AN EXPLORATORY CASE STUDY: THE IMPACT OF CONSTRUCTIVIST-BASED TEACHING ON ENGLISH LANGUAGE LEARNERS UNDERSTANDING OF SCIENCE IN A MIDDLE SCHOOL CLASSROOM

by

C. MATT SEIMEARS

B.S., Pittsburg State University, 1995

ME.d., Wichita State University, 1999

B.S., Newman University, 2002

ABSTRACT OF A DISSERTATION

Submitted in partial fulfillment

of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction

College of Education

KANSAS STATE UNIVERSITY

2007

Abstract

The purpose of this exploratory case study was to explore the middle school science classroom of a constructivist teacher and examine how constructivist-based teaching influences ELL students and their learning of science. The researcher's purpose was to discover patterns which emerged after close observations, careful documentation, and thoughtful analysis of the research topic. What was discovered by this exploratory case study was not sweeping generalizations but contextual findings.

This case study was conducted in the spring of 2006. The researcher sought to answer the question, "How does constructivist teaching help middle school English Language Learners understand science?" Two variable clusters were examined: 1) the independent variable cluster of the constructivist teaching practices of the one selected teacher; and 2) the dependent variable cluster of the middle school English Language Learners understanding of the science concepts being taught. Four broad categories of data were collected: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning.

Steve Loos an eighth grade middle school science teacher is an expert constructivist-based teacher. His teaching influences English Language Learners understanding of the science concepts being taught. Steve's teaching influenced the English Language Learners through a variety of pedagogical strategies. The researcher concluded in this study that, "Constructivist teaching helps middle school English Language Learners understand science."

AN EXPLORATORY CASE STUDY: THE IMPACT OF CONSTRUCTIVIST-BASED TEACHING ON ENGLISH LANGUAGE LEARNERS UNDERSTANDING OF SCIENCE IN A MIDDLE SCHOOL CLASSROOM

by

C. MATT SEIMEARS

B.S., Pittsburg State University, 1995

ME.d., Wichita State University, 1999

B.S., Newman University, 2002

A DISSERTATION

Submitted in partial fulfillment

of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction

College of Education

KANSAS STATE UNIVERSITY

2007

Approved by:________________

Major Professor

Dr. M. Gail Shroyer

Abstract

The purpose of this exploratory case study was to explore the middle school science classroom of a constructivist teacher and examine how constructivist-based teaching influences ELL students and their learning of science. The researcher's purpose was to discover patterns which emerged after close observations, careful documentation, and thoughtful analysis of the research topic. What was discovered by this exploratory case study was not sweeping generalizations but contextual findings.

This case study was conducted in the spring of 2006. The researcher sought to answer the question, "How does constructivist teaching help middle school English Language Learners understand science?" Two variable clusters were examined: 1) the independent variable cluster of the constructivist teaching practices of the one selected teacher; and 2) the dependent variable cluster of the middle school English Language Learners understanding of the science concepts being taught. Four broad categories of data were collected: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning.

Steve Loos an eighth grade middle school science teacher is an expert constructivist-based teacher. His teaching influences English Language Learners understanding of the science concepts being taught. Steve's teaching influenced the English Language Learners through a variety of pedagogical strategies. The researcher concluded in this study that, "Constructivist teaching helps middle school English Language Learners understand science."

Table of Contents

Chapter 5

List of Tables

Appendices

ACKNOWLEDGEMENTS

Thanks to all of those on my committee, Dr. Doris Wright Carroll for her patience and encouragement while preparing me for my preliminary exams; Dr. Socorra Herrera, for her knowledge and advice about English Language Learners, her positive attitude as well as valuable resources; and lastly Dr. Judy Burry-Stock for her late evening telephone conversations over the ESTEEM model.

I especially thank Dr. R. Scott Iriwn for being there everyday as an advisor, coach, colleague and scientist who helped me along this journey; and Dr. Scott Waters whose patience and wisdom allowed me to seek knowledge and self gratification from this dissertation.

I am thankful to Steve Loos for sharing his time, classroom, and his students. Steve's positive outlook on education, life, and his dedication as a classroom teacher inspired me to become a better educator and person in my field. Steve was a constant reminder that teaching touches lives, open doors, and encourages students to become great thinkers.

Many thanks to my family, my mother whose serenity and advice has taught me to always smile, my father who has always believed in me and would never let me give up, and two sisters who picked on me just enough to mold me into the thinker that I have become. I am indebted to my wife Lindsey for her support and willing to sacrifice many things so that I was able to work. To my son Charles Wesley Seimears who was born during this process; may my accomplishments pave a future for you. Lastly, to my grandmother Lois Meadows whose life ended too soon, but her joy and happiness live within me today.

DEDICATION

This Dissertation is dedicated to Dr. M. Gail Shroyer and Dr. John R. Staver.

“Teachers of Teachers”

"Do not train boys to learning by force and harshness, but lead them by what amuses them, so that they may better discover the bent of their minds.”

Plato

Chapter 1

Introduction

In education, we face important decisions regarding the education of our children that will affect our lives and the lives of countless millions, and we need to contemplate these choices systematically and thoroughly. We need to be aware that members of diverse groups will evaluate these decisions in different ways. These issues will be filtered through the screens of divergent experiences, group histories, educational problems, and present situations. The debates over which direction our society should go in education are not likely to be meaningful or even mutually intelligible without some understanding of the complex learning needs of culturally and linguistically diverse learners in America today.

These choices about the future of our society and education are especially urgent because we are at present in a period of increasing diversity, largely due to high rates of immigration. Over the past three decades, the number of immigrants arriving in the United States each year has increased from less than 300,000 to almost one million (U.S. Bureau of the Census, 2000). The current wave of immigration includes groups from all over the globe. Students whose home language is other than English are projected by the United States Census Bureau to be 40 % of the school age population by the 2030s, and possibly sooner if the present demographic trends continue (Thomas, et al., 2001). By the late 1900s one in every three children nationwide was from an ethnic or racial minority group, one in every seven children spoke a language other than English at home, and one in fifteen children was born outside of the United States (Garcia, 1997). In New York City alone, there are more than one hundred languages represented in public school classrooms (Bank Street, 2005). The same phenomenon is the norm in many areas of the country. In Rochester, Minnesota, another example, schools serve students speaking over 60 different languages. Some of the most common languages spoken by students in these classrooms include Spanish, Korean, Cantonese, Mandarin, and other dialects of Chinese, Haitian-Creole, and Russian (Key, 2004). In Kansas, the Limited English Proficient enrollment reported in 2003-2004 was 25,504 which affected a growth of 296.6% from 1993-1994 to be (U.S. Department of Education, 2003). The Wichita, Kansas school district USD 259, the site of this study, is also linguistically diverse. There are 5,573 English Language Learners, and over 69 different languages spoken in the Wichita school district (Wichita Public Schools, 2006).

Can our educational system successfully meet the growing needs of our culturally and linguistically diverse students? Concerns about addressing the educational needs of an increasingly diverse student population are compounded by other long standing minority issues and grievances that remain unresolved. In many ways, challenges facing African Americans, Native Americans, Hispanic Americans, and Asian Americans today are as formidable as they were a generation ago (Healey, 2003).

Linguistic diversity provides even greater challenges for our educational system. English Language Learners (ELLs) are a diverse population of students who are learning English in school. They come from numerous cultural and economic backgrounds, and they live in all 50 states. They may be: 1) Immigrants from countries all over the world seeking educational or economic opportunity; 2) refugees from war-torn countries; 3) refugees from countries wounded from natural disasters; 4) native Americans or other native born Americans; 5) children with well developed literacy skills in a first language; 6) adolescents with little prior formal schooling; and 7) migrants (Key, 2004).

ELLs come from a variety of linguistic backgrounds. After English, the most common languages in the United States are Spanish, Chinese, French, German, Tagolog, Vietnamese, Italian, Korean, Russian, Polish, and Arabic, followed by numerous other languages (Key, 2004).

While these English Language Learners may be all ages, come from a wide range of ethnic backgrounds and different economic situations, and come to this country for a variety of reasons, all have in common the desire to speak English and learn. Over the years educators have grown to understand the needs of students who are new to the English language. Throughout the history of education many different terms have been used to describe or characterize children whose second language is English. For example, students with Limited English Proficiency (LEPs), students for whom English is a Second Language (ESLs), or Second Language Learners (SLLs). Currently, educators refer to these children as English Language Learners (ELLs) or Culturally and Linguistically Diverse students (CLD). This shift in terminology represents a more accurate reflection of the process of language acquisition.

Almost every school district requires students to receive some type of science based institution. Science content alone can create significant barriers for all students, especially ELLs. English speaking students are prone to shut down in science because they may not understand what the teacher is trying to convey to them; add a language barrier to that in an English only classroom, and ELLs may have a difficult time interpreting what the teacher is teaching. However, it might be possible to help ELL understand science in an English only classroom by providing constructivist-based instruction. This study investigates the impact of constructivist teaching on ELL students’ ability to understand science in English only science classrooms.

Students who are learning English as a new language, especially younger students, often have difficulty interpreting the meaning of logical connections in mathematics and science discourse (Jarrett, 1999). Constructivist-based teaching might prepare English-only teachers to help ELL students understand science. Constructivist-based teaching may help these complex and abstract connections in science. In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to build understanding and to reflect on and talk about what they are doing and how their understanding is developing. The teacher makes sure he or she understands the students' preexisting conceptions, and guides the activity to address these prior concepts and then build on them.

Because constructivist-based teaching is not dependent upon verbal transmission of knowledge alone, because it incorporates frequent practice with language skills, and because it focuses on conceptual understanding, it might be useful in helping ELLs understand science. Looking at English Language Learners in the classroom, do students have the capabilities to interpret science terminology if they do not understand the meaning of the term in their native language? In certain cases, teachers try to remove or reduce language barriers in their English only classrooms, through pedagogical strategies such as sheltered instruction (Echevarria, Vogt & Short, 2000, 2002). The teacher may have a difficult time teaching the science content to the ELL students, because of challenging standards for English and content area instruction. The “No Child Left Behind Act” requires states to establish challenging academic science content standards for all students, and Title III of this act indicates that ELLs are not exempt from meeting these high expectations (U.S. Department of Education, 2003). All students are expected to understand the content of the curriculum and then demonstrate some understanding on state exams. The curriculum and state and national tests are not written with linguistically and culturally diverse students in mind. English Language Learners are faced with the compounded challenge of understanding American culture while at the same time trying to learn complex concepts in a new language and demonstrate this learning on an English only exam.

According to the Educational Broadcasting System (EBS) (2004), constructivism does not dismiss the active role of the teacher or the value of knowledge. Constructivism modifies the teacher’s role, so that teachers can help students construct knowledge rather than to re-produce a series of facts. The constructivist teacher provides tools such as problem solving and inquiry based learning activities so that students can prepare and test their own ideas, draw conclusions and inferences, and communicate their knowledge in a collaborative learning environment. Constructivist teaching transforms the student from an inactive recipient of information to an active participant in the learning process. Guided by the teacher, students construct their knowledge actively rather than just unconsciously ingesting knowledge from the teacher or the textbook (Educational Broadcasting System, 2004).

The EBS (2004), cites the benefits of constructivism: 1) Children learn more when they are actively involved; 2) student experiences in science works best when the concentration is on thinking and understanding, rather than on rote memorization; 3) students control their own learning process; 4) students take more possession of what they learn; 5) students are more engaged and collaborative; and 6) creation of a classroom environment that emphasizes teamwork.

> “Students must learn how to articulate their ideas clearly as well as to collaborate on tasks effectively by sharing in group projects. Students must therefore exchange ideas and so must learn to "negotiate" with others and to evaluate their contributions in a socially acceptable manner. This is essential to success in the real world, since students

> will always be exposed to a variety of experiences in which they will have to cooperate and navigate among the ideas of others (Educational Broadcasting System (EBS), 2004, p.2).

Many classrooms are comprised of ELL students. At the middle school level, science teachers have integrated classrooms, and depending on school funding for Title I purposes, they may have students who are “newcomer” English Language Learners. If a classroom is an English only classroom, the teacher must develop teaching strategies to help all students understand science. Not all students have language barriers, not every student struggles with science curriculum, and in order to find that connection, a teacher must incorporate a style of teaching that relates to every student in the classroom.

Problem

Mestre (1991), argues science education in grades K-12 needs restructuring. The issues that must be addressed are difficult. Basic or short-term solutions are not likely to succeed because both pre-service and in-service teachers must upgrade their science knowledge in three important content areas; 1) science content; 2) how students think and learn; and 3) instructional strategies. All three areas should be addressed together (Mestre, 1991). As ELL student population sizes increase, there are ways teachers can meet the educational needs in English only science curriculum/classrooms. Instruction should provide students the opportunity to interact with other students, interact with the content, learn to understand the viewpoint of others, think critically, test and question ideas, and form their own points of views (Miramontes, 1997). Constructivist-based teaching encourages these instructional approaches. Every child interprets content in a different way; they may have special needs, language barriers, social distractions and issues inside and outside school. Each student, therefore, needs the opportunity to construct his or her own ideas about science. If demographic trends continue, the population of ELL students entering classrooms will continue to grow. As educators we need a deeper understanding of how constructivist based teaching helps ELL students understand science in an English only science classroom.

Purpose

The researcher's purpose in this study was to explore the middle school science classroom of a constructivist teacher and examine how constructivist-based teaching influences ELL students and their learning of science. The researcher sought to explore patterns which emerged after close observations, careful documentation, and thoughtful analysis of the research topic. The researcher's goal in this exploratory case study was not sweeping generalizations but rather a deeper conceptual understanding of constructivist teaching and ELLs within one English only middle school science classroom.

In exploratory case studies, fieldwork, and data collection may be undertaken prior to definition of the research questions and hypotheses. This type of study has been considered as a prelude to social research (Tellis, 1997). According to Yin (1989), the framework of an exploratory study must be created ahead of time. Yin (1989) argues that the selection offers the opportunity to maximize what can be learned, knowing that time is limited. Cases that are selected should be easy and willing subjects. A good instrumental case does not have to defend its typicality. According to Sheffield (2005), exploratory case study research examines the patterns of meaning which emerge from the data and are often presented in the participants' own words. The task of the researcher is to explore patterns within words, actions, and to present those patterns for others to inspect while at the same time staying as close to the construction of the world as the participants originally experienced it.

Guided Question

This study is guided by the following question:

1. How does constructivist teaching help middle school English Language Learners understand science?

Significance of the Study

The researcher sought to contribute to the literature by presenting a picture of a middle school science constructivist-based teacher to examine how constructivist-based teaching influences ELL students and their learning of science. Five areas used to delineate the significance of this study: 1) The need for teachers to understand ELL students and how they understand science better using the constructivist learning model based on the assertion that a person must create knowledge for themselves; 2) the need for new knowledge in the field of education, constructivism, constructivist-based teaching, and an extension of what is known about ELL students and science; 3) a contribution to a practical problem faced by school districts, educators, and college teacher education programs in the area of bilingual education in society today; 4) the novel use of an exploratory case study of a middle school science classroom constructivist-based teacher to examine how constructivist-based teaching influences ELL students and their learning of science through the collection of teacher and student inventories, audiotapes of interviews, videotapes of classroom lessons, field notes of lesson observations, lesson plans, teaching artifacts, student work samples and other artifacts of student learning; and 5) the results of an exploratory case study that is considered to relate to other concurrent studies as a research effort to enhance teacher education.

Definitions of Terms

Constructivism - Constructivism is a theory of “knowing” and the nature of knowledge (Driver, 1995.)

Radical/Psychological Constructivism - Radical/psychological constructivism emphasizes the importance of cognition in understanding how an individual builds and uses knowledge. In Radical/psychological constructivism the focal points are cognition and the individual (Staver, 1998).

Social Constructivism - Social constructivism emphasizes the importance of culture and language based social interactions and knowledge at a group level (Staver, 1998).

Realist - Realists view the world in terms of what is; they focus on a situations objective facts (Wikipedia, 2007).

Solipsism - Solipsists believe that that only oneself exists, and that “existence” just means being a part of one’s own mental states. All objects, people, etc, that one experiences are merely parts of one’s own mind (Wikipedia, 2007).

English Language Learners - Learners who are beginning to learn English as a new language or have already gained some proficiency in English. Linguistically and culturally diverse students who have been identified through reliable and valid assessment as having levels of English language proficiency that preclude them from accessing, processing, and acquiring unmodified grade level content in English and, thereby, qualifying for support services (NCREL, 2007).

Science - Accumulated and accepted knowledge that has been systemized and formulated with reference to the discovery of general truths or the operation of general laws (Meriam-Webster, 1993).

Sheltered Instruction - A teaching approach promoting development of a second language. Sheltered Instruction can be used with first language students if they lack proficiency in the language for academic purposes.

Teaching—In education, teachers are those who teach students or pupils, often a course of study or a practical skill. There are many different ways to teach and help students. When deciding what teaching method to use, a teacher will need to consider students' background knowledge, environment, and their learning goals.

Summary

The goal of this study was to explore the middle school science classroom of a constructivist-based teacher and examine how their constructivist-based teaching influences ELL students and their learning of science. This dissertation is intended to contribute to the understanding of science for English Language Learners in science education. This study was conducted in a public school system. One middle school was selected to participate in the study to provide motivation for this dissertation.

In chapter one, a number of factors were introduced that influenced or shaped teachers, the changing demographics challenging our school systems, the increasing needs of English Language Learners and the reform needed in science education to help teachers make the proper connections to these ELLs. Chapter two is a review of the related literature. The methodology in chapter 3 presents: 1) The theoretical framework and research design for this study; 2) the middle school science teacher who was selected; and 3) the school district and location. In chapter four, the researcher interpreted the data collected in this study. Chapter four includes four primary sources of data collected: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning. The reflections of the researcher, discoveries from the study, final conclusions, and further recommendations for further study will be found in chapter five.

Chapter 2

Review of Related Literature

Introduction

The goal of this chapter is to review the literature related to an exploratory case study of constructivist based teaching and English Language Learners. First the changing demographics will be introduced. Second, an overview of literature on reform in science education will be shared. Third, constructivism and conceptual understanding will be reviewed, including what we know about how people learn, constructivism as an epistemology for science teaching, constructivism in science education, and the teacher's role in a constructivist classroom. Next, English Language Learners, bilingual education, best practices for ELL, science instruction for ELL, and overlaps in constructivism and best practices for ELL will be considered.

Reform in Science Education

There has been little research regarding the direct effects of constructivist epistemology on learning of English Language Learners in English only classrooms; however, a substantial amount of recent research has been reported regarding the effects of constructivist based teaching strategies. According to Keys (2000), several studies describe a potential research agenda for the teaching and learning of science as inquiry, drawing on the theoretical frameworks of cognitive and sociocultural constructivism, cultural models of meaning, the dialogic function of language, and transformational models of teacher education.

According to Mestre (1991), there are two main instructional practices found in American education. One is the long prevalent practice, which results from the so-called transmission model of instruction (Mestre, 1991). In this model, students are introduced to content through lectures, presentations, and readings, and they are expected to absorb the transmitted knowledge in ready-to-use form. Although it is not a model of learning *per se*, the transmission model does make a pivotal assumption about learning, namely that the message the student receives is the message the teacher intended. Within this model, students' difficulties in grasping a concept are interpreted as indicators that the presentation was not clear or forceful enough to be understood, or the student was just not able or prepared. Tishman (1993) maintains that many users of the transmission model believe that if they make the presentation coherent or persistent, for example by transmitting at a slower speed or in louder voice, then students will eventually understand. Too often teachers are inclined to believe that by speaking in shorter words and sentences they can teach the big ideas in relativity to ninth graders. Perry (1968) would argue that teachers should consider that students' intellectual development is not at a level where they can understand the subtleties of abstract concepts. Childhood psychologist Jean Piaget described a mechanism by which the mind processes information. Piaget agues that a person understands whatever information fits into ones established view of the world. Piaget asserts that when information does not fit, one must re-examine or re-adjust his/her thinking to accommodate the new information (Piaget, 1972). According to Piaget (1972), teachers need to be conscious of their students' cognitive development and strategically plan or develop curriculum that enhances logical growth.

The transmission model is often used largely by default rather than choice, both because it is the instructional method by which students are usually taught and because it may be the only instructional method some teachers know how to use. Not only does it lack theoretical justification, but also there is mounting evidence that it is not the most efficient or effective model of instruction.

Unlike the transmission model, the second major instructional practice, which has emerged over the last decade, begins with what is commonly termed the constructivist model of learning, constructivist epistemology, or simply constructivism (Mestre, 1991). This model contends that learners actively construct knowledge. The construction of knowledge is a lifelong process and at any time, the body of knowledge individuals have constructed makes sense and helps them interpret or predict events in their experiential worlds.

This view of learning contrasts with the view tacitly assumed in the transmission model. Constructivism contends that students are not sponges ready to absorb and use transmitted knowledge; the knowledge already written on their mental slates affects how they interpret new observations and how they accommodate newly constructed knowledge. If during the course of instruction teachers are not cognizant of students' prior knowledge, then the message offered by the teacher will not likely be the message constructed by the student (Mestre, 1991).

At the elementary level, the debate has included a discussion of the benefits of activity based science instruction built on constructivist concepts as opposed to the benefits of more direct instructional methods based on textbooks. Research on activity based science programs, primarily from the 1980s, indicated great value in their use (Shymansky, et al., 1990). The Elementary Science Study (ESS) originated as a post-Sputnik science curriculum and is now Delta Science Models. Development of ESS began in the early 1960s at Harvard University, with over 100 scientists and educators involved. The core thesis behind ESS was to give students hands-on learning experiences without pushing them toward a particular application. ESS took a radical approach by encouraging open ended activities for students (Lawlor, 2006). ESS found that “things” encourage children to ask questions and find their own answers.

Educators such as Hunt, Piaget, Bruner, and Almy capitalized on the learning potentials of children. These educators conducted research that illustrated the importance of concrete experiences. According to Sund (1973), the designers of the Science Improvement Curriculum Study (SCIS) looked closely at these educators' findings to develop an effective program of science instruction within an elementary education framework.

> "The SCIS program, allows children to learn science in an intellectually free atmosphere where their own ideas are respected, where they learn to accept or reject ideas, not on the basis of some authority, but on the basis of their own observations. Ideally, some of these experiences will carry over to other areas of life and incline the children to make decisions on a more rational basis after weighing the factors or evidence involved more objectively. "(Sund, 1973, p. 184)

Constructivism

Constructivist Epistemology

According to Phillips (2005), the term "constructivism" has been used extensively by such a large number of people and for a wide variety of purposes that there is almost no compromise as to its actual meaning. Constructivism is a theory of "knowing" and the nature of knowledge. Constructivism is not a new concept; it has deep roots in philosophy, education, psychology, and anthropology. Within constructivist theory; learners actively construct new meaning and connect it to previous knowledge (Driver, 1995).

According to Lorsbach & Tobin (1997), constructivist epistemology asserts that the only tools available to a knower are the senses. A person interacts with the environment through seeing, hearing, touching, smelling, and tasting. With raw data from the senses, the individual actively constructs meaning. Martin (2005) describes the constructivist view as grounded in the notion of subjective reality. Individuals construct their own reality from their own observations, reflections, and logical thought. Reality must be built by each individual for himself or herself. Staver (1998) points out that constructivists are sometimes labeled as solipsists because they confront realists' goals of knowing reality as it is. Moreover, they refuse to embrace truth as a correspondence of knowledge with reality. A solipsist believes that only one's self exists. Ironically, constructivism is an escape from solipsism (Staver, 1998). Realists assume that reality exists externally to our consciousness; then they set out to understand reality. Constructivists reject the realists' assumption, then escape from solipsism by a logical decision process. Constructivists then set out to understand their experiential world by organizing their experiences through coherence (Staver, 1998).

According to the Stanford Encyclopedia of Philosophy (2005), truth is correspondent to a fact, and consists in a relation to reality. This theory of truth is often linked to metaphysical realism. The correspondence theory maintains that truth is determined by how it relates to the world. Constructivists' rejection of the realist assumption stems from an ancient paradox presented here by Immanuel Kant.

> "Truth is said to consist in the agreement of knowledge with the object. According to this mere verbal definition, then, my knowledge, in order to be true, must agree with the object. Now, I can only compare the object with my knowledge by this means, namely, *by taking knowledge of it*. My knowledge, then, is to be verified by itself, which is far from being sufficient for truth. For as the object is external to me, and the knowledge is in me, I can only judge whether my knowledge of the object agrees with my knowledge of the object. Such a circle in explanation was called by the ancients *Diallelos*. And the logicians were accused of this fallacy by the sceptics, who remarked that this account of truth was as if a man before a judicial tribunal should make a statement, and appeal in

> support of it to a witness whom no one knows, but who defends his own credibility by saying that the man who had called him as a witness is an honourable man." (Kant, 1800, p. 45)

Truth as coherence is different from truth as correspondence. Truth as coherence states that "truth" is a specified set of propositions, a system of beliefs in one's mind.

> "A more plausible version of the coherence theory states that the coherence relation is some form of entailment. Entailment can be understood as strict logic entailment, or entailment in some looser sense. According to this version, a proposition coheres with a set of propositions if and only if it is entailed by members of the set." (Davidson, 1986, p. 307)

According to Staver (1998), there are two main forms of constructivism. In social constructivism the focal points are the language and the group. In radical/psychological constructivism the focal points are cognition and the individual. Social constructivism emphasizes the importance of culture and language based social interactions and knowledge at a group level. Radical/psychological constructivism emphasizes the importance of cognition in understanding how an individual builds and uses knowledge.

Foundation for Modern Cognitive Science Perspective of Learning

The goal of the Committee on Learning Research and Educational Practice was to bring together practitioners, policy makers, and researchers to react to a report called "How People Learn." The committee was organized in 1995 by the National Research Council (NRC) at the request of the U.S. Department of Education's Office of Educational Research and Improvement (OERI). The Committee on Learning Research and Educational Practice described the early foundations of learning, and how cognitive emerges from culture and community of the learner

(Brown, et. al. 1996). The committee delineated three findings; 1) Students come to the classroom with preconceptions; 2) Students need to develop competence in inquiry and understand facts in the context of a conceptual framework; and 3) a metacognitive approach to instruction can help students learn to take control of their own learning.

In constructivism, knowledge does not represent reality; rather, knowledge represents the dynamic coherent organization of individual or group thinking. As phrased by Wilkipedia (2006), a metacognitive design or approach monitors a student’s memory two ways: 1) conscious/factual; and 2) unconscious/implicit knowledge. In constructivism, the mind is constantly constructing new knowledge from experiences; therefore, implicit knowledge is seen as lifeless. A metacognitive approach to instruction may serve as constructivist-based teaching in two ways: 1) Students must be lucid or conscious to take control of their own learning; and 2) the teacher works as a facilitator as students consciously construct new knowledge.

Many instructional strategies exist to help student’s grasp science content. One instructional strategy, termed “bridging,” has been successful in helping students overcome persistent misconceptions (Brown, et. al. 1993). The bridging strategy attempts to construct students’ beliefs to their misconceptions through a series of intermediate analogous situations. In order to bridge the gap and anchor conceptions, students must make sense of new ideas in terms of existing ones. In doing so, they will achieve "meaningful learning." Meaningful learning results in knowledge that students can apply to novel situations. This type of learning is contrasted with rote memorized learning in which students’ grasp of the subject is limited to classroom contexts and is often of short duration. Learning may be influenced in fundamental ways by the situation in which it takes place. Often, a community-centered approach requires the expansion of norms for the classroom and school and connections to the outside world that support core learning values (Bransford et al, 2000).

Teaching and learning are interactive processes in which both the teacher and the student need opportunities to talk through and check out developing understandings. Students need help changing their ideas about a concept in ways that make sense to them. This change can only be achieved by helping the student construct a new and deeper understanding of the concept.

According to Linn (2000), the ideas of science are often counter to our intuition of common sense; unguided experiences with natural interpretations of phenomena can result in misunderstandings. Teaching for meaningful learning takes time. For this reason, the pressure to cover the entire curriculum may result in little comprehension on the part of the students. According to Danielson (1996), it is better to understand a few key concepts than to memorize pages of facts without in-depth understanding.

Unintended learning outcomes occur when students construct understandings that diverge from the teacher's instructional goals. A demonstration or explanation that seems clear to the teacher can take on entirely different meanings in the eyes of the students.

> “Students who have not achieved meaningful learning will often incorporate the language and forms of a lesson into their old ideas without making a fundamental change in their old frameworks” (Annenberg Media, 2006, p. 4).

Since each student constructs knowledge in her or his own unique way, fitting new ideas among the old, only the student can take accountability for her or his own learning. However, teachers can lead, coach, advice, and provide rich learning opportunities (Annenberg Media, 2006).

Constructivism in Science Education

According to Mintzes and Wandersee (1998), the history of science education is often categorized by large-scaled shifts and emphases in curricular and instructional practices. Science history is full of many examples of debates concerning reality and the nature of science. From a constructivist perspective, science is not the search for truth. It is a process that assists us to make sense of our experiential world. Using a constructivist perspective, teaching science becomes more like the science that scientists do; it is an active, social process of making sense of experiences, as opposed to what we now call "school science”. Actively engaging students in science is the goal of most science education reform. Lorsbach and Tobin (1997) embrace this goal as an admirable one and advocate that using constructivism as a referent can assist in reaching that goal.

According to Driver (1995), constructivist-based teaching allows students to become actively engaged in real-world relevant topics through a step by step process: 1) students use prior knowledge to achieve multiple solutions when solving science problems; 2) students share social significance through social interactions in the classroom; 3) science is accessible to students at many levels; 4) science becomes fun and interesting for both students and teachers in the classroom; 5) technology may be integrated in a meaningful way; 6) science can be communicated to a wider audience; and 7) instruction emphasizes science as an inquiry and science process skills.

A Foundation for Standards-Based Teaching and Learning

Constructivism is a theory of what “knowing” is and how students “come to know.” Many constructivists believe that the learner creates his or her own knowledge, and the teacher is simply a facilitator. Teachers working with their students as facilitators provides an excellent framework for improving science education (Bambach, 2000). With the teacher as the facilitator, students enter a classroom with their own experiences and prior knowledge. Often these experiences are perceived to be invalid or incomplete. Students must be able to process new information without the teacher forcing the information and the content on them. The teacher's job is to create an environment in which the student can actually explore the content. In a constructivist classroom, the role of the teacher is to organize the information and concepts using a variety of strategies such as: 1) questioning; 2) examining; 3) engagement; 4) exploring, and 5) developing new insights. In addition to these strategies the teacher needs to break down concepts, and allow students to: 1) answer their own questions, 2) conduct their own experiments, 3) analyze their own results individually or in a group setting, and 4) come with their own conclusions.

In the past few decades, educators have shown a rapid movement towards constructivism. Results from a study published in the *American Scientist* showed that "the past few decades have not been kind to the behaviorist school" (Robins et al., 1998, p. 310). Several studies support the idea that constructivism works best in fact-based, problem-solving learning (Southern Agricultural Education Research, 1998). Teachers have praised constructivism for its pedagogical design (Southern Agricultural Education Research, 1998). Educational theorists and researchers are constantly examining constructivist based instructional methods primarily in the context of teaching cognitive content.

In summary, constructivism can serve as a philosophy and a referent for science teaching (Lorsbach & Tobin, 1992). Although constructivism is an epistemology, it can also be understood as a theory of learning. Students actively construct knowledge in the process of learning through interactions with phenomena; they build up meaning of the phenomenon through interactions within a social framework (Greer & Rudge, 2003). Although the epistemological positions of constructivist theory are often challenged by philosophers and scientists, researchers generally agree that students learn by making sense of phenomena as they experience them, evaluate their qualities, and attempt to make sense of them within a socially acceptable context in light of prior knowledge (Linn 2000).

