derived from their personal histories. This would create a rich context from which to discuss their practice with colleagues. Teachers could also use video recording to answer specific questions they might have about their teaching. For instance, teachers may be interested in how their interactions with students are realized in the classroom. Such a question then becomes the focus of classroom observations and the analysis of those observations.

In this study, I only examined my lectures, but teachers could observe their entire class period, or they could observe other portions of their teaching. In either case, teachers could use this process to uncover the patterns and/or themes found within their
observations. The findings could be used as a basis for their understanding of their actions in the classroom.

Teachers could also develop a study group, where they discuss with others what they found in their self-study, meeting throughout a school year and discussing the issues they deem important to address. In such meetings teachers could discuss questions they have about their teaching, and how they were going to research and analyze their practice. Teachers could also discuss their findings and how they could use their newfound understanding in their classrooms. I focused the previous section on teachers, but this model could also be used for teacher educators wanting a better understanding of their own practice and their interactions with students. Regardless of which population is using this model, self-study becomes a tool teachers can use to help them grow as professionals, becoming better teachers for their students.

Implication for Theory

Originally I envisioned the third space as the meeting of the two worlds, the world of students and the world of science; yet I found that as their teacher, my world was also included in the third space. The world of the teacher influences both worlds. In my classroom I found the third space became a meeting of those three worlds, where my class came together to discuss science.

The modified third space illustrates the different relationships found across a science teacher, her students, and science. For instance, some of my students were interested in science and pursued their interest outside of the classroom, exploring in their own backyard. They had experience with science without the aid of their teacher.
I also experienced science outside of my classroom and was able to bring my examples to the classroom. These were seen in the examples I used in class, enriching the overall discussion of science in my classroom. For me, sharing how science related to my life, modeled the way for my students the way they could connect to science in their own lives. This use of my own personal experiences was an important link to bridging my students’ knowledge with the concepts in science. The modified third space incorporated my own world through these personal stories, which enabled all of the players within my classroom to be involved. This triadic form of the third space and the dynamics within that space illustrates the different types of relationships that can occur when teaching science to a diverse population of students. The modified third space also illustrated the complexities found within a science classroom, where students engage with the teacher, where the teacher engages with science, where the students engage with science, where the students and teacher engage together, and where all three come together in a negotiated space for making meaning about science. This frame for the third space goes beyond the uni-directional view of a teacher-directed bridge connecting students with science. This triadic view presents a negotiated space across three contexts where the teacher and the students negotiate together through language and actions to address the concepts and meaning of science.

Recommendations for Further Research

Self-Study Research

This study examined my philosophy of teaching and learning and also my teaching practices within an ELL science classroom. In this section, I will describe ways
in which my artifacts could be mined for a deeper understanding of my teaching practices.

An interesting aspect of this self-study is an exploration of the metaphors found within the entire dissertation. The third space, the world of students, the world of teachers, and the world of science could be examined and further analyzed to show their relationship with each other and the portrayal of the three worlds in a science classroom. This comparison becomes another way to understand my practice in the classroom.

A further exploration could also be an examination of the ways in which humor was used throughout the classroom observations. Why was humor so prevalent in the classroom observation? Why did I tell jokes in class? Was it used to help students relate to their teacher or a way to relate to each other, or even relate to science? Was it a device used to help students feel comfortable, lowering their level of anxiety to help them learn science? How is humor culturally constructed? What are the limits to humor in a culturally diverse setting?

I also used personal examples to help students relate to the various science concepts found within the classroom observations. Where does this storytelling originate? Does it come from my science background or does it relate to my African American identity? Or is storytelling a universal way in which teachers effectively teach science? Do I tell stories throughout my teaching, or does it occur only with certain topics? How does storytelling relate to using case studies as a means of teaching science to students? Would these stories be offensive to other ethnic and/or cultural groups?
Other Types of Research

Since the goal of this self-study was to understand how I help students learn science, I am curious about how strong the ties need to be between science, students, and their teacher in order to help students learn science. Can teachers be successful teaching science without having a relationship with science, or even a relationship with their students? In other words, I am curious about how the third space is realized in other science teachers’ classrooms. How is this dynamic being seen, if at all, in other teaching practices? If it is not being seen in other classrooms, how do teachers negotiate their teaching and their interactions with students? Also is the third space seen other than in an ELL classroom? For instance, examining a classroom with students with lower economic status, disabilities, or with gender-specific grouping? Is the third space found in other content areas, like math, English, social studies? How does my modification of the third space fit within other models of effective teaching?
REFERENCES


APPENDIX A

LIFE HISTORY TIMELINE
LIFEHISTORY TIMELINE

Timeline


1993 - 1999: Science Center- Carts Activity, Demonstrator, Camp Counselor.

