PROFESSIONAL DEVELOPMENT IN CURRICULUM ADAPTATION RELATED TO INQUIRY-BASED SCIENCE INSTRUCTION FOR ELEMENTARY SCHOOL TEACHERS OF STUDENTS WITH LEARNING DISABILITIES

A Dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Education in Professional Leadership
with a Concentration in Special Populations

by

Jana Belinda Cole

May 2014

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I am awestruck as I reflect on my journey to this momentous place. Many people have influenced and supported me throughout the events that brought me to this point. First I thank my family who believed in me and offered only encouraging words in my time of need. I thank my friends that still love me after being absent from events for so long. To my administrators and colleagues that have offered accolades and experience, I offer my sincere gratitude. Finally, I am grateful to my professors and cohort for sharing their vast knowledge, which made this research possible.

"Tell me and I forget. Teach me and I remember. Involve me and I learn."

~("Benjamin Franklin," n.d.)

PROFESSIONAL DEVELOPMENT IN CURRICULUM ADAPTATION RELATED TO INQUIRY-BASED SCIENCE INSTRUCTION FOR ELEMENTARY SCHOOL TEACHERS OF STUDENTS WITH LEARNING DISABILITIES

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Abstract

For the United States to remain competitive in current research and technology, a new workforce must be tapped to fulfill the predicted increase of employment opportunities in science, technology, engineering, and math (STEM). Students with learning disabilities often are an overlooked resource that can help fill this gap. Inquiry-based science instruction is a research-based method that increases the content knowledge of students with learning disabilities. Educators must be trained in science content and delivery of the curriculum to ensure the students’ success. One issue faced by today’s educators is interpreting Texas’ curriculum, Texas Essential Knowledge and Skills (TEKS). This study implemented a document analysis process using a TEKS Objective Analysis Rubric designed by the researcher, which analyzed the TEKS for inquiry-based science instruction adaptability. The rubric was supported with high-quality professional development materials, which trains teachers on rubric implementation, science content, and inquiry-based science instruction. The outcomes identify that the majority of the TEKS can be adapted for inquiry-based science; professional developers must understand teacher knowledge in science before content is presented; and effective instructional strategies, recommendations for lesson changes, and examples of effective teaching in science for students with learning disabilities can be provided. The study also includes an action plan that assists teachers in inclusive elementary classrooms to adapt inquiry-based science lessons for students with learning disabilities. The President’s Council of Advisors on Science and Technology

(PCAST) report identified substantial job growth in the STEM area; therefore, inquiry-based science instruction is necessary for students with learning disabilities to succeed.

Keywords:

Inquiry-based science instruction, professional development, students with disabilities, inclusion

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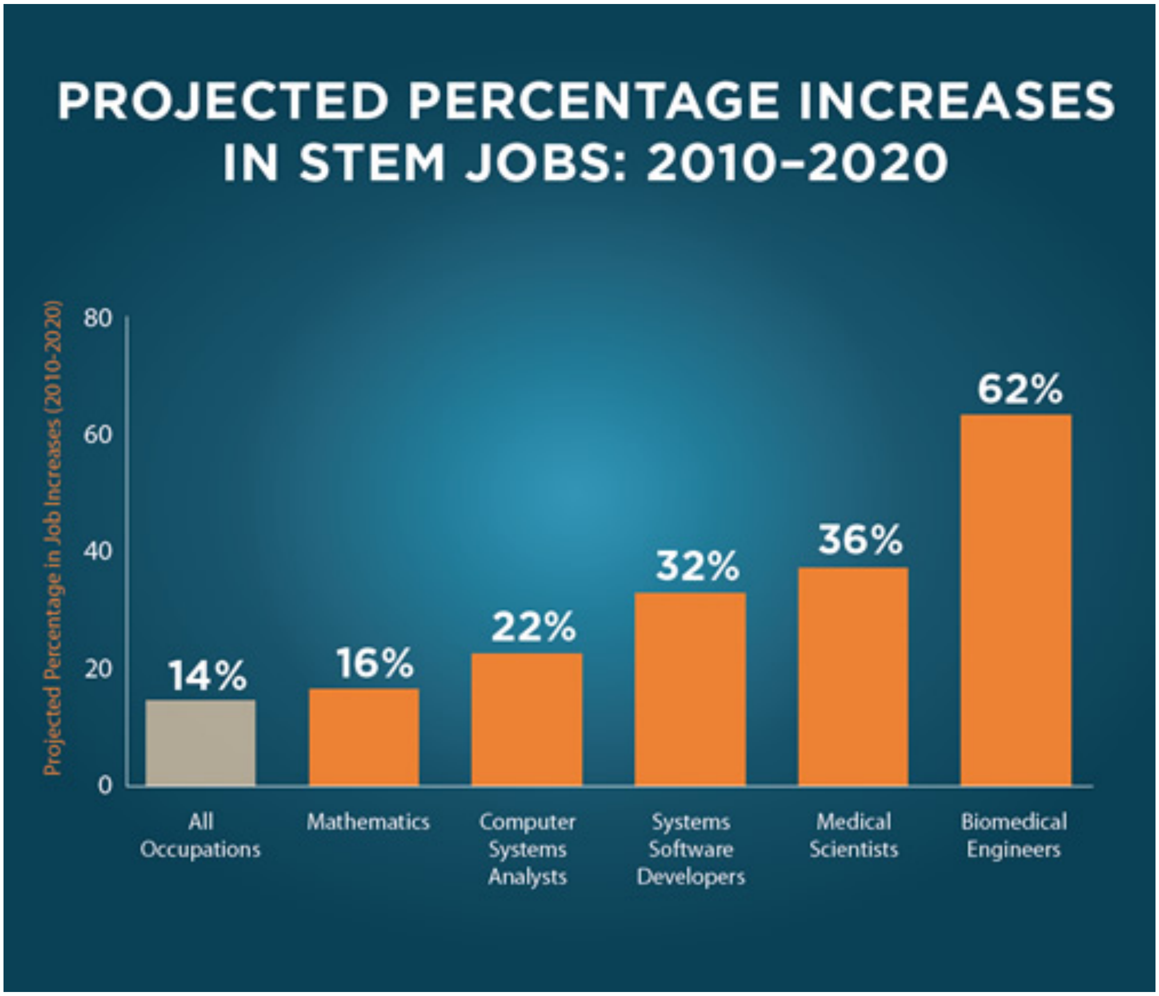
Chapter 1

Introduction

The popularity of inclusion of students with disabilities into the general education classroom is on the rise across various content disciplines. As such, methodologies must be investigated to support and ensure the success of the students. This research focuses on the science classroom. In today's world of high-stakes testing, new methodologies and different types of professional development must be implemented in science classrooms to support the success of students with learning disabilities. Providing such students with the opportunity to master science content through inquiry-based science instruction supplies the United States with a new workforce trained in science, technology, engineering, and math (STEM) knowledge and improves the students' outcomes. The President's Council of Advisors on Science and Technology (PCAST) concluded that if the United States wants to maintain its historic quality in STEM fields and gain social, economic, and national-security benefits that result from this quality, the workforce must be increased by approximately one million workers in STEM fields over the next decade (U.S. Department of Education, 2010; see Table 1). Providing educators with professional development that increases their science content knowledge and inquiry-based science instruction methodologies will increase the science content knowledge for students with learning disabilities and help fill the void in STEM fields.

Table 1

Projected Percentage Increase in STEM Jobs: 2010-2020



(U.S. Department of Education, 2010, p. 1)

Significance of the Research

This paper identifies the importance of the development of a document analysis to determine instructional adaptations for teachers in elementary school. The education system involves various types of learners, including English learners (EL), students with learning disabilities, students with autism, and those who are primarily visual or auditory learners (Texas Education Agency, 2013). Therefore, educators must use methods of instruction that reach all students in an engaging manner. Former President John Adams voiced support for educating all students when he stated that "laws for the liberal education of youth, especially for the lower classes of people, are so extremely wise and useful that to a humane and generous mind, no expense for this purpose would be thought extravagant" (as cited in McCullough, 2001, p. 103). An inclusive school offers opportunities for its science teachers to master differentiated instruction and inquiry-based science in order to implement Individualized Education Programs (IEPs) for students with learning disabilities. Teachers can no longer sit at desks or stand at chalkboards and deliver lectures; students need to be involved in active learning. Integrating learning strategies into practice activities will improve students' problem-solving skills, memory skills, understanding of textbooks, and capacity for summarizing information (Freiberg & Driscoll, 2005).

In the science classroom, students with learning disabilities need to be engaged through hands-on activities to increase their content knowledge, and teachers must be trained in both pedagogy and content. Goodnough and Nolan (2008) stated that teachers must be given the content framework, which would allow them to effectively assess their own knowledge and create and implement inquiry-based instruction. It is imperative for teachers to be aware of the content and pedagogy and access learners' needs when implementing inquiry-based instruction. The students' engagement in the learning process will vary across curricula and learning environments. Therefore, teachers must identify the goals of the content and how to engage the students to accomplish the goals.

The No Child Left Behind Act (NCLB) of 2001 was designed to level the learning field for all students and to target lower-income schools. The legislation provided federal money through grants for teacher training and instruction in reading in lower-performing schools. The program focused on reading, writing, and arithmetic, and was meant to bridge the achievement gap by measuring students' growth annually. It also emphasized quality education for students with disabilities and low-income populations (No Child Left Behind Act [NCLB], 2001). However, the legislation placed educators in a teach-to-the-test scenario. Additionally, because science, history, and foreign language are not tracked by NCLB, these subjects may not always be taught properly. This raises concerns for the future of learners and the United States.