English Language Learners

The experience of learning a new language can vary significantly from one individual to the next. According to Zeller (1994), ELL students come from diverse backgrounds, but they have several common needs. ELL students need to build their oral English skills, acquire reading and writing skills in English, and continue to learn in content areas such as mathematics, science, and social studies. Some ELL students have additional needs that will make the task of learning much more difficult. Some come from countries where schooling is very different. Some may have large gaps in their schooling while others may not have had any formal schooling and may lack important language literacy skills in their native language. ELL students are also diverse in their economic backgrounds. Some may come from backgrounds where there are financial difficulties or health problems. These students often need support from health and social service agencies. Others may simply need understanding about some of the special circumstances they face. For example, both parents may work long hours and cannot help with homework, or they may be required to baby sit brothers and sisters until late each evening, making it difficult to complete all of the assigned homework (Zeller, 1994).

According to Zehler (1994), three factors that may help educators understand cultural differences in the classroom; cultural differences can: 1) Mean different rules for classroom behavior; 2) affect a student’s understanding of content; and 3) affect interactions with others.

Culturally different ways of showing interest, respect, and appreciation can be misinterpreted by teachers. Zehler (1994) points out that in certain cultures a teachers' expectation may be opposite of the expectations in a U.S. classroom. For example, to show respect, a student may have been taught to not look directly at the teacher. For some cultural groups, praise to an individual student is not given publicly. Instead, a quiet word of praise to the student is more appropriate. Teachers need to be sensitive to student reactions and try to respect these, while also helping students to understand the cultural differences in their new environment (Zehler, 1994).

Bilingual Education

California has dramatically changed its approach to the education of English Language Learners (ELL) since the passage of Proposition 227 in 1998, which called for most ELL instruction to be conducted in English. Prior to that time, a transitional model was the most common instructional design (Mora, 1996). Now, most school districts still offering bilingual programs opt for the Structured English Emersion (SEE) model where the use of native language has been reduced considerably or eliminated all together. This has resulted in an increased need for specialized teaching skills as well as a renewed emphasis on curricular adaptation in order to make instruction more comprehensible and meaningful for English Language Learners (Klentschy, 2002).

Primary language instruction refers to those classroom settings where a transitional model of bilingual education is used. At the time of re-designation of a student's status from limited English proficient (LEP) to Fluent English Proficient (FEP), the use of the native language in the classroom declines until it is eliminated completely. Special instruction in English, also called "sheltered emersion," is a program where instruction is delivered in English and is geared toward the student's proficiency but without native language support provided to the student. According to Klentschy (2002), native language support is provided by either bilingual teachers or instructional assistants and can be provided within the classroom setting or in pull-out classes during the school day.

Klentschy (2002) observes that many teachers have turned to a constructivist process in content areas such as mathematics and science to help ELLs improve their content knowledge as well as a way to further develop their English skills. Klentschy believes that teachers chose a constructivist approach instead of relying on textbooks to teach ELLs. The National Clearinghouse for Bilingual Education (1998) points out that textbooks can be over whelming for ELLs. Often, school textbooks assume a common experience that is not shared by all students. ELLs may not fully understand these texts, and consequently, they will be less likely to understand or remember the content material (The National Clearinghouse for Bilingual Education, 1998).

Kansas and English Language Learners

According to Krashen (2004), Kansas has encouraged bilingual education support and is moving in the right direction in Bilingual Education. In Garden City, KS schools, pupils are placed in a dual-language program intended to make both Spanish-speaking and English-speaking children bilingual by fourth grade. Southwest Kansas educators assert that bilingual programs help bridge a performance gap between Spanish-speaking and English-speaking students (Kansas City Star, 2004). State test scores indicate that Hispanic students are improving. In Garden City, 62.4 % of Hispanic fourth-graders were proficient in mathematics in 2002; in 2003 the percentage grew to 73.4 %. In Dodge City, Kansas reading proficiency among Hispanic fourth-graders rose to 58.9 % in 2003 from 45 % in 2002 (Kansas City Star, 2004). Garden City is testing a pilot program in which students take a computerized version of the state mathematics test while listening to the questions in Spanish on headphones. Teachers credit the approach for improving mathematics scores by more than 10 % in one year. Similar innovations are needed in other areas to help students meet No Child Left Behind mandates, but the programs are expensive, and there is a shortage of bilingual teachers (Krashen, 2004).

An approach that has been especially useful in teaching science is known as the Cheche Konnen approach, which in Haitian Creole means search for knowledge (Rosebery, 1992). This approach with ELL elementary children stresses how communication is a primary means for the search for knowledge and scientific understanding. It also illustrates how scientific ideas are constructed (Medawar, 1982). The Cheche Konnen approach began by creating “communities of scientific practice” in ELL classrooms in a few Boston and Cambridge, MA public schools. “Curriculum” emerges in these classrooms from the students’ questions and beliefs and is shaped in constant interactions that include both the teacher and students. Students investigate their own questions, design studies, collect data, analyze data, and discuss the conclusions they obtain from their evidence (National Research Council, 2000).

Research reported by the National Research Council (2000) found that students constructed scientific understandings through an iterative process of theory building, criticism, and refinement based on their own questions, hypotheses, and data analysis activities. Roseberry (2001), found that the Cheche Konnen approach showed that question posing, theorizing, and argumentation formed the structure of the students’ scientific activity. Within this structure, students explored the theories they held, examined underlying assumptions, formulated and tested hypotheses, developed evidence, negotiated conflicts, argued alternative interpretations, and constructed conclusions. The process provides a more scientifically grounded experience than the conventional focus on textbooks or laboratory demonstrations (National Research Council, 2000).

Another instructional model that can be used in the classroom to help students construct knowledge is the Sheltered Instruction Observation Protocol (SIOP) model of sheltered instruction (Echevarria, Vogt & Short, 2000, 2002). The SIOP is grounded in both the latest literature on best practices with students (Herrera & Murray, 2005) and quality standards of effective teaching practices with these students (TESOL, 2001). SIOP incorporates several common themes of best practice in sheltered instruction for Culturally Linguistic Diverse (CLD) students through visuals and scaffolding (Calderon, 1993; Echevarria & Graves, 2003; Herrera & Murrary, 2005; Perez, 2002). The eight categories of the SIOP Model: A Sheltered Instruction Model for Academic Achievement (SIMAA) offer similar practices for ELLs as well as constructivist principles for teaching (Echevarria, Vogt, & Short). These categories are as follows: 1) preparation; 2) building background; 3) comprehensible input; 4) learning strategies; 5) interaction (social effective learning); 6) practice application; 7) lesson delivery; and 8) review assessment.

The Sheltered Instruction Observation Protocol (SIOP) developed by Echevarria, Vogt, & Short (2000) was originally designed as an observation and rating tool for researchers to use while viewing participating teachers in the classroom. Under each category of the SIOP are several subcategories. Under preparation there are six subcategories: 1) clear content; 2) clear language objectives; 3) content concepts appropriate; 4) supplementary materials; 5) adding content and texts; and 6) meaningful activities. Under building background there are three subcategories: 1) Link to student’s background experience; 2) link to past learning/concepts; and 3) key vocabulary. Under Comprehensible Input, there are 3 subcategories: 1) Speech; 2) explicit description of academic tasks; and 3) instructional strategies/techniques. Under learning strategies, there are three subcategories: 1) Metacognitive/cognitive learning strategies; 2) scaffolding techniques; and 3) variety of questions used for higher order thinking. Under interaction (social effective learning), there are four subcategories: 1) Provide multiple opportunities; 2) group configurations; 3) allow for wait time; and 4) give opportunities to clarify key concepts in first languages. Under practice application, there are three subcategories: 1) Hands on opportunities; 2) apply content and language objectives; and 3) integrate language skills. Under lesson delivery, there are four subcategories: 1) Content objectives supported by lesson delivery; 2) language objectives supported by lesson delivery; 3) students engaged 90% of period; and 4) pacing appropriate to ability level. Under review assessment there are four subcategories: 1) Review key vocabulary; 2) review key concepts; 3) give feedback to students; and 4) assessments.

Best Practices in Science Teaching for English Language Learners

An overlap exists regarding constructivism and best practices for English Language Learners. Science teachers who provide instruction to Limited English Proficient (LEP) students must ensure that these students make academic progress while they are in the process of learning English. ELLs must meet the same goals and objectives as students who are native English speakers. Whenever possible, beginning level ELLs should be provided content instruction in the native language of the students. However, when content instruction is provided in English, it must be made comprehensible through appropriate second language instructional strategies and clear expectations. Modifications for ELLs should include diverse teaching strategies.

According to Fathman, (et., al. 1992), science activities can provide meaning-making experiences for English Language Learners. In order for new knowledge to be acquired in science and in language it must be an active, meaning-making process; students must make sense of it or they may seem lost. The science classroom can provide an excellent atmosphere for developing the social behaviors students need in order to find solutions to local and global science problems. Science is often seen as a tool for communicating meanings and solutions. For students learning English as a second language, new science concepts can pose difficult problems because their prior knowledge may conflict with the information to be learned. Abandoning prior knowledge is a challenging process that may be accomplished only superficially, even after formal science teaching. According to Kessler and Quinn (1987), this is particularly relevant for learners who come from diverse cultural backgrounds with world views that may differ from those reflected in the science classroom.

Kessler, Quinn, and Fathman (1992) want to promote the development of a second language through science, and feel it may be helpful to examine learning and teaching principles that aid in the acquisition of both language and content. These principles of learning and teaching that form the foundation for a new core science curriculum are surprisingly similar to those widely recognized for promoting second language acquisition.

Learners construct their own meanings by relating new information and concepts to what they already know. Second language learners come to science with world-views shaped by prior knowledge gained from personal and cultural experiences. This prior knowledge helps students who have been exposed to science concepts and methods in their native languages to acquire similar concepts in a second language. The universality of scientific principles, laws, and procedures across cultures can help students as they learn about those same principles in a new language. Effective science learning frequently requires that learners restructure their understandings, change perceptions, and even discard long-held beliefs. Cook (1989) argues that learning a second language requires restructuring within the brain and making new connections between words and concepts and discarding old ones.

Concrete experiences facilitate the construction of appropriate conceptual structures. Science investigations actively involve students in carrying out the processes of science by moving from observing to hypothesizing and interpreting results. Objects and living things that can be touched and manipulated help in making the connections between words and meanings that are needed in order for understanding to occur for the ELL student. Piaget (1972) argued that all young children need concrete experiences in constructing new knowledge. Moreover, Piaget (1972) outlined numerous principles for constructing cognitive structures. During all development stages, children experience their environment using mental maps they have constructed. If a child’s experience is a repeated one, it fits easily into their cognitive structure. Piaget (1972) argues that different and new experiences will cause the child to lose equilibrium and alter their cognitive structure to accommodate new situations.

According to Sexton (1996), if students are to learn to think critically, analyze information, make sound arguments, communicate scientific ideas, and work as part of a group, they need to apply ideas learned in one context to new and realistic situations. ELL students need opportunities to apply the processes of science so that science comes to be understood, not as a set of facts to be memorized, but as a method for understanding themselves and the world around them. Language learning requires similar conditions. Students need opportunities for using language in new and authentic settings if they are to internalize the new language system and engage in higher order language processing. Learning to negotiate meaning through interaction with others requires exposure to many genuine real-life communicative situations. Feedback is more than just giving correct answers (Zehler, 1994). Feedback means guiding students in analytical thinking processes and providing suggestions for alternative ways of thinking. Feedback must come at a time when students are attentive and engaged so that they can reflect, make adjustments, and try again. Feedback plays a critical but complex role in science and second language learning. Error correction for its own sake has little value, but given in an appropriate manner and at a time when the learner is ready, it can trigger the necessary conceptual and language modifications. Interestingly, peer feedback is often more powerful than that given by the teacher (Zehler, 1994).

Good instruction does not necessarily lead to student understanding. Krashen (1987) emphasizes that the quality of understanding, rather than the quantity of information presented, is important for successful science and language learning. Selecting only the most important concepts and skills to teach enhances the quality of learning. The quantity of concepts presented needs to be kept at a level that facilitates language development. For Piaget (1972), this means developmentally appropriate. Piaget (1972) maintains that educators need to plan developmentally appropriate curriculum that enhances student logic and cognitive growth. Piaget (1972) argues that teachers need to emphasize the importance of student interactions with the surrounding environment, and the role that fundamental concepts play in establishing cognitive structures.

According to North (1997) science instruction can be meaningful for ELL students if appropriate strategies are used to make instruction comprehensible. The science content should not be simplified in any way, but the method of delivery should be adjusted to provide students with ample opportunity for participation, thereby making the concepts comprehensible. The following strategies from North (1997) might be utilized in the classroom for instructional enhancement for ELLs: 1) Simplify the input; teachers need to deal with the same content and vocabulary, but should slow down their speech and enunciate their words clearly. Teachers should use proper science terminology, restate, redefine, give examples and attempt to utilize students' prior knowledge; 2) provide context clues: Gestures and/or actions can be used to communicate meanings. Symbols, graphs, visuals and other props might also help ELL students; 3) draw on prior background: Students can be expected to share their prior knowledge through short verbal responses. The teacher might need to provide visuals to communicate the concept/concepts and allow students to communicate prior understanding by making a nonverbal choice; 4) provide opportunities for group work and student interactions: ELL students can learn a great deal of science and English from their peers. The teacher might consider heterogeneously grouping by language for some activities. The teacher should accept and encourage students' dialoguing in their preferred language within groups. Group reports can be helpful as this provides frequent restating and expansion of important concepts; 5) use appropriate materials: Whenever possible, science lessons for ELL students should be activity-based with all students having hands on access to materials; and 6) assess all students’ understanding. During instruction, teachers might be especially observant of ELL students' behavior. Student use of materials can be one indicator of involvement and understanding. When questioning, teachers need to be sure to provide adequate wait time and give students the option of responding through nonverbal signals. Teachers should give serious consideration to performance-based assessments for formal evaluation. Teachers might also consider accepting drawings and primary language as indicators of learning within a science journal or portfolio.

The New Jersey Science Curriculum Framework (NJSCF) (2003) suggests a very similar set of diverse strategies to help ELLs comprehend science. According to the (NJSCF), these strategies may consist of: 1) Integrating activities into thematic units; 2) assessing students’ prior knowledge and experiences; 3) teaching learning strategies and scaffold complex tasks; and 4) place students into an assortment of learning groups.

Overlaps in Constructivism and Best Practices for English Language Learners

In constructivism and best practices for ELLs, the focus of teaching is on essential concepts or big ideas as defined by national and state standards. There is an adaptation of content through the use of assignments and strategies to make content assessable. The literature for ELLs stresses the importance of content knowledge and language development. The National Science Educational Standards encourage a focus on concepts, theories, and processes of doing science (NRC, 2001).

In constructivism, students use background knowledge and previous experiences to construct meaning of the action or content. ELLs make meaningful connections through pair share strategies and one's prior knowledge. ELLs link previous experiences to build on prior knowledge and concepts. ELLs connect current lessons to previous lessons relevant to context for new concepts. In both constructivist and ELL classes concept maps are used to access students' prior knowledge of the concept and to assess their understanding of a lesson being taught. According to Burry-Stock (1995), concept mapping asks students to use key words and concepts in a graphing manner. Instead of having ELL students write out paragraphs and explanations, they map key words on a piece of paper. The students construct which words link together from an experience. Burry-Stock (1995) thinks this can be done in a linear fashion, a global fashion, or a combination of the two. The Expert Science Teaching Education Manual (ESTEEM) houses a Concept Mapping Rubric which was developed using much of Novak (1990) and Novak and Gowin's (1984) original work in the area of concept mapping (Burry-Stock, 1995). Student's complete concept maps after each lesson and a rubric is used to score the maps. According to Burry–Stock (1995), the rubrics are to be used as a summative student assessment activity given at the end of a lesson.

According to Piaget's Formal Operations Stage (ages 11/12 – Adult) (1972), students have the capability of thinking logically and in the abstract. Students have the ability to reason, relate symbols to abstract concepts, test hypotheses systematically, and to be concerned with the future and ideological problems. Best practices for ELLs as well as constructivist principles for teaching value the use of concrete instructional strategies/techniques to make concepts clear through modeling, visuals, hands-on activities, demonstrations, gestures, and body language. Students need to be given the opportunity to thoroughly explore the concepts being taught. Such constructivist-based teaching helps ELLs progress developmentally toward formal operational thinking.

According to ESTEEM, teachers need to demonstrate excellence of subject matter through the use of exemplars. A constructivist teacher must incorporate verbal, visual, and physical exemplars and metaphors frequently for ELLs, to make sure that these are accurate and relevant throughout the delivery of the lesson.

For best constructivist and ELL learning practices, teachers are encouraged to use a wide variety of instructional strategies to meet diverse needs. Students are encouraged to use mental imagery and draw diagrams of the problems to enhance understanding and provide support to move from one level of understanding to a higher level. A variety of questions are used for higher level thinking, such as science as an inquiry, Blooms Taxonomy (2006), and enhancement of questioning.

The ESTEEM uses a standardized performance measure titled Student Outcome Assessment Rubric Student Questions. The Student Outcome Assessment Rubric is a standardized performance measure with instructional content validity, because students are evaluated on information taught only in their class (Burry-Stock, 1995). The ESTEEM student questions instrument uses inquiry where students must use mental imagery to answer questions about the main idea, the lesson, and the importance of the topic.

Social interactions are essential in constructivist teaching as well as best practices for ELL. There must be multiple opportunities for social interaction such as: 1) Think pair-share activities; 2) debates; 3) justifying reason; 4) literature study groups; and 5) group problem solving activities. Teachers work as facilitators of these social interactions. They create interest, curiosity, ask open-ended questions, and encourage students to interact to share what they are learning. According to the ESTEEM, the Science Classroom Observation Rubric is designed to document classroom activities such as social interactions between students and the teacher. The four categories of the Science Classroom Observations Rubric are as follows: 1) Facilitating the learning process; 2) content specific pedagogy; 3) contextual knowledge (fluid control); and 4) content knowledge.

In constructivist based and ELL best practices, student engagement in activities is important. According to Burry-Stock (1995), students should be actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the lesson. Students should be actively engaged in experiences, and responsible for their own learning experiences. Hands-on activities should include opportunities to model representations such as: 1) small group or center activities, 2) use an ample amount of time to complete tasks, and 3) have appropriate support from the teacher.

In constructivist based and ELL best practices, teachers should align their teaching strategies and lesson delivery to state and national standards. The ESTEEM emphasizes that teachers constructivist classroom lesson delivery must: 1) Use novelty and newness to generate curiosity of the student; 2) not depend on a textbook in lesson presentation and delivery; 3) focus the lesson on activities that relate to student understanding; 4) use student relevance as a focus and allow for the lesson to relate to student experiences; 5) vary methods to facilitate student conceptual understanding through discussion questions, experiments, and student presentations; 6) consistently move students through different cognitive levels; 7) integrate content and process skills; 8) connect concepts to evidence; 9) facilitate students efforts when misperceptions become apparent and resolve them by gathering evidence; 10) demonstrate good interpersonal skills and relations with students; 11) be aware of student understanding and modify the lesson when needed; 12) integrate concepts, generalizations, and skills coherently throughout the lesson; 13) make sure that content has an appropriate balance, and 14) make sure content is evident and always accurate.

Summary

A review of the literature on constructivism has revealed that using a constructivist-based approach in teaching may benefit ELL students in the classroom. Constructivist-based teaching begins with prior knowledge of individual students and allows them to construct their own knowledge based on their experiences, discoveries and interactions with other students. The literature reveals that science educators have described constructivist-based teaching, and research shows success in learning when taught from a constructivist perspective. The literature has described best practices for ELL in science education and its alignment with the constructivist theory. Chapter 3 explains the methodology of this exploratory case study.

Chapter 3

Methodology

The researcher's purpose for this study was to explore the middle school science classroom of a constructivist-based teacher and examine how constructivist-based teaching influences ELL students and their learning of science. The question asked in this research study was:

1. How does constructivist teaching help middle school English Language Learners understand science?

Because few studies have been conducted examining the relationship between constructivist teaching and science learning of ELLs, this was an exploratory study based on a qualitative research case study design. Qualitative research is a generic term for investigative methodologies described as ethnographic, naturalistic, anthropological, field, or participant observer research (Key, 1997). It emphasizes the importance of looking at variables in the natural setting in which they were found. The interactions between variables are important. The variables explored in the case study were the independent variable cluster of constructivist teaching compared to the dependent variable cluster of ELLs understanding of science. In qualitative studies detailed data are gathered through open ended questions that provide direct quotations. The interviewer is an integral part of the investigation (Jacob, 1988). Qualitative research differs from experimental/quasi-experimental research which attempts to gather data by objective methods to provide information about relations, comparisons, and predictions and attempts to remove the investigator from the investigation (Smith, 1983).

There are ten characteristics of qualitative research that were applied to this study: reality, viewpoint, values, focus, orientation, data, conditions, and results (Key, 1997). The goal of qualitative research is to understand people, places, or situations. Qualitative research seeks to deeply describe people, their behaviors, experiences, interpretations, and their environment (Creswell, 1998). Reality is perceived differently for the observer and the participant; the observer may see reality differently than the participants. From the participants' viewpoint, reality is what they perceive it to be. The researcher's values will have an impact on the environment and should be understood and taken into account when conducting and reporting research. The researcher may bring different values to the research than will the participants. The focus of case studies is a total or complete picture of a situation, person, event, technique, or in-depth view of the environment. The orientation of case studies includes the theories and hypotheses that evolve as the data is collected. The data are the in-depth information regarding situations, experiences, and perceptions of people in their environment. The conditions include the naturalistic investigations conducted; these conditions represent one unique environment. The results include the analysis of data or the patterns, trends, and themes found through the data analysis.

In this exploratory case study, the researcher explored the constructivist-based teaching of one middle school science teacher and how his teaching influenced ELL students and their learning of science. The methodology chapter includes the theoretical framework behind the study, the sampling method used to select the teacher, the research design, a description of the data collection and data analysis methods that were used, and how access to the building was obtained to conduct the study.

Theoretical Framework

A theoretical framework is a collection of interrelated concepts which guides the research, determining what things will be measured, and what relationships will be sought in the data. According to Borgatti (1999), theoretical frameworks are important in exploratory studies because: 1) no matter how little one thinks they know about a topic, and how unbiased they think they are, it is impossible for a human being not to have preconceived notions, even if they are of a very general nature, and 2) the framework tends to guide what one may notice in an organization, and what they don't notice.

Constructivism is a very broad conceptual framework in philosophy and science and many theorists represent a variety of perspectives. Constructivist theory is a general framework for instruction based upon the study of cognition. According to Bruner (1996), the learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so.

Learning, teaching, and conducting research involve social interactions but each person must make personal sense of these experiences (Driver et al., 1994). A world view of constructivist-based teaching provided a theoretical framework for the construction and interpretation of data during this study. Constructivist teaching is based on the premise that a person must create his or her own interpretation of knowledge from his or her own mental structures (schema), prior experiences, and social, physical, and mental interactions with the concept to be learned.

> "Each person brings a unique background into the learning situation, and these schema interact with the learning process to generate meaning within the individual. The role of the teacher in this meaning-making process is very

> different from the role of the traditional teacher. The traditional teacher views themselves as the source or transmitter of knowledge and views the child as a receptacle into which knowledge must be added. The constructivist teacher, on the other hand, acts as a facilitator, offering multiple experiences (events and problems) which the learner uses to develop an understanding of the relationship between new experiences and old." (Hairston, 1997, p. 2)

Constructivism assumes that individuals are creative and dynamic. In order to promote a constructivist learning environment, the teacher becomes the facilitator of the learning environment. Learning focuses on understanding major concepts rather than memorizing bits and pieces of information (Burry-Stock, 1997). A researcher with a constructivist world view designed and conducted this study.

The theoretical framework for this research explains how constructivist-based teaching is an active process in which ELLs construct new concepts/ideas based upon their current/past knowledge, how ELL students create meaning during classroom instruction, how they develop student ownership for their own learning, and how they explain or interpret situations and understandings in a middle school science classroom.

Research Design

According to Trochim (2002), a research design provides the glue that holds the research project together. A design is used to structure the research, to show how all of the major parts of the research project -- the samples or groups, measures, treatments or programs, and methods of assignment -- work together to try to address the central research question and purpose. The purpose of this study was to explore the middle school science classroom of a constructivist-based teacher and examine how constructivist-based teaching influences ELL students and their learning of science. The question asked in this research study was: How does constructivist teaching help middle school English Language Learners understand science?

To answer the question, “How does constructivist teaching help middle school English Language Learners understand science?”, the researcher needed to frame the study as an exploratory case study. A case study is defined as an inquiry that “investigates a contemporary phenomena within its real-life contexts; when the boundaries between phenomena and context are not clearly evident; and in which multiple sources of evidence are used” (Yin, 1989, p. 23). Case studies are detailed investigations of individuals, groups, institutions or other social units. The researcher conducting a case study attempts to analyze the variables relevant to the subject under study (Polit and Hungler, 1985). The principal difference between case studies and other research studies is that the focus of attention is the individual case and not the whole population of cases. Most studies search for what is common and pervasive. However, in the case study, the focus may not be on generalization but on understanding the particulars of that case in its complexity.

An exploratory case study design was used to examine the relationships between constructivist-based teaching and ELL students’ understanding of science concepts being taught. Some researchers consider “the case itself,” an object of study (Stake, 1995) and others consider it a methodology (Merriam, 1988). This bounded system is bounded by time and place, and it is the case being studied, a program, an event, an activity, and individuals. A case study is an exploration of a bounded system or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context (Stake).

In this research, one teacher and his students became the focus of the case study. Multiple sources of information were used to examine the teaching and learning process including:

observations; interviews; inventories; and artifacts of learning. The context involved situating the case within its setting, which was the physical setting or the social, educational setting for this case. Field notes, a research journal, and videotapes were used to record data. School documents were examined to provide a deeper understanding of the school setting and the teaching and learning context.

The researcher used a case study design to explore the constructivist-based teaching of Mr. Loes, a middle school science teacher in the Wichita public school system, and to explore how his teaching influenced ELL students and their learning of science. Mr. Loes has over seventeen years of middle school science teaching experience. Mr. Loes was selected from a group of 40 workshop participants in the Physical Science and Mathematics Modeling Workshop at Emporia State University and Fort Hays State University conducted in the summer of 2005. The selection process was based on workshop observations, analysis of a workshop survey, and the demographics of Mr. Loes' classroom and school.

The researcher served as a participant observer constructing interpretations of the data through the use of four primary sources of data: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning.

More specifically, the constructivist teaching of Mr. Loes was documented through the analysis of: 1) observational evidence that included field notes of observed teaching, videotapes of observed teaching, and lesson plans and other teaching artifacts; 2) audiotapes of interviews with Mr. Loes, his colleagues, his administrator, and his students focused on teaching; and 3) teaching inventories completed by Mr. Loes. Student responses to constructivist teaching and student understanding of the concepts being taught were documented through the analysis of: 1) observational evidence that included field notes of observed learning, videotapes of observed learning; 2) audiotapes of student and teacher interview questions focused on student learning; and 3) two learning inventories completed by the students (The ESTEEM Student Questions and Student Outcomes Assessment Rubric and Concept maps and ESTEEM Concept Mapping Rubric); and 4) artifacts of student learning which included: a) District Common Assessment (DCA) Science Exam Scores; and b) Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons. Each of these pieces of data was analyzed using the Expert Science Teaching Educational Evaluation Model (ESTEEM).

The ESTEEM was used to assess the constructivist teaching of Mr. Loes as well as the conceptual understanding of students in his classroom. The ESTEEM (Burry-Stock, 1995c) was developed by Judith Burry-Stock at the University of Alabama to enhance professional development in science teaching. It was developed through a US Office of Educational Research and Improvement (OERI) project supported by the Center for Research on Educational Accountability and Teacher Evaluation (CREATE) that was directed by Dan Stufflebeam (Burry-Stock, 1995). It was developed according to a combination of constructivist and expert teaching philosophy, and it matches the professional development section of the National Science Education Standards (National Research Council, 1996). The emphasis of the ESTEEM model is student-centered teaching that promotes meaningful, conceptual learning. The first edition of ESTEEM has been used in professional development and evaluation for well over 15 million dollars of grant money. The model can be implemented by a mentor teacher, or an external person, or can be self-administered (Burry-Stock, 1995).

ESTEEM 1st edition now houses five instruments designed to assess expert science teaching from multiple aspects of teaching practices and student outcomes. Instruments are used as diagnostic tools and templates of best practice. ESTEEM includes: 1) a constructivist classroom observation rubric called, Science Classroom Observation Rubric, 2) the Teaching Practices Assessment Inventory, 3) Student Questions and Student Outcome Assessment Rubric, 4) Assessment of Classroom Learning in Science Inventory, and 5) Concept Maps and the Concept Mapping Rubric.

These five instruments in the ESTEEM use one of two formats, rubrics or Likert scale inventories. Rubrics are used for the performance assessment of the classroom teacher and the student outcome assessments and inventories were developed using a Likert-type scale. All of the instruments utilize a 5-point rating scale.

The principal component used for the factor analysis of the ESTEEM was conducted on the assessment of 46 nominated expert science teachers. The component used an orthogonal rotation of four factors. According to Burry-Stock (1995), the final factor solution accounted for 71.3% of the variance with the following four factors and subscales, which are labeled categories: 1) Facilitating the Learning Process; 2) Content Specific Pedagogy; 3) Contextual Knowledge, and 4) Content Knowledge. Eighteen teaching practices were identified under these four categories. All of the 18 teaching practices have factor loadings of .8538 to .5596. Factor loadings were interpreted in the same manner as correlation coefficients that were above .7000 (Burry-Stock).

In this case study, the researcher sought to establish meaning using the researcher as the primary research instrument in the natural setting of the middle school science classroom. In addition, the researcher served as an interactive participant with the teacher and students in the classroom. The researcher gathered and interpreted all observational data, interviews, inventories, and learning artifacts using the ESTEEM model as a data collection and analysis tool.

Purposeful Sampling

Purposeful sampling was used to select the teacher who became the focus of the investigative case study. The teacher was selected from a group of 40 workshop participants in the Physical Science and Mathematics Modeling Workshop at Emporia State University and Fort Hays State University conducted in the summer of 2005. This large group of 40 teachers made up the initial pool of teachers to select from because they all were exposed to constructivism through the Physical Science and Mathematics Workshop. All 40 teachers were considered based on their teaching methods and their years of teaching. All teachers were evaluated on their level of constructivist teaching based on the teachers' responses to a survey given to them at the end of the 2005 summer workshop.

. Science lessons were observed on all 40 teachers throughout the workshop and the participants were given surveys to describe their teaching. Each participant in the Physical Science and Mathematics Workshop was observed using the Expert Science Teaching Educational Evaluation Model, ESTEEM, (Burry-Stock, 1995). Two teachers were identified because they provided the strongest example of constructivist-based teaching. Mr. Loes was selected from this final group of two teachers based on his classroom and school demographics. Mr. Loes' school was more diverse and there were a greater number of ELL students in his classes.

Mr. Loes teaches at Maymont Middle School which is a magnet school that is 51.76 % male, 48.24 % female, 69.65 % economically disadvantaged, 30.35 % non-economically disadvantaged, 21.88 % Hispanic, 17.09 % African American, 51.76 % White, and 9.27 % other.

Mr. Loes teaches more than one science discipline, regular science classes and an elective physics course offered to eighth grade students; this gave the researcher an opportunity to observe several different science subjects being taught.

Data Collection

Data Collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. The data collection component of research is common to all fields of study including physical and social sciences, humanities, and business. While methods vary by discipline, the emphasis on ensuring accurate and honest collection remains the same.

This case study was conducted in the spring of 2006. The independent variable cluster was the constructivist teaching practices of the selected teacher. The dependent variable cluster was the middle school English Language Learners' understanding of the science concepts being taught. Variables are characteristics of cases. They are attributes, qualities of the cases that we measure or record. For example, if the cases are persons, the variables could be sex, age, height, weight, feeling of empowerment, math ability, etc. Variables are called what they are because it is assumed that the cases will vary in their scores on these attributes (Borgatti, 1999). This case study explored the relationships between the independent and dependent variable clusters by examining the relationships between constructivist teaching and student understanding of science.