Summer 1997: Internship at Public Health Department.


APPENDIX B

SAMPLE OF CLASSROOM OBSERVATIONS TRANSCRIPTION
1. Teacher: Come, come, have a seat, have a seat.

*The students are talking and walking around the classroom. The bell rings and a student mimicking the sound of the bell. The teacher turns the lights down and talks with another student.*

2. Teacher: Okay so today, today, today, we are going to um review our notes, from what we did yesterday. And what I mean by review we are going to talk through it. You are going to finish up the coloring if you have not already finish and then you are going to answer questions based on your coloring. Take out your notes. Please. Take out your notes.

3. Student 8.: I thought we were done with all this yesterday.

4. Teacher: Ha-Ha-Ha. Nope. You are never. Last day of school we will be done with notes.

5. Student 1.: You serious, last day of school. Shut up. Not umm.

6. Teacher: This is what we talked about chromosomes and [mitosis].

7. Student 3.: [?]

8. Teacher: Yes. I will talk about that.

9. Student 5.: [?]

10. Teacher: I hope not.

*Teacher is talking with students in general. Answering questions and giving directions.*

11. Teacher: I know we are going to have review.

12. Student: 8. L. doesn't have notes.
13. Teacher: Oh yeah. L. and M. [Student: Me too.] you will have to get these notes. And M. After we go through it. After we go through it then I will run it back while people are working on their other assignments. I will run it back. And we can talk about it. Okay. So for now just listen.

14. Student 11.: [?]

15. Teacher: Not right now.

16. Teacher: Okay here we go. You see yesterday we talked about cell division. Right. [Students are talking with each other.]

17. Student 1.: [The recording to see if we do bad.]

18. Teacher: I will talk about that in a little bit. First I want to review our notes. So we got cell division. What’s another word... [Students continue to talk amongst themselves.]

19. Teacher: Okay so now we need to stop talking. [Pause and looks at students.] L. was talking.

20. Student 9.: I’m not talking it was him.

21. Teacher: Was. Was. Was. [Student: she was chewing her gum] J. you ready. Like I said I want you guys just to listen. And then when we are through I’ll go back and you can take these notes. Okay?. Alright. So cell division. Yesterday we talked about cell division. What’s happening to these cells?

22. Students [All]: [?]. . . dividing... separating...

23. Teacher: They are dividing. They are separating. [Gesturing with her hands.] Okay. How? That is a good question. How? Now you notice in your book and also yesterday I talked about how these cells, we call the original cells the parent cell and then once they split they become, we call them the daughters cells. You have the parent cells and the daughter cells. The parent cells is the original and the daughter cells is what?


25. Teacher: The copy. I am not going to say babies. I am not going to say babies because are you know [Gesturing: rocking a baby.] Okay. These are just cells. These are before they turn into babies.

26. Teacher: Alright. We did that. And then mitosis. Mitosis is a name for cell division. We also called it mitosis, cell division, cell [Student: division] it starts with an “r”.
27. Student 5. : Reproduction.


29. Student 5. : [I said that].

30. Teacher: I know you did good. And it is control in the nucleus. It occurs all of the time, right. It replaces our dead skin, heal our cuts and bruises, we grow. Now, the nucleus right. [Points to the screen that has the an image of a nucleus.] Here is the nucleus and inside the nucleus are ... what is that?

31. Students [All]: Chromosomes.

32. Teacher: Chromosomes. In the nucleus is chromosomes. That's the beginning of mitosis. The nucleus divides in half and when it divides in half [Gesturing: cuts the air into two sides] it makes two new cells.