The multiple-choice format generated by the state also may be a questionable practice. The State of Texas Assessment of Academic Readiness (STAAR) test has caused many issues, most notably of which is making the learning process homogenous—all students learn the same material, learn at the same rate, and test at the same time. In addition, NCLB increased the number of students receiving special education services, thereby creating a need for highly qualified special education teachers who use best practices. This research includes a rubric that a teacher in an inclusive classroom can use to evaluate the science curriculum for inquiry-based instruction and provides an instruction manual and professional development materials.

Rationale

Historically, the United States has embraced innovation through science and technology (President's Council of Advisors on Science and Technology [PCAST], 2012). The products of American basic and applied scientific research provide high-quality jobs, support high-tech and knowledge economies, and define the United States as a nation. The United States has an inventive, entrepreneurial society (PCAST, 2012); students with learning disabilities can be trained for science employment. Science innovations provide Americans with many benefits, such as longer and healthier lives; superior technology to adversaries; solutions to energy, food, and water supply issues; and global environmental protection (PCAST, 2012). Scientific innovation may lead to an increase in high-quality jobs and create a need for an educated, skilled workforce (PCAST, 2012). From the assembly line of Henry Ford to the digital revolution of Steve Jobs, the United States has been a leader in innovation; new pedagogy must be researched to remain this way.

Literature shows that professional development in inquiry-based instruction, with a collaborative team of educators, could impact the education of students. Learners of all ages acquire information best through inquiry-based instruction. When learners receive instruction through experiences, they internalize the information via the five senses, providing multiple pathways to the brain. The learner experiences the whole event, which teaches the child (i.e., learner) through a total physical response. Children are natural scientists, ready to investigate what the world has to offer, and learn through this natural investigative inquiry. Students' interests and curiosities initiate the inquiries and then engage them in the gathering and processing of information (Freiberg & Driscoll, 2005).

With such a strong national focus on high-stakes assessment, alternative pedagogical methods must be explored to ensure students with learning disabilities experience success in the science content area. Research suggests that inquiry-based instruction has a positive impact on the learning process Mastropieri et al. (2006). For example, research on curriculum depends heavily on training in the curriculum content and the teaching strategies that need to be implemented (Joyce & Showers, 2002). With the implementation of inquiry-based professional development, an educator might develop useful pedagogical tools that can be used to develop a more effective lesson that instructs the learner and increases his or her knowledge of the content.

Reform of the education system is essential, as "scientific training often includes little or no focus on science education itself" (Bower, 2005, p. 1). Along with inquiry-based methodologies, collaboration and problem-based instruction are imperative to science education reform.

Jorgenson (2005) also studied problem-based inquiry and suggested that “the push for standardized test preparation in many school settings does not leave much room for divergent instructional improvement strategies, especially when ‘covering the content’ through direct instruction, texts, and worksheets seems the most expedient approach” (p. 49). For students to succeed, they must receive inquiry-based instruction because “active science enables students to acquire valuable skills through their interaction, collaboration, and problem-solving with other students—skills that cannot be learned sitting at desks and listening to a teacher” (Jorgenson, 2005, p. 50). Additionally, students must understand the foundation of the ideas in order to fully understand the lesson.

Although the STAAR and Stanford 10 data are useful for quantitative research, “there has been little research to determine the quantitative benefits of inquiry science, there is a growing body of anecdotal evidence supporting its positive impact on academic performance” (Jorgenson, 2005, p. 51). Jorgenson (2005) cited numerous case studies and teacher testimonials in order to show a long history of successful inquiry-based science instruction.

This study contains an instructional adaptation rubric for elementary science that teachers can use in the classroom to support the needs of students with learning disabilities and to reform science classrooms. The primary research question of this study addresses what types of adaptations elementary school teachers need to ensure students with learning disabilities success in science. A rubric has been developed, which enables teachers to acquire the necessary tools and knowledge of the content to implement inquiry-based instruction for the student with learning disabilities.

Workforce Versus College Science

Scientific research creates high-quality jobs that employ and demand a highly skilled workforce (PCAST, 2012). This workforce must be trained in routine laboratory testing and inquiry-based endeavors, which instigates curiosity, innovation, and invention. The enterprise of scientific research can touch the imagination and idealism of young people and empower them to build a world that strengthens American ideals (PCAST, 2012). It is through innovation and imagination that discoveries are born. The needs of an innovation-based economy provide an incentive for transforming the entire national system of education, from kindergarten through postgraduate education and technical training (PCAST, 2012). A highly trained educator with knowledge of the content and inquiry-based science instruction that research has shown to be effective can plant this inspiration in a student with learning disabilities.

Wu and Hsieh (2006) suggested that inquiry-based instruction offers differentiated learning opportunities and helps students with learning disabilities develop their inquiry skills. Inquiry-based instruction provides the rigor and total physical response the learner needs to synthesize the content. Teachers may utilize content-specific workstations (i.e., centers) for student exploration. The hands-on quality of the centers adds motivation and interest to practice activities, along with the potential for adjustable, individualized, and differentiated tasks for learning (Freiberg & Driscoll, 2005). If a teacher can acquire the skills to implement inquiry-based instruction in the classroom, his or her learners will receive quality instruction, which might have a positive effect on their learning outcomes in science. Rowell and Ebbers (2004) stated that learners should be engaged in inquiry-based instruction and educators should receive professional development in the content. This study provides teachers with a rubric that will help them adapt each lesson, along with professional development in inquiry-based science instruction to help ensure that the student learning process will be enriched.

Importance to the U.S. Economy

The United States was previously the world's leading investor in research and development; however, by 2009, it had dropped to eighth in the world and fourth among large economies (PCAST, 2012). Educators must reach learners to improve the standing of the United States in research and development. Asia is equal to the United States in research and development, but is expected to surpass the United States soon (PCAST, 2012). It may be possible to close this research and development gap by implementing new inquiry-based pedagogy in science instruction for students with learning disabilities; however, educators must receive professional development to increase their knowledge of the content area and inquiry-based practices. The global competitiveness of the United States can be increased through the productivity of its researchers, positioning of its universities, and using national laboratories as central innovation and geographical anchors of the nation's science and technology enterprise (PCAST, 2012).

The United States must regain its establishment in the field of science. Teaching all children through effective science techniques could ensure a better future. Inquiry-based science professional development for teachers will promote an understanding of the content and offer teachers the hands-on experience needed to implement the lessons in the classroom. Goodnough and Nolan (2008) concluded that teachers need to be given the content framework in order to effectively implement inquiry-based instruction. By offering professional development using the inquiry-based methodology, the method is modeled for and then performed by the teacher in the professional development setting. This allows the teacher to fully understand how to implement the lesson in the classroom.

National and State Content

Federal and state policies for students with disabilities provide the foundation for the need of this study. Children with disabilities have rights to accountability, services, and highly qualified teachers, through federal policy. Data from *The Condition of Education* (NCES, 2012) reveals that in the United States, 6.5 million children, ages of 3 and 21, receive special education services, which is 13% of the public school population. In addition, it identified students by specific learning disability category. In Texas, 8.6% (430,350) of students enrolled in the 2009-2010 school year had disabilities, thus creating a need for highly qualified teachers to provide service for these students. According to the Texas Education Agency (TEA; 2012), Texas employed 340,328 classroom teachers, which included 30,384.6 special education teachers, or 9.1% of the teaching population. However, 7.9% (2,400) of special education teachers were not certified in special education, had out-of-field permits, and were not fully certified; therefore, they were not highly qualified (NCLB, 2001).

The increase in the number of students receiving special education services in the United States and Texas results in a need for more highly qualified teachers, which is driven by the NCLB policy. The large number of special education teachers who are teaching out-of-field and need certification and ongoing professional development exacerbates the needs in Texas. Approximately 10% of the school enrollment in Texas receives special education services; and 8 out of 10 of their teachers are practicing without the proper special education certification (TEA, 2012). The large population of special education students and the low number of properly trained special education teachers creates a problem in the education system under the highly qualified teacher requirements of NCLB. There is a need for support programs, such as teacher mentoring, team teaching, reduced class schedules, reduced caseloads, and rigorous professional development following the state standards that align with the Elementary and Secondary Education Act (ESEA) of 1965 and NCLB (Individuals with Disabilities Education Act (IDEA, 2004), for both special education and general education teachers. The training for these teachers should include professional development activities that promote superior pedagogy in early literacy instruction and early and appropriate interventions to identify students with disabilities (IDEA, 2004). Due to the extraordinary number of special education teachers in Texas who are teaching out of their certification area, professional development programs that target the development of highly qualified individuals are needed to establish, expand, and/or improve alternative paths for state certification of special education teachers (IDEA, 2004).

Originally, the U.S. education system kept students with disabilities separated from the general population or those students did not attend school, with the exception of blind and deaf students, who have been provided separate schools since the early 1800s. Students with disabilities did not receive a full learning experience because they were warehoused in separate classrooms and did not participate in any activities with the general education population. The Bureau of Education was established in 1966 under Title VI and provided leadership in special educations programs under the Elementary and Secondary Education Act. In 1970, the Education of the Handicapped Act (EHA), which provided grant opportunities to promote special education programs, was passed and Title VI was repealed. In 1975, all schools that received federal funds were required to assess handicapped students and develop an educational plan in collaboration with the students' parents, as a result of the Education for All Handicapped Children Act (Public Law 94-142; EAHCA). This act required states to provide a free and appropriate education for all students between the ages of 3 and 21. This resulted in more students receiving services and schools receiving funds. In 1977, services were broadened by Public Law 94-142, which provided grants that subsidized state and local education agencies, created individual student rights, and underscored special education and a free and appropriate education for all students.