Four broad categories of data were collected: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning. These data were analyzed to identify how constructivist-based teaching was being used in the middle school science classroom, and how this teaching helps middle school English Language Learners understand science. The data collection strategies were separated into two categories, those used to provide evidence of constructivist teaching and those used to provide evidence of student understanding of the science being taught (See Table 1).

Table 1

Data Collection Strategies Providing Evidence of Constructivist Teaching

Observational Evidence (focus on teaching)
  - Field notes of observations of teaching
  - Videotapes of lessons (focus on teaching)
  - Lesson plans and other teaching materials
  - The ESTEEM Science Classroom Observation Rubric

Interviews
  - Interviews with the teacher, his administrator, colleagues, and students

Inventories
  - Teaching Practices Assessment Inventory
  - The ESTEEM Assessment of Classroom Learning in Science Inventory

Data Collection Strategies Providing Evidence of Student Learning

Observational Evidence (focus on learning)
  - Field notes of observations of learning
  - Videotapes of lessons (focus on learning)

Interviews
  - Interviews with ELL students

Inventories
  - The ESTEEM Student Questions and Student Outcomes Assessment Rubric
  - Concept maps and the ESTEEM Concept Mapping Rubric

Learning Artifacts
  - District Common Assessment (DCA) Science Exam Scores
  - Student work samples (assignments: Section Summary on Chemical Bonding Carbon

    Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons

The five ESTEEM instruments completed by Mr. Loes and his students were used as the primary sources of data for this study. These data were triangulated with observational evidence, interview data, and artifacts of learning. Observational evidence from field notes, videotapes, and an analysis of teaching plans and other teaching materials along with interviews with the teacher, his administrator, and colleagues, provided additional insights into teaching practices. Observational evidence of learning from field notes, and videotapes, along with student interviews and samples of student work provided additional information regarding student understanding of the science concepts being taught. Although the ESTEEM observation rubric was the primary tool used to examine observational data, the researcher also examined observational data in relation to the Sheltered Instructional Observational Protocol (SIOP) model.

Observational Evidence

Observations are powerful tools for researchers. Visiting and observing the classroom of Mr. Loes was an overt process. It helped the researcher locate and find important topics, themes, and patterns related to the research question. A total of 208 hours of observational data were collected. Observations took place everyday from April 10, 2006 to May 24, 2006. Observations started when class began promptly at 7:15 a.m. each day and concluded when Mr. Loes' teaching ended at 12:30 p.m. On April 18, 2006 there were no classroom observations due to the absence of Mr. Loes. Observations focused on the teaching and learning that occurred during units on force and motion, mouse trap cars, chemical bonds, and Rube Goldberg.

As the participant observer, the researcher recorded the day, month, time and description of the building atmosphere during each observation to create a holistic picture of what was happening each day. The researcher described classroom features, daily operations, where ELL students sat in the classroom, and with whom they sat (ELL or non-ELL). Evidence of teaching practices was collected along with evidence of student learning. These descriptions promoted accuracy in documenting and analyzing each lesson. A journal was used to record the researcher’s feelings, thoughts, and impressions that might not otherwise have emerged in the case study. This journal allowed the researcher to document and process experiences according to individual and group settings, various building atmospheres, time of year, and time of day. Journaling created a structure for the case study.

Videotapes of classroom lessons captured teaching behaviors, students’ interactions during each unit and the teaching and learning atmosphere. This provided the researcher with: physical trace evidence; recordings of the social situation of the group; and sound (e.g., musical sounds, a child’s laughter, noises on a loud speaker) (Creswell, 1998). The researcher videotaped each unit looking for, “What is Mr. Loes doing to help the ELL students understand the science concepts being taught?” Each videotaped observation took 40 to 45 minutes to complete.

Field notes were taken during each observation to determine how each lesson was taught, student reactions to the lesson, teacher interactions, as well as other evidence of teaching and learning. Field notes were recorded using an observation protocol (Appendix G). Field notes were recorded on each class visit in the teacher’s classroom. Handwritten notes were word processed and transferred into storage by filing them according to weekly visitations. The purpose of the field notes was to identify specific patterns in teaching and learning that occurred in the classroom. The field notes were divided into categories and classified so that the researcher could compare field notes to each video tape of the same lesson.

Artifacts of Mr. Loes’ constructivist teaching provided the researcher additional evidence of his teaching practices and student learning. The researcher was given the opportunity to examine Mr. Loes’ plan book. The researcher observed Mr. Loes using a Green River Lab Book as his planning guide each day. The Green River Lab Book had a graphing paper design to it, a green cover, and black binding. The researcher observed Mr. Loes planned long term units and lessons. Units and lessons were written at the top of each page with questions following the title. The researcher observed that Mr. Loes did not use the district recommended planning manual. The school district Mr. Loes teaches in had recently adopted a planning process designed by a local university. This planning process was developed to be used by all teachers in the district.

Interviews

A total of 64 teacher, student, administrator, and teaching colleague interviews were conducted. An interview protocol was used to allow the researcher to take notes during each interview (Appendix A-F). The researcher found a quiet location free from distractions to record the interview through audio taping to promote accuracy when recording the information (Creswell, 1998). The research journal served as a log of whom was interviewed, how long, when, and where they were interviewed.

Interviewing of students began once all permission slips were collected and turned in to the teacher. Mr. Loes provided the researcher with a list of student names he had confirmed were English Language Learners and what classes they were in. Twenty four ELL students were interviewed at least twice depending on their availability, class, or lesson being taught. Some students were interviewed four times. The researcher observed student interactions, classroom routines and atmosphere before sitting down with a student to interview. Students were interviewed in the hallway outside Mr. Loes’ classroom, with the interviewer facing the student. Classroom doors were open and the interview could be seen by numerous teachers.

The first interview was with a female student. This student set the pace and time constraints it would take to conduct all interviews with the ELL students. All students interviewed were briefed about what was taking place, who the researcher was, where the researcher was a doctoral candidate, and the purpose for the interview. Students were given the opportunity to ask open ended questions before and after the interviewing process.

Additional to these individual interviews with each ELL student, students were interviewed as a group. The researcher conducted one group interview with five ELL students. The interview took place outside the classroom in the hallway to capture the students' emotions once they were introduced to a new lesson. The researcher also informally conducted videotaped conversations with ELL students while working on their lessons. Students were asked what they were doing, what they were suppose to be doing, how they were developing their project, and if they understood what their teacher wanted them to do.

Mr. Loes, the teacher, was formally interviewed nine times. He was interviewed once at the beginning of the study and before and after each of the four units observed. Mr. Loes was informally interviewed two additional times through conversations that occurred during observations. Mr. Loes' interviews took place in his classroom during his plan time each week. The interview with Mrs. Ballwin, the other eighth grade science teacher in the building, took place on April 27, 2006 in Mr. Loes' classroom. Mr. Loes was not present in his classroom during the interview. Ms. Lea, the librarian, and Miss Danes, a Para-educator in the classroom, were interviewed in the school library during the same week. Ms. Lea was interviewed during a break, and Miss Danes was interviewed during the time she spends as a Para-educator in Mr. Loes' fifth hour. Mr. Daniels, the building administrator, was interviewed in his office on May 11, 2006 at 8:00 a.m. The secretary of Mr. Daniels was present during the interviewing process.

The only interruptions that occurred were telephone rings and individuals who were passing in and out of the office. Mr. Daniel’s office was located in the library during the interview due to building construction on that day.

The length of each interview varied between each ELL student and the interview averaged 20 minutes. Each interview with Mr. Loes lasted for 30 minutes up to an hour. The interview with the building administrator lasted 35 minutes and interviews with other educators in the building lasted 30 minutes. Interviewing the ELL students in the classroom, teacher, building administrator, and other educators in the building provided the researcher greater insight into the constructivist-based teaching of Mr. Loes and the learning needs and outcomes of his students. All student, teacher, administrator and staff interview data was sorted by the researcher and filed in a locked cabinet.

Instruments

Currently there are five ESTEEM instruments that are designed to assess expert science teaching from multiple aspects of teaching practices and student outcomes; all of these instruments have been field tested. These instruments are used as diagnostic tools and templates of best practice. Two of the ESTEEM instruments are inventories that use Likert-type formats, and three instruments are rubrics.

The two ESTEEM inventories are the Teaching Practices Assessment Inventory and the Assessment of Classroom Learning in Science Inventory. These inventories were used to assess Mr. Loes’ teaching behaviors. The three ESTEEM rubrics are the Science Classroom Observation Rubric, Student Questions and Student Outcome Assessment Rubric, and the Concept Mapping Rubric. The Science Classroom Observation Rubric was used to assess Mr. Loes’ teaching behaviors. The Student Questions and Student Outcome Assessment Rubric, student constructed concepts maps and the ESTEEM Concept Mapping Rubric were used to assess students' understanding of the concepts being taught. These instruments will be described under two headings: those used to assess constructivist teaching practices and those used to assess student understanding of science.

Instruments Used to Assess Constructivist Teaching Practices

The Science Classroom Observation Rubric from the ESTEEM (Appendix H) was used to assess the independent variable cluster of constructivist teaching practices. More specifically, the observation rubric was used by the researcher to code observational and video data. The instrument was used to document student engagement in activities, the content of each lesson, and the specific pedagogy used in each lesson. The categories of teaching behaviors assessed by the rubric are: Facilitating the Learning Process from a Constructivist Perspective (FLPCP), Content-Specific Pedagogy (Pedagogy Related to Student Understanding) (CSP1), Context-Specific pedagogy (Fluid Control with Teacher and Student Interaction) (CSP2), and Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject Matter) (CK). The rubric has a scale from "0" (no behavior is exhibited) to "5" (the behavior is exhibited at the "expert" level). The mean of the totals is computed and the overall total is converted into a percentage for each science lesson. The Science Classroom Observation Rubric helped the researcher determine if the teacher demonstrated teaching practices consistent with constructivist-based teaching, such as proficiency in utilizing contextual knowledge and prior student learning within each lesson.

The Teaching Practices Assessment Inventory (Appendix I), also was used to assess the independent variable cluster of constructivist teaching practices. The instrument is a self-report instrument that is designed to provide a teacher with awareness of expert teaching based on the constructivist perspective of the ESTEEM instruments. This inventory assesses each of the behaviors listed above from The Science Classroom Observation Rubric. There are four categories for the Teaching Practices Assessment Inventory. Category 1 Facilitating the Learning Experience (FLE), Category 2 Context-Specific Pedagogy (CSP1), Category 3 Content Experiences (CE), and Category 4 Content Specific Pedagogy (CSP2). The developmental stages designed to assess the constructivist teaching are novice, advanced beginner, competent, proficient, and expert. The following scale (Figure 1) is an approximation for estimating competency levels based on scores from the Teaching Practices Assessment Inventory (Burry-Stock, 1995). The percentages for each competency levels are as follows: 85% -100% Expert; 70% - 84% Proficient; 35% - 69% Competent; 15% - 34% Advance Beginner; and 01% - 14% Novice.

The Assessment of Classroom Learning in Science Inventory (Appendix J) also was used to assess the independent variable cluster of constructivist teaching practices. This instrument assesses the degree to which a teacher perceives his or her skills in using student evaluation procedures appropriate for science. There are seven categories for the Assessment of Classroom Learning in Science Inventory. Category 1 Assessment Communication/Enhancing Learning (ACEL), Category 2 Product Evaluation/Enhancing Motivation (PEEM), Category 3 Formal Questioning (FQ), Category 4 Interacting Feedback (IF), Category 5 Conceptualization Activities (CA), Category 6 Grading Implementation (GI), and Category 7 Immediate Informal Feedback (IIF). The developmental stages for the inventory are novice, advanced beginner, competent, proficient, and expert for the inventory. The following scale (Figure 2) is an approximation for estimating competency levels (Burry-Stock, 1995). The percentages for each competency levels are as follows: 85% -100% Expert; 70% - 84% Proficient; 35% - 69% Competent; 15% - 34% Advance Beginner; and 01% - 14% Novice.

Instruments Used to Assess Student Understanding of Science

The Student Outcome Assessment Rubric (Appendix K) was used to assess the dependent variable cluster of middle school ELL understanding of the science concepts being taught. According to Burry-Stock (1995), the rubrics are based on the constructivist concept of “teaching for meaning,” which suggests that the rubric also has construct validity. The student question form was used to determine the extent to which the ELL students understood the main idea of the lesson/experience. The Student Outcome Assessment Rubric is a motivational instrument that questions the ideas/concepts being taught, and to what degree the lesson was relevant to the students.

The scoring of the Student Outcome Assessment Rubric was done on the Student Questions response sheet. Once the ELL students completed their Student Questions response sheet, the responses were compared to the descriptions on the Student Outcome Assessment Rubric. Ratings were assigned, based upon the fit between the student response and the description (Burry-Stock, 1995). After making a comparison of the ELL student responses, the researcher evaluated whether the response were rated as a “1,” “2,” “3,” “4, or “5.” The students were given a “0” if there was no response. The ratings for all three questions were anchored at levels “5,” “3,” and “1”, based on descriptors that are provided with the instrument as criteria for scoring student responses. If a student’s response was described by a “5” level description, the student received a “5.” If the student response was best described by a “3” level description, the student received a “3.” However, if the student response was better described somewhere between a “5” and a “3,” the student received a score of “4.” A “2” rating was given to responses that fell between a “3” and a “1” (Burry-Stock, 1995).

Student constructed concept maps and the Concept Mapping Rubric (Appendix L) also were used to assess the dependent variable cluster of middle school ELL understanding of the science concepts being taught. The Concept Mapping Rubric was developed using much of Novak (1990) and Novak and Gowin’s (1984) original work in the area of concept mapping (Burry-Stock, 1995). The students’ concept maps were completed after each lesson, and the rubric was used to score the maps. According to Burry-Stock, the rubric is to be used as a summative student assessment activity given at the end of a lesson. The categories of the Concept Mapping Rubric are as follows: KNKY is Key and Non–Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern.

A key word list was used to score the concept maps. The Concept Mapping Rubric asks students to include words over and beyond the key word list. This scoring system is intended to encourage students to learn more concepts than those required. Students were given more points for doing this. The categories on the Concept Mapping Rubric start with individual words (Burry-Stock, 1995). If a student mapped all the words from the key list; he/she received a “5” for the scoring item “A.” If there are more words on the student’s concept map that did not appear on the key list, the researcher rounded up when grading the concept maps.

Once all of the averages were scored, then the total numbers were transferred to the class tally sheet and the researcher obtained percentages for each interval scale point 1 through 5. The totals were divided by the total number of students in the class. The class percentage was obtained by summing the students’ total scores and dividing by the total number of students in the class. This average was divided by 40, the number of possible points on the rubric (Burry-Stock, 1995).

Artifacts related to student learning provided the researcher with additional evidence. As the researcher entered Mr. Loes' classroom each day, the researcher never observed a strict agenda of the activities that day or a calendar of future activities. The researcher observed that students were aware of what they will be working on, the names of the unit, goals and learning outcomes established by Mr. Loes, but were not given a strict routine of what to do. Out of 208 hours of observational data collected, the researcher never observed the students taking a quiz, doing worksheets over each unit, or listening to a formal lecture by Mr. Loes. The artifacts of student learning observed by the researcher consisted of constructed lab activities, on force and motion, mouse trap cars, chemical bonds, and Rube Goldberg, student DCA science exams, Section Summary on Chemical Bonds, and presentations of lab work developed by student groups.

Compliance with University Internal Review Board

The researcher complied with the policy on the human subjects of Kansas State University, and IRB approval was granted on April 6, 2006. All participants were provided with consent forms agreeing to participate in the study. Students and their parents or guardians were asked to sign consent statements. All confidentiality was guaranteed throughout the data collection methods used in the case study. Students were given pseudonyms to protect their identity but the teacher preferred to have his real name used. Access to the school was obtained through contact of the school districts' main office, the union, and the building principal. The school and district also gave permission to use the real name of the school.

Data Analysis

Data Analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. According to Shamoo and Resnik (2003), various analytic procedures "provide a way of drawing inductive inferences from data and distinguishing the signal (the phenomenon of interest) from the noise (statistical fluctuations) present in the data" (Shamoo and Resnik, 2003, p. 14.)

The researcher analyzed and interpreted all of the data collected, which consisted of observational evidence, interviews, inventory responses, and artifacts of learning. The researcher's journal, field-notes, audiotapes, and videotapes, were used to record and store data and were a valuable part of the analysis of the study.

The first step in data analysis was to process the data by transferring all recorded data into word typed documents and viewing, re-reading, coding, and categorizing the data. This gave the researcher the opportunity to re-examine each lesson and experiment conducted in the classroom. Journal entries, field notes, and teaching and learning artifacts were sorted and stored with the video tapes from the same lesson.

In the second step, the researcher looked for trends and patterns in each type of data collected. Teaching plans and other teaching materials were combined with other observational data. Observational data, interviews, inventories, and artifacts of learning were each analyzed separately and then compared. Teacher and student behaviors also were analyzed separately and in comparison to one another. The researcher looked for evidence of constructivist teaching and student understanding. The Student Question Response Sheets and Concept Maps were scored by the researcher and member checked by Mr. Loes.

The researcher used the ESTEEM categories as an organizational structure for coding. The observational rubric categories of: facilitating the learning process, content specific pedagogy (related to student understanding), context-specific pedagogy (fluid control with teacher and student interaction), and content-knowledge (teacher demonstrates excellent knowledge of subject matter) were used to categorize or code all observational data. The observational rubric sub-headings from the rubric categories also were used to categorize or code all observational data. The researcher listed an observational rubric category and its sub-headings. Once the sub-headings were listed below each category, the researcher looked for evidence and overlaps between the sub-heading and the observational data collected. This coding process allowed the researcher to look for deeper connections and overlaps between the independent and dependent variables. All data collected remained confidential throughout the data collection and data analysis process.

In the third step, the researcher looked for a relationship between teaching and learning seeking to answer the question “How does constructivist teaching help middle school English Language Learners understand science?” All interpretations of the data were re-analyzed and recorded through voice taped sessions when the researcher reflected on the data being observed.

Trustworthiness of ESTEEM Model

According to the ESTEEM manual (Burry-Stock, 1995), one way to control for inherent measurement problems and increase the validity of the performance measure is to standardize the procedure for collecting data. To obtain, analyze, and provide information for making a decision on the behavior of the teacher, there must be a consistent procedure used across all instruments that will result in accurate sound decisions. The ESTEEM provides the researcher with five steps to ensure a valid performance using a standardized procedure for data collection. The FIVE

STEPS to a Valid Performance Evaluation (Burry-Stock, 1995) are: 1) observe the data source; 2) record objective and accurate data; 3) retrieve the performance using some form of record; 4) analyze/score the observation by comparing the record from the data source to a specific criterion (criteria); and 5) evaluate the observed performance using the information from the analysis completed in step four.

Establishing Trustworthiness of Qualitative Data

The processes of triangulation of data, prolonged engagement, peer debriefing, member checks, and audit trails also were used to ensure trustworthiness of the qualitative data. Triangulation was used to improve the credibility of the study by comparing multiple sources of data used to assess the same variables. Prolonged engagement enhanced credibility by providing the researcher the opportunity to develop a trusting relationship with the research participants. Prolonged engagement also enhanced dependability. Peer debriefing enhanced credibility by soliciting additional data collection and analysis processes from colleagues (those who were experts in the field of study and those who were not). Member checks also enhanced credibility of the findings by subjecting them to the additional interpretations and opinions of the study participants. Interpretations were reported back to the participants to see if these interpretations made sense to them. This process enhanced credibility and provided another opportunity to incorporate the teacher’s perspective and experience into the analysis process. An audit trail was established to document the research process, as well as the decisions and choices made by the researcher so the decision could be reviewed by others.

Triangulation

Multiple sources of data and data collection strategies were used to triangulate the findings of this study. Multiple sources of data included Mr. Loes, his students, administrators, colleagues, and the researcher. The multiple data collection strategies used in this study included: observational evidence including field notes, lesson plans, and other teaching materials, interviews of the teacher his students, administrators and colleagues; inventories completed by the teacher and his students; and samples of student work and other artifacts of student learning. This process of triangulation ensured that all patterns and trends were supported by multiple sources collected through multiple strategies enhancing the credibility of the findings.

During the interview process with the ELL students, the researcher asked the same set of questions, in the same order, using the same words to all interviewees. The structured interviews were convenient for triangulating different interviewees' answers to the same questions. The researcher used different types of interview questions for the building administrator, colleagues, students, and Mr. Loes. Interviewing different individuals in this exploratory case study was important because the data collected used different methods to show the same pattern. This process enhanced the credibility of the patterns that emerged and became a useful tool for this exploratory study.

Prolonged Engagement

Prolonged engagement was used by the researcher to establish trustworthiness of the findings. Prolonged engagement enhanced the credibility of the findings through the development of a trusting relationship with those researched and through repeated opportunities to gather data and explore relationships among variables. This engagement allowed the researcher to observe and interact in various contexts over time, and obtain a deeper understanding of the case study being explored.

The researcher served as an overt participant while observing and videotaping lessons of classroom interactions. First, the extent of the researcher's presence varied from participant to observer. By participating as an observer in Mr. Loes' classroom, the researcher was able to identify important patterns in the data collected and to notice events that ELL students may not have talked about in their interviews. Students may have thought topics were unworthy of discussion, or they may have overlooked certain events, or they may not have wanted to talk about certain issues. Prolonged engagement as a participant observer allowed these topics, events, and issues to emerge as a natural part of the teaching/learning process.

Peer Debriefing

Dr. R. Scott Irwin, science education professor at Emporia State University, was asked to serve as a peer debriefer by co-analyzing all concept maps completed by the ELL students in Mr. Loes' class. Dr. Irwin is an expert in the field of elementary science education. Although an expert in the field of science education, Dr. Irwin had no experience working with the ESTEEM concept mapping rubric. Dr. Irwin was asked to listen to the analysis the researcher was in the process of developing and asked for feedback. Once this process was completed, Dr. Irwin coded the student concept maps using the ESTEEM manual and his scores were compared to the researcher's scores for consistency. The researcher's major professor, Dr. Gail Shroyer, also served as a peer debriefer by examining all interview data once it was transcribed and analyzed.

Member Checks

Mr. Loes Loes was asked to examine the chain of evidence collected by the researcher to see if the analysis/interpretations made sense to him, as a verification of interpretations. The researcher went back to the educators researched or interviewed, at the completion of the study, and asked each participant if the researcher was accurate or needed correction or elaboration on the data as it was collected and interpreted.

Audit Trail

The decisions and actions of the researcher were documented from initiation through study completion using the ESTEEM. This use of the ESTEEM and the researcher's journal provided an audit trail of the study. The audit trail was a record of the research process, as well as the decisions and choices made by the researcher. Dr. Gail Shroyer served as an external auditor by reviewing the data collection and analysis process through the audit trail.

Research Bias

The issue of bias in qualitative research is an important one and demands special attention and discussion in any qualitative research case study. This case study, conducted as a constructivist-based exploration, presents an analysis of the relationship between constructivist teaching and ELL understanding of science. While researcher bias and subjectivity are commonly understood as inevitable by most qualitative researchers, the researcher conducted a qualitative research case study so that the teachers and students involved were comfortable with the idea of someone observing, interviewing, video-taping, audio taping, and note taking in a way that is not value-neutral. This helped minimize bias in the data.

Because it is not possible to eliminate the researcher's bias, it is important to understand his background. The researcher in this study is a 35 year old white male. He has a science degree and psychology minor from Pittsburg State University, a master’s degree in education from Wichita State University and an elementary education degree from Newman University. He taught for eight years at the elementary and middle school level. The researcher was a Grow Your Own Teacher (GYOT) participant for the Wichita Public School District. He worked as a program participant in the Wichita Reads Program under the supervision of Ms. Rupa to provide ELL students’ with reading, writing and mathematics enhancement through tutoring. The researcher served on science curriculum committees, Quality Performance Accreditation (QPA) committees at both the elementary and middle school levels, and coached high school wrestling. The researcher worked on an ESOL endorsement through Kansas State University while teaching in an 8th grade science classroom. As an 8th grade science teacher, the researcher taught in a diversified middle school that was 51.21 % male, 48.79 % female, 85.29 % economically disadvantaged, 14.71 % non-economically disadvantaged, and 51.21 % Hispanic, 27.8 % White, 12.8 % African American, and 8.13 % other.

The researcher returned to graduate school to pursue a doctorate in curriculum and instruction to find answers related to how instructional strategies, pedagogy, and student understanding overlap with curriculum. During his graduate studies, the researcher first became familiar with constructivism and its use in mathematics and science teaching through a course called Seminar in Constructivism in Science and Mathematics. The researcher began the study familiar with constructivism and best practices for English Language Learners.

The researcher entered the school environment at Maymont Middle School un-aware of the depth of constructivism evident in Mr. Loes’ teaching. Having a background as a middle school science teacher, the researcher understood the level of the students and the science content adopted by the school district. During the research study, the researcher found himself looking at different perspectives of constructivist-based teaching, student's conceptual understanding of the science content, how English Language Learners interact in a eighth grade science classroom, and how constructivist-based teaching may work at this level. This case study results is a rich description that presents a clear audit trail so the reader can construct his or her own meanings of the researcher's discoveries.

Summary

The researcher collected and analyzed observational evidence, interviews, inventory responses, and artifacts of student learning. One middle school science teacher, Mr. Loes was selected for the study because of the constructivist-based teaching he demonstrates in the classroom as well as his diverse school and classroom demographics. Mr. Loes was selected through a summer workshop conducted at Emporia State University. Chapter 4 describes the data and events of the eighth grade science classroom of Mr. Loes at Maymont Middle School, his constructivist teaching, and evidence of student learning.

Chapter 4

Results

Introduction

The researcher served as a participant observer in Mr. Loes' eighth grade classroom in an urban magnet middle school in a Midwestern city. Data were collected using 1) observational evidence, which included field notes of classroom observations, videotapes of observed lessons, the ESTEEM classroom observation rubric, lesson plans and other teaching materials; 2) interviews of the teacher, his students, his colleagues; and his administrator; 3) inventories or survey responses from the teacher and his students; and 4) artifacts of student learning which included: a) District Common Assessment (DCA) Science Exam Scores; and b) Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons. The Expert Science Teaching Educational Evaluation Model ESTEEM (Burry-Stock, 1995) was used to collect and code all data.

A total of 208 hours of observational data was collected. The researcher interviewed the school administrator, the teacher, students in the classroom, and colleagues of Mr. Loes. A total of 64 teacher, student, administrator, and teaching colleagues' interviews were conducted. A total of two inventories were completed by Mr. Loes. The ELL students completed two inventories on each lesson taught. These data were analyzed to identify how constructivist-based teaching was being used in the middle school science classroom, and how constructivist-based teaching helps middle school English Language Learners understand science.

City

Wichita, Kansas is the largest city in Kansas located by the Arkansas River, which forks just north of downtown into the big and little Arkansas River. The estimated population of Wichita is 354,617. The city of Wichita is the chief commercial and industrial center of Kansas and has railroad shops, flour mills, meatpacking plants, grain elevators, oil refineries, and a very large aircraft industry. In the heart of Wichita, nestled in distinct neighborhoods, Wichita Public School District (USD 259) offers its community a variety of options for each family's educational choices (Wichita Public Schools, 2006). The district offers 103 learning centers for its 49,065 students.

According to Wichita Public Schools (2006), in addition to traditional neighborhood schools, the district's 24 magnet schools provide a focus on science, technology, international studies, back-to-the-basics, foreign language, and health. In addition, the district hosts an International Baccalaureate program. Wichita Public Schools provide career and technical education programs at district high schools. The Wichita school district offers programs that allow home-school students and parents to have the benefit of utilizing the Wichita Public Schools' lessons and teachers through computers and email.

The Wichita Public School District was recognized nationally by American School Board Journal as one of seven leading urban school districts in the U.S. for gains in student achievement. Parents and staff work together to create a learning environment for each student. The district has produced National Merit Semi-Finalists and the district's teachers and staff continuously earn state and national honors for excellence in teaching (Wichita Public Schools, 2006).

In addition to academic honors, the Wichita Public School District offers students a range of extra-curricular activities including sports, drama, fine arts, community service clubs, speech, debate, forensics and JROTC leadership programs. Partnerships, mentoring programs and tutoring extend help to students who need it. The Wichita community passed a $285 million bond issue in 2000 to update and build new schools. Parents work with staff to shape the direction of each school through site-based management, partnerships, and engagement. According to a brochure produced by the Wichita Public School District, “District staffing understands the values of the parent-child connection in the learning process.” The Wichita Public School district brings a caring approach to the individual and communities it serves (Wichita Public Schools, 2006).

Maymont Middle School

According to Wichita Public Schools (2006), Maymont Middle School is a school located in USD 259. Students are not assigned to Maymont by boundaries; students choose to apply to be a part of a program and its immersion into the study of culture and the arts. Students are selected by a lottery from applications received all across the school district. The building administrator, Mr. Daniels, is a former high school administrator from Wichita Western High School.

The Mission Statement of Maymont Middle School is:

> “As a diverse community of learners and staff, strives to provide a learning environment in which students are challenged to excellence in academics and the arts. Our mission is to work together with students, parents and community to provide all students the opportunities to maximize their learning potential” (Wichita Public Schools, 2006).

Maymont Middle School features a structured academic program with opportunities to explore culture and the arts. Teachers integrate this theme throughout their instruction, making connections between subject-area, content and the arts. Performing arts programs are offered for all students. Maymont’s music program features instrumental and vocal music classes. The drama program combines in-class performance opportunities with an after-school drama program that is open to all students. Computer studies classes provide a strong foundation for all students; technology is integrated throughout the school program. The exploratory offerings are rounded out with classes in physical education, the visual arts, and family and consumer science. Maymont students study a number of cultures, languages, and customs in 7th and 8th grade. Students who experience difficulty in language arts or math, are placed in an intervention class (instead of foreign language) to assist them in their academic advancement (Wichita Public Schools, 2006).

The enrollment at Maymont varies between 610-630 students, with around 210 students at each grade level. There are 51.69 % females, 48.31 % males, and 67.95 % of the students at Maymont are economically disadvantaged. Maymont has a Hispanic population of 21.42 %, 16.10 % of the students are African American, 55.39 % are White and 7.09 % are classified as “other”. Grade level Learning Communities are comprised of the CORE teachers (Language Arts, Math, Science, Social Studies, Foreign Language, and Special Education) (Wichita Public Schools, 2006). According to the building administrator Mr. Daniels, teachers at Maymont work together with students and parents to ensure that the students are successful in academic and social experiences. Mr. Daniels encourages his teachers to become part of all social interactions in the classroom and outside of the classroom.

The researcher often observed that the middle school is kept clean and has new science classrooms due to the bond issue passed in the school district in 2000. The researcher noticed that teachers stand in the hallways to ensure safe passage between class dismissals. Students are respectful to staff and one another as they pass from one classroom to the next. There is student work displayed throughout the hallways of the middle school. Photographs of student’s activities are placed in locked glass cases, and records of student athletics are presented in front of the gymnasium from years past to present. The teachers’ classrooms have signs on their doors with their names in English and a translation of “Panther Pride” in Spanish.

School Dress

Students and teachers dress casually at Maymont Middle School. While being observed from April 10 – May 24, 2006, Mr. Loes usually wore shorts with sandals, and a short sleeve button up shirt to class. He is clean cut with no facial hair. He has grey hair, strong build with a deep voice, a large mandible and wears prescription glasses. The other teachers in the building dressed casually, wearing slacks, nice shirts and often jeans depending on the day of the week. Mr. Daniels, the building administrator, wore slacks and usually a colored shirt bearing the schools insignia and mascot.