33. Student 10: And those cells divide again.

34. Teacher: And those cells divide again and those cells divide again and those cells divide again.

35. Student 10: And when, when do they stop? They don't stop.

36. Teacher: Well.

37. Student 10: What [if] we don't stop growing.

38. Teacher: We do stop growing. Okay. Usually people. [student: I mean, but] Like I, personally, I've been the same height since [student says something] No. Since I was in fifth grade. So in fifth grade I was really tall. Okay. I was really tall. Boys we are like this [Gestures: puts hand up to shoulder to indicate a height.] Then what happened? In high school I stopped growing, but what happened to boys? They kept growing [Gestures: raises hand over head to show growth.] and so I become short. Just like that. Nothing happened to me, but the people around me grew. So our cells do stop growing and they do stop growing. They do stop reproducing. Like our brain cells. They say by the time that you are I think nine years old or ten years old or four years old you have made all the brain cells that you are going to make. So if you damage your brain. Or you know they have/ you've seen those commercial with the frying pan and they crack the eggs and this is your eggs/this is your brain on drugs. You know what I am talking about? Because once you kill your brain cells, they're gone. And your [?]

39. Student 8: What about the cells that grow slow. [Teacher says slow very slowly.]
40. Teacher: There are some cells that grow slow. [Students also say slowly, like um.]

41. Teacher: I’m thinking, I’m thinking [student interrupts].

42. Student 8: [This doesn’t go for guys, but for girls like girls breast grows really small.]

43. Teacher: It all depends. It all depends. [Student: she’s talking about breast] I was thinking more of/ you know babies/ when babies are born their skulls are soft. [Students in unison: yeah]. You have to be really careful. [Students: make joke and laugh] Well if you push on their head you could damage their skulls, you can damage their brains. Because those cells are still growing. Okay.

44. Student 7: [could it kill them].

45. Teacher: Yeah, most definitely [it could kill them].

46. Student 12: Oh my god their so soft and [?].

47. Teacher: I know it’s crazy/ So mitosis is controlled/mitosis is controlled in the nucleus. Okay the nucleus [points to image of nucleus on the board] remember our nucleus. Small dark region we called it the brain of the cell. It holds these chromosomes. I believe this is where we stop? No. Chromosomes tightly coiled DNA. [student: yep] DNA was the genetic material.

48. Student 6: Yeah this is where we stopped.

49. Teacher: This is where we stopped. Okay. The genetic material, genes they get passed down from your mom and dad to you.

50. Student 11: [?].

51. Teacher: [laughs] Genetic material they get passed down. And we are going to talk more about genetics. After we finish mitosis, we’ll talk more about genetics. Genetics is fun. We will make babies in here.

52. Students [All]: How ya goin’ to make babies? We’re going to make babies. How are we going to make babies? Laughs [?].

53. Teacher: They’re not real.

55. Student 1: Hey Ms. Magee I need a pencil?

56. Teacher: I don’t have one to give you hun.

57. Student 1: Do you have a pen?

58. Teacher: I don’t have one to give you. Oh wait. There is an extra one up here, but make sure you give this back. You ready? [Teacher throws the pen to the back of the room.]

59. Student 1: Don’t stab me.

60. Teacher: [Pointing to the screen with laser pointer.] Okay did you get this stuff down? Tightly coiled DNA, genetic material passed down from parent to child from one cell to another cell. Okay. Alright, now remember our chromosomes/ so chromosomes very important. So ready, R. you ready. [Teacher is touching the board with her hands touching the chromosomes on the screen.]

61. Student 7: What does that little blue thing called?

62. Teacher: the little blue thing is called chromosome. The chromosomes are found inside the nucleus. And the chromosomes/ what they did was/ they took one of the chromosomes and they blew the picture up. [Gestures: expands hands to show the idea of making bigger.] Kay. They broke down just one part of the chromosomes to show that it is DNA.

63. Student 1: Chromosomes are DNA?

64. Student 3: That’s how they find out?

65. Teacher: Chromosomes are DNA. That’s how the whole my baby’s daddy. [gestures to the board, touching the screen]. This is how you find out.

66. Student 10: That’s Mom and Dad right there?

67. Teacher: [Nodding her head] That’s Mom and Dad right there. Okay. Actually for humans its 43 of these chromosomes. It’s 43. While forlike guinea pigs/ I don’t know why I know this. But for guinea pigs they only have like 14 chromosomes.

68. Student 10: What if you have 45 chromosomes?

69. Teacher: Oh good question. What if you have like 45? 45 chromosomes is what we call a person/a person with Down Syndrome.
70. Student 6: What’s that?