In 1986, the Handicap Children's Protection Act (Public Law 99-372) passed, which allowed families to be reimbursed for legal fees for hearings or court actions they won. In 1988, the Technology-Related Assistance for Individuals with Disabilities Act (Public Law 100-407) passed, which recognized the need for assistive technology to enhance the performance of students with disabilities and provided funding to fulfill the need. In 1990, the Individuals with Disabilities Education Act (IDEA) was created with the amendment of Public Law 94-142, and the word *handicapped* was replaced with *disabled*. Finally, November 17, 2004, President Bush authorized HR 1350, which reauthorized IDEA through 2011, and on December 3, 2004, the President signed it into law in alignment with No Child Left Behind (NCLB), formerly the Elementary Secondary Education Act (ESEA) of 1965.

Traditionally, the significance of services for children with disabilities has been recognized by the policies of the United States Congress ensuring those students' rights and services, including accountability, the number of children served, and highly qualified teachers (NCLB, 2001). Furthermore, professional development is to be provided per federal policy to:

> Improve the knowledge of special education and regular education teachers concerning--
> (i) the academic and developmental or functional needs of students with disabilities; or
> (ii) effective instructional strategies, methods, and skills, and the use of State academic content standards and student academic achievement and functional standards, and State assessments, to improve teaching practices and student academic achievement. (IDEA, 2004).

Variables

The rubric to be designed will provide the tool or method to measure the dependent variable, which is the effectiveness of the lesson derived from the Texas Essential Knowledge and Skills (TEKS). The rubric will be applied to the TEKS that represent the independent variable, the science curriculum for elementary school. Other variables that could impact the effectiveness of the future impact of this study include:

- Professional development modules, which would provide the educator with professional development in the area of inquiry-based science instruction and curriculum adaptation.
- A Science games resource guide, which would provide a variety of science curriculum games that could be used for instruction, as a reinforcement tool, or a reteach.
- Peer-mediated tutoring, which would use differentiated inquiry-based science instruction.
- Training visuals, which would deliver professional development for adapting science curriculum to inquiry-based science instruction and could be viewed electronically to reach a wide variety and high volume of educators during professional development, thus increasing the skills of highly qualified teachers.
- Time, which would ensure that teachers have enough time to set up and implement inquiry-based science instruction and administrators provide the time required for professional development in the content area of inquiry-based science instruction. Modules and training visuals could decrease the time necessary for professional development by offering an electronic version that the educator could view at his or her convenience.
- Money, which would provide highly qualified teachers for students. With the financial constraints of the public school system, sufficient funds must be budgeted to purchase

supplies for inquiry-based science instruction and for professional development (e.g., substitutes and stipends).

- Curriculum, which must lend itself to inquiry-based instruction; the rubric will analyze this aspect.
- Certification level of teachers, which would insure a high quality teacher
- Education level of teachers, which would insure a high quality teacher
- Teachers' science content knowledge, which would ensure that the teachers are familiar with the TEKS and STAAR science content.
- Quality of teacher instruction, which would insure students' success in the classroom
- Students' science content knowledge, which would increase success on state exams and opportunities in higher education
- Students' success in science content, which would increase students' prepared for STEMS employment and fulfill projected STEM's opportunities.

Research Questions

This study will answer the following research questions:

1. What types of adaptations must elementary school teachers have to ensure students with learning disabilities succeed in science?
2. What must the teachers look for in the curriculum to adapt the lesson to inquiry-based instruction?
3. What are the components of effective instruction that should be incorporated into future professional developments that relate to elementary science lesson design?

This study will demonstrate adaptations that elementary school teachers need to ensure that students with learning disabilities succeed in science. A teacher might need to use a rubric to analyze the TEKS curriculum for usage of verbs. For example, when the TEKS uses the verb phrase *recognize landforms,* the teacher can provide the students with the opportunity to observe landforms and reflect on the formation of each and allow the students to create different landforms using a model with sand (STEMscopes, 2011). It is no linguistic accident that *building*, *construction*, and *work*, designate both a process and its finished product; without the meaning of the verb, that of the noun remains blank (Dewey, 1934). Allowing the students to be involved with the creation of the landform offers the noun meaning and gives the students a multisensory opportunity to learn the information. This follows the three principles of the Universal Design for Learning (UDL; The Iris Center, 2013) philosophy: (a) representation—presenting information and course content in multiple formats so that all students can access it; (b) action and expression—allowing students alternatives to express or demonstrate their learning; and (c) engagement—stimulating students' interest and motivation for learning in a variety of ways. Finally, this study should have a positive impact on the design of professional development for educators by offering an inquiry-based method of delivery. Tate (2012) offered strategies in the form of games, visual aids, and reflection, which engage the adult learner in an inquiry manner.

Chapter 2

Literature Review

The instructional methodology, pedagogy, and inquiry-based instruction information are derived from the literature reviewed in this chapter. This literature review provides supporting data for changing classroom teaching methodologies in science instruction for grades K-12, with a focus on the fifth grade. The literature also provides information that can change teaching methodologies across the curricula and about adapting lessons into inquiry-based instructional lessons.

Students in the United States are falling behind the rest of the world in science education. “Earlier international comparisons of scientific performance by students at higher-grade levels from various countries have indicated surprisingly low levels of achievement by United States students” (St. Omer, 2002, p. 318). Therefore, in order for students to be successful in science, new methodology must be explored and implemented. Collaboration is necessary at all levels to prepare U.S. elementary students for the future. Stamp and O’Brien (2005) stated, “elementary science is a local district, state, and national weak link in the continuum of K-16 (kindergarten through college) science education” (p. 70).

The U.S. public education system is not effective for teaching science. Many students struggle with the material presented in the science classroom; however, it is especially difficult for students with learning disabilities. Steele (2004) stated, “Learning strategies are recommended for teaching students with mild disabilities and can be used for science instruction” (p. 21). These strategies can be used with all populations, including English language learner (ELL) students, special education students, emotionally disturbed students, and others. According to Bower (2005):

> Over the last several years, the deplorable state of public science education and the perceived consequences for our nation's economic and intellectual vitality has attracted not only the attention of educators and politicians, but also an increasing number of professional scientists and engineers. (p. 1)

As such, a collaborative effort is needed among educators to change the system to inquiry-based learning, which approaches the learning process in a nontraditional manner. Through it, the student is presented with a task and has to solve the problem. Rowell and Ebbers (2004) stated, "Curricular shifts in emphasis from science content to science processes, and now to science inquiry, are accomplished with textual resources of institutional discourse" (p. 916). An inquiry-based classroom is different from the traditional classroom. A traditional classroom is quiet, with students working independently; an inquiry-based classroom is active, with students interacting with each other and with their teacher. Jorgenson (2005) described an inquiry-based classroom as follows:

> A principal opening the door during an inquiry activity will likely see children working together in groups to complete their own investigation, independently and with considerable excitement, bustle, and noise, with the teacher moving from group to group to monitor and check understanding as the children ask questions, question answers, record data, write observations, ask more questions, and work towards their own conclusion. (p. 49)

Curriculum adapted to inquiry-based instruction may provide a more equal playing field for all students. As the modern education system has placed a growing emphasis on standardized testing, students with learning disabilities have been left behind. Aydeniz, Cihak, Graham, and Retinger (2012) examined the effects of and attitudes toward inquiry-based science instruction in five U.S. elementary school students with learning disabilities using a single-subject method. The purpose of the article was to study the effects of inquiry-based science instruction on students with learning disabilities and examine the students' attitudes toward science pedagogy. The results suggested that inquiry-based science instruction implemented through science kit instruction increased the students' science content knowledge and improved their attitudes toward the subject. Implementing an experimental design, however, could have strengthened this study even further. Additionally, the optimal method for assigning participants to study conditions is through random assignment, although in some situations, this is impossible (Gersten et al., 2005). Therefore, with a larger sample size and random sampling, the results would have carried more weight in the science community. However, the results of the Aydeniz et al. (2012) study show promise for future, larger scale implementation.

Science Instruction Research

Mastropieri et al. (2006) examined the effects of peer tutoring using hands-on activities in an experimental approach. The results suggested that inquiry-based instruction has a positive effect on students with learning disabilities in the science content area in eighth grade. The quantitative research of Mastropieri et al. (2006) suggests substantial learning in a short period of time and retention of the content on the end-of-year test. The quantitative nature of the research strengthened this study.

Cook, Tankersley, and Landrum (2009) asked if researchers use single-subject studies to determine evidence-based practice in special education, how should they evaluate the effect of the intervention? By finding a group large enough for a quantitative study, the researchers avoided this question and added validity to future single-subject research that had similar results. One of the challenges of investigating special education intervention is the small sample size.

However, if researchers can find large groups to study, results can be used to compare to single-subject outcomes, which aids in the validity of single-subject results.

Learning Disabilities Research

Meeting the needs of students with learning disabilities continues to be a challenge for the inclusive classroom teacher, regardless of content area. With further research in the area of inquiry-based instruction, educators can develop a sound pedagogy that meets the needs of all students and increases their knowledge across content. Mastropieri et al. (2006) stated that differentiated instruction with peer tutoring may provide an approach that would help meet that challenge. Implementing pedagogy that engages the whole child and provides a total physical response to learning, while incorporating inquiry-based instruction, might be the intervention required by students with learning disabilities. Simpkins, Mastropieri, and Scruggs (2009) suggested that differentiated and peer tutoring resulted in higher production test gain scores across two 5-week science units. Educators should consider inquiry-based instruction as part of the curriculum delivery options and teacher professional development.

Pedagogy and Teacher Training

Teachers must be trained in the proper pedagogy for effective implementation of inquiry-based instruction. The constructivist approach should be examined and evaluated for effectiveness in helping new educators teach science. According to Liang and Gabel (2005), "From a constructivist perspective, learning is an individual process that involves linking new ideas and experiences with what the learner already knows" (p. 1144). Inquiry-based instruction links new ideas to prior knowledge in an effort to effectively implement instruction that is tailored to the learning process of the individual.