During the observed period of April 10, 2006 to May 24, 2006 all students wore jeans, shorts, t-shirts with propaganda, sweatshirts, tennis shoes, sandals, or the occasional work boot. The girls wore a lot of makeup, did their hair up, had highlights or extensions in their hair, wore plenty of perfume and carried compacts with mirrors everywhere they went. Many girls were observed putting on glitter lip gloss, eye make-up, flossing their teeth in public and spraying on some type of body spray. Girls wore necklace jewelry and short cut top shirts they tended to hide with a hooded jacket. Boys were observed wearing jeans or baggy shorts with team logos on them, basketball or football jerseys; concert t-shirts, metal jewelry with some type of logo. Many had dyed hair with blonde streaks in it, and soiled garments with stains. The boys occasionally wore watches and repeated the same outfit throughout the week. Students were constantly chewing gum, eating candy, or sneaking the occasional beef jerky and pop in their book bags or purses. Students are not supposed to carry a book bag or jacket in the classroom of Mr. Loes. Mr. Loes was observed sending many students to the office numerous times to have them retrieve an article of clothing that would cover up their midriff.

School Atmosphere

As the researcher walked up to Maymont Middle School for the first time, he observed the main entrance faced the East. Across the street from the middle school were apartments, rental houses, homes owned by individuals and businesses in operation. As the researcher walked down the sidewalk at the front of the school, there were broken Bourbon bottles on the sidewalk, fragments of clear and green glass spread along the brown patches of dirt that once bore grass along the sidewalks edge. The researcher approached the front doors of the building and observed a female student being escorted out of the building’s main entrance in handcuffs and placed into a squad car by a city police officer.

As the researcher entered Maymont Middle School for the first time, he observed the smell of an old gymnasium, wrestling mat rubber filling the air, heat from classrooms, concrete block walls painted some time ago, an old outdated floor with multi patterns, and the lines and rows of lockers that housed many items for students throughout the years. There were anti drug posters of Barry Sanders and his brother that were dated back to 1986 still hanging on the walls in front of the girls locker room entrance.

Like many middle schools, Maymont was under construction so bathroom space was limited. The office was moved into the library, classrooms were being invaded by district employees and the lighting was dim and bleak. The researcher felt a warm positive environment filled with the roar of sixth through eighth grade middle school students who passed him in the hallways. The researcher often observed students spilling and dropping papers, slamming books, stepping on pencils, and shooting unusable pens into the trash receptacles as if they were basketballs. The researcher saw groups of students huddled together talking about who was cute and who made them mad. The researcher noticed students smiling, plowing solo through the halls, moving in packs, groups of two or three, and making turns as if they were on a Metro that had a specific time schedule to follow.

Many times as teachers passed the researcher in the hallways they conversed with one another, talking about who was leaving the building and when, how hot the hallways were, and why the summer was not here soon enough. Teachers passed the researcher in the hallway asking who the researcher was subbing for, did the researcher know how to get to where he was going, did the researcher need any help, and what grade level was the researcher teaching for that day. Many times teachers looked right at the researcher, pointed to the office and said, “That is where you need to go, right down there.” Both secretaries in the office were very busy and friendly. The researcher asked them for a meeting time with the principal at his convenience, they looked up from their piles of papers, over the shoulders of students and provided the researcher with a block of times for a meeting. Each encounter with the secretaries was welcoming and they were willing to help the researcher with any item he needed or questions he asked. To many outsiders, one might consider this to be organized chaos or a place where noise rains supreme. As a former middle school teacher, this was home; a place the researcher once spent so much time trying to help so many people. A seasoned veteran is someone who can come into a place recognize its internal working abilities, jump right in to lend a hand, understand why things are the way they are, and feel right at home with the chaos.

When asked about his school Mr. Daniels explained, “We are cultural fine arts magnet school; we have a great school here with a great group of kids.” Ms. Lea, the school’s only librarian, was the researcher’s middle school librarian when he attended middle school in Derby, Kansas. She commented on the school and her role within the school as, “The building, its resources and these kids are really great. We have issues like anyone else but this was a great place for me to come out of retirement for. I have not regretted coming out of retirement to work with these kids. I feel that there needs to be more people in our school systems who would want to see all children make it. I am glad to be doing what it is I am doing right now in my life.”

Because Maymont has students who apply to come to this school, many of the students come from a wide variety of backgrounds and scattered locations throughout the city of Wichita. Boundary issues in the district are different for students who apply to attend a magnet school. A majority of these students will attend high school at a magnet high school, or the high school that is within their boundaries due to their home location.

Overall the atmosphere at Maymont Middle School felt warm, exciting, adventurous, and safe. Maymont Middle School appeared to have its ups and downs when it came to student cooperation, discipline issues, teacher interactions, building improvements, and other issues that many other middle schools encounter. Maymont appeared to have a non threatening environment, which provided teachers and students the positive opportunity to grow in education through cooperation, determination, dedication and satisfaction. According to the school administrator, there is community support which enhances the positive levels the school needs to function as a middle school. The building administrator felt the community that surrounds the school provides the students the opportunity to grow and maintain positive values outside of the school walls.

Like many other schools, teachers expressed they still take work home, find little time for lunch, wait in line to make copies, wait to use a microwave in the teachers' lounge, are limited on their budgets and supplies, would like to see more interaction with each other without feeling overwhelmed, and would like the opportunity to see all children succeed.

Physical Classroom Environment

The classroom of Mr. Loes is a unique one. The room has five rows of six desks in each row in the middle of the room that face forward to the dry erase boards and are surrounded by seven lab stations that seat up to four students each. Each lab station is complete with an Apple computer that was salvaged from the library's scrap section. There is internet access for each computer which gives students the opportunity to use the internet for additional technology support. Each lab station has a sink, fire proof table top, cabinets for supplies and paper towel racks for cleaning up after lab procedures.

The researcher observed Mr. Loes had a tall lab table in the front of the room where he can conduct demonstrations, access the computer to take role in his classroom, write on a double wide dry erase board, have access to water for lab work and control the climate in the classroom. Mr. Loes has many science experiments hanging on the wall from students he previously taught as well as current projects being constructed in the classroom. These experiments range from constructed solar systems that operate on light, a Jacobs's ladder, a pickle light, marshmallow cannons, mouse trap cars, bio systems and many other items students can observe while in his classroom. Hanging on the dry erase board is an overstuffed rat that speaks its mind once the noise level in the class rises. Hanging by the rat is a Seeing Eye cane that you may find Mr. Loes using to walk down the hallway with a pair of dark sunglasses pretending to be a blind teacher on the run trying to get to the bathroom in between passing periods.

To the west of the dry erase boards in his classroom is a door that leads into an office which he shares with the other eighth grade science teacher, Mrs. Ballwin. The office has a wide variety of supplies that both teachers share, provides access to more counter top space, has items placed in a refrigerator, and contains a sink outside of the classrooms. Mr. Loes keeps his geology rock collection in the back office due to its size and the space it occupies. Both teachers do their grading and prepare for teaching in this office. By the door of Mr. Loes classroom is a Panther Pride cushioned chair that is covered in the traditional school colors of black and yellow. This chair serves a purpose of allowing visitors to come into his classroom anytime to see what he may be doing in the class that day.

In the 2005 – 2006 fiscal school year, there were 119 students who entered and exited Mr. Loes' classroom. There was a diverse group of students in each of his classes, ELL, African American, Native American, Asian, and Caucasian students. During this year, Mr. Loes taught a dual science curriculum with a first hour general science, second hour physics class (this is an elective that the students sign up for), third hour general science, fourth hour general science, lunch break, fifth hour general science, sixth hour team planning time and a seventh hour personal plan time.

Observations of Teaching

The researcher observed four major units: 1) Force and Motion; 2) Mouse Trap Cars; 3) Chemical Bonds; and 4) Rube Goldberg. Each observation was videotaped for forty to forty five minutes. The researcher often videotaped multiple observations of each unit. The ESTEEM

Observation Rubric includes four major categories used to assess constructivist teaching: 1) Facilitating the Learning Process from a Constructivist Perspective (FLPCP), 2) Content-Specific Pedagogy (Pedagogy Related to Student Understanding) (CSP1), 3) Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction) (CSP2), and 4) Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject matter) (CK). Each of these categories contains subheadings to more specifically delineate observational evidence of constructivist teaching. Each category and subheadings also provide opportunities to document student learning in relationship to constructivist theory. Observational data related to teaching and learning will be reported under these four categories and subheadings.

Facilitating the Learning Process from a Constructivist Perspective

The five subheadings from the Facilitating the Learning Process from a Constructivist Perspective are (Appendix H): Teacher as a Facilitator, Student Engagement in Activities, Student Engagement in Experience, Novelty, and Textbook Dependency. The researcher assessed Mr. Loes' level of constructivist teaching at 5 on a 5-point scale. The following examples provide evidence of the rating in each subheading. In subheading A., Teacher as a Facilitator, the rubric describes a level five as, "Students are responsible for their own learning experiences. Teacher facilitates the learning process. Teacher-student learning experience is a partnership." The students in Mr. Loes classroom were responsible for their own learning experiences. He praised students constantly on what it was they were doing at that very moment. Students did not have time to get on the internet and look up the latest music videos, write notes to one another (unless it was a blueprint of the object), or to attempt other means of getting out of the current lesson.

The researcher observed Mr. Loes as part of the learning process at all times. Students appeared to feel comfortable asking his advice. But many times the researcher observed students stopping before they asked because they knew he would not give them the direct answer to their question. The researcher often noticed that students were given any opportunity to look around to see what other students may be doing in the classroom. The researcher often observed the class working as a team. He did not try to fill them with pre-determined knowledge.

The researcher observed a thirty minute lesson from the Chemical Bond unit in Mr. Loes's first hour. The researcher observed him passing out 500ML beakers, balances, wax paper (for the balances), salt, water, a hard boiled egg (one per group), and red dye food coloring. The students were asked to predict what would happen if they dropped a hard boiled egg in water? Students looked at each other and without any reply, Mr. Loes said, "Would it float?" The researcher observed one student raise her hand and ask is there anything in the water. Mr. Loes commented, "You tell me" Students were then given the opportunity to decide how much water they would pour into their beakers and record it in their lab books. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> Students discussed how much water they would place in their beaker. After doing this they had to decide if the egg would float. Each lab group did complete opposites; not one group followed the same pattern. One group placed the egg in the beaker and then added water to see if the water level rising would float the egg. Another group measured out the salt on their balance to see what the mass was. One student from that group commented, "Would more salt mean more mass in the water or would more egg mean that the mass of the salt would change the mass of the water?" One of the lab partners said, "Not all of the eggs mass were recorded so not one mass should be the same." Students added more salt

and then they tried to remove the salt once it was added in the beaker throughout the entire lab. Some of the students were using words such as, “massive” or “less dense” and “less means more.” Mr. Loes keeps walking around and the students know not to ask for the answer to the problem, “The Great Egg Float.”

In subheading B., Student Engagement in Activities, the rubric describes a level five as, “Students are actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the lesson.” Students were observed to be actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the units. In the Rube Goldberg, Force and Motion, Chemical Bonds, and Mouse Trap Cars units, Mr. Loes encouraged his ELL students to test their own ideas by answering their own questions, exploring and reasoning, conducting a trial and error, and discussing with one another their guesses, predictions, explanations, and questions. Mr. Loes did not answer direct questioning from his ELL students; they had to examine the evidence.

Students prior knowledge was activated through a questioning routine that involved asking the students what they knew about the content and brainstorming and predicting outcomes. Students were given an ample amount of time to discuss in groups what they knew about new concepts. Students also performed simple processes or tasks to see what they knew about the new concept. During a fifteen minute observation of the Force and Motion unit, the students were asked to come up with their own ideas about how to construct something that can withstand great force from an object. Two female ELL students developed a truss system for the enhancement of a bridge. These two students constructed their own ideas regarding how a truss is a support enhancement for the force of an object. During a five minute observation of the

Mouse Trap Car unit, Mr. Loes encouraged his ELL students to examine and interpret the evidence in order to test their own ideas and answer their own questions.

In subheading C., Student Engagement in Experience, the rubric describes a level five as, “Students are actively engaged in experiences (physically and/or mentally).” Students were actively engaged in experiences both physically and mentally, on a constant basis. All observed units were taught from a hands-on perspective in Mr. Loes’ class and there was a level of student ownership from all constructed experiences. The students in the physics class had to design and build a Rube Goldberg activity that functioned. Mr. Loes showed two movie clips so that the students could see what a seven step operation look liked. The movie clips that were selected for the students viewing were *Goonies* and *The Were Rabbit*. Mr. Loes said, “This is basically what I want, how can you build a series of events to do the simplest things?” Each lab group had to provide its own materials for this lesson. Mr. Loes worked only as their consultant; he would provide input but no answers. Each day the students would run trial after trial testing their events to make sure that it would address a simple step procedure. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> The students record each step in the lab manual checking for consistency, fluency and operator error. Each group has constructed a completely different seven step Rube Goldberg operation. One group has brought race cars, race car tracks, mouse traps, a rat trap, marbles, and dominos. Another group has brought paper towel rolls, toilet paper rolls, glue, golf balls, an egg (They hid this from the teacher each time), and some plastic baskets. Each time the lab groups would operate their step procedures, they would discuss if it met the grading requirements set by Mr. Loes. His grading requirements for the success of this lab are based on how many events occurred, and whether they were

different instead of one large event. He stressed to each group that each event must be separate. He would walk around having the students justify why they felt theirs met each criterion. Only two groups passed the seven event stage. Two other groups had five, and one other group had four. I did not detect any sorrow from the students after their event did not meet the exact criteria of seven events. The students seem happy that they had a successful operation after all.

In subheading D., Novelty, the rubric describes a level five as, “Novelty, newness, discrepancy, or curiosity are used consistently to motivate learning.” All lessons observed consistently used novelty, newness, discrepancy, and curiosity to motivate learning. In the thirty minute lesson example provided in sub category A, Teacher as a Facilitator, “*The Great EGG Float”*, the concept was new and the materials and introduction to the lesson created a challenge that stimulated curiosity and motivation.

Mr. Loes motivated learning by allowing his ELL students to explore the science content with their hands and minds through experiments and artifacts. To motivate learning, Mr. Loes used student questions, interests, and ideas to guide his lessons and entire instructional units. He provided his ELL students the opportunity to examine new knowledge, discuss their ideas, use hands-on exploration, and pursue answers to their own questions.

In subheading E., Textbook Dependency, the rubric describes a level five as, “Teacher does not depend on the text to present the lesson. Teacher and Students adapt or develop own content materials for their needs.” Mr. Loes did not show a dependency on a textbook for student learning. The researcher observed that students learned through the materials and artifacts presented to them. When Mr. Loes was asked about textbooks in his classroom, he responded, “I am not a believer in cookbook learning or recipe teaching, and students need to construct or develop what they understand it to be. Textbooks and science lessons in books are someone else’s construction of that knowledge. Basils are cookbooks and sometimes they can be a great guideline for a teacher; however, students’ knowledge should not be constructed from Basils alone. Students need to explore within their own minds as to what the lesson/unit means to them.”

In the Force and Motion unit, students were given a pile of toothpicks and glue and were asked to construct a bridge that would hold a book. As the students completed the project, Mr. Loes applied a string to the book and said he was going to “hang” the book from their bridge instead of place it on top of it. Mr. Loes changed the force capabilities of the object. ELL students had to re-formulate “new” ideas around the concept to modify their bridge; they were not given a recipe on how to do this. During the unit on simple machines, students arrived at class to find piles of materials at their lab station. The dry erase board read, “Using the materials in front of you, how can you create a simple machine?” List of materials: 1) mousetrap; 2) hot glue gun; 3) wooden dowel; 4) wheels; 5) string; and 6) metal washers.

The textbook that was available in the classroom is called *Science You Can Use* by Stone and Stephenson, copyrighted in 1959 by Prentice Hall. Mr. Loes feels it is one of the best textbooks for kids to see another example of the content they are studying. But there are not enough textbooks to send home with each student so the books lie on lab stations and the students can examine it if they like. Mr. Loes provides a variety of alternative sources for new information both through written materials and experts. The researcher observed him incorporate aerial pictures he took from an airplane. He asked his students to discuss and question what they saw on each slide. Then he walked around the room asking students what they knew about geology.

Content-Specific Pedagogy (Related to Student Understanding)

The six subheadings from the Content-Specific Pedagogy (Related to Student Understanding) are (Appendix H): Student Conceptual Understanding, Student Relevance, Variation of Teaching Methods, Higher-Order-Thinking Skills, Integration of Content and Process Skills, and Connection of Content and Evidence. The researcher assessed Mr. Loes level of constructivist teaching at a 5 on 5-point scale. The following examples provide evidence of this rating on each of the subheadings.

In subheading F., Student Conceptual Understanding, the rubric describes a level five as, “The lesson focuses on activities that relate to student understanding of concepts.” All units observed were focused on activities that related to student understanding of the concepts. Mr. Loes planned his units to match the appropriate level of his students and their educational background. He used student ideas, experiences, and interests to drive his units. He built understanding through his planned activities and he reinforced understanding through questions and discussions. He also adapted his lessons for his ELL students. Mr. Loes continued the activities until students could demonstrate their understanding of the concept. The researcher observed two ELL students who came to class with outside information on a Rube Goldberg contest and with new ideas they could incorporate into their seven step procedure. The researcher videotaped ELL students constructing their mouse trap cars. After analyzing the videotapes, the researcher observed that each group of ELL students understood how to build a functional mouse trap car through the concepts being taught. The evidence was a completed functional mouse trap car that traveled a certain distance.

In subheading G., Student Relevance, the rubric describes a level five as, “Student relevance is always a focus and the lesson relates to student experiences.” Student relevancy was always a focus and the lessons related to student experiences outside of the classroom. In the Chemical Bonds unit, Mr. Loes related the unit to the students' everyday lives by asking them to examine what the words chemical and bond meant. There was never a clearly defined definition of the word chemical or bond on the classroom dry erase board. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes:

> Mr. Loes began the introduction to the lesson by talking about something they had explored earlier in the school year, "Atoms and Chemistry." Students were asked if they remember anything about atoms (Students raised their hands and answered). The students were asked if they remember what a building block was? Mr. Loes continued his discussion by saying, "When we think of how things bond together, I want you to give me some examples of what bonding means. Now write it down and talk about it with one another (students begin to write and discuss what bonding is)." "Now share with me what you think bonding is." One student raised her hand (An ELL student from Nigeria). "Bonding is my basketball team; we have to bond together to function as a group." Mr. Loes smiled and told her great job. He then asks for further participation from the group. A student shares how bonds are like marshmallows that get sticky and clump together, Mr. Loes says, "Exactly." He then asked "If I gave you starch, glue, water (He only refers to water as water), beakers, and corn starch, would this be a bonding activity? I want you to be able to explain to me if this is: 1) a bonding activity, 2) a physical reaction, or 3) a chemical reaction. Can anyone tell me if you can undo a chemical reaction?" Students reply, "This cannot be reversed." Mr. Loes passes out the materials and lets the students explore. Students mix and create a glob like substance. As he walks around the room he asks students, "Do you think all of these materials have bonded together? Can we undo

> this bonding relationship? Why or Why not?” Students began to share-explaining that everything has stuck or bonded together because of the chemical reaction involved.

The next day Mr. Loes had written “Chemical Bonds” in big red and blue letters on the dry erase board (there was no definition). Students arrived as the final bell was announced; Mr. Loes was in the back office bringing in a stack of papers. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes:

> Mr. Loes looked at the class to see who was missing, he then turned to the dry erase board pointing and saying, “What are these? Have you ever seen these before? Take a minute and think about what I have written on the board.” One student replied, “You have written about permission slips.” Mr. Loes gave the student a casual look and said, “Bonds, what about bonds, James Bonds everyone. Take some time to discuss this with one another. Ok, I am going to take role.” As he introduced Chemical Bonds to his students, he did not lead them into the specifics of what chemical bonds were. He allowed plenty of time for the students to discuss what a chemical bond was (7 minutes). He then had the students share with the whole class what they thought a chemical bond was as a group. After the discussion, he let the students look on their lab Mac computer to search the internet. He walked around the room watching as an observer and then slowly integrating other types of bonds by saying, “What can you find out about, “hydrogen, ionic, and covalent bonds?” One student raised his hand and asked if a hydrogen bond was the same as a hydrogen bomb. Mr. Loes asked the student to look at both of them and try to find similarities. The student came back to Mr. Loes telling him that a Hydrogen Bond is the bond in water and a hydrogen bomb is a fission bomb that is produced when you incorporate hydrogen gas and do many other alterations to it. The

student then said, “I cannot believe it tells me how to build one.” The student had discovered on his own the difference between the two without relying on a definite answer from Mr. Loes or a textbook. The researcher wrote that all students were engaged through this entire process. Having students look for themselves and construct what they think the differences between the bonds are is the use of a constructivist teaching style.

In subheading H., Variation of Teaching Methods, the rubric describes a level five as, “During the lesson the teacher appropriately varies methods to facilitate student conceptual understanding i.e., discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, demonstration etc.” The researcher observed that Mr. Loes varied methods to facilitate student conceptual understanding. He used discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, and demonstration. Each day in Mr. Loes’ classroom was an event waiting to happen. The day began with what he wanted the students to be doing for that day. Many times it was a questions such as, “What did you have for dinner?” “How was your evening last night?” He likes to see where his students are as the day begins. He is often interrupted by the pledge of allegiance.

Mr. Loes’ long term lessons and units were examined. He planned out the weekly events in a Green River Lab Book that is made of grid graphing paper. He rarely used the district planning manual. Mr. Loes feels that a structured, school monitored, planning process does not allow freedom for the “creative” planning teacher; it controls too much of the person inside of you. Mr. Loes feels that a good teacher can actually make adaptations to their original plans to take advantage of a “teachable moment”. “If we followed a plan book to extreme detail and never left it to explore a “teach at the teachable moment”, we would break down if a step was left out.”

The researcher never observed Mr. Loes delivering a formal lecture where information was transmitted from teacher to student. All lessons were interactive and involved multiple modes of delivery. All strategies included oral interactions. Readings were supplemental and not used to present new information.

In subheading I., Higher-Order-Thinking Skills, the rubric describes a level five as, "Teacher consistently moves students through different cognitive levels to reach higher order thinking skills." Mr. Loes consistently challenged students to use higher order thinking skills through their assigned tasks and his questioning skills. In the Mouse Trap Car unit, students were never given direct instruction on how to construct their cars. The researcher often observed students asking Mr. Loes how to build a lever that could withstand the force of the spring on the mouse trap. He answered with a question, "How strong is your spring?" Students then asked if it is possible to allow the lever to be stronger than the spring to provide enough force to make their car travel at a velocity fast enough to create more distance. Mr. Loes asked the students what the word velocity meant.

The researcher often observed students making minor adjustments to their mousetrap cars. Students used problem solving and trial and error to construct their car. The researcher observed students make modifications by building three separate kinds of levers to see which one could withstand the greatest force. Once each lever was constructed and tested, the students would record the results in their lab book. These students made adjustments and modifications to the levers until one could be wound with string to support the force of the spring on the mouse trap.

In subheading J., Integration of Content and Process Skills, the rubric describes a level five as, "Content and process skills are integrated." Mr. Loes utilized the scientific processes of observing, inferring, predicting, communicating, hypothesizing, experimenting, interpreting data, and forming conclusions when teaching each major science concept in the unit and any other content area he integrated into the unit. In the Rube Goldberg unit, Mr. Loes provided students with video clips of easy ways to achieve difficult results. Students were encouraged by Mr. Loes to exert maximum effort into their lab that modeled a Rube Goldberg process to accomplish minimal results. Students observed the video clips, discussed what materials they would need, predicted an outcome, developed a hypothesis, and tested their hypothesis. The researcher observed a group of four ELL students whose materials consisted of plastic race car tracks, race cars, marbles, dominoes, green army men, a mouse trap, bucket, string, hammer, and some paper cups. Students discussed where the materials should go, constructed the Rube Goldberg process and tested it. The students continued this process until their maximum effort produced a seven step process that accomplished minimal results.

In subheading K., Connection of Content Evidence, the rubric describes a level five as, “Concepts are connected to the evidence.” Mr. Loes used evidence to build understanding of the concepts and expected students to do the same. The researcher observed ELL students working in groups on the Chemical Bond unit. Students discussed how the words chemical bonds, ionic bonds, and hydrogen bonds connected. Through three separate observations, the researcher observed students gluing white styrofoam balls to the ends of wooden dowel rods to demonstrate how bonds would react with one another. During these observations, the students went to Mr. Loes asking for his input on the content he provided for them about chemical bonds. The researcher observed Mr. Loes teach at a teachable moment when the students asked for support. Mr. Loes took a clear plastic tub and filled it with water. He then asked the students to describe what they saw. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes:

After the students observed the plastic tub of water, they began to generate questions of what they saw. Mr. Loes asked them if there is anything from the content that would relate to what they were observing. Mr. Loes asked them if there was any bonding occurring in the tub, if so what? Mr. Loes sprinkled pepper in the water and asked the students if the pepper is evidence that bonding is occurring or if the pepper is just floating on the water? Mr. Loes asked the students what would happen if he touched the water with a toothpick. The students discussed with one another what might happen. Before Mr. Loes placed the toothpick on the water he paused and asked the students if they were comfortable with what bonding actually meant. The students replied with no. Mr. Loes told the students to go back and provide him with evidence of what chemical bonding really means, then he would show them what would happen when he touched the water with the toothpick. The students went back to their lab stations and looked for evidence on the internet. The students returned with a definition they found on the internet. Mr. Loes asked the students to read him the definition, a student read, “A chemical bond is the phenomenon of atoms being held together in molecules or crystals. All chemical bonds are due to electrons interacting simultaneously with the atoms in question. These electrons are normally part of an atom's atomic orbital, but in a bond, they form a molecular orbital. These electron-nucleus interactions are caused by the fundamental force of electromagnetism. Atoms will form a bond if their orbital’s become lower in energy when they interact with each other.” Mr. Loes asked the students to interpret that definition to prove they understood what it actually meant. A student said, “If there was no bonding there would be no water, water is dense and needs a bond. Because the pepper is on top of the water does not mean that those atoms are constantly bonding.

To bond means to share, so since there is bonding occurring there is sharing between the atoms." Mr. Loes smiled and touched the water with the toothpick. One student asked why that happened, he replied, "You tell me. Go look it up and provide me with evidence that the pepper has nothing to do with the water molecules bonding." Before Mr. Loes walked away, he told the students not to get too far off track and to provide him with evidence that there is a connection between the content and their model.

Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction)

The three subheadings from the Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction) are (Appendix H): Resolution of Misperceptions, Teacher-Student Relationships, and Modifications for Student-Understanding. The researcher assessed Mr. Loes level of constructivist teaching at a 5 on 5-point scale. In subheading L., Resolution of Misperceptions, the rubric describes a level five as, "As student misperceptions become apparent, the teacher facilitates student efforts to resolve them by gathering evidence, participating in discussions with students, or fostering discussion among students." When student misconceptions became apparent, Mr. Loes challenged students to re-examine the concepts by gathering additional evidence, by asking questions and engaging the class in discussion, and by encouraging the students to talk about the concept in their terms.

The researcher observed in the Force and Motion unit that there were student misperceptions. He observed one group of students discussing how they could stack the toothpicks in a pile and lay the book on top of it. The students emptied their boxes of toothpicks and then ask Mr. Loes to come lay the book on top of their pile of tooth picks. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> Mr. Loes was asked by a group of ELL students to place the book on their bridge. He looked at the student and said, “There is no way you are done already, it hasn’t even been twenty minutes.” The student told Mr. Loes they were done. He grabbed the book and walked over to their lab station. He said, “What is this, it is just a pile of tooth picks, I asked you to build a bridge.” The students smiled and said that this was the easiest thing they could come up with. Mr. Loes walked over to his computer and asked the class to put everything down. He asked a student to turn off the lights and he then brought up a website from the internet for the class to observe. He said to the class the class, “Have you ever traveled across a bridge before? Was it a pile of steel stacked on top of each other? Are all bridges alike?” He then said, “Look at the screen, what do you see?” He gave the student’s time to talk with one another as he explained to them that their bridges must be a structural object that can be placed between two desk ends and be able to hold the force of the book he had on display at the front of the room on his lab table.

This provided the researcher with evidence that Mr. Loes confronted misperceptions through the use of evidence and discussion. Misperceptions became apparent when the group of ELL students piled toothpicks together instead of building a bridge. Mr. Loes worked as a facilitator to resolve the misperceptions by gathering evidence, having the students gather evidence, and fostering discussion among students.

In subheading M., Teacher Student Relationships, the rubric describes a level five as, “Teacher consistently demonstrates good interpersonal relations with students. No differentiation is made regarding: ethnicity, gender, multi-cultural diversity, and special education classifications.” Mr. Loes demonstrated great interpersonal relations with his students. The relationships the researcher observed between Mr. Loes and his students were very professional.

The first day the researcher observed Mr. Loes, the room was filled with laughter, excitement, energy, cooperation, student enthusiasm, and questioning. Here is an excerpt from the researcher's journal,

> The students seem so comfortable with all of the questioning going on. Mr. Loes does not seem like the teacher at the moment, but someone who is mildly interrogating students' knowledge about the subject being discussed. The energy in this class rivals anything I have seen at the middle school level. Students know what is expected of them, and they fit comfortably into that routine.

Across multiple observations, the researcher saw Mr. Loes make no differentiations made regarding ethnicity, gender, multi-cultural diversity, and special education classifications. According to Mr. Daniels, Mr. Loes was successful with his classroom management because of the low percentage of discipline problems that were yielded from his classroom by the front office. Mr. Loes often used music in his classroom to get his students motivated. Mr. Loes had order and respect of his class. The researcher never noticed Mr. Loes loosing his temper, getting frustrated or loosing the respect of his students. The researcher observed ethical communication between Mr. Loes and his students at a level everyone understood. The students appeared to act as if they were scientists in his classroom.

Mr. Loes expected all students to succeed and to be given the opportunity to grow and enjoy what they do in school. He therefore took it upon himself to create experiences in his class that would help each student understand the concepts being taught, rather than expecting students to learn at home.

In subheading N., Modifications for Student Understanding, the rubric describes a level five as, “Teacher has continuous awareness of his/her student understanding and modifies the lesson when necessary.” Mr. Loes is continuously aware of his students’ level of understanding through social interactions, and questioning procedures. Instead of sitting at his desk, he constantly moved among students watching closely and asking them questions to informally assess their understanding. During seven videotaped lessons, Mr. Loes was continuously aware of student understanding and modified the lesson when necessary. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> Mr. Loes continuously geared the difficulty of the Rube Goldberg lesson up and down through questioning and science as an inquiry. An ELL student raised their hand and asked, “How do we know that an event is actually one event and not several?” Mr. Loes replied, “Excellent question, lets go back to the video clips and I can go over each step with you.” Mr. Loes said, “What I want from you is to identify when a step ends and a new step begins.” Mr. Loes ran the video clips and the students watched. A student raised their hand and said, “There, that is a new step.” Mr. Loes asked why. The student said, “Because it is a different step.” Mr. Loes said, “Now I am going to show it to you in slow motion so you are sure that the step changes.” Mr. Loes slowed the video clip down and students watched each step take place.

This provided the researcher with evidence that Mr. Loes was aware of his students’ understanding of what was classified as a step. Mr. Loes used questioning as a formative assessment strategy to identify each student’s understanding of the concept being taught. He then created additional experiences, like watching the video in slow motion, to be sure to clear up any confusion. Once Mr. Loes was confident the students could determine the differences between steps, he let the students work more as he reduced how many questions he asked.

Because Mr. Loes did not follow a scripted lesson planning format, he allowed himself freedom to modify the lesson when necessary. On a separate video analysis, the researcher observed Mr. Loes modify the Rube Goldberg lesson when an ELL student asked the question, “Why are we limited to seven events? All events are not limited in society, like car crashes on race day. One car can cause many events to occur, why should a race be limited to only a few crashes?” He modified the lesson by asking the student what he/she would do to make the process easier and provide evidence of his/her explanation.

Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject Matter)

The four subheadings from the Content-Knowledge (Teacher Demonstrates Excellent Knowledge of the Subject Matter) are (Appendix H): Use of Exemplars, Coherent Science Experiences (Lesson), Balance Between Depth and Comprehensiveness, Novelty, and Accurate Content. The researcher assessed Mr. Loes’s level of constructivist teaching at a 5 on 5-point scale. In subheading O., Use of Exemplars, the rubric describes a level five as, “Exemplars and metaphors (verbal, visual, and physical) are frequently used and are accurate and relevant throughout the lesson.” Mr. Loes frequently used real life examples and metaphors to help his students understand the content being studied. All exemplars observed were accurate and relevant to the topic. Students were provided opportunities to see visual examples such as pictures and power point slides from a computer. They created physical models such as bridges and mouse trap cars.

During a Geology unit Mr. Loes provided students with pictures he had taken from an airplane of the western part of the United States of America. Students examined the photographs through an overhead projection. There were examples of previous student work, annotated illustrations of learning, achievement, and quality in relation to the levels of science being taught in Mr. Loes' classroom hangings on walls and on top of cabinets. Students also were responsible for creating their own examples and metaphors. The teacher and students used verbal analogies and metaphors such as comparing a chemical bond to bonding of a basketball team or like marshmallows that get sticky and clump together. Visual, verbal, and physical examples and models from current students were examined in a group atmosphere.

In subheading P., Coherent Science Experience (Lesson), the rubric describes a level five as, "Concepts, generalizations, and skills are integrated coherently throughout the experience (lesson)." Mr. Loes focused each unit on a few major concepts. He helped students make generalizations about the concepts and use skills to reinforce understanding in a unified coherent manner. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes:

> Mr. Loes is helping students understand the concept of bonding and the difference between a chemical change and a physical change. Mr. Loes talked about his experiences as a field geologist and how chemical bonds relate to oil. He said, "Have you ever seen your mother cook with oil? Did you know that by heating oil to a certain degree actually changes the chemical bonding process? Where do you think we get Trans fats from?" Mr. Loes shared an example of a previous experience and then led the students into a discussion about the materials on their lab stations. He walked patiently around the room watching his students' expressions as they observed the white materials in front of them. He asked the students what would happen if they mixed the materials together? What would they see? The students began to mix the materials with their hands. The student's hands became sticky and white. The result was a glob like gooey substance that bonded together. Mr. Loes was using this as an anticipatory set to show students how items can

> be bonded together and changed. Mr. Loes said, "Is this a physical or chemical reaction? Can this be undone? Can cooked oil become uncooked? What is a physical or chemical reaction? Once items bond together, are they bonded for good? When oil gets hot and changes a bond, does mixing things change a bond? What would happen if we heated what you mixed?"

In subheading Q., Balance Between Depth and Comprehensiveness, the rubric describes a level five as, "Content has an appropriate balance between in-depth and comprehensive coverage." All content in Mr. Loes's classroom demonstrated an appropriate balance. The units were not too broad for the topic; there was an appropriate balance between coverage and depth of the unit. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> The researcher observed Mr. Loes discuss the concept of bonding with his students. Students generated questions about the word bonding. One student asked, "Does bonding mean gluing?" Mr. Loes explained, "It is easy to go beyond the focus of this topic by just using the word bonding. We must focus on the topic of chemical bonding in order to keep everyone on the same page. I am ok if you look up what bonding means; however, I want you to see how it relates to chemical bonds, ionic bonds, and hydrogen bonds.

This provided the researcher with evidence that Mr. Loes balanced the unit by keeping his students together and on task. Students could have easily focused on the word bonding instead of the concept of chemical bonding. By working as a facilitator, Mr. Loes provided a deep and comprehensive coverage of chemical bonds while limiting the focus to chemical, ionic, and hydrogen bonds.

In the physics class all three units related to Rube Goldberg, Mouse trap Cars, and Force and Motion were focused on the major concepts of force, motion, and simple machines. By focusing on the three major concepts, Mr. Loes could scaffold and build from one unit onto the next. Many times he referred to the previous unit while teaching the current unit providing a manageable breath and depth.

In subheading R., Accurate Content, the rubric describes a level five as, "Content is always evident and always accurate." All lessons observed involved accurate content. As the participant observer and a former eighth grade science teacher, the researcher was able to determine the accuracy of the content in each lesson. On the first observation of Mr. Loes, the researcher observed that he explained the concept of bonding from memory. Mr. Loes demonstrated he had an excellent background knowledge in bonding. Mr. Loes checked to make sure that the delivery of the content was accurate by consulting with the eight grade science teacher in the building. He also allowed his students to examine the evidence of the content in the classroom to detect any missing areas. Here is an excerpt from the ESTEEM Science Classroom Observation Rubric used by the researcher to record field notes,

> As the researcher in this exploratory case study, it is my obligation to examine the accuracy of the content that was being taught. During each observation, I examined the content and concepts for accuracy. Mr. Loes was accurate 100% of the time. There was a moment when the researcher was incorrect about geology content and Mr. Loes was correct. The researcher noticed the mistake and learned from it.

Students constructed, developed, and presented all completed projects based on the concepts covered in the classroom. The researcher often observed Mr. Loes thinking out loud about a concept and its relation to daily experiences outside of the classroom. When asked about how important it is for a teacher to know the concept prior to teaching it Mr. Loes explained,

> You have to have the content base. If you have the content base, you can become a teacher. It is easier to learn to become a teacher once you have the content base. I think it is easier to learn the art of teaching than it is to learn all of the information and then try to teach it. How can a teacher fully integrate something such as force and motion if they do not know the entire content level of physics? What will they be integrating? Parts of the physics content or only the parts that they know? How can a teacher help someone construct knowledge if they are not qualified in the area they are teaching individuals to construct from that concept or content area? Content is the most important in my opinion. Teaching must follow the content knowledge.

Mr. Loes often admits he may be wrong sometimes and acknowledges his errors in front of his students. The researcher observed Mr. Loes correcting himself during the Chemical Bond unit regarding the content of ionic bonds. The researcher often observed Mr. Loes explain to his class that he is still learning, taking classes, and attending workshops so that he can provide the richest content examples to his students. The results of the analysis of video tapes using the ESTEEM Science Classroom Observation Rubric are reported in Table 2.

Table 2

Results of the Analysis of Videotapes using ESTEEM-Science Classroom Observation Rubric

	Categories of the Science Classroom Observation Rubric					
	FLPCP	CSP1	CSP2	CK	Overall Total	Overall Total (%)
Science Lesson						
Rube Goldberg	25/25	30/30	15/15	20/20	90/90	100%
Chemical Bonds	25/25	30/30	15/15	20/20	90/90	100%
Mouse Trap Cars	25/25	29/30	15/15	20/20	89/90	99%
Force and Motion	25/25	30/30	15/15	20/20	90/90	100%

Note. Abbreviations for categories of the Science Classroom Observation Rubric are as follows: FLP is facilitating the learning process from a constructivist perspective; CSP1 is content-specific pedagogy (pedagogy related to student understanding); CSP2 is context-specific pedagogy (fluid control with teacher and student interaction), and CK is content-knowledge (teacher demonstrates excellent knowledge of subject matter).

Although the ESTEEM observation rubric was the primary tool used to examine observational data, the researcher also examined observational data in relation to the Sheltered Instructional Observational Protocol (SIOP) model. First it should be noted there are great overlaps between constructivist teaching as identified in the ESTEEM and Sheltered Instruction as identified in the SIOP. The ESTEEM Observation Rubric included the following four major categories: 1) Facilitating the Learning Process from a Constructivist Perspective (FLPCP), 2) Content-Specific Pedagogy (Pedagogy Related to Student Understanding) (CSP1), 3) Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction) (CSP2), and 4) Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject matter) (CK). The SIOP model consists of the following categories: 1) Preparation; 2) Building Background; 3) Comprehensible Input; 4) Learning Strategies; 5) Interaction; 6) Practice/Application; 7) Lesson Delivery; and 8) Review Assessment. The teaching behaviors suggested under the SIOP category of Building Background, Comprehensible Input, Learning Strategies, Practice Application, and Lesson Delivery are very similar to the behaviors identified as a level five, constructivist teacher, under the ESTEEM category of Facilitating Learning Process and Content Specific Pedagogy. The teaching behaviors suggested under the SIOP category of Interaction, are very similar to the behaviors identified as a level five under the ESTEEM category Content Specific Pedagogy. SIOP strategies not discussed in the ESTEEM model would be those specifically related to teaching a new language such as Clear Language Objectives, Adapting Content and Texts, Apply Content and Language Objectives, Content Objectives Supported by Lesson, and Language Objectives Supported by Lesson.

All observational data were examined in relation to the suggested teaching behaviors listed under each SIOP category. The researcher coded each suggested teaching behavior as “no evidence" (1 on a 5-point scale), "some evidence" (3 on a 5-point scale), or "strong evidence" (5 on 5-point scale) that these behaviors were evident in the observational data. The results of the analysis are reported in Table 3.

Table 3

SIOP Model: A Sheltered Instruction Model for Academic Achievement

<table>
<tr><td colspan="12">Preparation</td></tr>
<tr><td colspan="2"><i>Clear Content:</i>
Some Evidence</td><td colspan="2"><i>Clear Language Objectives:</i>
No Evidence</td><td colspan="2"><i>Content Concepts:</i>
Strong Evidence</td><td colspan="2"><i>Supplementary Materials:</i>
Strong Evidence</td><td colspan="2"><i>Adapting Content and Text to Meet Student Needs:</i>
No Evidence</td><td colspan="2"><i>Meaningful Activities:</i>
Strong Evidence</td></tr>
<tr><td colspan="12">Building Background</td></tr>
<tr><td colspan="4"><i>Link to Student Background/Experience:</i>
Strong Evidence</td><td colspan="4"><i>Link to Past Learnings/Concepts:</i>
Strong Evidence</td><td colspan="4"><i>Build and Strengthen Key Vocabulary:</i>
Some Evidence</td></tr>
<tr><td colspan="12">Comprehensible Input</td></tr>
<tr><td colspan="4"><i>Sensitivity to Specialized Vocabulary Speech:</i>
Strong Evidence</td><td colspan="4"><i>Explicit Description of Academic Tasks:</i>
Strong Evidence</td><td colspan="4"><i>Varied Instructional Strategies/Techniques:</i>
Strong Evidence</td></tr>
<tr><td colspan="12">Learning Strategies</td></tr>
<tr><td colspan="4"><i>Metacognition/Cognitive Learning Strategies:</i>
Strong Evidence</td><td colspan="4"><i>Scaffolding Techniques:</i>
Strong Evidence</td><td colspan="4"><i>Variety of Questions Used for Higher Order Thinking:</i>
Strong Evidence</td></tr>
<tr><td colspan="12">Interaction (Social Affective Learning)</td></tr>
<tr><td colspan="3"><i>Provide Multiple Opportunities for Interactions:</i>
Strong Evidence</td><td colspan="3"><i>Use Multiple Group Configurations:</i>
Strong Evidence</td><td colspan="3"><i>Allow for Wait Time:</i>
Strong Evidence</td><td colspan="3"><i>Give Opportunities to Clarify Key Concepts in First Language:</i>
Strong Evidence</td></tr>
</table>

<table>
<tr><th colspan="12">Practice Application</th></tr>
<tr><td colspan="4"><i>Provide Multiple Hands On Opportunities:</i>
Strong Evidence</td><td colspan="4"><i>Apply Content and Language Objectives:</i>
Did not do.</td><td colspan="4"><i>Integrate Language Skills:</i>
Strong Evidence</td></tr>
<tr><th colspan="12">Lesson Delivery</th></tr>
<tr><td colspan="3"><i>Content Objectives Supported by Lesson Delivery:</i>
No Evidence</td><td colspan="3"><i>Language Objectives Supported by Lesson Delivery:</i>
No Evidence</td><td colspan="3"><i>Students Engaged 90% of Period:</i>
Strong Evidence</td><td colspan="3"><i>Pacing Appropriate to Ability Level:</i>
Strong Evidence</td></tr>
<tr><th colspan="12">Review Assessment</th></tr>
<tr><td colspan="3"><i>Review Key Vocabulary:</i>
Some Evidence</td><td colspan="3"><i>Review Key Concepts:</i>
Strong Evidence</td><td colspan="3"><i>Give Feedback to Students:</i>
Strong Evidence</td><td colspan="3"><i>Provide a Variety of Appropriate Assessments:</i>
Strong Evidence</td></tr>
</table>

Table three demonstrated the observational data provided strong evidence that Mr. Loes practiced suggested teaching behaviors from each of the eight SIOP categories. In particular, the observations of Mr. Loes demonstrated strong evidence of all behaviors suggested under Comprehensible Input, Learning Strategies, and Interactions. There were five suggested teaching behaviors identified in the SIOP model that were not evident in the observational data. These exceptions were the lack of use of some strategies from category one, Preparation Clear Content, category six, Content Objectives Supported by Lesson Delivery, and category eight, Lesson Delivery. The researcher never saw Mr. Loes identify for students, teach or apply pre-determined content or language objectives in his classroom. When the researcher examined Mr. Loes' plan book, there were broad content goals, but not narrowly defined content objectives and no language objectives were identified. Even though the objectives were not clearly stated for students, they were aware of expectations, curious about what to do with lab materials and supplies, and were able to meet the teacher's planned goals. The teacher and student learning process was a partnership; Mr. Loes sought out and used student questions and ideas to guide lessons and entire instructional units. Although Mr. Loes provided many opportunities for students to integrate language skills, he spent a limited amount of time on the following: 1) Clearly defining language objectives; 2) adapting content with a textbook; 3) applying content and language objectives; 4) supporting content objectives through each lesson delivery; and 5) using language objectives to support the delivery of each lesson.

Interviews

A total of 64 teacher, student, administrator, and teaching colleague interviews were conducted. Twenty four ELL students were interviewed at least twice depending on their availability, class, or lesson being taught. Mr. Loes, was formally interviewed nine times. He was interviewed once at the beginning of the study and before and after each of the four units observed. Mr. Loes was informally interviewed two additional times through conversations that occurred during observations. The researcher used the ESTEEM Observation Rubric's four major categories to assess the interview data: 1) Facilitating the Learning Process from a Constructivist Perspective (FLPCP), 2) Content-Specific Pedagogy (Pedagogy Related to Student Understanding) (CSP1), 3) Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction) (CSP2), and 4) Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject matter) (CK). The interview data were placed into the four categories of the Observation Rubric. The Observation Rubric was then used to assess the level of constructivist teaching demonstrated in the interview data. The researcher used the four categories for coding looking for trends in the data. Each of these categories contains subheadings to more specifically delineate observational evidence of constructivist teaching.

Facilitating the Learning Process from a Constructivist Perspective

The five subheadings from the Facilitating the Learning Process from a Constructivist Perspective are (Appendix H): Teacher as a Facilitator, Student Engagement in Activities, Student Engagement in Experience, Novelty, and Textbook Dependency. Student, teacher, administrator, and colleague interviews provided evidence that Mr. Loes' level of constructivist teaching is 5 on a 5-point scale. In subheading A., Teacher as a Facilitator, the rubric describes a level five as, "Students are responsible for their own learning experiences. Teacher facilitates the learning process. Teacher-student learning experience is a partnership." The students in Mr. Loes classroom are responsible for their own learning experiences. When the students were asked to tell the interviewer about Mr. Loes, the fifth student interviewed said,

> "Pretty cool guy, I still don't know how he teaches, he teaches in a way to where you can relate something to another and kind of see how they come together. Like, when he says, "Do some research", but has not really told us exactly what to look up and where to go. So we are researchers in a way."

When students were asked to describe Mr. Loes' teaching or how he teaches, letting them figure it out for themselves was cited by ten students. One student explained, "Well, he doesn't teach from his desk, he goes around to your tables to see how you are doing. He interacts with us."

In subheading B., Student Engagement in Activities, the rubric describes a level five as, "Students are actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the lesson." The first student described her activities and engagement as,

> Very open. If you have a question during an activity we can ask Mr. Loes or we can ask one another (even if the question is a stupid one). Mr. Loes will not answer the question/questions directly. He makes a point to flip the question around to what we already know to answer it. Why is the sky blue? He will respond….. "what is in the sky?": He goes back to something he has taught and that's why we learned it. He will always refer back to something."

A response from a second student was, “Mr. Loes teaches us to expand on what we know. We have to make suggestions on what needs to be done to modify our lab activity. It helps us with what we know. I learn a lot more when he teaches.”

In subheading C., Student Engagement in Experience, the rubric describes a level five as, “Students are actively engaged in experiences (physically and/or mentally.).” When students were asked what their favorite subject was, science was named by two students as their favorite subject because they get to do a lot more, and it is more hands on. They felt that they do not have to just sit there and read all day. The first student said, “I think, once you read so much it all sounds the same. If you get to do it and it is explained well you understand it better.” One student described their experiences with Mr. Loes and his teaching as, “He is not the type of teacher who just writes on the board and hands out worksheets. We have fun with what we do. We rarely ever work alone. It is always like a group effort.” The second student said, “He likes to have us play while learning. We interact. Other teachers don’t do that at all.” The third student explained, “He likes to joke a lot. He makes everybody laugh. He makes science fun, not like Mrs. X who makes everyone do worksheets. Worksheets are boring.”

In subheading D., Novelty, the rubric describes a level five as, “Novelty, newness, discrepancy, or curiosity are used consistently to motivate learning.” According to Mrs. Ballwin the other eighth grade science teacher, “Mr. Loes teaches very uniquely. He wants them to find the big picture; he doesn’t give them the overall concept. He gives them the little pieces and he has them take those little pieces and figure out what they have in common to come up with the big concept. He gives them the direction in which to go but doesn’t give them the guidance to get there. He wants them to figure it out for themselves. And in the end, no matter what route they took to get there, the point is that they got there.”

In subheading E., Textbook Dependency, the rubric describes a level five as, “Teacher does not depend on the text to present the lesson. Teacher and Students adapt or develop own content materials for their needs.” One student summed up Mr. Loes’ textbook dependency, “There is no book work and he works around the book.” Two other students said, “Letting us figure it out and not relying on a book like most teachers.” An ELL student said, “We do not read out of the book.” Another ELL student said, “No textbook reading, because he wants it to be interesting and books can be to boring and hard to understand.” When one ELL student was asked to describe their class, she said, “He doesn’t make us read books; I do not like to read. It is hard for me to stay focused while just reading.” A male ELL said, “How much to depend on myself, come up with ideas by myself, instead of depending on other people or books.” An ELL student from Puerto Rico explained, “Last year we did only book work. Book work does not help me. It is different than projects in Mr. Loes class. Books only tell you what someone else knows not what you know. The hands on stuff helps me learn it well. Mr. Loes has taught me a lot of stuff.”

Content-Specific Pedagogy (Related to Student Understanding)

The six subheadings from the Content-Specific Pedagogy (Related to Student Understanding) are (Appendix H): Student Conceptual Understanding, Student Relevance, Variation of Teaching Methods, Higher-Order-Thinking Skills, Integration of Content and Process Skills, and Connection of Content and Evidence. The researcher assessed Mr. Loes level of constructivist teaching at a 5 on a 5-point scale.

In subheading F., Student Conceptual Understanding, the rubric describes a level five as, “The lesson focuses on activities that relate to student understanding of concepts.” Students were interviewed on their understanding of the science concepts being taught, one replied, “Science gives me the opportunity to think." An ELL student said, "He teaches where we have to think." No homework or anything. When ELL students were interviewed as a group they replied, "Non boring stuff. I learn this way better than any other class. You get to talk to people around you to find out what they are thinking. If I do not get it Mr. Loes may show us a little bit but not all of it. He lets us think about it first. I speak two languages so I am learning it two ways. This helps us think instead of tells us how to think. We want to learn how he teaches. He makes it so fun." One ELL described his teaching of science by saying, "Like, he puts it in ways that we can understand in a way a teenager would like to hear. Ways that we understand what he is talking about." A second ELL student was asked separately about their understanding of science and they replied, "Mr. Loes does not teach as much as other teachers, this my first time with physics, I like it. Mr. Loes makes it fun and interesting. The stuff he chooses to do makes it interesting." When students were asked to tell the interviewer about what concepts they were learning right now, (18) students out of (24) were able to describe what they were currently learning about in class. One student was not able to answer the question because they had to leave during the interview process.

In Mr. Loes' physics class, students were asked, "What did you know about this concept before this class?" Out of seven students interviewed who were studying Force and Motion, three mentioned that they knew about machines, four knew things ran and worked and had a lot of events. In the words of a student, "I knew things ran or worked, but did not know about Rube Goldberg." One student knew that things move with levers, another student said she knew nothing about the concept before class. In Mr. Loes' general science class, students were asked, "What did you know about this concept before this class?" Out of eleven students interviewed who were studying Chemical Bonds, eight mentioned that they knew what bonds were and how they worked, three described Chemical Bonds like a group that is close together. According to a female ELL student, “I knew mass, how much matter takes up space. I knew volume was how much of something. I knew density and what a bond was.” There were five students who knew nothing at all about the concept before class. In the words of a male ELL student, “nothing really, I didn’t know about the different changes in chlorine.” and another replied, “Basically little to nothing.”

All of Mr. Loes’ lessons have something in common; they are linked together in a way that all students can understand. Mr. Loes feels that if a teacher starts with an experience then by scaffolding onto the next experience, this allows for some type of linking mechanism through each unit which gives the teacher an opportunity to go back through units linking previous experiences together so that the students are given the opportunity to build knowledge.

In subheading G., Student Relevance, The rubric describes a level five as, “Student relevance is always a focus and the lesson relates to student experiences.” The students were asked what they learned from Mr. Loes’ class; a female ELL student who was in Mr. Loes’ first hour physics class described her experience as, “A lot. To build machines, basically building things and how they move because of physics” A male ELL student from the same class described what he has learned in the class was, “Mmmm. I learned a lot, like what happens in the work and why they happen. How different things affect the world people, like when those big buildings fell and effect everyday life.” One ELL female student from Nigeria responded, “I learned how one thing in science leads to something else. It is like music, there is not skipping, no gaps, it keeps going into the next thing. It flows.” When asked his opinions of effective strategies to teach science Mr. Loes said, “Keeping it relevant, busy, occupied, and engaged.”

In subheading H., Variation of Teaching Methods, the rubric describes a level five as, “During the lesson the teacher appropriately varies methods to facilitate student conceptual understanding i.e., discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, demonstration etc.” Mr. Loes explained to me that if someone is going to facilitate a student’s construction of knowledge (or help with the construction), or if you are going to have someone construct their own knowledge in your classroom, there has to be experiences to base it on. Mr. Loes believes one can get a sense of direction, but he doesn’t think that you can build your own knowledge by being able to quote what a random scientist did from a textbook or field study. Mr. Loes said, “You’re just quoting all of their information and you have no experience behind it.”

Mr. Loes explained to the researcher that if English Language Learners are expected to read information that somebody else has already synthesized or put together in a collective group, he wanted to know how they are expected to make sense out of it. He said, “It may make perfect sense for 90% of the people in society, but it doesn’t stay very long unless you have experiences to tie the information to. One builds experiences through lab experiences, hands on activities, things you have tried to do and it did or didn’t work.”

Mr. Loes was interviewed about his views on how English Language Learners should learn science in his class. He explained that ELL students have to feel it, see it, and touch it before they can start to understand it. He said, “Students need a variety in the classroom. If my ELL students do an activity, or if they do some kind of a project where they have to put stuff together, they can see it and they have a visual picture and tactile picture to put together with words that they might be able to deal with it. This would reinforce or enhance the meaning of what they are doing with them.” He feels he is giving them a basic break from their everyday routines in other classrooms where they sit and read from books or do worksheets everyday. Mr. Loes gives his ELL students the opportunity to get up out of their seats and explore, touch the material and apply some new information within the science content area. Mr. Loes feels that many ELL students are lost because of specific pedagogical strategies of teachers in schools today. Mr. Loes also added, "Your strategies have to be creative, interesting, changing, consistent, and powerful. Books offer little or none of those strategies. A cookbook teacher is exactly that, someone who is predictable and follows only recipes."

When asked about Mr. Loes' teaching, Miss. Danes, Mr. Loes' fifth hour Para-educator, described him with his students as, "Pretty cool, I like how he is with the students, and I never seem to get into his way. I feel like I can come in to his class relax and watch as something new is about to happen. I am in a lot of classes each day where the teacher stands in front of the students all day and talks to them. Mr. Loes is moving around so much he is hard to keep track of. If students look at the front of the room, all they see is a white board without a teacher standing in front of it."

In subheading I., Higher-Order-Thinking Skills, the rubric describes a level five as, "Teacher consistently moves students through different cognitive levels to reach higher order thinking skills." Mr. Loes was asked how he reaches the ELL population in his classes. According to Mr. Loes, he teaches them science content in a way so that when they go on to the next level they are mentally prepared. Mr. Loes feels that you must incorporate higher level thinking skills to keep the students engaged. He feels that students must be challenged and think critically through each scientific process. "Students need to be blown away mentally every time they leave your class."

In subheading J., Integration of Content and Process Skills, the rubric describes a level five as, “Content and process skills are integrated.” Mr. Loes was asked a series of questions before and after he taught each lesson. When the researcher asked Mr. Loes to explained what he planned to teach with the Rube Goldberg lesson, he explained that the lesson was designed to come before simple machines, because Rube Goldberg was a master at using very simple processes over and over again in an extremely complex way to do a simple procedure. He explained that each student needed to identify a problem, make a prediction, set up a hypothesis, and design an experiment to test their hypothesis, conduct the experiment, collect data, interpret their data and state a conclusion. Mr. Loes followed the same procedure for each lesson he taught in the class.

Often, the researcher watched Mr. Loes observe his students, communicate with them, have the students make predictions, develop one hypothesis that could be tested, experiment with their materials, collect data during the experiment, analyze their data through cooperative discussions amongst each other, and conclude/present their findings to others in the class.

In subheading K., Connection of Content and Evidence, the rubric describes a level five as, “Concepts are connected to the evidence.” Mr. Loes was asked why he decided to have his physics class build bridges for a force and motion lesson. He said, “I wanted to see evidence that each student can take a concept such as structure or support and provide evidence that the concept aligns with constructed evidence. I want my students to show me they can construct something from a concept. Students who build a car after we discussed the concept of force and motion and bridges are the students who cannot align a concept with the evidence from the teacher. Constructed bridges are evidence that the concept was achieved by the student in my class.”

Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction)

The three subheadings from the Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction) are (Appendix H): Resolution of Misconceptions, Teacher-Student Relationships, and Modifications for Student-Understanding. Interview data indicated Mr. Loes level of constructivist teaching is a 5 on 5-point scale. In subheading L., Resolution of Misperceptions, the rubric describes a level five as, "As student misperceptions become apparent, the teacher facilitates student efforts to resolve them by gathering evidence, participating in discussions with students, or fostering discussion among students." Students were asked to describe Mr. Loes' teaching or how he teaches. One student explained, "Well, he doesn't teach from his desk, he goes around to your tables to see how you are doing and makes sure we are all on track. He interacts with us." Mr. Loes was asked by the researcher, "How do you keep your students on task?" His reply to the questions was, "You will commonly see me asking students if they are confused or do not know what is going on. I take the time to acknowledge the students misconceptions in the curriculum. Student teacher discussions occur a lot in my classroom. Students discuss with me if they are confused about something. Students are expected to explain to me why they may not understand something, provide evidence to defend their answers and always be willing to discuss problems with me."

In subheading M., Teacher Student Relationships, the rubric describes a level five as, "Teacher consistently demonstrates good interpersonal relations with students. No differentiation is made regarding: ethnicity, gender, multi-cultural diversity, and special education classifications." When Mr. Loes' colleagues were asked to described his teaching characteristics, they spoke of his interpersonal relationships with students, classroom management, and involvement and passion for the sciences. Mr. Loes was described as compassionate with students learning science and someone who is motivated and always changing how people learn in his classroom. Mr. Loes has been described by colleagues as a teacher who does not differentiate on ethnicity, gender, multicultural diversity, and special education classifications. Mr. Loes expects all students to succeed not just his eighth graders. He believes all students need to be given the opportunity to grow and enjoy what they do in school, it needs to be fun and interesting for them. As to why the ELL students respect Mr. Loes, out of 14 students interviewed, the most common adjectives used by the students interviewed were cool (5) and funny (5). One student described Mr. Loes to the researcher as, “He’s fun, funny. He likes to joke a lot. He makes everybody laugh. He makes science fun.

In subheading N., Modifications for Student Understanding, the rubric describes a level five as, “Teacher has continuous awareness of his/her student understanding and modifies the lesson when necessary.” Mr. Loes was asked to describe how he plans a lesson and then modifies it to meet his student’s needs. He replied, “All of my lessons begin as the big idea. I begin with the idea and then I start to plan it in my plan book. Planning is a rough sketching process. You will often see whiteout in my plan book because that is where the modification process begins. In the classroom during the lesson, modification is a different story, one cannot “whiteout” what a student thought during the modification process. I am constantly modifying things so that each student may grasp the concepts differently and make their own interpretations from the modifications. If we taught like robots, students would act and think like robots.”

Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject Matter)

The four subheadings from the Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject Matter) are (Appendix H): Use of Exemplars, Coherent Science Experiences (Lesson), Balance Between Depth and Comprehensiveness, Novelty, and Accurate Content. The interview data demonstrates Mr. Loes' level of constructivist teaching is a 5 on 5-point scale. In subheading O., Use of Exemplars, the rubric describes a level five as, "Exemplars and metaphors (verbal, visual, and physical) are frequently used and are accurate and relevant throughout the lesson." Mr. Loes was asked how he felt ELLs come to know; he explained that since he was a constructivist type of teacher, ELL students build those connections through manipulating things or doing projects and activities so that they now have a visual and tactile experience to put with the words. He smiled when he told me if he could incorporate smell into all of his activities he would incorporate that too to help the ELL students in his science class.

In subheading P., Coherent Science Experience (Lesson), the rubric describes a level five as, "Concepts, generalizations, and skills are integrated coherently throughout the experience (lesson)." Mr. Loes was asked about Chemical Bonding and what he had planned to teach, he explained that his class had come to a point in general science where they had looked at cells at the beginning of the year, then they covered sound and light and now they had come to chemistry and chemical bonding. He wanted to ask his student's one question before going into chemical bonding which was, "How all of the previous items they had discussed as a class were stuck together?" He wanted his students to see the connections or bonding between chemical processes. The major concepts he focused on for this unit were the three major types of bonds, Ionic, Covalent and Hydrogen. Hydrogen bonding related to previous knowledge they had discovered at the beginning of the year, in the study of DNA and RNA. He explained that his evidence that his students had learned what he wanted them to learn was two-fold; the students created a framework from previous experiences and were able to tie it together with chemical bonding and being able to construct a functional moving model of how chemical bonds work from previous knowledge.

In subheading Q., Balance Between Depth and Comprehensiveness, the rubric describes a level five as, “Content has an appropriate balance between in-depth and comprehensive coverage.” Mr. Loes based a lot of what he does in his classroom from the moment in time so long ago when he discovered the term “teach at a teachable moment.” Mr. Loes feels that is the way you build knowledge. A teacher must lay out a big broad foundation and then, when the time is right, focus the students in on more specific examples and then bring them back out and refocus them on to a related broader topic and just keep building and connecting understanding as you go.

> They, (students) have very broad based experiences and then your next experience refines it just a little bit more and funnels it down in. As it funnels down in, then you get to the general principle or the concept that you are trying to get across at the center. And then after you do that, you branch it out and expand on that and you relate it to other things. So it’s kind of a two shaped funnel. Kind of like an hour glass type shape. The content begins at the bottom of the hour glass. Once the teacher flips the hour glass over or begins the lesson, the content slowly pours through the center of the narrow part of the hour glass. The students are at that center part. The content pours through the center slow enough so that there is a perfectly balance between the sand, the students and the pace or rate at which it travels. No matter how deep the teacher goes with the content, it is still perfectly balanced through the student because of that narrow opening. Teachers need to

be aware of that narrow opening in the hour glass. Without it, the content would pour straight to the bottom. The result once the sand/content pours to the bottom of the hour glass is the assessment. If the balance was not perfect, the teacher can flip the hour glass over again until the students comprehend the content.