71. Teacher: They’re/ They’re mental retardation.

72. Student 7: They’re slow.

73. Teacher: They’re slow. They have sort of a squished face. They usually have like um. [Gestures to chin-cleft.] They usually have sort of a squished face, squished nose. I believe in/ not in your guys biology books, but in the other biology books there’s picture.

74. Students [All]: [discussion about down syndrome.]

75. Student 10: What if you have 43 or 42?

76. Teacher: If you have now/ Now if you have less 43 to 42. [student: you’re normal, duh] That’s when/ No No No/ This is even worse/ If you don’t have/ How can I say this/ If you have more chromosomes you are more likely to survive um in the womb compared to if you have less chromosomes. If you have less chromosomes/ like if something happens then you would um probably die, you know we are talking in the womb [gestures to the stomach/womb] and maybe even before.

77. Student 5: That’s in the stomach.

78. Teacher: Yeah.

79. Student 10: So you have to 44?

80. Teacher: You got to have 46.

81. Student 10: 46.

82. Student 7: Normal.

83. Teacher: 46 to be quote unquote normal.

84. Student 10: Why?

85. Teacher: That’s how many genes we have.

86. Student 1: [Asks a question?]

87. Teacher: Yeah.
88. Student 7: L. got like 100.

89. Teacher: Oh M.

90. Student 7: L. started it.

91. Students [All]: Okay lets keep going.

92. Teacher: Okay let’s keep going. We don’t have a lot of notes/ So chromosomes. So see I’ve got one, two, three, four, five different pictures of chromosomes. So chromosomes can come in various stages [gesture- expands her hands sideways]. Well this one. Here is our DNA. So chromosomes have different names. Come on [touching the board with her hand]. Before we go through mitosis it is called chromatin. Chromatin. That is our loose. So our chromatin are here. A single DNA strand is our number 1. Number 2 is chromatin.

93. Student 5: [do you want us to copy it down].

94. Teacher: No. What I want you to copy down. Is chromosomes have two different names. One name is called chromatin. [gestures to board with hand, to show the things she wants the students to copy down] You have chromatin and chromatid. So chromosomes. We can call chromosomes chromosomes, We can call chromosomes? chromatid. And we can call chromosomes chromatid. So this picture tells us/ One/ Picture number one single DNA strand.

95. Student 10: [What DNA?]

96. Student 7: What?

97. Teacher: Deoxy-ribo-nulcuic acid. And we are going to spend a bunch of time on this. Yes. Deoxyribonucleic acid is a bit blah-blah-blah. [gestures to mouth-mouthful] rather than DNA [gestures with hand]. Uh two/the second picture, that is our chromatin strand. So when it is called chromatin, you know it is before mitosis/before it replicates. Picture number 3, chromatin during interphase. Here is chromatin and here is chromatin [pointing to the image on the board with pointer]. Picture number 4 condense chromatin during prophase. And then picture number 5 becomes our chromosomes. So when we go through mitosis, when that cell is starting to divide our chromosomes change. Our chromosomes change. We are going to talk more about this. I just wanted to show you that chromosomes have different names. And has different names because it changes during the process. So Here are the chromosomes. So Here are the cartoon pictures that somebody drew. So chromosomes is the “x” and in the middle you have this called the hydromere or the centromere. And we are going call it the centromere. It is what we are going to focus on. Draw a picture of it. It doesn’t have to be pretty.
98. Student 3: Draw it?

99. Teacher: Yeah. Draw your picture of a chromosome. It is pretty much an “x” with a dot in the middle. Yes a “x” with a dot in the middle of it. And that /Label that dot centromere. Label the dot centromere. Here is some chromosomes I took off the um interent. This is what chromosomes actually look like. If we took a picture of our chromosomes. This is just what they are, they look like little “x’s”. Oh look at that one, look at that one. Look at that one [gesturing to the different chromosomes with pointer].

100. Student 1: Hey what I am not done with the picture.

101. Teacher: You have five seconds. [Starts a silent countdown with her fingers] Ding.

102. Student 1: Seriously, seriously hold on.

103. Teacher: Cell cycle. Cell cycle. The cell cycle is called the cell cycle the reproduction of cells. The reproduction of cells. Basically when a parent cells divide into two. This is what we talked about.