As the number of students that are included in the general education class grows, so too does the need for professional development in adapting science lessons into inquiry-based instruction. This need is particularly critical in science education, as science achievement scores of U.S. students lag behind those of students in other developed nations (Schmidt, McKnight, & Raizen, 1997). Supovitz and Turner (2000) stated, “The implicit logic of focusing on professional development as a means of improving students achievement is that high quality professional development will produce superior teaching in classrooms, which will, in turn, translate into higher levels of students achievement” (p. 965). Therefore, teachers could receive professional development that trains them in adapting the science curriculum into inquiry-based science instruction, which may result in positive student growth.

Students need to be instructed across the curriculum, building vocabulary and accessing prior knowledge, and teachers must be trained in these methods. Once a teacher receives the necessary training, he or she can return to the classroom and model the lesson for the students. As Goodnough and Nolan (2008) stated:

> Teachers play a pivotal role in helping students develop scientific understanding, abilities, and dispositions...[however,] many elementary teachers may feel ill equipped and ill prepared to assume the task of engaging students in problem- and inquiry-based approaches to teaching and learning science. (p. 197)

Students in the Science Curriculum

Many students have difficulty with science vocabulary. Amaral, Garrison, and Duron-Flores (2006) argued, “Imagine a science activity that excites native English speakers and English learners alike while simultaneously teaching students about tools used in science experiments, increasing science vocabulary, and improving students’ skills in recording information” (p. 30). Students require engaging activities to learn vocabulary; having students write a vocabulary word in a sentence will not teach them. In fact, students need to be involved in and build on prior knowledge.

If students are to engage in science and its applications within society, they must be scientifically literate (Goodrum, Hackling, & Rennie, 2001). Fleming and Panizzon (2010) built on this idea and stated:

> Learning is most effective when the scientific context used in the classroom is a transformed extension of the students' real world and so inspires students' intrinsic motivation, encouraging students to ask meaningful questions and seek their own answers through an inquiry of investigative approach. (p. 27)

Building on prior knowledge leads to the success of the student. Stimulating a student's curiosity helps him or her become engaged in learning. "The most exciting (and educational) experiences have always been when kids make their own inventions...building and making projects is one of the best ways to truly understand, own, and master knowledge about scientific and engineering principles" (Nagel, 2008, pp. 1–3).

Numerous articles, books, and websites are designed to assist teachers in developing lessons for inquiry-based learning. Plant-in-a-Jar as a Catalyst for Learning (Thompson, 2007) is an article that offers an excellent example of an inquiry-based activity. It teaches across the curriculum and is engaging. It gives students the opportunity to explore independently and communicate findings. A student places a seed in a jar with dirt and a small amount of water. The jar is sealed and placed in a window that receives generous sunlight. Over a period of time, the student observes the plant's development. During this process, the students can learn about plant development, water cycles, data collection, graphs, tables, and charts. The students also enhance and refine their vocabulary building, spelling, and handwriting.

Professional Development

Adult learning research has provided a base of effective strategies that can be incorporated into adult learning opportunities, such as professional development, to improve the likelihood that the information will be remembered by students and be used in classroom teaching in the future. Tate (2012) provided a summarization of research-based strategies that are effective (see Table 2). The professional development created for this study will incorporate many of these strategies.

Table 2

Effective Professional Development Strategies for Adults

Tate's #	Strategy Title	Description
1	Brainstorming and Discussion	During the professional development session, the presenter should stop frequently and allow the participants to brainstorm and discuss what they are learning. This falls in line with the Fogarty's (2007) strategy of, following an actual experience, having people verbally retell events and ideas through discussion and dialogue to assist the brain in tapping into cognitive memory (as cited in Tate, 2012). For the purpose of this study's professional development, the process will be called *Table Talk*. This is a moment in time during professional development when the participants are given the opportunity to participate in discourse about the material covered in the training.
2	Drawing and Artwork	To assist the participants in developing a better understanding of material and synthesizing the information, they would be encouraged to use art, draw, doodle, and make projects throughout the professional development. The thinking in which we engage while producing art precedes improved thinking across curriculum (Dewey, 1934). This process might help educators retain the information and provide them an experience that can be used in their classrooms.
3	Field Trips	A field trip is a tool that will be utilized during on-campus trainings. The presenter will take the participants on a walk around the neighborhood so they can get a feel for the community and student population and get out of their school

		learning experiences. Tate (2012) stated that this type of experience lets the educator experience where the students and their families live, work, and play.
4	Games	Giving educators templates and instruction on the development of board games, card games, interactive white board games, and physically active games is an essential element of professional development. The educators would play games, which develop vocabulary and reinforce science content, enabling the participants to learn or relearn the science content and provide a product that can be used in the classroom immediately. Tate (2012) reported that adults in the workshop learned and retained a significant amount of information for a long period of time.
5	Graphic Organizers	At the beginning of each professional development, the group will perform a brainstorming session that draws on prior knowledge, sets expectations for learning, creates a pathway to develop that knowledge, and organizes what they know, what want to know, how they want to learn it, and what they learned (KWHL) on a chart. Then several graphic organizers would be distributed and the educator would receive training on the implementation of the different organizers. The organizers would be used through the training so they could engage in hands-on experience with the strategy. Tate (2012) stated that they are pictorial representations of linear ideas and show the connections of the content area.
6	Humor and Celebration	Humans love to celebrate. This professional development would incorporate humor and celebration throughout the training, offering the educators ideas to implement in their classroom. Humor puts the brain in a positive state for learning, boosts creativity, and creates a memorable professional learning experience for the right reason (Tate, 2012). In my classroom, I use “Kiss your brain!” and the students kiss their finger then place the kiss on their forehead with a smile. Often the students will ask if they can kiss their brain, to which I answer, “You may always kiss your brain if you feel deserving. You don’t need my permission to kiss your brain when you know you have done something brilliant!”
7	Manipulatives and Models	Manipulatives and models are an intricate part of inquiry-based science instruction and instruction for students with learning disabilities; therefore, manipulatives and models will be at the forefront of this professional development design for science educators of students with learning disabilities. Throughout the training, the participants will build models and learn the art of

		manipulatives in a manner that enables them to return to the classroom and deliver instruction in an inquiry manner. Students with learning disabilities need the hands-on experience. "One learns to do by doing" (Tate, 2012, p. 57).
8	Metaphors, Analogies, and Similes	When teaching about the brain or any subject, metaphors, analogies, and similes are the most influential strategies available (Tate, 2012). They provide a higher order of thinking and create more meaningful learning experiences. The educators would be trained in the power of metaphor, analogy, and simile throughout the professional development, which would provide them the tools necessary to implement this strategy in the classroom. Tate (2012) stated that people who think metaphorically think at higher levels. Students with learning disabilities need tools that enable higher-order thinking skills that are incorporated into hands-on learning. "How would you ever know that you could catch a ball from a distance if the only balls you have ever caught in real life have been handed to you" (Tate, 2012, p. 62)? We must not hand the information to the learner; he or she must reach for it.
9	Mnemonic Devices	What are the colors in a rainbow? Everyone can answer that question because of a form of mnemonic called *acrostic*. This is a useful tool for all learners, especially for students with learning disabilities. It is easier for the brain to remember small chunks of information instead of one huge chunk. According to Materna (2007), because mnemonic devices reduce large amounts of data into smaller sets or chunks, they can help people metacognitively encode and retrieve information.
10	Movement	Movement is essential to the learning process of students with learning disabilities. This strategy would be taught and used throughout the professional development for educators of students with learning disabilities. Most individuals know at least one sign from American Sign Language that they learned as children. Incorporating movement with learning has a positive outcome on knowledge acquired. Anything learned while moving goes into one of the strongest memory systems in the brain—procedural or muscle memory (Tate, 2012). This explains why individuals never forget how to ride a bike or swim.
11	Music, Rhythm, Rhyme, and Rap	Girls spend hours playing handclap games and practicing cheers; many remember at least one as adults. In addition, boys typically play soldiers marching to a cadence that they can still recite as adults. The researcher will use music, rhythm, rhyme, and rap to reinforce science content and allow projects to be

		created using this strategy to evaluate learning. The educator will then be able to return to the classroom and implement this strategy. In addition, music can be used to set the mood of instruction. Calm music can relax an energetic crowd and music with pep can get the crowd fired up. Tate (2012) suggested ending class by celebrating and moving to the left and right to the song “Celebrate” by Kool and the Gang so that every participant leaves class with a positive feeling that they are able to implement whatever was acquired during the professional learning experience. This is incorporating celebration, music, and movement, which suggests the strategies can overlap and work together; they do not have to be independent.
12	Project-Based and Problem-Based Instruction	Project-based and problem-based instruction for students with learning disabilities is the hallmark of this research. This strategy will be the foundation of the professional learning experience. The educator will learn through project-based instruction and leave the training able to implement it in the classroom. Westwater and Wolfe (2000) stated neuroscientists have found that throughout history, those characteristics that did not enhance the brain and body’s survival in the real world have disappeared, while those attributes that enhanced survival have endured or become more pronounced over time. Humans learn by figuring things out—as inquiry-based learners.
16	Technology	Technology is everywhere and must be harnessed and utilized in the 21st-century classroom. Brown (2008) stated educators are now finding that blogs can improve writing skills, wikis foster collaboration, Skype engages people in discussion while not in the classroom, and niche group software enables people to create their own music. The professional development will train educators on the use of technology in the classroom and share beneficial links for students with learning disabilities.
17	Visualization and Guided Imagery	Visualization and guided imagery will be used in the professional development, and educators will be encouraged to implement it in their classrooms. Many people are visual learners; therefore, this strategy is essential to the professional development plan. Tate (2012) explained a method where participants view a science concept on the document camera for a few seconds, then the information is removed, and the participants are asked to visualize the concept, jot it down on paper, compare their results, and engage in discourse. This implements several of the strategies and reinforces learning at a higher level. It incorporates the needs of the visual learner and fosters collaboration, brainstorming, and art. This is a

		practical strategy for professional development and for students with learning disabilities.
20	Writing and Reflection	Similar to the Table Talk strategy, reflective writing will be used sporadically throughout the professional development and in projects. The participants will occasionally reflectively write in place of Table Talk and then participate in Table Talk by discussing what they wrote. Additionally, their reflective writing can be used in the process of making projects (e.g., brochures, flyers, posters, and newspaper articles). Jensen (2000) suggested that multiple complicated bits of information from presentations and observations can be organized and made easier to understand when written down.