In subheading R., Accurate Content, the rubric describes a level five as, “Content is always evident and always accurate.” Mrs. Ballwin, explained that she and Mr. Loes have been taking a class together that is inquiry based to learn more. Mr. Loes was interviewed about his science content background, he said, “I attended Kansas State University where I received a Bachelors degree in Geology; I started out as Forestry major. From there I took Agronomy type classes and then went into general education or as he described it, “An Aggie type of environment,” and also acquired many more science classes such as Geology coursework.” Mr. Loes explained to me his teaching License for Kansas is saturated with science courses; he is qualified to teach at any science level except high school chemistry where he lacks an organic chemistry class.

Teacher Inventories

The two ESTEEM inventories completed by Mr. Loes are the Teaching Practices Assessment Inventory and the Assessment of Classroom Learning in Science Inventory. These inventories were used to assess Mr. Loes’ teaching behaviors. The Teaching Practices Assessment Inventory is a self-report instrument that is designed to provide a teacher with awareness of expert teaching based on the constructivist perspective of the ESTEEM instruments. The Assessment of Classroom Learning in Science Inventory assesses the degree to which a teacher perceives their skills in using student evaluation procedures appropriate for science.

There are four categories for the Teaching Practices Assessment Inventory (Appendix I): Category 1 is Facilitating the Learning Experience (FLE), Category 2 is Context-Specific Pedagogy (CSP1), Category 3 is Content Experiences (CE), and Category 4 is Content Specific Pedagogy (CSP2). The means of the totals were computed and the overall total was converted into a percentage. The four categories of the Teaching Practices Assessment Inventory are similar to the Science Classroom Observation Rubric. Categories were constructed by using factor analysis (Burry-Stock, 1995). The rubric has a scale from “0”, no behavior is exhibited to “5”, the behavior is exhibited, at the “expert” level. The percentages for each competency levels are as follows: 85% -100% for Expert, 70% - 84% for Proficient, 35% - 69% for Competent, 15% - 34% for Advance Beginner, and 01% - 14% for Novice. The Teaching Practices Assessment Inventory was taken by Mr. Loes at the beginning of the observation period April 10, 2006. Mr. Loes worked on the Teaching Practices Assessment Inventory during his plan time. The levels of competence were determined for each category and then a percentage was calculated. The results of the analysis are reported in Table 4.

Table 4

Results of the ESTEEM Teaching Practices Assessment Inventory

	Categories of the Teaching Practices Assessment Inventory				
	FLE	CSP1	CE	CSP2	Total
Sub Total	38/40	43/45	20/20	28/30	
(%)	95%	96%	100%	93%	96%
Competency Level	Expert	Expert	Expert	Expert	Expert

Note. Abbreviations for categories of the Teaching Practices Assessment Inventory are as follows: FLE is facilitating the learning experience; CSP1 is context-specific pedagogy; CE is content experiences, and CSP2 is Content Specific Pedagogy.

Assessment of Classroom Learning in Science Inventory

There are seven categories for the Assessment of Classroom Learning in Science Inventory (Appendix J): Category 1 is Assessment Communication/Enhancing Learning (ACEL), Category 2 is Product Evaluation/Enhancing Motivation (PEEM), Category 3 is Formal Questioning (FQ), Category 4 is Interacting Feedback (IF), Category 5 is Conceptualization Activities (CA). Category 6 is Grading Implementation (GI), and Category 7 is Immediate Informal Feedback (IIF). The rubric has a scale from “0”, no behavior is exhibited to “5”, the behavior is exhibited, at the “expert” level. Percentages for each competency levels are as follows: 85% -100% for Expert, 70% - 84% for Proficient, 35% - 69% for Competent, 15% - 34% for Advance Beginner, and 01% - 14% for Novice. The Assessment of Classroom Learning in Science Inventory was taken by Mr. Loes at the beginning of the observation period April 10, 2006. Mr. Loes worked on the Assessment of Classroom Learning in Science Inventory during his plan time and at home. The results of the analysis are reported in Table 5.

Table 5

Results of the ESTEEM Assessment of Classroom Learning in Science Inventory

	Categories of the Assessment of Classroom Learning in Science Inventory							
	ACEL	PEEM	FQ	IF	CA	GI	IIF	Total
Sub Total	66/75	38/45	28/50	32/35	20/30	28/35	13/15	
(%)	88%	84%	96%	91%	67%	80%	87%	84.71%
Competency Level	Expert	Proficient	Expert	Expert	Comp.	Prof.	Expert	Prof.

Note. Abbreviations for categories of the Assessment of Classroom Learning in Science Inventory are as follows: ACEL is assessment communication/enhancing learning, PEEM is product evaluation/enhancing motivation, FQ is formal questioning, IF is interacting feedback, CA is conceptualization activities. GI is grading implementation, and IIF is immediate informal feedback. Prof. is Proficient. Comp. is Competency.

When asked about the Assessment of Classroom Learning in Science Inventory, he replied, “I have not given a summative multiple choice test to my students in over twelve years. Concepts, criteria, and material should be communicated to students, including all English language learners, verbally. Many of these students cannot even read at their grade level.” Mr. Loes was .29% away from the Expert level.

Student Inventories

The Student Outcome Assessment Rubric and Student constructed concept maps and the Concept Mapping Rubric were inventories used to assess the dependent variable cluster of middle school ELL understanding of the science concepts being taught.

Student Outcome Assessment Rubric

The Student Outcome Assessment Rubric is a motivational instrument that questions the ideas/concepts being taught, and to what degree the lesson was relevant to the students. The three categories from the Student Outcome Assessment Rubric are (Appendix K): Capturing the Main Idea, Student Inquiry, and Student Relevance. The students were given the Student Outcome Assessment Rubric Tally Sheet Student Questions at the end of each lesson. The ELL students were asked to answer three separate questions per lesson using the ESTEEM (Burry-Stock, 1995) Student Outcome Assessment Rubric Tally Sheet Student Questions: 1)What do you think your teacher wanted you to learn today (what was the main idea)? 2) List some questions that today’s lesson made you want to ask? 3) How is this topic important to you? The roots of the Student Outcome Assessment Rubric are in the constructivist concept of “teaching for meaning.” (Burry-Stock, 1995). These student questions were used to assess the extent to which the ELL students understood the main idea of the lesson/experience.

In category 1, Capturing the Main Idea, in order for a student to receive a 5, the student's response must state the main idea and provide details; descriptions or explanations that indicate the student did not just copy or regurgitate the main idea. The student response must indicate the student understood the big picture surrounding the main idea. The student response may go beyond the idea as discussed in class. For the student to receive a 3, the response must state the main idea, with no elaboration, and the statement may appear to be book related. For the student to receive a 1, the student's response must have little or no relationship to the main point of the lesson (Burry-Stock, 1995).

In category 2, Student Inquiry, in order for a student to receive a 5 on 5-point scale, the student must have asked an abstract question that related to part of the lesson, but the answer was not provided during the lesson. The question may be complex, and multifaceted. According to Burry-Stock (1995), the question might be a "what if" or "how do we know" kind of a question. For the students to receive a 3, the student must have asked a concrete question that relates to the lesson, but the answer was not provided during the lesson. The question could be answered with a yes/no, a fairly simple fact, or set of facts. The question calls for a precise answer, such as, "How many bones does a frog have?" For a score of three, the question may appear to be book-related. The student would receive a 1 if he or she indicated that he/she did not understand the major concepts being taught, has no questions, or the question did not relate to the lesson or it addressed a totally different topic, but was related to science. For example: A question about horses when the topic was weather.

In category 3, Student-Relevance, the student would receive a 5 on a 5-point scale if he/she stated in detail that the content from the lesson is important to some aspect of society. The student would receive a 3 if he/she in some way state that the content is tied to something relevant in his/her life. In order to receive a 1, the student must comment about the lesson, but did not make it relevant to his/her life or to society.

The scoring of the Student Outcome Assessment Rubric was done on the Student Questions response sheet. Once the ELL students completed their Student Questions response sheet, the responses were compared to the descriptions on the Student Outcome Assessment Rubric. Ratings were assigned, based upon the fit between the student response and the description from the rubric (Burry-Stock, 1995). After making a comparison of the ELL student responses, the researcher evaluated whether the response were rated as a “1,” “2,” “3,” “4, or “5.” The students were given a “0” if there was no response. The ratings for all three questions were anchored at levels “5,” “3,” and “1”, based on descriptors that are provided with the instrument as criteria for scoring student responses. If a student’s response was described by a “5” level description, the student received a “5.” If the student response was best described by a “3” level description, the student received a “3.” However, if the student response was better described somewhere between a “5” and a “3,” the student received a score of “4.” A “2” rating was given to responses that fell between a “3” and a “1” (Burry-Stock).

This procedure was followed for all three instrument categories for every ELL student in each class. After analyzing all responses to the student questions, the researcher transferred the ratings to the Student Outcome Assessment Rubric Tally Sheet. A percentage was determined based on the total possible for each of the 3 categories. After calculating the percentage, the researcher placed a dot on the profile for the percentage of each rating for every ELL student question on the Student Outcome Assessment Rubric Tally Sheet. The dots on the graph were connected to graphically examine the students’ conceptual understanding of the content of the lesson. The percentage scores were assigned a competency level based on the following scale:

85% -100% for Expert, 70% - 84% for Proficient, 35% - 69% for Competent, 15% - 34% for Advance Beginner, and 01% - 14% for Novice.

All ELL student responses were analyzed and scored one at a time. The researcher scored all of the “Main Idea” questions of each ELL student first. Once the “Main Idea” questions were scored then the “Inquiry” questions were scored. The “Relevance” questions were scored last. All documents were classified by lesson. Member checks were performed by Mr. Loes to examine the Student Outcome Assessment Tally Sheets collected by the researcher to see if the analysis/interpretations made sense to him, as a verification of interpretations. The results of the analysis are reported in Table 6.

Table 6

Results of the Analysis of the Student Outcome Assessment Rubric Tally Sheet

	Student Outcome Assessment Rubric Tally Sheet																					
	MI					IQ					RV					Overall Total					Overall Total	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	N=	(%)
<u>Science Lesson</u>																						
Rube Goldberg	0	0	0	2	5	0	0	0	1	6	0	0	0	4	3	0	0	0	7	14	7	97
Chemical Bonds	0	0	0	5	3	2	0	1	0	5	1	0	1	1	5	3	0	2	6	13	8	82
Mouse Trap Cars	1	0	2	4	6	0	0	1	0	12	1	0	2	1	9	2	0	5	5	27	13	88
Force and Motion	1	0	1	1	3	0	0	1	0	5	0	0	1	1	4	1	0	3	2	12	6	87

Note. Abbreviations for categories of the Student Outcome Assessment Rubric Tally Sheet are as follows: MI is Main Idea; IQ is Inquiry; and RV is Relevance. 1 2 3 4 5 under each category are representations from descriptors that are the criteria for scoring the ELL student responses. N=, is the total number of students who completed the Student Outcome Assessment Rubric Tally Sheet in each science lesson category.

The results from Table 6 indicate that the ELLs who completed the Student Outcome Assessment Rubric Tally Sheet understood the main idea of the lesson, asked abstract questions, and the lesson showed importance to some aspect in society.

Concept Mapping Rubric

The Concept Mapping Rubric was developed using much of Novak (1990) and Novak and Gowin's (1984) original work in the area of concept mapping (Burry-Stock, 1995). The students' concept maps were completed after each lesson and the rubric was used to score the maps. According to Burry – Stock (1995), the rubric is to be used as a summative student assessment activity given at the end of a lesson. The concept maps were given to each ELL student in each of five of Mr. Loes' classes at the end of each lesson. A list of concepts were constructed and given to the students before they were asked to complete their concept maps.

The five categories from the Concept Mapping Rubric are (Appendix L): Key and Non-Key Words (Concepts), Meaningful Connections, Meaningful Segment, and Meaningful Total Pattern. A key word list was used to score the concept maps. The Concept Mapping Rubric asked students to include words over and beyond the key word list. This scoring system was intended to encourage students to learn more concepts than those required. Students were given more points for doing this. The categories on the Concept Mapping Rubric start with individual words (Burry-Stock, 1995). If a student mapped all the words from the key list; he/she received a "5" for the scoring item "A." If there are more words on the student's concept map that did not appear on the key list, the researcher rounded up when grading the concept maps.

The number of key words a student used in his/her concept map was divided by the total number of key words on the word list to determine the percentage of words used in each map. In category 1, Key and Non-Key Words, in order to receive a 5 on a 5-point scale, the student must show that 90% or more of the key words/concepts from the key list are present. The student received a 3 if 70% or more of the key words/concepts from the key list were present. A student received a 1 if 50% or less of the key words/concepts from the key list is present.

In category 2, Lines, in order to receive a 5 on a 5-point scale, the student must have shown the relationship between two words that were indicated by a connecting line approximately 90% of the time. A student received a 3 if the relationship between two words were indicated by a connecting line approximately 70% of the time, and he/she received a 1 if the relationship between two words was indicated by a connecting line approximately 50% or less of the time.

In category 3, Meaningful Connections, in order to receive a 5 on a 5-point scale, the connecting lines needed to be labeled with a word or symbol approximately 90% or more of the time. A student received a 3 if the connecting lines are labeled with a word or symbol approximately 70% or more of the time and a 1 if the connecting lines were labeled with a word or symbol approximately 50% or less of the time.

In category 4, Meaningful Segment, in order to receive a 5 on a 5-point scale, the map must have shown significant and meaningful connections between one segment and another segment approximately 90% or more of the time. A student received a 3 if the map showed significant and meaningful connections between one segment and another segment approximately 70% or more of the time and a 1 if the map showed significant and meaningful connections between one segment and another segment approximately 50% or less of the time.

In category 5, Meaningful Total Pattern, in order to receive a 5 on a 5-point scale, the map must have shown a meaningful pattern approximately 90% or more of the time. Each key concept that is more specific and less general than other key concepts was drawn or written to demonstrate the relationship. A student received a 3 if the map showed a meaningful pattern approximately 70% or more of the time, and a 1 if the map showed a meaningful pattern approximately 50% or less of the time.

The ELL students in Mr. Loes' classroom were given general instructions on how to construct a concept map. Students were not given a scripted guideline prior to the activities being taught to them by Mr. Loes. The ideas behind a concept map were introduced to the ELL student's in Mr. Loes' class by the researcher. The students in Mr. Loes' general science class developed the key word list as a whole class, and then each ELL student worked individually to complete their maps. The ELL students' in the physics class worked in small groups to generate a word list. The ELL students were given general directions regarding how to draw their concept maps, and they were given a variety of examples and methods. Once students observed the examples they worked on their maps individually. Mr. Loes did not draw a model map; instead the ELL students were encouraged to try the map on their own. According to Burry-Stock (1995), students would probably concept map, according to the instruction they would receive from the classroom teacher, and they will know how the material would be presented.

Mr. Loes explained to his students that the concept maps were not being used for grading purposes, but as an evaluation of what concepts they learned from each lesson. Mr. Loes checked all completed concept maps completed by his ELL students. All of the concept maps were scored by the researcher and the total numbers were transferred to the class tally sheet. The class percentage was obtained by summing the students total scores (Burry-Stock, 1995). The percentages that were used to assign competency levels were: 85% for Expert, 10%-84% for Proficient, 35%-69% for Competent, 15%-34% for Advance Beginner and 01%-14% for Novice. According to Burry-Stock (1995), the expert stage is established on maturity and practical understanding. The proficient stage involves thinking analytically but intuitively organizing and understanding the task. The competent stage defines students as those who cope with problems and use a hierarchical process of decision making. The advanced beginner stage is characterized by the importance of broad skills and by the use of more sophisticated rules. The novice stage is characterized by skill development (Burry-Stock, 1995, p. 19).

The Concept Mapping Rubric Class Tally Pages were analyzed by the researcher and member checked by Mr. Loes. A third member check was performed by an outside source, Dr. R. Scott Irwin, Science Education Professor at Emporia State University. Dr. Irwin used a "Condensed Rubric for Scoring Concept Mapping" developed by R. S. Irwin, 2006 (after Burry-Stock, ESTEEM Instruments, 1995) (Appendix L) to member check and score all students concept maps. The member check scores determined by Dr. Irwin were consistent with the scores determined by the researcher and Mr. Loes. The results reported by Dr. Irwin, thus did not significantly alter the researcher's final results.

All ELL student concept maps were analyzed and scored one at a time. The researcher scored all of the "Key and Non-Key Words," "Labeled Lines" "Meaningful Connections" on a first analysis. All documents were classified by lesson; then they were separated by the researcher. All member checks followed the same procedures as stated above. The results of the analysis are reported in Tables 7, 8, 9, 10, and 11.

Table 7

Results of the Analysis of the Concept Mapping Rubric Class Tally Sheet for ELL Students in General Science Class

	Concept Mapping Rubric Class Tally Sheet							
	KNKW	LL	MC	MS	MTP	O.T.	O.T.	
Total Points Possible	10	5	10	5	10			
							(%)	C.L.
Science Lesson								
Chemical Bonds								
Student								
1) (F)	6	5	8	1	6	26	65	Competent
2) (M)	6	5	2	2	4	19	48	Competent
3) (M)	6	4	2	1	3	16	40	Competent
4) (F)	6	3	3	2	5	19	48	Competent
5) (F)	6	4	2	1	2	15	38	Competent
6) (M)	6	4	5	1	3	19	48	Competent
7) (F)	8	4	6	3	5	26	65	Competent
8) (F)	8	4	6	3	4	25	63	Competent
9) (F)	6	3	4	3	3	19	48	Competent
10) (M)	6	3	3	1	2	15	38	Competent
11) (F)	7	4	6	3	6	26	65	Competent
12) (F)	7	4	5	3	6	25	63	Competent

13) (M)	7	4	4	1	4	20	50	Competent
14) (F)	8	1	6	2	4	21	53	Competent
15) (M)	8	3	6	3	6	26	65	Competent
16) (F)	4	2	1	0	2	9	23	Advance
17) (M)	8	3	6	1	4	22	55	Competent
Class Average	6.65	3.53	4.24	1.82	4.06	20.47	51.48	Competent

Note. Abbreviations for categories of the Concept Mapping Rubric Class Tally Sheet are as follows: KNKW is Key and Non – Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern. (F) is Female Student; (M) is Male Student. O.T. is Overall Total. C.L. is Competency Level.

Table 8

Results of the Analysis of the Concept Mapping Rubric Class Tally Sheet for ELL Students in Physics Science Class

	Concept Mapping Rubric Class Tally Sheet							
	KNKW	LL	MC	MS	MTP	O.T.	O.T.	
Total Points Possible	10	5	10	5	10			
							(%)	
								C.L.
Science Lesson								
Chemical Bonds								
Student								
1) (M)	6	5	2	2	4	19	48	Competent
2) (M)	6	4	5	1	3	19	48	Competent
3) (F)	8	4	6	3	5	26	65	Competent
4) (F)	7	4	6	3	6	26	65	Competent
Class Average	6.75	4.25	4.75	2.25	4.5	20.47	51.48	Competent

Note. Abbreviations for categories of the Concept Mapping Rubric Class Tally Sheet are as follows: KNKW is Key and Non – Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern. (F) is Female Student; (M) is Male Student. O.T. is Overall Total. C.L. is Competency Level.

Table 9

Results of the Analysis of the Concept Mapping Rubric Class Tally Sheet for ELL Students in Physics Class

Concept Mapping Rubric Class Tally Sheet	KNKW	LL	MC	MS	MTP	O.T.	O.T. (%)	C.L.
Total Points Possible	10	5	10	5	10			
Science Lesson								
Mouse Trap Cars								
Student								
1) (M)	10	2	8	2	8	30	75	Proficient
2) (F)	6	5	4	2	4	21	53	Competent
3) (M)	6	5	4	2	5	22	55	Competent
4) (F)	8	7	3	1	4	23	58	Competent
5) (M)	7	4	5	0	4	20	50	Competent
6) (M)	5	4	1	1	2	13	33	Advanced
7) (M)	8	5	8	3	4	28	70	Proficient
8) (M)	5	4	1	1	2	13	33	Advanced
9) (F)	10	5	8	2	5	30	75	Proficient
10) (F)	9	3	6	3	5	27	68	Competent
11) (F)	7	4	6	3	6	26	65	Competent
Average	7.36	4.36	4.91	1.82	4.45	23	57.73	Competent

Note. Abbreviations for categories of the Concept Mapping Rubric Class Tally Sheet are as follows: KNKW is Key and Non – Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern. (F) is Female Student; (M) is Male Student. O.T. is Overall Total. C.L. is Competency Level.

Table 10

Results of the Analysis of the Concept Mapping Rubric Class Tally Sheet for ELL Students in Physics Class

	Concept Mapping Rubric Class Tally Sheet							
	KNKW	LL	MC	MS	MTP	O.T.	O.T.	
Total Points Possible	10	5	10	5	10			
							(%)	C.L.
Science Lesson								
Force and Motion								
Group								
1) (F, F, M)	8	5	8	1	6	28	70	Proficient
2) (M,M)	7	4	9	2	10	32	80	Proficient
3) (M,M,F)	7	4	6	2	7	26	65	Competent
4) (F,F)	8	4	8	2	9	31	78	Proficient
Average	7.5	4.25	7.75	1.75	8	29.25	73.25	Proficient

Note. Abbreviations for categories of the Concept Mapping Rubric Class Tally Sheet are as follows: KNKW is Key and Non – Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern. (F) is Female Student; (M) is Male Student. O.T. is Overall Total. C.L. is Competency Level.

Table 11

Results of the Analysis of the Concept Mapping Rubric Class Tally Sheet for all Classes

	Concept Mapping Rubric Class Tally Sheet							
	KNKW	LL	MC	MS	MTP	O.T.	O.T.	
Total Points Possible	10	5	10	5	10			
							(%)	C.L.
<u>Science Lesson</u>								
Chemical Bonds(GS)	6.65	3.53	4.24	1.82	4.06	20.47	51.48	Competent
Chemical Bonds(PS)	6.75	4.25	4.75	2.25	4.5	20.47	51.48	Competent
Mouse Trap Cars	7.36	4.36	4.91	1.82	4.45	23	57.73	Competent
Force and Motion	7.5	4.25	7.75	1.75	8	29.25	73.25	Proficient

Note. Abbreviations for categories of the Concept Mapping Rubric Class Tally Sheet are as follows: KNKW is Key and Non – Key Words; LL is Labeled Lines; MC is Meaningful Connections; MS is Meaningful Segments; and MTP is Meaningful Total Pattern. O.T. is Overall Total. C.L. is Competency Level. (GS) is General Science Class. (PS) is Physical Science Class.

The Concept Mapping Rubric was used as an assessment tool given at the end of a lesson. The results of the ELL students' concept maps are records showing the students understood the concepts being taught through a constructivist-based teaching style. Students were able to construct their own understanding of the concepts, and connect those concepts on a map. Because Mr. Loes is a constructivist teacher, students did not receive direct instruction on how to do a concept map. The researcher's explanation of, and the ideas behind what a concept map is and what it is used for was their only guide.

On the final analysis and member check results of Concept Mapping Rubric Class Tally Pages, the Chemical Bonds lesson, the ELL student average was a score of 51.48% which placed the ELL students at the competent level. Only one student scored below the competent level as advanced beginner. Burry-Stock (1995), defines competent as someone who has a target in mind and might see a new situation as a set of facts. The ELL student average on the Mouse Trap Cars lesson was 57.73% which placed the ELL students at the competent level. Only two students scored below the competent level as advanced beginner. The ELL students who did a "group" concept map for the Force and Motion lesson scored an average of 73.25% which placed them at the proficient level. One student scored below the proficient level. No students scored below competent on the Force and Motion lesson. Burry-Stock (1995), defines the proficient level as thinking analytically, and understanding the task. The ELL students in Mr. Loes' physics class scored a higher average of 6.25% on the Mouse Trap Cars lesson than that of his general science class Chemical Bonds lesson who scored 51.48%. The physics class "group" Force and Motion lesson Concept Map scored 15.52% higher compared to the general science class Mouse Trap Car lesson. The physics class "group" Force and Motion lesson Concept Map scored 21.77%

higher than the general science class Chemical Bond lesson. There was not a Concept Map completed by the physics class Rube Goldberg lesson due to scheduling conflicts.

On the final analysis and member check results of Concept Mapping Rubric Class Tally Pages, the Chemical Bonds lesson in the general science class, the calculated ELL student average on Key and Non – Key Words (KNKW) was 6.65 out of a total points possible of 10; Labeled Lines (LL) was 3.35 out of a total points possible of 5; Meaningful Connections (MC) was 4.24 out of a total points possible of 10; Meaningful Segments (MS) was 1.82 out of a total points possible of 5; and Meaningful Total Pattern (MTP) was 4.06 out of a total points possible of 10. The total class average was 20.47 out of 40.

The calculated ELL student average on the Chemical Bonds lesson in the physics science class for Key and Non – Key Words (KNKW) was 6.75 out of a total points possible of 10; Labeled Lines (LL) was 4.25 out of a total points possible of 5; Meaningful Connections (MC) was 4.75 out of a total points possible of 10; Meaningful Segments (MS) was 2.25 out of a total points possible of 5; and Meaningful Total Pattern (MTP) was 4.5 out of a total points possible of 10. The total class average was 20.47 out of 40. The calculated ELL student average on the Mouse Trap Cars lesson in the physics science class for Key and Non – Key Words (KNKW) was 7.36 out of a total points possible of 10; Labeled Lines (LL) was 4.36 out of a total points possible of 5; Meaningful Connections (MC) was 4.91 out of a total points possible of 10; Meaningful Segments (MS) was 1.82 out of a total points possible of 5; and Meaningful Total Pattern (MTP) was 4.45 out of a total points possible of 10. The total class average was 23 out of 40. The calculated ELL student average on the Force and Motion lesson in the physics science class for Key and Non – Key Words (KNKW) was 7.5 out of a total points possible of 10; Labeled Lines (LL) was 4.25 out of a total points possible of 5; Meaningful Connections (MC) was 7.75 out of a total points possible of 10; Meaningful Segments (MS) was 1.75 out of a total points possible of 5; and Meaningful Total Pattern (MTP) was 8 out of a total points possible of 10. The total class average was 29.25 out of 40.

Learning Artifacts

The artifacts of student learning observed by the researcher consisted of constructed lab activities, on force and motion, mouse trap cars, chemical bonds, and Rube Goldberg, student DCA science exams, Section Summary on Chemical Bonds, and presentations of lab work developed by student groups. All learning artifacts provided the researcher with evidence of the understanding of science concepts being taught.

District Common Assessment (DCA) Scores

The DCA was adopted by USD 259 Wichita Public School system in 2004. This assessment provides the district with information on the academic level of students in each content area. The DCA for science is taken at Maymont Middle School in the sixth, seventh, and the eighth grade. Mr. Loes' eighth grade students took the DCA exam in May, 2006, giving him, the building administrator, the school district and the researcher a general indication of the students' understanding of science.

As a point of comparison, the researcher examined the scores for all ELL seventh graders in 2005. In 2005, on a scale of 100%, 52.1% of the students with LEP scored "Unsatisfactory," 31.5% "Basic," 11.5% "Proficient," 3.3% "Advanced," and 0.9% scored "Exemplary" for the DCA. All names were removed from the ELL student scores to ensure confidentiality. All of the ELL students' scores were tallied by the researcher; all results were transferred to a tally sheet. The researcher totaled the number of ELL student's scores and divided them by the total number of students who took the DCA exam for an average score, and placed the number in the bottom row marked “Average.” The total was then divided by the total number of students to obtain a percentage. The results of the 2006 DCA analysis are summarized on Table 12.

Table 12

Results of the Analysis of the DCA 8th Grade ELL Science Exam 2006

	DCA Science Exam Results		
Student	Correct/Attempted	(%) Correct (Out of 100%)	Proficiency Level
1 (F)	20 of 25	80%	Advanced
2 (M)	20 of 25	80%	Advanced
3 (F)	13 of 25	52%	Basic
4 (F)	10 of 25	40%	Unsatisfactory
5 (F)	14 of 25	56%	Basic
6 (M)	16 of 25	64%	Basic
7 (M)	21 of 25	84%	Advanced
8 (F)	14 of 25	56%	Basic
9 (M)	18 of 25	72%	Proficient
10 (M)	16 of 25	64%	Basic
11 (M)	20 of 25	80%	Advanced
12 (M)	19 of 25	76%	Proficient
13 (M)	4 of 25	56%	Basic
14 (F)	17 of 25	68%	Basic
15 (M)	22 of 25	88%	Advanced
16 (F)	15 of 25	60%	Basic
17 (M)	14 of 25	56%	Basic

18 (F)	14 of 25	56%	Basic
19 (M)	16 of 25	64%	Basic
20 (M)	16 of 25	64%	Basic
21 (F)	16 of 25	64%	Basic
22 (F)	7 of 25	58%	Basic
23 (F)	22 of 25	88%	Advanced
24 (F)	11 of 25	54%	Basic
Average		65.83%	

Note. Abbreviations for categories of the DCA Science Exam are as follows: (F) is Female Student; (M) is Male Student.

On a scale of 100%, the average score on the DCA exam for the total student population across all classes was 70%; scores that fall below the 50% range are considered to be an “Unsatisfactory” score on the DCA. The scoring range is as follows: 1) Unsatisfactory; 2) Basic; 3) Proficient; 4) Advanced; and 5) Exemplary. The mean score for his ELL population was 65.83. The ELL female mean on the DCA exam was 61% and the male mean was 70.67%; both genders scored in the “Basic” range on the DCA science exam in Mr. Loes’ class. On a scale of 100%, 0.04% of the ELL students scored “Unsatisfactory,” 71% “Basic,” 0.08% “Proficient,” 25% “Advanced,” and 0 scored “Exemplary” for the DCA. Out of a total population of 24 students one student scored in the unsatisfactory range; 15 students out of 24 scored in the basic range; two students out of 24 scored in the proficient range; and six students out of 24 scored in the advanced range. Only one student scored below satisfactory. In comparison to the 2005 DCA scores, Mr. Loes’ ELL students scored 0.04% in the “Unsatisfactory” range, and the ELL students in 2005 scored 52.1%. Mr. Loes’ ELL students scored 71% in the “Basic range, and the ELL students in 2005 scored 31.5%. 0.08% of Mr. Loes’ students scored in the “Proficient” range, and the ELL students in 2005 scored 11.5%. 25% of the ELL student population in Mr. Loes’ class scored in the “Advanced” in comparison to the 2005 ELL student population which scored 3.3%. None of Mr. Loes’ ELL students scored in the “Exemplary” range, whereas 0.9% of the total ELL student population scored in the Exemplary” range in 2005.

Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons

All students in Mr. Loes’ class had to take a Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons. This student work sample was taken at the end of the Chemical Bonds lesson. All ELL students’ scores were graded by Mr. Loes, and member checked by the researcher. The Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons was taken at the end of the Chemical Bonds lesson. All names were removed from the ELL student scores to ensure confidentiality. All of the ELL students' scores were tallied by the researcher; all results were transferred to a tally sheet. The researcher averaged the number of ELL students' scores and divided them by the total number of students who took the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons for a mean score, and placed the number in the bottom row. The average was then divided by the total number of points possible to obtain a percentage. The results of the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons analysis are summarized on Table 13.