104. Student 1: What was that thing in the circle/in the center?

105. Teacher: centro/c-e-n-t-r-o...

106. Student 1: No the little drawing.

107. Teacher: It was just a dot.

108. Teacher: And when they divide/ They are exactly alike, exactly alike.

109. Student 6: [?].

110. Teacher: Oh they are going to go back and take notes from yesterday.

111. Teacher: And there are three parts. The first part is called interphase. The second part is mitosis. And the last part is cytokinesis. I wanted us to go to the computer lab on Wednesday. Tomorrow. But we’re not, I want us to at least get through mitosis. But I don’t think I want to do anymore notes today. Mitosis. Not your “toe-sis.”

112. Student 7: I said your “toe-sis”my-tosis.

113. Teacher: Mi-tosis not your- tosis. Ha-ah. [Students and teacher laugh.] We will go on Friday.
APPENDIX C

SAMPLE: POWERPOINT LECTURE NOTES
SAMPLE: POWERPOINT LECTURE NOTES

Heredity

Ms. Magee
ELL Biology

Mendel

- Monk and a gardener
- Experiment with pea plants
  - Sired patterns
  - Shape, color, flower color, pod color, plant height, and plant position
  - Crossed (mated) plants
- See Figure 6.8

Mendel Continued...

- Mendel's Conclusion
  - Law of Segregation
    - Organisms inherit two copies of each gene
    - One from each parent
    - Organisms only donate one copy of each gene
  - Law of Independent Assortment
    - Alleles separate independently during meiosis
    - Each member of each different version of a gene

Review

- Meiosis
  - Each parent gives half of its chromosomes to offspring
  - Form gametes
    - Sex cells: sperm and egg
- Fertilization
  - Gametes unite
  - Form Zygote

Heredity

- Passing of traits from parent to child
- Genetics
  - Study of heredity

Traits

- A type of characteristic that is passed down
  - Ex: Eyes, Nose, Hair, Ears, Lips, Eyebrows, Hair Color, Eye Color
- Dominant Traits
  - Seen
- Recessive Traits
  - Seen only if the dominant is not around
### Traits continued...

- **Allele**
  - Symbol used to represent trait
  - Two alleles for each gene
  - Homozygous characteristics
  - Each allele may be dominant or recessive
  - 1 or 2 alleles
  - In isolation
  - Alleles occur in pairs
  - BB, Bb, or bb
  - Dominant, co-dominant, or recessive

### More Gene Vocabulary

- **Alleles**
  - BB or bb, non-penetrant
  - BB, heterozygous
  - Co-dominant
  - Genotype
  - Phenotype
  - Phenotypic characteristics
  - When you have blue
  - Germines
  - Which organ grows material

### Punnett Squares

- **Way to determine alleles of offspring**
  - Monohybrid Cross
    - Homozygous vs. heterozygous
    - Heterozygous vs. Heterozygous
    - Homozygous vs. heterozygous

### Incomplete Dominance

- **Parent genes combine to form a mixture**
  - Alleles are not completely dominant
  - Red vs. white flower Example

### Codominance

- **Alleles are both dominant**
  - Chicken feathers

### Sex Linked Traits

- **Sex chromosomes**
  - XX - girl
  - XY - boy
  - Each chromosome carries certain traits
  - Determine sex of child by a punnett square
Cystic Fibrosis
- Affects the respiratory and digestive system
- Thinnest the pathway with thick mucus
- Causes bacteria to build up and cause infection
- Digestive problems
- Treatment
  - Physical therapy
  - Medications
  - Exercise
  - Nutrition

Sickle Cell Anemia
- Hemoglobin combines with oxygen to transport it to various parts of your body
- Can't combine
  - Cells can't get enough oxygen
  - Cells become sick-shaped
  - Swelling and pain, fever, and purplish areas
- Treatment
  - Transfusion
  - Gene therapy

Hemophilia
- Body doesn't have the ability to clot blood
- Passed down on X-chromosome
- Sex linked
  - Only found in males
  - Do example on board

Color Blindness
- Can't tell the difference by colors
- Carried on X-chromosome

Pedigrees
- Family Trees
- Genetic representation of an individual family
- Shows inheritance patterns

Genetic Disorders
- Based on heredity patterns
- Mistake occurs with human genes
- Autosomal

Huntington’s Disease
- Dominant gene
- Deteriorating brain cells
- Chaotic, irritable, depressed
- Lose muscle control