Note. Adapted from *Sit & Get Won't Grow Dendrites* (2nd ed.), by M. L. Tate, 2012, Thousand Oaks, CA: Corwin. Copyright 2012.

It is imperative that educators understand the effectiveness of professional development. If professional development is not effective, the outcome for the students will be less than desirable. Staff development affects its ultimate goal of student learning via a chain of events (Joyce & Showers, 2002). Therefore, the effectiveness of the professional development will be measured using a survey completed by the participants at the end of the professional development. The educators will also receive a lesson self-assessment rubric that evaluates the effectiveness of the professional development in the classroom.

Chapter 3

Method

Students' success will drive the economic future of the United States. Each individual student's future contribution is essential to society. Research shows that many students are not successful in STEM fields, especially students with disabilities. Most students with disabilities can make valuable contributions to society when instruction is available that meets their needs and helps them succeed. Educators must create new pathways for students to pursue that help them bridge the transition from school to the workforce. More students must be trained in STEM fields. According to Symonds, Schwartz, and Ferguson (2011), jobs requiring STEM skills have doubled and the United States lacks the workforce to fill these positions. Many students that currently receive special education services can be trained to satisfy this need. Research shows that most students thrive with an inquiry-based science approach (Mastropieri & Scruggs, 1992).

Inquiry-based science involves teaching the curriculum through exploration, which engages the student and reinforces a natural learning process that all children possess. The student is actively involved in problem solving, while using higher-order thinking skills, and engages in a total physical response to their learning. The student is presented with a problem and must find a solution independently; therefore, the information is synthesized in a manner that gives the student a better understanding of the concepts. For example, while learning about circuits, a teacher might lecture about electron flow and turn the light switch on and off in the classroom as a demonstration; however, the students will receive a better understanding of the concept if given a battery, wire, and lights with the instruction to make the lamp illuminate. This is true inquiry-based science instruction that will benefit students with learning disabilities.

An obstacle to overcome is assisting teachers in the area of inquiry-based science instruction for students with learning disabilities. Teachers often lack knowledge of how to implement instruction for students with learning disabilities and may be uncomfortable with the science content; therefore, there is a need for professional development to help teachers grow in this area.

The goal of this project is to provide quality professional development in elementary science. The project prepares professional development materials for teachers, including: (a) a background survey to determine teacher experience and interest in science; (b) a science content knowledge evaluation tool; (c) two professional development lessons that can be used to train teachers; (d) a training PowerPoint; (e) a post professional development survey; (f) materials for use when the teachers return to their classrooms; (g) sample lessons; and (h) a rubric to help with the analysis of the TEKS/objectives. These materials constitute a professional development action plan to meet the needs of elementary teachers who deliver science instruction to students with disabilities. The following list identifies the various components of professional development materials:

Background Survey—a survey given to the participants prior to professional development to acquire their background knowledge. The professional development can be adjusted to fit the needs of the participants. If the participants report a low value in science curriculum, the professional development can be adapted to fulfill that deficiency. This survey is essential to the success of the professional development and ensures the participants' achievement in acquiring the skills necessary to implement inquiry-based science instruction in their classrooms.

Science Content Knowledge Assessment Tool—an assessment administered before and after the professional development to gauge the participants' content knowledge. The participants will be given a science content knowledge assessment prior to the professional development to evaluate their existing understanding of the curriculum. After completing the professional development, the participants will complete the same assessment and scores could be compared to evaluate the effectiveness of the professional development on the teachers' growth in the area of science content knowledge.

Professional Development Lessons—lessons adapted to inquiry-based science instruction for the TEKS outlined in this thesis, as well as a template for the teachers' personal use. The participants will receive three sample lesson plans for TEKS from life science, earth science, and physical science and a template for personal use in the classroom. The TEKS profiled in this thesis for professional development are areas of weakness in the science curriculum.

PowerPoint—an outline of the professional development designed in this thesis and can be use for the training of inquiry-based science instruction for teachers of students with learning disabilities. The visual aid covers the TEKS outlined in this thesis and offers a segue from the TEKS to inquiry-based science instruction.

Post Professional Development Survey—a survey developed to evaluate the participants' opinions of the professional development. This information will be evaluated to perfect future professional developments for educators of students with learning disabilities.

Classroom Materials—materials provided to the participants that are related to the lessons highlighted in the professional development to support the implementation of the lesson upon returning to the classroom.

TEKS Objective Analysis Rubric—a rubric designed to analyze the TEKS for frequency of verbs. The more verbs the TEKS contains, the more it is adaptable for inquiry-based science instruction and the more opportunities the students with learning disabilities will experience.

Sample

This thesis is a document analysis study; therefore, instead of sampling people, the study samples documents. To help provide a breadth of potential content, three diverse TEKS from the elementary science curriculum were selected: (a) 4.8C, (b) 3.5AB, and (c) 1.10CD. These TEKS were identified for this document analysis because of their ability to be adapted to inquiry-based science instruction. This allowed the professional development plan to incorporate content knowledge support for teachers in the three areas teachers are frequently found to be deficient in science content knowledge. The professional development has the potential to impact teacher science knowledge and increase science skills.

Instrument

Rubric creation. To create an adaptive rubric, several verbs that were conducive to inquiry-based science instruction were isolated. For example, in TEKS 1.10CD Life Cycles, the students are expected to explore, illustrate, and compare life cycles in living organisms, such as butterflies, beetles, radishes, or lima beans (STEMscopes, 2011). This TEKS uses three verbs—explore, illustrate, and compare—thus giving the teacher three opportunities to provide inquiry-based science instruction to the students with learning disabilities and providing the students with three opportunities to master the TEKS.

In TEKS 3.5AB Classifying Matter, the students are expected to measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float; describe and classify samples of matter as solids, liquids, and gases; and demonstrate that solids have a definitive shape and liquids and gases take the shape of the container (STEMscopes, 2011). This TEKS uses three verbs—measure, record, and classify—thus giving the teacher ample opportunity for inquiry-based science instruction and providing the students with learning disabilities multiple learning opportunities.

Finally, in TEKS 4.8C Patterns on Earth, the students is expected to collect and analyze data to identify sequences and predict patterns of change in shadows, tides, seasons and the observable appearance of the moon over time TEKS 4.8C (STEMscopes, 2011). This TEKS uses four verbs—collect, analyze, identify, and predict—thus offering numerous opportunities for teaching and learning.

By analyzing the TEKS for the occurrence of verbs, the teachers can calculate the opportunities available in the TEKS for inquiry-based science instruction that can be delivered to the students with learning disabilities. The more verbs the TEKS has, the more learning opportunities the students can have to practice inquiry-based science. By increasing the students' learning opportunities, their science content knowledge is increased, thus increasing their marketability in the STEM employment arena.

Teachers must be trained to read the science TEKS to determine whether they can be adapted for delivery that uses inquiry-based science instruction. By analyzing the TEKS for verbs, a teacher can evaluate the objective for possible adaptation to inquiry-based science instruction. The stronger the verb, the more likely the objective can be adapted to inquiry-based science instruction. To facilitate the TEKS/objective evaluation process, teachers need tools. Rubrics can be used successfully to work with teachers to provide the support they need to determine the potential for adapting objectives to fit an inquiry science model. This project develops and pilots an inquiry-based science curriculum adaptation rubric for use throughout the K-12 science curriculum.

A *rubric* in education literature is an assessment tool used to describe and score observable qualitative differences in performances (Reddy, 2010). According to Popham (1997), rubrics should contain between three and five evaluation criteria that guide teachers, rather than overwhelm them. Each evaluation criterion must represent a key attribute of the skill being assessed (Popham, 1997). For the purpose of this research, the skill is components of the TEKS. The verb in the TEKS is the component that identifies the action the teachers must take to implement inquiry-based science instruction in a classroom setting.

Furthermore, the rubric must contain quality definitions and a scoring strategy (Popham, 1997). The rubric designed for this study will evaluate the curriculum for adapting lessons into inquiry-based science instruction. A document analysis will be conducted using an effective instructional rubric, which measures the effectiveness of the lesson for inquiry-based science instruction. The rubric will focus on the usage of verbs and elements of the 5E model in the TEKS to identify the adaptability of the curriculum to inquiry-based science instruction. This will ensure that students with learning disabilities can respond on the fifth-grade STAAR assessment. Three TEKS from the elementary science curriculum will be analyzed using the rubric designed in this study. Each lesson has its own rubric analysis tool and a coded degree of presence or absence of effective instruction variable from the rubric in the lesson. The outcome will be the frequency (+/-) of sufficient effective instructional variables, recommendations for changes, and examples of effective teaching.

The data will be analyzed using an effective instructional rubric that incorporates the following numerical system or rating: 0 not adaptable, 1-5 possible adaptation, 6-11 practicable adaptation, and 12-18 adaptable. The TEKS receiving a rating of 0 cannot be adapted to inquiry-based science instruction. The likelihood of the curriculum being adapted to inquiry-based science instruction increases as the value from the rubric increases, with 18 representing the highest value.