Table 13

Results of the Analysis of the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons

Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons			
Student	Correct/Attempted	(%) Correct (Out of 100%)	Proficiency Level
1 (F)	29 of 32	91%	Passing
2 (F)	27 of 32	84%	Passing
3 (M)	25 of 32	78%	Passing
4 (M)	31 of 32	97%	Passing
5 (F)	24 of 32	75%	Passing
6 (M)	31 of 32	97%	Passing
7 (M)	28 of 32	88%	Passing
8 (F)	17 of 32	53%	Not Passing
9 (M)	29 of 32	91%	Passing
10 (M)	25 of 32	78%	Passing
11 (M)	28 of 32	88%	Passing
12 (M)	19 of 32	59%	Not Passing
13 (M)	25 of 32	78%	Passing
14 (F)	28 of 32	88%	Passing
15 (M)	23 of 32	72%	Passing

16 (F)	32 of 32	100%	Passing
17 (M)	30 of 32	94%	Passing
18 (F)	32 of 32	100%	Passing
19 (F)	9 of 32	28%	Not Passing
20 (F)	25 of 32	78%	Passing
21 (F)	26 of 32	81%	Passing
22 (F)	13 of 32	41%	Not Passing
23 (M)	29 of 32	91%	Passing
24 (F)	11 of 25	34%	Not Passing
25 (M)	26 of 32	81%	Passing
Average		77.8%	

Note. Abbreviations for categories of the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons are as follows: (F) is Female Student; (M) is Male Student.

The average score for the total ELL student population in his science class on the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons was 77.8% on a scale of 0-100%. Any score above 60% was considered to be passing. Out of 25 students, five students 28%, 34%, 41%, 53%, and 59% scored below 60%. Four out of the five students who scored below 60% were females. There was one male who scored 59% below 60%. The ELL female average on the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons was 71.08% and the male average was 84%. The males in Mr. Loes''s class performed 12.92% higher than the females.

Summary of Results from all Four Data Sources

Independent Variable Cluster of Constructivist Teaching

There were four major units observed by the researcher 1) Force and Motion 2) Mouse Trap Cars 3) Chemical Bonds and 4) Rube Goldberg. Each observation was videotaped for forty to forty five minutes. The researcher often videotaped multiple observations of each unit. The ESTEEM Observation Rubric includes four major categories used to assess constructivist teaching. The observational data provided evidence that Mr. Loes level of constructivist teaching is a 5 on a 5-point scale. Mr. Loes, the teacher, was formally interviewed nine times. He was interviewed once at the beginning of the study and before and after each of the four units observed. Mr. Loes was informally interviewed two additional times through conversations that occurred during observations. The interview data provided evidence that Mr. Loes level of constructivist teaching is a 5 on a 5-point scale. The two ESTEEM inventories completed by Mr. Loes are the Teaching Practices Assessment Inventory and the Assessment of Classroom Learning in Science Inventory. These inventories were used to assess Mr. Loes' teaching behaviors. On the Teaching Practices Assessment Inventory, Mr. Loes' overall percentage level was rated at the 96%, the expert competency level. On the Assessment of Classroom Learning in Science Inventory, Mr. Loes' overall percentage level was rated at 84.71%, the Proficient competency level. He was .29% away from the Expert level.

Dependent Variable Cluster of ELL Students Understanding of Science

Observational evidence demonstrated students understood the concepts being taught and were able to participate in constructing their own understanding. Interview data showed all students believed they were learning through Mr. Loes' approach to teaching. Student inventories demonstrated students understood concepts and were able to participate in building understanding. Student artifacts provided evidence that students understood the science concepts being taught. The results of the ELL student's concept maps are records showing the students understood the science concepts being taught through a constructivist-based teaching style.

On the DCA science exam, the ELL students on a scale of 0-100% had a mean score of 65.83 (65.83%) this score is classified as "basic" and considered to be passing; scores that fall below the 50% range are considered to be an "Unsatisfactory" score on the DCA. Only one student scored in the "Unsatisfactory" range. The ELL female average on the DCA exam was 61% and the male average was 70.67%; both genders scored in the "Basic" range on the DCA science exam in Mr. Loes' class, but males did outperform females.

During the spring of 2006 in Mr. Loes middle school classroom, it was determined through the constructed and analyzed data by the researcher that not all ELL students were successful. Even though Mr. Loes was identified as an "Expert" in constructivist teaching, there was one student who scored in the "Unsatisfactory" range on the District Common Assessments (DCA). The student was identified as a female student.

In Mr. Loes' class, males performed better than females on the DCA. Nine females out of the total population of 15 students scored in the "Basic" range on the DCA. Both students that scored in the "Proficient" range were males. There were no females that scored in the "Proficient" range. Only two female students scored an advanced score out of a total population of six, the other four were males.

On the Section Summary Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons, the ELL students in Mr. Loes' general science class scored an average of 77.8% (on a 0-100% scale). The ELL female average on the Section Summary was 71.08% and the male average was 84%. The Section Summary Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons were taken at the end of the Chemical Bonds unit. These scores document that the ELL students understood chemical bonding carbon style, carbon compounds, and simplest hydrocarbons. Students were able to apply their constructed knowledge of these concepts to achieve a passing score. Students who scored below 50% did not pass the Section Summary Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons unit. Two female students did not pass. The males outperformed the females in this unit.

The students were given the Student Outcome Assessment Rubric Tally Sheet Student Questions at the end of each lesson. The ELL students were asked to answer three separate questions per lesson using the ESTEEM (Burry-Stock, 1995) Student Outcome Assessment Rubric Tally Sheet Student Questions: 1)What do you think your teacher wanted you to learn today (what was the main idea)? 2) List some questions that today's lesson made you want to ask? 3) How is this topic important to you? The ELL students, on the average, scored 97%, at the expert level for the Rube Goldberg lesson, 82%, or proficient level, for the Chemical Bonds lesson, 88%, or expert level, for the Mouse Trap Car lesson, and 87%, or expert level, for the Force and Motion lesson. The results from the Student Outcome Assessment Rubric Tally Sheet Student Questions indicate the students understood the concepts of each lesson.

Summary

The constructivist teaching of Mr. Loes and the ELL students understanding of science being taught was described in Chapter 4 through four broad categories of data: 1) observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning. These data were analyzed to identify how constructivist-based teaching was being used in the middle school science classroom, and how constructivist teaching helps middle school English Language Learners understand science. Chapter 5 focuses on the conclusions, discussions, and recommendations from the results presented in Chapter 4.

Chapter 5

Conclusions and Recommendations

Introduction

The central purpose of this study was to explore the middle school science classroom of a constructivist-based teacher and examine how his teaching influenced ELL students and their learning of science. In chapter one, a number of factors were introduced that influence or shape teachers: the changing demographics challenging our school systems; the increasing needs of English Language Learners; and how constructivist-based teaching might prepare English-only teachers to help ELL students understand science. The goal of chapter two was to review the literature related to an exploratory case study of constructivist based teaching and English Language Learners. The methodology in chapter 3 presented: 1) Data collection strategies which provided evidence of a) constructivist teaching and b) student learning; and 2) how the researcher established trustworthiness. Chapter four included the analysis of four broad categories of data that were collected: 1) Observations of teaching and learning (including teaching plans and other teaching materials); 2) interviews related to teaching and learning; 3) inventories of teaching and learning; and 4) artifacts of learning.

This study was guided by the following question:

1. How does constructivist teaching help middle school English Language Learners understand science?

In Chapter 4, Results, a holistic picture of Mr. Loes was illustrated through the eyes of the researcher, ELL students, teachers, administrators and colleagues through the presentation of observations, interviews, inventories, and teaching and learning artifacts. This study reveals an expert constructivist teacher who provides English Language Learners the opportunity to construct their own knowledge and understanding of the science content in an eighth grade middle school science classroom.

Relationship Between Constructivist Teaching and Student Understanding of Science

The researcher used a case study design to explore the constructivist-based teaching of Mr. Loes, a middle school science teacher in the Wichita public school system, and to explore how constructivist teaching influenced ELL students and their learning of science. To answer the research question, "How does constructivist teaching help middle school English Language Learners understand science?" the researcher had to "unpack" the question to identify the independent and dependent variables. The independent variable cluster was the constructivist teaching practices of Mr. Loes. The dependent variable cluster was the middle school English Language Learners' understanding of the science concepts being taught.

The data collection strategies that provided the researcher evidence of constructivist teaching (independent variable cluster) were: 1) Observational Evidence (focus on teaching) which included field notes of observations of teaching, videotapes of lessons (focus on teaching), lesson plans and other teaching materials, and The ESTEEM Science Classroom Observation Rubric; 2) Interviews which included interviews with the teacher, his administrator, colleagues, and students; and 3) Inventories which included the Teaching Practices Assessment Inventory and The ESTEEM Assessment of Classroom Learning in Science Inventory.

The data collection strategies that provided the researcher evidence of student learning (dependent variable cluster) were: 1) Observational Evidence (focus on learning) which included field notes of observations of learning, and videotapes of lessons (focus on learning); 2) Interviews with ELL students; 3) Inventories which included The ESTEEM Student Questions and Student Outcomes Assessment Rubric, concept maps and the ESTEEM Concept Mapping

Rubric; and 4) Learning Artifacts which included District Common Assessment (DCA) Science Exam Scores and student work samples (assignments: Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons.

Conclusions

Three broad conclusions were reached based on the triangulation of data presented in chapter four: 1) based on a synthesis of data from the observations, interviews and inventories, Mr. Loes is a constructivist teacher; 2) based on a synthesis of data from observations, interviews, inventories, and learning artifacts, the ELL students understood the science concepts being taught; 3) constructivist teaching supports many sheltered instructional strategies.

Constructivist Teaching

The videotapes of Mr. Loes' classroom lessons were analyzed using the ESTEEM (Burry-Stock, 1995) to determine, "Is Mr. Loes a constructivist teacher?" The audiotapes of interviews from students, Mr. Loes, the building administrator and Mr. Loes' colleagues were analyzed, re-analyzed, placed into categories, and documented. The researcher examined and analyzed the teacher and student inventories, triangulated data and used member checks on all inventories. The scores from the ESTEEM observational rubric places Mr. Loes' teaching at the "Expert" level. Observational data, interviews, inventories and artifacts, all support this assessment. They provide additional support that Mr. Loes' teaching is at the Expert level according to the ESTEEM rubric.

Mr. Loes exhibits a social/radical constructivist teaching style. Mr. Loes taught science as inquiry throughout his teaching strategies, group work, and student technology research. He made minimal use of the textbook in his classroom. Students' ideas, concepts, and understanding of ideas were encouraged in his classroom. After analyzing the video data, the researcher concluded that Mr. Loes' constructivist pedagogy aligned well with the ELL educational needs. Mr. Loes never answered questions directly but allowed ample time for students to solve problems or construct an idea from a problem. Mr. Loes' constructivist-based teaching style was consistent, recognized by his colleagues, building administrator, and his own students as an outstanding contribution to learning middle school science.

Students Understand Science

The researcher analyzed and examined all data collected to answer the dependant variable cluster, "Do the middle school English Language Learners understand the science concepts being taught in the science class?" ELL students were videotaped during each lesson. Students were interviewed concerning their learning and inventories and learning artifacts were collected to document their understanding. They provide additional support that the students understood the science concepts being taught.

The researcher noticed that all ELL students were engaged in activities during each lesson. The ELL students were never given strict instructions, questions were answered with questions, and student ideas were always valued by Mr. Loes. The researcher often interviewed students during a lesson. Students described Mr. Loes as the type of teacher who keeps it interesting and still can make it fun to learn about science. A majority of his students liked the hands-on working environment because they described it as the way they learn about things, by touching and feeling, to make meaning out of something. They liked the social interactions between one another and they demonstrated they understood what was going on in the class. The researcher never noticed that students were frustrated by the science concepts being taught. Students often commented through their interviews that they felt like they could "think on their own" in science class. The students often explained to the researcher that they were able to ask a lot of questions; their questions were respected and they could construct their own learning from their own questions. The students told the researcher that Mr. Loes' style of teaching made their learning environment a place where they got to interact with one another while learning about science.

The inventory results from the Student Outcome Assessment Rubric Tally Sheet Student Questions indicated the students understood the concepts of each lesson. The student artifacts indicated that students understood the science concepts being taught. These results are records that indicated the students understood the science concepts being taught through a constructivist-based teaching style.

According to the summary of evidence supporting the students' understanding of science, not all students learned at the same level. There were differences between the females and the males and between the general and physical science classes, and the learning artifacts (test scores) provided different results than the inventories (specifically the concept maps).

These four broad categories of collected data were constructed and interpreted through the perspectives of the researcher, former eighth grade science teacher, and overt participant. This exploratory case study allowed the researcher to examine the relationship between Mr. Loes and his ELL students. An examination of the independent variable cluster indicated Mr. Loes is a constructivist teacher and an examination of the dependent variable cluster indicated the ELLs understood science. The relationship between Mr. Loes' constructivist teaching and the ELL understanding of the science being taught was a dynamic relationship. Overall, the researcher was able to identify that the constructivist-based teaching used in the middle school science classroom helped middle school English Language Learners understand science.

According to North (1997) science instruction can be meaningful for ELL students if appropriate strategies are used to make instruction comprehensible. The science content should not be simplified in any way, but the method of delivery should be adjusted to provide students with ample opportunity for participation, thereby making the concepts comprehensible.

Constructivist Teaching and Sheltered Instruction for ELLs

There is an overlap that exists regarding the relationship between Mr. Loes' constructivist teaching (independent variable) and the ELLs understanding of science (dependent variable). Why does constructivism help ELLs understand science? Mr. Loes' constructivist teaching supports many sheltered instructional strategies such as: 1) preparation for teaching that included appropriate content, supplementary materials, and meaningful activities; 2) linking science content to student's background experience; 3) the use of multiple instructional strategies and techniques to support the learning needs of all students; 4) the use of metacognitive/cognitive learning strategies such as scaffolding techniques and a variety of questions to promote higher order thinking; 5) using multiple grouping configurations, allowing for wait time, and giving students opportunities to clarify key concepts in their first languages; 6) providing hands on opportunities; 7) keeping students engaged 90% of each class period using pacing appropriate to each ability level; 8) providing ongoing feedback to students; and 9) the frequent use of formative assessments. These strategies forged a relationship between constructivist teaching and the ELLs understanding of science.

Discussion

An Expert Constructivist Science Teacher

Martin (2005) describes the constructivist view as grounded in the notion of subjective reality. Individuals construct their own reality from their own observations, reflections, and logical thought. Constructivism is an epistemology, a theory of knowledge used to explain how we know what we know.

According to Staver (1998), there are two main forms of constructivism. In social constructivism the focal points are the language and the group. In radical/psychological constructivism the focal points are cognition and the individual. Social constructivism emphasizes the importance of culture and language based social interactions and knowledge at a group level. Radical/psychological constructivism emphasizes the importance of cognition in understanding how an individual builds and assess knowledge.

According to the results of the ESTEEM (Burry-Stock, 1995) instruments, Mr. Loes was rated as an Expert in constructivist teaching on the Teaching Practices Assessment Inventory, and Proficient in constructivist teaching on the Assessment of Classroom Learning in Science Inventory. Based on the analysis of the videotapes using the ESTEEM Science Classroom Observation Rubric, Mr. Loes was at the expert level four out of four units observed.

Mr. Loes considers himself to be a constructivist teacher but not at the expert level yet. Mr. Loes enjoys how he teaches and would like to maintain that with his students throughout his career. Mr. Loes takes science inquiry courses throughout the year to stay current with science pedagogy, attends summer science and mathematics workshops to enhance his knowledge in the field of science, as well as attending Kansas Association of Teachers of Science (KATS) camp each year as a participant. He is considered by his building administrator, Mr. Daniels, and eighth grade colleague, Mrs. Ballwin, to be a constructivist when teaching science. In an interview with the researcher, Mrs. Ballwin stated, “Mr. Loes teaches very uniquely. He wants them to find the big picture; he doesn’t give them the overall concept. He gives them the little pieces and he has them take those little pieces and figure out what they have in common to come up with the big concept. He gives them the direction in which to go but doesn’t give them the guidance to get there. He wants them to figure it out for themselves and in the end no matter what route they took to get there, the point is that they got there. He is the model of constructivism.”

Mr. Loes used a constructivist approach to teaching. Mr. Loes might be identified as a social constructivist teacher. Mr. Loes focused on the language and the group, and then he “radically” made students construct their own interpretations of the science concepts being taught.

A Classroom Environment Where ELLs Can Learn

The AAAS (1989) argues that the way ELLs understand science is by allowing the student to construct their own meanings by linking new information and concepts to what they already know. ELLs come to science with world views formed by previous knowledge gained from personal and cultural experiences (AAAS, 1989). Kessler, Quinn, & Fathman, (1992) point out that learning requires practice in new situations. In science, if ELL students are to learn to think critically, analyze information, make logical arguments, communicate scientific ideas, and work as part of a team, they need to apply these ideas to new and practical situations. ELL students need opportunities to apply the processes of science so that science comes to be understood, not as a set of facts to be memorized, but as a method for approaching important questions.

Childhood psychologist Jean Piaget described a mechanism by which the mind processes information. Piaget agues that a person understands whatever information fits into ones established view of the world. Piaget asserts that when information does not fit, one must re-examine or re-adjust his/her thinking to accommodate the new information (Piaget, 1972).

According to Piaget (1972), teachers need to be conscious of their students' cognitive development and strategically plan or develop curriculum that enhances logical growth.

Mr. Loes works as a facilitator with his students instead of lecturing to them. He does not sit at his desk for very long; a majority of this time is spent interacting with the students in the classroom. A student described the classroom experience as, "Very open, a workshop, we have to think in his classroom. We do not sit there all class period looking at books and worksheets."

Mr. Loes helps students think, he helps students construct their own understanding without giving them the answers. Many ELL students described Mr. Loes as a teacher who makes the learning process fun and interesting. Students felt that Mr. Loes taught in a way they could understand what was going on in the classroom. Students did not feel they needed to read textbooks to understand what was being taught.

Mr. Loes explained to the researcher that if someone is going to teach students science, the students must be given the opportunity to make their own sense of the content. Students must have their own experiences; teachers cannot tell students how to think. "Students must figure out their own experiences as they go through the learning process." Mr. Loes is a firm believer that ELL students cannot construct new knowledge from reading textbooks alone.

Recommendations

The case study of Mr. Loes was constructed by the researcher to show how constructivist teaching helps English Language Learners understand science. The researcher came to this study with a background in middle school science teaching, a belief in ELL curriculum enhancement and an understanding for the need of educational enhancement in society today.

The researcher generated two recommendations from this study: 1) further exploration is needed to understand gender differences and assessment issues related to constructivist-based teaching and ELLs; and 2) include more ELL students in the physics courses to give them an intense opportunity to examine science content in the classroom.

During the spring of 2006 not all ELL students were successful. Even though Mr. Loes was identified as an “Expert” in constructivist teaching, there was one student who scored in the “Unsatisfactory” range on the District Common Assessments (DCA). The student was identified as a female student.

In Mr. Loes’ class, males performed better than females on the DCA. Nine females out of the total population of 15 students scored in the “Basic” range on the DCA. Both students that scored in the “Proficient” range were males. There were no females that scored in the “Proficient” range. Only two female students scored an advanced score out of a total population of six, the other four were males.

On the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons, there were five students out of a total population of 25 who did not pass. Four out of those five students who did not pass were females. The ELL female average on the Section Summary on Chemical Bonding Carbon Style, Charcoal, Carbon Compounds, and Simplest Hydrocarbons was 71.08% and the male average was 84%. The males in Mr. Loes’ class performed 12.92% higher than the females.

Even though it seemed that the males out performed the females based on the Learning Artifacts, females outperformed males based on the Student Inventory Concept Mapping Rubrics. The average female score in the general science class on the Concept Mapping Rubric Class Tally Page for the science lesson Chemical Bonds unit was 53.1 compared to the male average score of 49.14. The female group average score on the general science Concept Mapping Rubric Class Tally Page for the Chemical Bonds unit was 65 compared to the male group average of 48. The female student average in the physics class on the Concept Mapping Rubric Class Tally Page for the science lesson Mouse Trap Cars was 63.8 compared to the male average of 52.7. The female student average in the physics class (group) on the Concept Mapping Rubric Class Tally Page for the science lesson Force and Motion was 78 compared to the male group of 80. Additional research is needed to further explore this relationship between gender, assessment strategies, constructivist teaching, and ELLs.

The second recommendation is to include more ELL students in the physics course to give them an intense opportunity to examine additional science content in the classroom. The data indicated that ELL students who were in the physics class demonstrated a higher level of understanding of the science concepts than the general science class. On the Concept Mapping Rubric for the Force and Motion unit, the physics ELL students scored 6.2 points higher than the general science ELL students'.

Giving ELL students more scientific opportunities in the classroom can enhance conceptual understanding of the concepts being applied. According to Rupp (1992), enhanced science investigations can actively involve students in carrying out the processes of science by moving from observing and measuring concrete objects to classifying, hypothesizing, and interpreting results. Kessler, Quinn, & Fathman, (1992), argue that graphic organizers, charts, diagrams, visuals, objects, and living things that can be touched and manipulated help in making the connections between words and meanings that are needed in order for understanding to occur. Students in the physical science class were provided with additional opportunities such as these to experience science.

The physics class was an elective the students had to sign up for. Students who were enrolled in the physics class also were enrolled in a general science class so they had twice the opportunity to explore science concepts. The physics class also was much smaller than the general science classes allowing for more individualized attention. The expectations were higher in the physics class and the students in the physics class were given additional opportunities to explore science content in the classroom.

In the fiscal school year 2005-2006 Mr. Loes taught one physics elective course and four general science courses during his daily schedule. In the fiscal school year 2006-2007, Mr. Loes will teach two physics elective courses giving more students the opportunity to examine the physics curriculum as well as the general science curriculum at Maymont Middle School.

Suggestions for Future Research

There needs to be more research conducted in the field of constructivist-based teaching and ELLs' understanding of science. This was an exploratory case study to examine the middle school science classroom of a constructivist-based teacher and how constructivist teaching helps ELLs understand science. Since this was an exploration to identify the relationships between constructivist teaching and student understanding, this case was limited to one teacher and his students in one specific environment involving two different science courses. Now that this exploration has indicated that constructivism is an appropriate strategy for this teacher to help his students understand science, further research is needed to determine if these findings are transferable to a larger audience, or if they are unique to this teacher. It is possible that as an experienced teacher, other teaching variables might be equally influential in helping ELLs understand science. Further research should involve a large number of teachers and students, additional grade levels, additional subjects, and additional environments.

This additional research might further help to answer the question, "How does constructivist teaching help middle school English Language Learners understand science?"

There is a relationship between sheltered instruction and constructivist teaching. These two models may seem similar; however, there are differences that might impact students' understanding. For example, sheltered instruction places a much greater emphasis on identifying language and content objectives for students, developing language skills, and identifying language objectives supported by a lesson.

Future research might also explore the constructivist-based teaching of teachers who have endorsements in both middle school science and English Second Other Language (ESOL). Examining teachers who have a middle school science endorsement and ESOL endorsements might lead to new discoveries explaining how ELLs understand science at the middle school level. This additional research may increase our understandings of the significant relationships between ESOL strategies, effective middle level science teaching, and constructivist teaching.

In addition, further research is needed to more deeply understand the relationship between constructivist-based teaching, assessment strategies, and male and female English Language Learners. This research may help explain why the males outperformed the females based on Learning Artifacts (traditional tests) but not based on the Student Inventories (concept maps).

In education, we face important decisions regarding the education of our children that will affect our lives and the lives of countless millions. In a time of increased accountability and testing, we need to be sure our testing strategies are free of bias as well as language and cultural bias. If certain assessment tools are more appropriate for assessing learning for males while others are more appropriate for assessing females, it is crucial to use a variety of assessment tools with both genders and not make important instructional decisions based on one assessment. It is also important to look at differences in assessment results for ELLs compared to native speakers. The ESTEEM inventories documented higher levels of understanding for ELLs compared to the learning artifacts which were more traditional assessments. Sheltered instructional strategies and constructivist practices both highlight the importance of multiple culturally and linguistically appropriate assessments for ELLs. Future research might explore which assessment strategies are most appropriate for culturally and linguistically diverse students as well as both males and females.

Summary

The purpose of this study was to explore the middle school science classroom of a constructivist teacher and examine how constructivist-based teaching influences ELL students and their learning of science. Mr. Loes is an individual who influences the lives of English Language Learners in a middle school science classroom. This exploratory case study was constructed through multiple lenses of Mr. Loes' colleagues, administrator, students, himself, and the researcher. This study reveals Mr. Loes, a teacher who has a passion for middle school science teaching and someone who helps middle school English Language Learners understand science through constructivist teaching strategies.

Mr. Daniels left Maymont Middle School during the summer of 2006. Mr. Daniels was replaced by a new building administrator. Mr. Loes was asked by the new building administrator to change his pedagogy. The administrator believes that students perform much better with direct instructional strategies.

Our job as educators is to provide multiple opportunities for the enhancement of student conceptual understanding of the concepts being taught in the classroom today. As teachers we must examine processes, strategies, in-service opportunities, curriculum changes and educational advancements to enhance our own values and growth so that we understand the variables needed for opportunities so that “all” have the ability to grow and learn in our societies today. It was revealed through the four broad categories of data collected by the researcher, that Mr. Loes constructivist teaching provided English Language Learners an opportunity to understand the science concepts that were being taught in a middle school classroom.

These results provide suggestions for future research, as well as insights and guidance, for improving science instruction during the middle years. As educators, it is our goal to prepare students to become educated consumers of scientific information and ensure that our nation’s children reach their potential.

Appendix A

Interview Guide

Middle School Student

1. Tell me about your classroom.
2. What is your favorite subject? Why?
3. Tell me about science.
4. Tell me about your teacher.
5. How does he teach?
6. Tell me about what you are learning right now.
7. What did you know about this concept before this class?
8. What have you learned from this class?

Appendix B

Interview Guide

Teachers

1. Tell me about your students.
2. Tell me about your teaching.
3. Tell me about your lesson or unit you are teaching now. Why are you teaching this concept?
4. Is it important for your students to learn? In what ways? How does it relate to other concepts your students have studied?
5. Do you think all of your students understand this concept? What is your evidence?

Appendix C

Interview Guide

Administrator

1. Tell me about Mr. Loes and his teaching.
2. Tell me about your students and their learning.
3. Do you think they understand the science concepts being taught? What is your evidence?

Appendix D

Interview Guide

Middle School Science Teacher

Biography

1. Describe the community and schools where you grew up.
2. What was science like for you when you were in middle school?
3. Describe how your science teachers taught you in middle school.
4. Describe your experiences with science in high school.
5. Describe your experiences with science in college.

Science

1. What does science mean to you?
2. How do you think English language learner students should learn science?
3. What are effective teaching strategies to teach science?
4. How do you define success in a middle school science classroom?
5. How would you describe science epistemologies in middle school science classrooms?

Teaching

1. Why did you choose to teach science at the middle school level?
2. Tell me about constructivist-based teaching.
3. How do you think teachers help English language learner students come to know?
4. In which ways do you feel you are reaching your English language learner students in the classroom?

5. How do your English language learner students react to science curriculum?
6. How do your English language learner students react to difficult or challenging curriculum?
7. Describe your own philosophy about how your English language learner students learn.
8. Tell me about your most effective science lessons.

Appendix E

Teaching Pre-Unit

1. Tell me what you plan to teach?
2. What major skills or concepts are you trying to teach?
3. What will be your evidence that students have learned what you want them to learn?

Appendix F

Teaching Post-Unit

4. Tell me about what you taught?
5. What major skills or concepts did you use to teach the unit?
6. What will be your evidence that students have learned what you taught them?

Appendix G

Observation Protocol

Length of Activity

Descriptive Notes:	Reflective Notes:
General Notes:	
	Sketch of Classroom

Appendix H

ESTEEM

SCIENCE CLASSROOM OBSERVATION RUBRIC
(Teacher)

Directions:

The Science Classroom Observation Rubric is used to assess expert science teaching from a constructivist perspective. A rubric is an analytical scoring guide. In order to administer the rubric, documentation is needed. Documentation may be in the form of a written record (script of all classroom activities, presentations, interactions, etc.), a video tape, and/or an audio tape. An administrator of this rubric should spend time learning the practices described on the rubric. This may be done by receiving training or reading the descriptions in the *ESTEEM Manual*. It takes at least 10 hours of practice to become efficient with the scoring procedures. This is true for self, peer, or external evaluations.

A Preobservation form should be completed before the classroom observation. This form helps to clarify the lesson purpose, procedures, and outcomes. This is a necessary step for the classroom observation and for scoring the *Student Outcome Assessment Rubric* the companion student component of the classroom observation.

Classroom behaviors from the record are to be compared with the descriptions in the rubric (scoring guide). If the classroom behavior is best described by the "5" level description, then the rating should be a "5." If the classroom behavior is best described by a "3" level description, then the rating should be a "3." However, if the classroom behavior would be best described somewhere between a "5" and a "3," then a "4" rating should be used. A "2" rating would fall between a "3" and a "1." Teaching practices are described at a "5," "3," and "1" level. Ratings of "4" and "2" should be used when the behavior would be best described between "5" and "3" and "3" and "1" respectively. Ratings should be recorded on the accompanying scoring sheet.

ESTEEM PREOBSERVATION FORM

An observation form should be completed before a classroom observation is done.

Teacher______________________

Date___________________

Observer (if there is one)

School______________________ Grade______________________

Class Period or time of Lesson

Topic of Lesson

Length of the Lesson or Module (circle one)_

Placement of lesson within the Unit of Study

Purpose of the lesson

Intended Outcome

Materials and/or text used (Copies should be given to the observer ahead of the classroom observation.)

Other Comments

ESTEEM
SCIENCE CLASSROOM OBSERVATION RUBRIC
(Teaching Practices)

Category I: Facilitating the Learning Process from a Constructivist Perspective

A. Teacher as a Facilitator

5 Students are responsible for their own learning experience. Teacher facilitates the learning process. Teacher-student learning experience is a partnership.

3 Students are not always responsible for their own learning experience. Teacher directs the students more than facilitates the learning process. (Teacher-student learning experience is more teacher-centered than student-centered.)

1 Students are not responsible for their own learning experience. Teacher directs the learning process. (Teacher-student learning experience is completely teacher-centered, i.e. teacher lectures or demonstrates and never interacts with students.)

B. Student Engagement in Activities

5 Students are actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the lesson.

3 Students are partially engaged in initiating examples and asking questions at time during the lesson.

1 Students are almost never engaged in initiating examples and asking questions during the lesson.

C. Student Engagement in Experience

5 Students are actively engaged in experiences (physically and/or mentally.)

3 Students are moderately engaged in experiences.

1 Students are seldom engaged in experiences.

D. Novelty

5 Novelty, newness, discrepancy, or curiosity are used consistently to motivate learning.

3 Novelty, newness, discrepancy, or curiosity are used sometimes to motivate learning.

1 Novelty, newness, discrepancy, or curiosity are used occasionally or not at all to motivate learning.

E. Textbook Dependency

5 Teacher does not depend on the text to present the lesson. Teacher and students adapt or develop own content materials for their needs.

3 Teacher does depend somewhat on the text to present the lesson. Teacher and students make some modifications.

1 Teacher does depend solely on the text to present the lesson. Teacher makes no modifications with students.

Category II: Content-Specific Pedagogy (Pedagogy Related to Student Understanding)

F. Student Conceptual Understanding

5 The lesson focuses on activities that relate to student understanding of concepts.

3 Most of the time the lesson focuses on activities that relate to student understanding of concepts.

1 Much of the time the lesson focuses on activities that do not relate to student understanding of concepts.

G. Student Relevance

5 Student relevance is always a focus and the lesson relates to student experiences outside the classroom.

3 Student relevance is always a focus.

1 Student relevance is not a focus.

H. Variation of Teaching Methods

5 During the lesson the teacher appropriately varies methods to facilitate student conceptual understanding; i.e., discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, demonstration, etc.

3 During the lesson the teacher sometimes varies methods to demonstrate the content; i.e., discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, demonstration, etc.

1 During the lesson the teacher uses only one method to demonstrate the content; i.e., discussion, questions, brainstorming, experiments, log reports, student presentations, lecture, demonstration, etc.