Sample lesson creation. To create lessons that are inquiry-based for students with learning disabilities, as previously stated, the verbs in the TEKS must be examined. If the TEKS state the student will (TSW) observe, the educator must give the students items to observe. If the TEKS states TSW measure, the teacher must give the students items to measure. If the TEKS states TSW identify, classify, or predict, the educator must follow suit. Once teachers can determine the viability of an objective to meet an inquiry science model, they must identify how the objective can be taught as part of a lesson. Lesson components and learning opportunities need to match the knowledge and skills that students must learn in a specific objective. For example, when the objective to be mastered involves measurement, students must have meter sticks, triple beam balance, thermometers, magnets, etc. to ensure that they can select the appropriate measurement tool. Additionally, teachers must have the skills to use the various measurement tools appropriately and ensure that students have been taught how to generate the correct solution. Finally, teachers must provide the students with multiple opportunities to complete the measurement task. This project designs three sample lessons and provides materials lists for lesson implementation and teacher guidelines to support the success of students with disabilities.

Chapter 4

Results

Students with learning disabilities generally need hands-on activities for success in science; inquiry-based science uses hands-on opportunities to learn that meet the learning needs of these students (Mastropieri, Scruggs, Boon & Carter, 2001). While this technique can work well for the students, their teachers must know the science content and be able to adapt lessons to the inquiry-based format before implementation can occur.

Implementation of Inquiry-Based Science

There are three main components related to the implementation of inquiry-based science: (a) TEKS analysis; (b) teacher content knowledge; and (c) curriculum adaptation professional development (see Figure 1); these can be considered the cycle of activities that support student success. Unless teachers can select viable objectives and possess the science knowledge necessary for instruction, they cannot adapt the curriculum to meet the needs of students. This study provides practical examples to address each of these requirements.

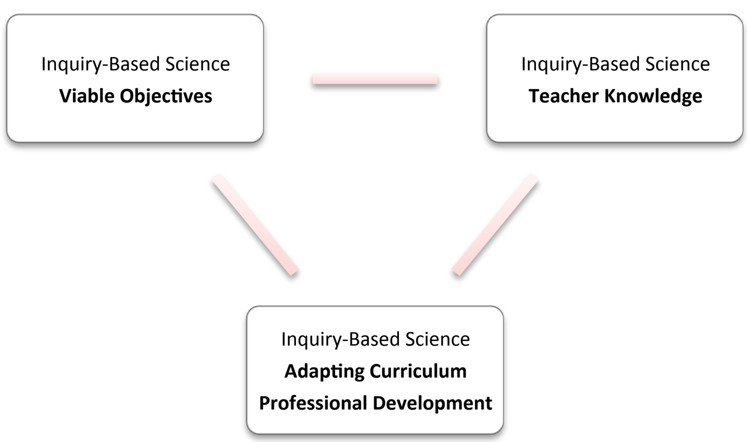


Figure 1. The Cycle of Success: TEKS Analysis, Teacher Content Knowledge, and Curriculum Adaptation Professional Development.

Phases of Inquiry

Three phases of inquiry will constitute this study: (a) viable objectives; (b) teacher knowledge; and (c) adapting curriculum (see Figure 2).

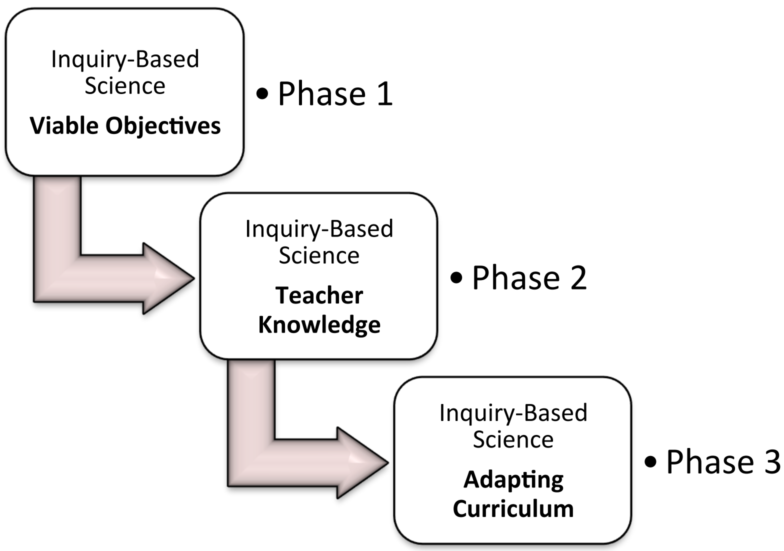


Figure 2. Phases of success: Viable Objectives, Teacher Knowledge, and Adapting Curriculum

Phase I: Viable objectives. To determine if science TEKS objectives are viable for use in an inquiry-based science approach, teachers must learn how to identify suitable objectives. Inquiry-based science involves student activity; therefore, action verbs in the TEKS objectives act as a guide for success. The action verbs are: analyze, compare, connect, construct, demonstrate, describe, draw, evaluate, explain, explore, formulate, identify, make, observe, predict, recognize, record, use, and differentiate (see Appendix A). This phase of the study uses a sample of TEKS, as prescribed by the Texas Education Agency for science curriculum in public elementary school, specifically the fifth-grade science TEKS. These TEKS from Earth and space science, life science, and physical science were evaluated to determine the ease of adapting the curriculum to inquiry-based science instruction. Table 3 and Figure 3 demonstrate the sample TEKS and whether they can be adapted to inquiry-based science.

Table 3

Grade 5 Science Texas Essential Knowledge and Skills (TEKS)

Experimental Design	Adaptable Yes	Adaptable No
Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:		
Demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations; and	✔	
Make informed choices in the conservation, disposal, and recycling of materials.	✔	
Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:		
Describe, plan, and implement simple experimental investigations testing one variable;	✔	
Ask well-defined questions, formulate testable hypotheses, and select and use appropriate equipment and technology;	✔	
Collect information by detailed observations and accurate measuring;	✔	
Analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence;	✔	
Demonstrate that repeated investigations may increase the reliability of results;	✔	
Communicate valid conclusions in both written and verbal forms; and		✔
Construct appropriate simple graphs, tables, maps, and charts using technology, including computers, to organize, examine, and evaluate information.	✔	
Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:		
In all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;	✔	
Evaluate the accuracy of the information related to promotional materials for products and services such as nutritional labels;	✔	
Draw or develop a model that represents how something works or looks that cannot be seen such as how a soda dispensing machine works; and	✔	
Connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.	✔	

Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:	
Collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, prisms, mirrors, pan balances, triple beam balances, spring scales, graduated cylinders, beakers, hot plates, meter sticks, magnets, collecting nets, and notebooks; timing devices, including clocks and stopwatches; and materials to support observations of habitats or organisms such as terrariums and aquariums; and	✔
Use safety equipment, including safety goggles and gloves.	✔
Physical Science	
Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:	
Classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy;	✔
Identify the boiling and freezing/melting points of water on the Celsius scale;	✔
Demonstrate that some mixtures maintain physical properties of their ingredients, such as iron filings and sand; and	✔
Identify changes that can occur in the physical properties of the ingredients of solutions, such as dissolving salt in water or adding lemon juice to water.	✔
Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:	
Explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;	✔
Demonstrate that the flow of electricity in circuits requires a complete path through which an electric current can pass and can produce light, heat, and sound;	✔
Demonstrate that light travels in a straight line until it strikes an object or travels through one medium to another and that light can be reflected, such as the use of mirrors or other shiny surfaces, and refracted, such as the appearance of an object when observed through water; and	✔
Design an experiment that tests the effect of force on an object.	✔

Earth and Space	
Earth and space. The student knows that Earth's surface is constantly changing and consists of useful resources. The student is expected to:	
Explore the processes that led to the formation of sedimentary rocks and fossil fuels;	✔
Recognize how landforms, such as deltas, canyons, and sand dunes, are the result of changes to Earth's surface by wind, water, and ice;	✔
Identify alternative energy resources, such as wind, solar, hydroelectric, geothermal, and biofuels; and	✔
Identify fossils as evidence of past living organisms and the nature of the environments at the time using models.	✔
Earth and space. The student knows that there are recognizable patterns in the natural world and among the sun, Earth, and moon system. The student is expected to:	
Differentiate between weather and climate;	✔
Explain how the sun and the ocean interact in the water cycle;	✔
Demonstrate that Earth rotates on its axis once approximately every 24 hours, causing the day/night cycle and the apparent movement of the sun across the sky; and	✔
Identify and compare the physical characteristics of the sun, Earth, and moon.	✔
Life Science	
Organisms and environments. The student knows that there are relationships, systems, and cycles within environments. The student is expected to:	
Observe the way organisms live and survive in their ecosystems by interacting with the living and non-living elements;	✔
Describe how the flow of energy derived from the sun, used by producers to create their own food, is transferred through a food chain and food web to consumers and decomposers;	✔
Predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways; and	✔
Identify the significance of the carbon dioxide-oxygen cycle to the survival of plants and animals.	✔
Organisms and environments. The student knows that organisms undergo similar life processes and have structures that help them survive within their environments. The student is expected to:	
Compare the structures and functions of different species that help them live and survive, such as hooves on prairie animals or webbed feet in aquatic animals;	✔
Differentiate between inherited traits of plants and animals, such as spines on a cactus or shape of a beak, and learned behaviors, such as an animal learning tricks or a child riding a bicycle; and	✔

Describe the differences between complete and incomplete metamorphosis of insects.	✔	
Total	37	1

Note. Adapted TEA August 2013. §112.16. Science, Grade 5, Beginning with School Year 2010-2011. Revised August 2013.

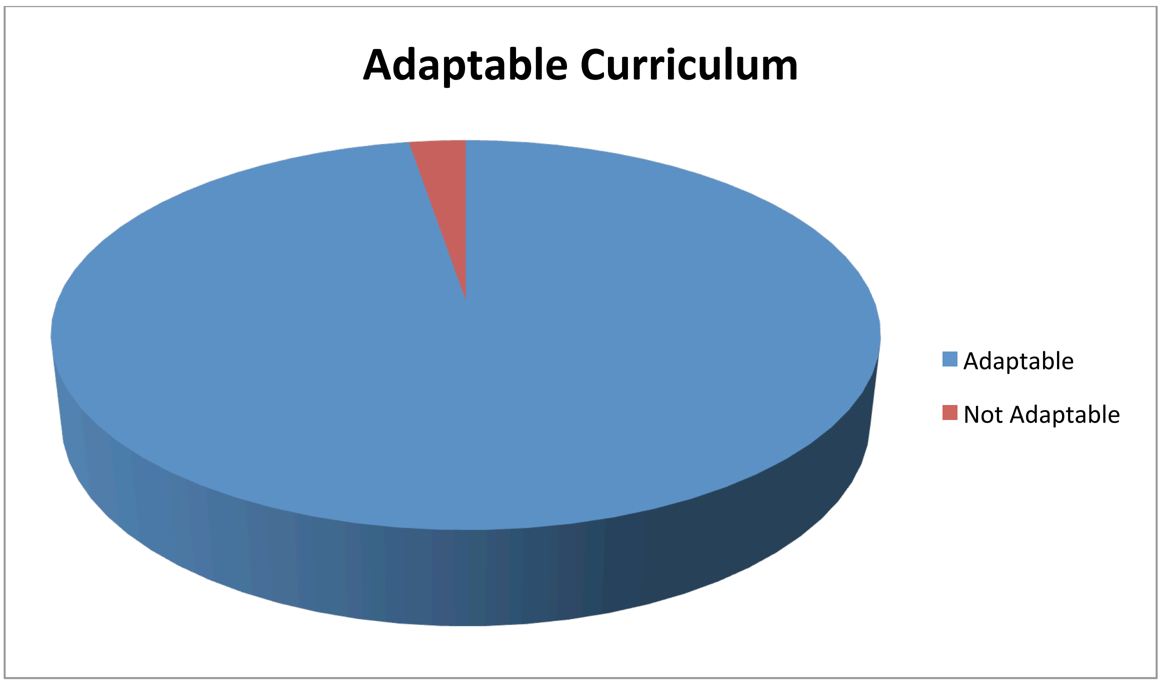


Figure 3. Adaptable TEKS Fifth-Grade Science as identified by the TEKS Objective Analysis Rubric.

As illustrated in Table 3 and Figure 3, 97.4% of the TEKS can be adapted to inquiry-based science instruction. The Texas fifth-grade science curriculum, therefore, is a viable set of objectives for use in an inquiry-based science approach. According to Steele (2004), students with learning disabilities work best with active learning and inquiry-based approaches; therefore, it is imperative that their teachers can deliver science instruction in this manner. The TEKS sample provided here passes the adaptability test and provides the foundation for the cycle of success. Active lessons can be generated from the TEKS that could be used with inquiry-based science while ensuring that teachers comply with state standards. In general, teachers teach from a book or worksheets, even though science kits are the superior approach for inquiry-based science Aydeniz, Cihak, Graham, and Retinger (2012). Kits offer students with learning disabilities a hands-on experience by allowing them to be actively involved in the lesson. Teachers must have the support and training to implement inquiry-based science instruction in the classrooms so they open the kits and use them.

Phase II: Teacher knowledge. The second necessary, but insufficient, component in the cycle of success is teacher knowledge in science. The teachers' science content knowledge can be assessed using a sample test that was developed for this study. The assessment is given to the teachers before and after professional development to identify initial deficiencies/challenges in science knowledge and any gains as a consequence of training. The science TEKS were examined for elementary grades and an assessment was designed that matched the TEKS throughout the development of the test. In the development of the assessment, three TEKS objectives were used: (a) SCI.4.8C; (b) SCI.3.5A; and (c) SCI.1.1CD. These are the same TEKS objectives that will be used to generate sample lesson plans in Phase III. The items are examples of the types of items that can be generated to assess whether teachers know the material they will teach. When other material is presented during science professional development, the assessment items must be changed to match the content.

Unlike a rating scale or a multiple-choice test, the items in the test require generative answers. These sample questions were designed to elicit knowledge that could not be determined from the items themselves. This is an important aspect of this work, as it helps reduce guessing and ensures that sufficient information is requested in the response to ensure that teachers understand the science content. The following are the sample items:

- TEKS SCI.4.8C states, “Collect and analyze data to identify sequences and predict patterns of change in shadows, tides, seasons, and the observable appearance of the Moon over time” (TEA, 2010). The assessment asks the teachers to explain and illustrate why the moon appears to change shape, predict the next moon in a sequence, and defend their answer. Each component of the item requires teacher action.
- TEKS SCI.3.5A states, “Measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float” (TEA, 2010). The assessment focuses on density and asks the teacher to explain and illustrate what happens when oil, water, and a cork are placed into one beaker. Each component of the item requires teacher action.
- TEKS SCI.1.10D states, “Observe and record life cycles of animals such as a chicken, frog, mealworms, or fish” (TEA, 2010). The assessment asks the teacher to explain and illustrate complete and incomplete metamorphosis. Each component of the item requires teacher action.

A copy of the sample assessment is provided in Figure 4.

Teacher Science Content Knowledge
Texas Science TEKS 1.10CD, 3.5AB, and 4.8C

Name:_________________________ Date:____________________ Group:____________

1. Explain and illustrate why the moon appears to change shape:

2. Which moon is next in the following sequence?
   Defend your answer using DOC.

3. Explain and illustrate what most likely will happen if oil, water, and a cork are all placed into one beaker.

4. Explain and illustrate complete and incomplete metamorphosis.

Figure 4. Sample science content knowledge assessment tool.

The teachers' science content knowledge assessment tool evaluates the teachers' content of the TEKS and supports both professional development and the student success cycle. Professional developers can gauge teacher science knowledge and the way teachers approach science. By knowing teacher outcomes, professional development can be customized to meet the needs of the group. Content knowledge will help teachers to adapt curriculum; without both an ability to analyze the objectives to determine adaptability and knowledge of the content, teachers cannot adapt curriculum. By assessing the teachers' content knowledge of the TEKS and providing high-quality training, students can be successful in mastering the TEKS. The Teachers Science Content Knowledge Assessment Tool is designed on the content of the lessons developed in Phase III. Each question is directly based on the science content of the TEKS from each sample lesson. By developing a backwards design that bases the assessment on the TEKS it ensures an evaluation of the exact content knowledge the State requires the students to know. Designing an assessment in this manner establishes a baseline prior to the professional development to bridge gaps in the teachers' content knowledge, which addresses deficiencies, then offers the tools necessary for the educator to adapt their curriculum in the classroom. Providing high quality professional development will result in high quality training that transfers to the classroom.

Phase III: Adapting curriculum. A document analysis of various science TEKS was conducted for this study. The Inquiry-Based Science Lesson Adaptation Effectiveness Rubric (see Appendix B) was developed to evaluate the TEKS. In the future, this rubric, in conjunction with professional development in inquiry-based science, can enable teachers to acquire the necessary tools and knowledge to implement inquiry-based science instruction for students with learning disabilities.

The initial process in Phase III utilized the outcomes of Phase I to identify which TEKS are conducive to inquiry-based science instruction. Three sample TEKS were identified, as previously mentioned. An inquiry-based science instruction lesson plan was adapted for each of the three TEKS. In Phase I, each of the science TEKS was evaluated for verbs (analyze, collect, identify measure, observe, predict, record, and test). Students would be required to perform some type of action to master these objectives. Inquiry-based lesson plans were developed for each of the three TEKS objectives, each of which was focused on the actions that should be taken based on the verbs in the objective. Each sample lesson was evaluated using a rubric created for this project. For the Inquiry-Based Science Lesson Adaptation Effectiveness Rubric (see Appendix B), the evaluation criteria ranked key attributes, such as the verb(s), student questioning opportunities, student engagement, explanations to questions, links to scientific knowledge, and student communication from the curriculum. The rubric was created on a 4-point (0-3) Likert type scale.

Lesson development. Each lesson follows the same basic outline of a 5E lesson for science (Biological Sciences Curriculum Study, 2006). This outline organizes lesson information into 11 basic components:

1. Teacher name,
2. Date of lesson,
3. Subject/Grade level,
4. Materials,
5. TEKS,
6. Lesson objective(s),
7. Differentiation strategies to meet diverse learners' needs,

8. Engagement,
9. Exploration,
10. Explanation,
11. Elaboration, and
12. Evaluation.

The first lesson is based on TEKS SCI.4.8C, The Lunar Cycle. The students are engaged with a video depicting the moon changing shapes. Then they are asked, “Why do you think the moon appears to change shape?” The teacher models the movement of the moon around the earth and uses a flashlight to represent the sun, then introduces the memory technique DOC. The first letter in the word DOC is D, and the first quarter moon looks like the letter D. The second letter in the word DOC is O, and the full moon looks like the letter O. The third letter in the word DOC is C, and the third quarter moon looks like the letter C.

For the exploration component, six stations are used for the students to explore the lunar cycle. At the first station, the students explore the lunar cycle by constructing clay models of the earth, moon, and sun. At the second station, the students watch videos and play games on the computer related the TEKS. The third station has library books on the lunar cycle. The fourth station allows the students to make their own models of the lunar cycle using materials of their choice. At the fifth station, the students participate in reflective writing in their journals about the lesson. Finally, at the sixth station, the students participate in Table Talk and the group engages in discourse about the lunar cycle. During the explanation component, the teacher enters the Table Talk discourse to ask higher-order thinking questions and to have students explain terms. The lesson then provides an opportunity for the students to elaborate by allowing them to develop a presentation of their findings, develop a vocabulary activity to enhance their vocabulary, and asks, “How can we apply our knowledge of the moon in our daily lives?” The students are evaluated on their presentations and performance on an exit ticket. The Lunar Cycle lesson is provided in Table 4.