I. Higher-Order-Thinking Skills

5 Teacher consistently moves students through different cognitive levels to reach higher order thinking skills.

3 Teacher sometimes moves students through different cognitive levels to reach higher order student thinking skills.

1 Teacher does not move students through different cognitive levels to reach higher order thinking skills.

J. Integration of Content and Process Skills

5 Content and process skills are integrated.

3 Content and process skills are not integrated.

1 Content is taught without process or process without content.

K. Connection of Content and Evidence

5 Concepts are connected to the evidence.

3 Concepts are partially connected to evidence.

1 Concepts are not connected to evidence.

Category III: Context-Specific Pedagogy (Fluid Control with Teacher and Student Interaction)

L. Resolution of Misperceptions

5 As student misperceptions become apparent, the teacher facilitates student efforts to resolve them by gathering evidence, participating in discussion with students, or fostering discussion among students.

3 As student misperceptions become apparent, the teacher usually facilitates student efforts to resolve them by gathering evidence, participating in disucssion with students, or fostering discussion among students.

1 As student misperceptions become apparent, the teacher does not facilitate student efforts to resolve them by gathering evidence, participating in discussion with students, or fostering discussion among students.

M. Teacher-Student Relationships

5 Teacher consistently demonstrates good interpersonal relations with students. No differentiation is made regarding: ethnicity, gender, multi-cultural diversity, and special education classifications.

3 Teacher does not consistently demonstrate good interpersonal relations with students most of the time. On occasion, some differentiation is made regarding: ethnicity, gender, multi-cultural diversity, and special education classifications.

1 Teacher does not demonstrate good interpersonal relations with students. Differentiation is made regarding: ethnicity, gender, multi-cultural diversity, and special education classifications.

N. Modifications for Student - Understanding

5 Teacher has continuous awareness of his/her student understanding and modifies the lesson when necessary.

3 Teacher has a general awareness of student understanding and occasionally modifies the lesson when necessary.

1 Teacher has little or no awareness of student understanding and does not modify the lesson when it is appropriate.

Category IV: Content-Knowledge (Teacher Demonstrates Excellent Knowledge of Subject Matter)

O. Use of Exemplars

5 Exemplars and metaphors (verbal, visual, and physical) are frequently used and are accurate and relevant throughout the lesson.

3 Exemplars and metaphors (verbal, visual, and physical) are sometimes used and are accurate and relevant some of the time.

1 Exemplars and metaphors are rarely used and are not accurate and relevant. **P.**

Coherent Science Experience (Lesson)

5 Concepts, generalizations, and skills are integrated coherently throughout the experience (lesson).

3 Concepts, generalizations, and skills are not always integrated as a coherent organization of events throughout the experience (lesson).

1 Concepts, generalizations, and skills are not integrated and lack coherency throughout the experience (lesson).

Q. Balance Between Depth and Comprehensiveness

5 Content has an appropriate balance between in-depth and comprehensive coverage.

3 Lesson does not have an appropriate balance between depth and comprehensive much of the time. (Lesson has too much depth for the topic and too little coverage, or lesson has too much coverage and too little depth.)

1 Content is shallow, incomplete, or lacking. (Lesson has neither depth or breadth.) **R.**

Accurate Content

5 Content is always evident and always accurate.

3 Content is usually evident and mostly accurate.

1 Content is missing or inaccurate.

Revised March, 1995

Originally written by the committee of: Kathleen Bolland, Judy Burry-Stock, David Hedgepath, Kathleen Pittman, Jeanie Rice Seprenant, Dennis Sunal, Melanie Turner, and Zhicheng Zhang. Contributing editors are lead teachers and staff (special credit to Gary Varrella) from Iowa's Scope, Sequence, & Coordination and Chatauqua Programs coordinated by the University of Iowa's Science Education Center.

Appendix I

ESTEEM

TEACHING PRACTICES ASSESSMENT INVENTORY
(Teacher)

Directions

The *Teaching Practices Assessment Inventory* was designed as a self-report inventory to assess how much a teacher perceives the degree to which they practice classroom behaviors associated with expert teaching from a constructivist perspective. It is assumed that it is a teacher's duty to teach in such a manner as to maximize student learning.

Please reflect on your classroom teaching and respond to the following statements. There are no incorrect answers; however, the more honestly you can reflect on your own teaching practices, the more meaningful the results of the inventory will be to you in your professional development

Computer Scoring

Fill in the name section of your answer sheet and any other information that may be requested by you or your project. Scanning and scoring may be done by sending the scantron sheets to the author at The University of Alabama. Begin responding with item "1" in the General Purpose section of your scantron sheet. If your responses are to be analyzed by a computer use the scantron answer sheet provided. Blacken in the appropriate circle using a #2 pencil.

Hand Scoring

You may also answer the items by hand. If you hand score, use the accompanying answer sheet so that it can be easily scored. Fill in the requested information at the top.

Use the following format to respond to the statements.

ALMOST NEVER
(1)SELDOM (2)
SOMETIMES (3) **OFTEN**
(4) ALMOST ALWAYS (5)

Revised March, 1995. Originally adapted from the <u>Classroom Observation Rubric</u> by Melanie Turner. Special credit to Gary Varella for his editorial contributions.

ESTEEM TEACHING PRACTICES ASSESSMENT INVENTORY

ALMOST NEVER (1); SELDOM (2); SOMETIMES (3); OFTEN (4); ALMOST ALWAYS (5)

1. Your students are responsible for their own learning experience. (You are a facilitator of the learning experience.)

Your students are actively engaged in initiating experiences.
Your students are actively engaged in asking questions throughout class-time.
Your students are actively engaged in suggestion activities throughout class-time.
Your students are actively engaged in implementing activities throughout class-time.
Your students are actively engaged in experiences (physically or mentally) throughout class-time.
You use novelty to motivate learning.
You use newness to motivate learning.
You use discrepancy to motivate learning.
You use curiosity to motivate learning.
You do not depend on the textbook for class experiences.
You and/or your students adapt content material.
You and/or your students develop content materials.
Your class time focuses on activities that relate to student understanding of concepts.
Student relevance is a focus of your lesson.
Your students have the opportunity to experience the relationship of concept(s) to their everyday lives.
During the lesson you appropriately vary methods to facilitate student conceptual understanding; i.e., discussion, questions, brainstorming, experiments, log reports etc.
You move students through different cognitive levels to reach higher order thinking skills.
You integrate content and process skill during a class-time.
You allow students to establish concepts from evidence gathered during a lesson.
As student misperceptions become apparent, you facilitate student efforts to resolve misperceptions i.e., gathering evidence facilitating discussion with or among students.
Your students are motivated to gather evidence to resolve their misconceptions.
You have good interpersonal relations with students.
You have an awareness of your students' understanding of content and modify your lesson when necessary.
You use exemplars that are accurate and relevant.
You use metaphors that are unique, accurate, and relevant.
You integrate concepts, generalizations, and skills coherently.
Your science class experiences have an appropriate balance between depth and breadth.
You accurately present the information in your lessons.
Your teacher-student learning experience is a partnership. Written by Melanie Turner and Judy Burry-Stock. Revised July, 1994.

Appendix J

ESTEEM

ASSESSMENT OF CLASSROOM LEARNING IN SCIENCE INVENTORY

(Teacher)

ESTEEM

ASSESSMENT OF CLASSROOM LEARNING IN SCIENCE INVENTORY
(Teacher)

DIRECTIONS: Science teachers are continuously involved in assessment of student learning. This inventory addresses the degree to which you feel that you are skilled in using various classroom learning assessment practices. There are no right or wrong answers.

Machine Scored: Your responses to all items are to be coded on the green answer sheet. You must use a number 2 lead pencil when marking your response. In the NAME grid (upper left) of the answer sheet, please print your name in the spaces provided starting with your last name, your first name, and your middle initial. Then, fill in the circles in each column corresponding to the letters in your name.

Record your first response in row number 1 of your answer sheet in the "GENERAL PURPOSE" section of your answer sheet.

Hand Scored: Record your responses on the answer sheet designed for this inventory. For each of the following statements, rate the degree to which you feel that you are skilled in implementing each of the following activities for assessing classroom learning in science. A "1" indicates that you feel that you are **"NOT AT ALL SKILLED"** in using the statement as an assessment of classroom learning activity. A "5" indicates that you feel that you are **"HIGHLY SKILLED"** in using the statement as an assessment of classroom learning activity. You may also choose any of the numbers in between "1" and "5" that best describe you. Read each statement and record the number that best represents how skilled you feel you are about using the assessment of classroom learning activity.

NOT AT ALL SKILLED /1/2/3/4/5/________________________ HIGHLY SKILLED

ASSESSMENT **OF CLASSROOM LEARNING IN SCIENCE INVENTORY**

NOT AT ALL SKILLED **/1/2/3/4/5/____________HIGHLY SKILLED**

1. Using teacher-made paper-pencil tests.
2. Using multiple-choice questions.
3. Using matching questions.
4. Using true/false questions.
5. Using short answer questions.
6. Assigning letter grades.
7. Assigning number grades.
8. Obtaining diagnostic information from standardized norm-referenced tests for enhancing instruction.
9. Obtaining diagnostic information from standardized criterion-referenced tests for enhancing instruction.
10. Using performance measures.
11. Using concept mapping for informal assessment
12. Using concept mapping for grading purposes.
13. Using portfolios for grading purposes.
14. Implementing systematic grading procedures.
15. Implementing a grading model.
16. Developing a grading philosophy.
17. Communicating criteria to students.
18. Weighing differently projects, exams, homework, etc. when assigning semester grades.
19. Developing classroom incentive systems to enhance achievement.
20. Developing assessments that are based on clearly defined objectives.
21. Establishing student expectations for determining grades.
22. Using announced quizzes for informed feedback.
23. Incorporating homework in the grading model.
24. Using individual science reports for grading purposes.
25. Using science fair projects.
26. Using individual laboratory reports for grading purposes.
27. Using group laboratory reports for grading purposes.
28. Using systematic procedures for determining borderline grades.
29. Using group oral discussion for informal assessment.
30. Using teacher student oral discussion for informal assessment.
31. Using group or participation for informal assessment.
32. Enhancing student motivation for learning.
33. Providing timely written feedback.
34. Providing immediate" oral feedback.
35. Incorporating extra credit activities in the calculation of grades.
36. Using oral questions from students for informal assessment.
37. Using laboratory/activity worksheets for grading purposes.
38. Using individual hands-on activities for informal assessment.
39. Using group hands-on activities for informal assessment.
40. Using individual class presentations for grading purposes.

ASSESSMENT **OF CLASSROOM LEARNING IN SCIENCE INVENTORY**

NOT AT ALL SKILLED /1/2/3/4/S/_____________**HIGHLY SKILLED**

41. Using group class presentations for grading purposes.
42. Using the end-of-chapter questions for enhancing student understanding.
43. Using teacher observations for informal evaluation.
44. Incorporating hands-on activities for enhancing student understanding.
45. Incorporating computer projects for enhancing student understanding.
46. Incorporating computer exercises for grading purposes.
47. Using class review questions for enhancing student understanding.
48. Choosing appropriate assessment methods for grading purposes.
49. Using assessment results when making decisions (instructional, placement, and promotion) about individual students.
50. Using assessment results when planning teaching.
51. Using assessment results in curriculum development.
52. Using formal assessment results when evaluating class improvement.
53. Communicating assessment results to students.
54. Communicating assessment results to parents.
55. Recognizing unethical, illegal, and otherwise inappropriate assessment methods.
56. Recognizing unethical, illegal, and otherwise inappropriate assessment uses of assessment information.
57. Communicating grading expectations.[3]

---

[3] Revised 1994. Judith Burry-Stock. The forerunner of this instrument was the *Grading Practice Assessment Inventory* written by Rosalyn Malcolm-Payne and Judith Burry.

Appendix K

ESTEEM

STUDENT QUESTIONS

STUDENT OUTCOME ASSESSMENT RUBRIC

(Student)

ESTEEM

STUDENT QUESTIONS
(Student)

Directions;

The *Student Questions* and the accompanying rubric *Student Outcome Assessment Rubric* are companions to the *Classroom Observation Rubric*. *Student Questions* should be administered with every classroom observation that is to be evaluated using the *Classroom Observation Rubric* to provide student data for one lesson. These questions may also be used alone to obtain student feedback.

Student Questions should be administered at the end of a daily lesson. The following directions are to be read by the evaluating teacher who may be the teacher, a peer, or an external evaluator.

> **"I would like very much if you would give us some information about today's class. There are three questions for you to answer on this sheet of paper."**
>
> **Pass out a set *of Student Questions* to every student.**
>
> **"What you say is important, please take a minute to think through your answers."**
>
> **"Thank you."**
>
> **Pick up the papers.**

ESTEEM

STUDENT QUESTIONS

Name:____________________________ Date:__________________________

Teacher:__________________________ Grade:_________________________

1. What do you think your teacher wanted you to learn today (what was the **main** idea)?*

2. List some questions that today's lesson made you want to ask?

3. How is this topic important to you?

**This question is an adaptation of a "Main Idea" question written by Angela and Cross (1993).*

ESTEEM

STUDENT OUTCOME ASSESSMENT RUBRIC

Directions;

A Preobservation form should be completed before the lesson plan from which the *Student Questions* are administered. *Student Questions* are to be administered when a classroom observation using the *Classroom Observation Rubric* is done. These two instruments should be viewed as companion pieces. The *Student Outcome Assessment Rubric* may be administered alone, but the classroom observation should always be accompanied with the *Student Outcome Assessment Rubric.* The completed Preobservation form provides the necessary information (lesson purpose, procedures, and intended outcomes) necessary for scoring the *Student Outcome Assessment Rubric*.

Student Questions are to be scored on the *Student Questions* sheet using the criteria detailed in the *Student Outcome Assessment Rubric.* A rubric is a scoring guide. Student responses should be scored one question at a time. All of the "Main Idea" questions should be scored at one time. On a second pass through, the "Inquiry" question should be scored. A third pass through is required to score the "Relevance" questions.

Evaluators should become familiar with the scoring guide before using it.

The ratings for all three questions are anchored at levels "5," "3," and " 1" with descriptors that are the criteria for scoring student responses. If a student's response is described by a " 1" level description, the student receives a "5." If the response is best described by a "3" level description, the student receives a "3." However, if the student response would be better described somewhere between a "5" and a "3," the student score should be a "4." A "2" rating would fall between a "3" and a "1." Ratings of "4" and "2" should be used when the student response is best described by a criteria between "5" and "3" and "3" and "1" respectively.

ESTEEM

Student Outcome Assessment Rubric

1. Capturing the Main Idea

Coding addresses whether or not the student captured the main idea as it was presented during the lesson.

5 = The response states the main idea **and** provides details, descriptions, or explanations that indicate the student did not just copy or regurgitate the main idea. The response indicates the student understood the big picture surrounding the main idea. Response may go beyond the idea as discussed in class.

3 = The response states the main idea, with no elaboration. The statement may appear to be book-related.

1 = The student's response has little or no relationship to the main point of the lesson. The response is about a different topic or an aspect of the broader topic. For example, humans have two arms should be rated 1 if the lesson was about the endocrine system.

2. Student Inquiry

Coding addresses the relationship of the student's question(s) to the lesson. Was the question one that was addressed during the lesson but the student did not understand, or was it a question that arose out of the lesson but could not be answered from material addressed? Was it a fairly straightforward question or was it an imaginative question?

5 = The student asks an **abstract** question that relates to **a part** of the lesson, but the answer was **not** provided during the lesson. The question may be complex, multifaceted. The question might be a "what if or a "how do we know" kind of a question, for example. The question relates to **the big picture** of the lesson, but the answer was **not** provided during class.

3 = The student asks a **concrete** question that relates to the lesson, but the answer was **not** provided during the lesson. The question could be answered with a yes/no, a fairly simple fact, or set of facts. The question calls for an explicit answer. Example: How many bones does a bird have? The question may appear to be book-related.

1 = The student indicates he/she did not understand, has no questions, or the question does not relate at question is not related to the lesson at all—to any part of the lesson—it addresses a totally different topic, but it is related to science. For example, a question about dogs when the topic was planets.

3. Student-Relevance

Coding addresses whether or not the student was able to make the class material relevant to his/her life.

5 = The student states in detail that content from the lesson is important to some aspect of society.

3 = The student in some way states that the content is tied to something relevant in his/her life.

1 = The student comments about the lesson, but does not make it relevant to his or her life or to society.

Appendix L

ESTEEM

CONCEPT MAPPING RUBRIC

(Student)

ESTEEM

CONCEPT MAPPING RUBRIC
(Students)

Directions:

The *Concept Mapping Rubric* is an analytical scoring guide used to evaluate student concept maps. Concept mapping should be taught and practiced by students before it is used for evaluation. It may be employed as a diagnostic tool for preteaching to capture students' level of conceptual understanding of the topic. Directions for teaching are detailed in *Administration, Scoring, and Interpretation Manual.*

A formal administration of the *Concept Mapping Rubric* is done at the end of a unit of study. It may be used, if previously taught, as a substitution for a unit test. Thus, making it an alternative summative measure. A list of important concepts must be constructed and given to the students before they are asked to complete a concept map. The list may be teacher- or teacher- and student-generated. Students are asked to complete a map during class time just as they would take a test. They must have a copy of the word list. This can be done by placing the word list in one comer of an otherwise blank sheet of paper. There should also be a place for the student's name and the date.

Scoring the concept map should be done on the student's paper. The *Concept Mapping Rubric* is the criterion for scoring the concept maps. Student concept maps are to be compared with the descriptions on the scoring guide. If the student's response is best described by the "5" level description, then the rating should be a "5." If the student's response is best described by a "3" level description, then the rating should be a "3." However, if the student's response would be best described somewhere between a "5" and a "3", then a "4" rating should be used. A "2" rating would fall somewhere between a "3" and a " 1." The *Concept Mapping Rubric* uses approximate percentages. For example, the "5" rating is described as "ninety percent or more," and the "3" rating is described as "seventy percent or more," and the "1" rating is described as "fifty percent or less." When the approximate percentage is 80, a "4" rating should be used and when the approximate percentage is 60, then a "2" rating should be used. It may be easier to use the *Concept Mapping Rubric* by writing on the students' work. Ratings should be recorded on the accompanying answer sheet.

Examples are included in the *Administration, Scoring, and Interpretation Manual.* Evaluators should practice the scoring procedures before a formal evaluation is done.

References

Amaral, M. O. (2002) Helping English learners increase achievement through inquiry-based science instruction. *Journal Of Bilingual Research, 26*(pp. 1-6).

American Association for the Advancement of Science, AAAS (1989). Science for all americans. *American Association for the Advancement of Science*, Retrieved June 24, 2006, from 'http://books.nap.edu'

Arora, A.G. (1995). Elementary teachers' practice and perceptions of a new science curriculum in a culturally diverse school setting (Doctoral dissertation, University of Nebraska-Lincoln, 1995). *Dissertation Abstracts International, 56,* 256.

Bolick, M. E., (1996). *Socialization influences of the elementary school environment on a beginning teacher prepared as a constructivist educator: An interpretive study.* Unpublished doctoral dissertation, Kansas State University, Kansas.

Brooks, J. G.,& Brooks, M. G. (1993). In search of understanding: The case for constructivist classrooms. Alexandria, VA: American Society for Curriculum Development.

Brown, D. & Clement, J. (1993). National Research Council. *How People Learn: Brain, Mind, Experience, and School.* Washington, DC: National Academy Press, 2000.

Burry-Stock, J. (1993). *Expert science teaching educational evaluation model (ESTEEM) manual.* Kalamazoo, MI: Center for Research on Educational Accountability and Teacher Evaluation at Western Michigan University.

Cain, S.E., & Evans, J.M. (1990). *Sciencing: An involvement approach to elementary science methods.* Columbus, OH: Merrill Publishing Company.

Caine, G., Caine, R.N., & McClintic, C. (2002). Guiding the innate constructivist. *Educational Leadership, 60*(1), 70-73.

Cohen, D., & Hill, H. (1998). *Instructional policy and classroom performance*. Manuscript submitted for publication.

Creswell, J. W. (1998). Qualitative Inquiry and Research Design. *Choosing Among Five Traditions.* Thousand Oaks, California: Sage Publications.

Crowther, D.T. (1997). The constructivist zone: Editorial. *Electronic Journal of Science Education, 2*(2).

Danielson, C. (1996). *Enhancing professional practice*. New Jersey: Association for Supervison and Cirriculum Development.

Davidson, D. (1984). Inquiries into truth and interpretation. Retrieved December, 2006, from Correspondence Theory of Truth Web site: 'http://www.answers.com/correspondence-theory-of-truth'

Driver, R. (1989). The construction of scientific knowledge in school classrooms. Doing science: Images of science education. (pp.83-106). New York: Falmer Press.

Echeverria, J., Vogt, M., & Short, D. (2004). Making content comprehensible for English language learners: *The SIOP model*. Boston: Allyn & Bacon.

Fathman, A.K. (1992). Academic achievement for secondary language minority students; Standards, measures, and promising practices. Retrieved April, 2006, from National Clearing House for Bilingual Education Web site: 'http://www.ncela.gwu.edu'

Floriani, Ana. (1997). Creating a community of learners: Constructing opportunities for learning and negotiating meaning in a bilingual classroom (Doctoral dissertation, University of California, 1997). *Dissertation Abstracts International, 58,* 390.

Garcia, E. (1997). *Restructuring schools for linguistic diversity*. New York: Teachers College Press: (pp. ix-xi).

Gredler, M.E. (1997). *Learning and instruction: Theory into practice* (3rd ed.). Upper Saddle River, NJ: Prentice-Hall.

Grose, C. English language learners: Working with children for whom english is a new language. Retrieved March 19, 2007, from Bank Street Web site: http://www.bankstreet.edu/literacyguide/ell.html

Guba, E., & Lincoln, Y. (1989). *Judging the quality of fourth generation evaluation.* Newbury Park, CA: Sage Publications.

Hairston, J. E. (1997). Perceived knowledge level, utilization, and implementation of school-to-work by pre-service teacher educators of Ohio. *Journal Of Vocational Education Research, 27*(2).

Healey, J.F. (2003). *Race, ethnicity, gender, and class: The sociology of group conflict and change.* Thousand Oaks, CA: Pine Forge Press.

Herrera, S. G., & Murry, K. G., (2005). Mastering ESL and bilingual methods. Boston: Pearson

Isaac, S., & Michael, W.B. (1981). *Handbook on research and evaluation*. San Diego, CA: EDITS Publishers.

Jacob, E. (1988). Clarifying qualitative research: A focus on traditions. Educational Researcher, 16-24.

Jarrett, D. (November 1999). *The inclusive classroom: Teaching mathematics and science to English-language learners.* Northwest Regional Educational Laboratory.

Kant, I. (2005). *Introduction to logic*. New York, NY: Barnes and Nobel.

Kessler, C. (1992). Science and cooperative learning for lep students. Retrieved April, 2006, from National Clearing House for Bilingual Education Web site: 'http://www.ncela.gwu.edu'

Key, S.G. (1995). African american eighth-grade students' perceived interest in topics taught in tradition and nontraditional science curricula (Doctoral dissertation, University of Houston, 1995). *Dissertation Abstracts International, 56*, 154.

Keys, C.W., & Bryan, L.A. (2001). Co-constructing inquiry-based science with teachers: Essential research for lasting reform. *Journal Of Research of Science Teaching, 38*(pp.631-645).

Klentschy, M. (2002). Helping English learners increase achievement through inquiry-based science instruction. *Journal Of Bilingual Research, 26*(pp. 1-27).

Krashen, S. (2004). Research on the latino and english language learner student achievement gap. Retrieved November, 2005, from Factors Contributing to the Latino Achievement Gap Web site: 'http://www.swcompcenter.org'

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. The American Journal of Occupational Therapy, *45*(3),(pp.214-222).

Ladner, D., Wingenbach, G., Raven, M. (1998). Internet and paperbased data collection methods in agricultural education research. Retrieved July, 2006, from Agricultural Education Research Web site: 'http://aaae.okstate.edu'

Lawlor, F. (2006). The elementary science study. Retrieved April 4, 2007, from ESS Web site: 'http://www.coe.ufl.edu'

Lee, O., Fradd, S. (1998). Science for all, including students from non-english-language backgrounds. *Educational Researcher*, *27*, Retrieved July, 2006, from 'http://jstor.org'

Lincoln, Y. S., & Guba, E. G. (1985). Natuarlistic Inquiry: Beverly Hills, CA: Sage Publications.

Linn, M.C. (2000). Scientific arguments as learning artifacts. *International Journal of Science Education, 22,* Retrieved May, 2006, from 'http://vdc.cet.edu'

Lorsbach, A., & Tobin, K. (1992). Research Matters to the science teacher: Constructivism as a referent for science teaching. National Association of Research in Science Teaching. *5*(pp.21-27).

Martin, D.J. (2006). *Elementary science methods: A constructivist approach.* Belmont, CA: Thomson Wadsworth.

Matthews, M. (2000). The scope of constructivism. Retrieved November, 2005, from Constructivism in science and mathematics education Web site: 'http://www.csi.unian.it.html'

McClintock, M. (1989). *Stop that ball!* New York: Random House.

Merriam, S. B. (1988). *Case Study Research in Education.* San Francisco, CA: Jossey-Bass.

Merriam-Webster. (1993). *Merriam-webster's collegiate® dictionary*. (11th ed.). Sprinfield, MA: Macmillan.

Mestre, J. P. (1991, September). Learning and instruction in pre-college physical science. *Physics Today*, *44*, 56-62.

Mora, J. (1996). Unpublished course materials. San Diego, CA: San Diego State University.

Nachmias, C.F., & Guerrero, A.L. (2002). *Social statistics for a diverse society.* Thousand Oaks, CA: Pine Forge Press.

National Research Council. NRC. (2000). *Inquiry and the national science education standards.* Retrieved May 5, 2005, from http://www.nationalacademies.org.

North, S. (1997). Including esl strategies within the elementary science methods course. Retrieved November, 2006, from Sheltered Strategies for Science Instruction for ELL Students Web site: 'http://www.ed.psu.edu'

O'Loughlin, M. (1997). Rethinking science education: Beyond piagetian constructivism toward a sociocultural model of teaching and learning. *Journal of Research in Science Teaching, 29*(pp.791-820).

Parnell, R. (2006). Involving users in the school design process. Retrieved July 12, 2006, from Centre for the Study of Childhood and Youth Web site: 'http://www.cscy.group.shef.htm'

Penner, D.E. (2001). Cognition, computers, and synthetic science: Building knowledge and meaning through modeling. In W.G. Secada (Ed.) *Review of research in education 2000-2001* (pp. 1-35). Washington, DC: American Educational Research Association.

Phillips, D.C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher, 24*, Retrieved June, 2006, from 'http://wolfweb.unr.edu'

Piaget, J. (1964, 2003). Development and learning. *Journal of Research in Science Teaching,* *2*(3), 176-184. Reprinted in *Journal of Research in Science Teaching,* Suppl. 40, S8-S18.

Piaget, J. (1972). *The psychology of the child*. New York, NY: Basic Books.

Polit, D., & Hungler, B. (1985). *Essentials of research: Methods and application*. Philadelphia, PA: J.B. Lippincott Co.

Robins, R.W. (1998). Psychological science of the crossroads. Retrieved March 24, 2007, from A comparison of Behaviorist and Constructivist-Based Teaching Methods in Psychomotor Instruction Web site: http://www.gsa.vt.edu'

Roseberry, A. S. (1992). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press, 2000.

Saturnelli, A.M., & Repa, J. T. (1995, April). *Alternative forms of assessment in elementary science: The interactive effects of sex, reading, race, economic level, and the elementary science specialist on hands-on and multiple choice assessment of science process skills.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Schroeder, P. (1999, October 14). Texts made to fit local standards. *USA Today,* pp.A14.

Sexton, (1996). Integrating scientific ally-based practices in reading education. Retrieved July, 2006, from Project Inspire Web site: 'http://education.ufl.edu'

Shamoo, A.E., & Resnik, B.R. (2003). *Responsible conduct of research.* Oxford University Press.

Shymansky, J.A. & Hedges, L. V., & Woodworth, G. (1990). A reassessment of the effects of inquiry-based science curricula of the 60's on student performance. *Journal Of Research On Science Teaching, 27*(pp. 127-144).

Smith, S. D. (1983). Specific reading disability. Identification of an inherited form through linkage analysis. Science *219*

Stake, R. (1995). *The art of case research*. Thousand Oaks, CA: Sage Publications.

Staver, J.R. (1998). Constructivism: Sound theory for explicating the practice of science and science teaching. *Journal Of Research of Science Teaching, 35*(pp.501-520).

Sund, R. B. (1973). *Becoming a better elementary science teacher*. Columbus. Ohio: Charles E. Merrill.

Tellis, W. (July, 1997). Introduction to case study. *The Qualitative Report, 3,* Retrieved July 10, 2006, from 'http://www.nova.edu/ssss/QR/QR3-2/tellis1.html'

Thomas, W. P., & Collier, V. P. (1997). *School effectiveness for language minority students.* Washington, D. C. National Clearing House for Bilingual Education. Retrieved June 5, 2005 from http://www.ncbe.gwu.edu.

Tishman, S., Jay, E., & Perkins, D. N. (1993). Teaching thinking dispositions; From transmission to enculturation. *JSTOR. 32*, [147-153].

U.S. Census Bureau *(2000., Population division: Population projections branch.* Retrieved April 10, 2005, from http://www.Census.gov.

U.S. Department of Education *(2003.,Survey of the states: Limited English proficient students and available educational programs and services.*
Retrieved January 12, 2006, from http://www.ncela.gw.edu.

Vygotsky, L.S. (1986). On development of scientific concepts in childhood. A. Kozulin (Ed.). In *Thought and Language.* Cambridge, MA: MIT Press. Cited in Ash, D. & Levitt, K. (2003). Working within the zone of proximal development: Formative assessment as professional development. *Journal of Science Teacher Education, 14*(1), 23-48.

Vygotsky, L.S. (1978). *Mind in society.* Cambridge, M.A: Harvard University Press.

Wheatley, J. (1995). This science is sound. Science and Children. NSTA. *33*(pp.28-31).

Wikipedia: The free encyclopedia. Retrieved February 22, 2007, from Wikipedia Web site: 'http://en.wikipedia.org'

Windschitl, Mark. (1997). The pedagogical, cultural, and political challenges of creating a constructivist classroom. *International Congress on Personal Construct Psychology: Vol. 120* (pp.1-25). Washington: University of Washington Press.

Wolcott, H. F. (1990). *Writing up qualitative research*. Newbury Park, CA: Sage Publications.

Yager, R. E. (1991). The constructivist learning model. *The Science Teacher, 58*(pp.52-57).

Yager, R. E., & Lutz, M.V. (1994). Integrated science: The importance of “how” versus “what.” *School Science and Mathematics, 94*(pp.338-346).

Yin, R. (1989). *Case study research design and methods*. Beverly Hills, CA: Sage Publications.

Zehler, A. (1994). Working with english language learners: Strategies for elementary and middle school teachers. *NCBE Program Information Guide Series, 19,* Retrieved September, 2005, from 'http://www.sube.com'

(2006). A vison for the future. Retrieved October, 2006, from Annenberg Media Web site: 'http://www.learner.org'

(2006). English language learners. Retrieved June 19, 2006, from Wichita Public Schools Web site: www.wichitapublicschools.org

(2006). District information. Retrieved June 19,2006, from Wichita Public Schools Web site: www.wichitapublic schools.org

(2004, October). What is constructivism. Retrieved June 12, 2005, from Concept To Classroom Web site: 'http://www.thirteen.org/edonline/concept2class/constructivism/

(May 31, 2005). The coherence theory of truth. Retrieved December, 2006, from Stanford Encyclopedia of Philosophy Web site: 'http://stanford.edu/truth-coherence'

(May, 2006). Learing point associates. Retrieved November 23, 2006, from North Central Regional Educational Laboratory Web site: 'http://www.ncrel.org'

(2004). Literacy in schools. Retrieved November, 2005, Web site: 'http://www.kansascity.com'