Table 4

5E Lesson Plan – Earth and Space Science – Lunar Cycle

Teacher	Jana Cole
Date	July 16, 2013
Subject/Grade Level	Science/Fourth Grade
Materials	Oreo cookies; books on the lunar cycle: model of the sun, earth and moon; clay; sentence strips; construction paper; markers; and presentation materials.
TEKS	SCI.4.8C – Collect and analyze data to identify sequences and predict patterns of change in shadows, tides, seasons, and the observable appearance of the moon over time.
Lesson Objective(s)	The students will identify the lunar phases: New, First Quarter, Full, and Last Quarter; explain why the moon appears to change shape; and predict the next lunar phase in the sequence.
Differentiation Strategies to Meet Diverse Learner Needs	Workstations, student choice project, lunar cycle manipulatives, computer station, library station, and vocabulary projects.
Engagement	Peep and the Big Wide World: Peep's Moon Mission http://www.youtube.com/watch?v=gdj8lPvW0rc (sponge activity) The teachers will ask, "Why do you think the shape of the moon appears to change shape?" The teacher will model the movement of the moon around the earth and introduce DOC.
Exploration	Clay – construct a model of the earth, sun, and moon. Computer station – visit http://www.brainpop.com Library station – provide books on the lunar cycle. Models of the earth, sun, and moon are presented. The students reflect in journals. Table Talk occurs between students.
Explanation	Table Talk with teacher – the teacher will ask higher-order thinking questions, and have students explain terms.
Elaboration	The students will develop a presentation of their findings. The students will develop a vocabulary-enhancing activity. The teacher will ask, "How can we apply our knowledge of the moon in our daily lives?"
Evaluation	The students will present their findings to the class. The students will complete the attached exit ticket.

The second lesson was TEKS SCI.1.1D – Metamorphosis, and follows the same 5E lesson format. The students are engaged with a video about metamorphosis and are asked, “Why do you think the organism shape changes?” The teacher presents the life cycle of a live specimen to the class. The students are allowed to explore life cycles in six lab stations. At the first station, the students construct a clay model of a life cycle. At the second station, the students explore life cycles on the computer. At the third station, the students explore life cycles in library books. At the fourth station, students explore models of life cycles. At the fifth station, the students participate in reflective writing in their lab journals. Finally, at the sixth station, the students participate in discourse with Table Talk, where they provide explanations and the teacher joins them in the discourse. This gives the students the opportunity to ponder higher-order thinking questions and/or explain terms. The students are then given the opportunity to elaborate by developing a presentation of their findings, developing a vocabulary-enhancing activity, and answering the question, “How can we apply our knowledge of the life cycle in our daily lives?” The students then present their findings and complete an exit ticket evaluation. The Life Cycles lesson is provided in Table 5.

Table 5

5E Lesson Plan – Life Science – Life Cycles

Teacher	Jana Cole
Date	July 16, 2013
Subject/Grade Level	Science/First Grade
Materials	Tenebrio (mealworms), tadpoles/frogs, chrysalis/butterflies, and/or fish; books on life cycles; models of the life cycles; clay; life cycle puzzles; sentence strips; construction paper; markers; and presentation materials.
TEKS	SCI.1.10D – Observe and record life cycles of animals, such as a chicken, frog, mealworms, or fish.
Lesson Objective(s)	The students will observe and record the life cycles of organisms—chicken, frog, mealworms, and fish—explain why the organism's change shape, and predict the next phase in the sequence.
Differentiation Strategies to Meet Diverse Learner Needs	Workstations, student choice project, life cycle manipulatives, computer station, library station, and vocabulary projects.
Engagement	Peep and the Big Wide World: Peep's New Friend http://www.youtube.com/watch?v=aYhxrkKmUsM (sponge activity) The teacher will ask, "Why do you think the organism's shape changes?" The teacher will present the life cycle of a live specimen using a document camera.
Exploration	Clay – construct a model of a life cycle. Computer station – visit http://www.brainpop.com. Library station – provide books on life cycles. Model of life cycles are presented. The students reflect in journals. Table Talk occurs between students.
Explanation	Table Talk with the teacher – the teacher will ask higher-order thinking questions and have the students explain terms.
Elaboration	The students will develop a presentation of their findings. The students will develop a vocabulary-enhancing activity. The teacher will ask, "How can we apply our knowledge of the life cycle in our daily lives?"
Evaluation	The students will present their findings to the class. The students will complete the attached exit ticket.

The third lesson developed for this study was TEKS SCI.3.5A Sink or Float. The student is engaged with a video and asks, “Why do you think objects float or sink?” The teacher demonstrates objects floating or sinking while the students write their predictions in their lab journals. The students explore six lab stations. The first lab station contains materials for physical property investigation. The second station has computer games and video clips. The third station contains library books on density. The fourth station has materials for a density investigation. At the fifth station, the students participate in reflective writing in their lab journals. Finally, at the sixth station, the students participate in discourse during Table Talk, where the teacher joins them, asks them higher-order thinking questions, and has them explain key terms. The students are encouraged to elaborate by developing a presentation of their findings and a vocabulary-enhancing activity and are asked, “How can we apply this to our daily lives?” The students are evaluated when they present their findings to the class and complete an exit ticket evaluation. The lesson for Sink or Float is provided in Table 6.

Table 6

5E Lesson Plan – Physical Science – Sink or Float

Teacher	Jana Cole
Date	July 16, 2013
Subject/Grade Level	Science/Third Grade
Materials	Oil, water, cork, beaker, thermometer, graduated cylinder, balance, magnetics, books on density, model of density, sentence strips, construction paper, markers, and presentation materials.
TEKS	SCI.3.5A – Measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float.
Lesson Objective(s)	The students will explore and record the mass, volume, temperature, magnetism, and ability to sink or float of various materials, including, but not limited to, oil, water, and a cork. The students will also explain why the cork floats and the oil and water separate.
Differentiation Strategies to Meet Diverse Learner Needs	Workstations, student choice project, density manipulatives, computer station, library station, and vocabulary projects.
Engagement	Peep and the Big Wide World: Making things Float or Sink. http://www.youtube.com/watch?v=EVIcW-Ih-sU (sponge activity). The teacher will ask, "Why do you think objects float or sink?" The teacher will demonstrate objects floating or sinking while students write predictions in journals.
Exploration	Lab station – provide physical property materials. Computer station – visit http://www.brainpop.com. Library station – provide books on density. Lab station – provide density materials. Students reflect in journals. Table Talk occurs between students.
Explanation	Table Talk with the teacher – the teacher will ask higher-order thinking questions and have the students explain terms.
Elaboration	The students will develop a presentation of their findings. The students will develop a vocabulary-enhancing activity. The teacher will ask, "How can we apply our knowledge of the density in our daily lives?"
Evaluation	The students will present their findings to the class. The students will complete the attached exit ticket.

The rubric analysis of each of these lessons is provided in Table 7. The values assigned to each of the lessons are provided in the three columns on the right and are identified by their TEKS code.

Table 7

Inquiry-Based Science Lesson Adaptation Effectiveness Rubric

Criteria	0	1	2	3	Value Selected		
					4.8C	1.10D	3.5A
The curriculum provides opportunities to ask questions that can be answered through inquiry-based science instruction.	No evidence	One opportunity	Two opportunities	Three or more opportunities	3	3	3
The curriculum engages learners in planning an investigation or gathering evidence to respond to a question while conducting an inquiry-based investigation.	No evidence	One opportunity	Two opportunities	Three or more opportunities	3	3	3
The curriculum offers answers and explanations to questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	3	2	3
The curriculum engages learners to consider alternative explanations and links explanations with scientific knowledge.	No evidence	One opportunity	Two opportunities	Three or more opportunities	3	2	3
The curriculum offers opportunities for explanations and appropriately responds to comments while raising additional questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	3	3	3
The curriculum uses an inquiry-based verb (e.g., describe, identify, observe, record, predict).	No evidence			Evidence	3	3	3
TEKS ID				*Total	18	16	18

Inquiry-based science lesson plans: Overall analysis. For the lesson adaptation effectiveness rubric, the evaluation criteria ranked a key attribute from the curriculum as: 0 not adaptable, 1-5 possible adaptation, 6-11 practicable adaptation, or 12-18 adaptable. The data was collected from a rubric and the curriculum was adaptable into effective inquiry-based science instruction. TEKS SCI.4.8C, SCI.1.10D, and SCI.3.5A received scores of 18, 16, and 18 respectively.

The results of Phases I-III demonstrate: (a) the science TEKS objectives can be adapted to meet the inquiry-based science needs of students with disabilities; (b) assessments that determine the impact of teacher knowledge can be created and linked to the science content their students will study; and (c) 5E lessons can be generated that meet the criteria outlined in the literature for effective science instruction.

Chapter 5

Discussion

Historically, the United States has embraced innovation through science and technology (PCAST, 2012). The nation reaps the benefits of science innovations, such as longer and healthier lives, superior technology to our adversaries, global environmental protection, and solutions to energy, food, and water supply issues (PCAST, 2012). Superior science education is essential to the success of the nation. Scientific innovation may lead to an increase in high quality jobs and create a need for an educated, skilled workforce. From the assembly line of Henry Ford to the digital revolution of Steve Jobs, the United States is a leader in innovation research and must investigate a new pedagogy to stay on top. This study determined whether inquiry-based science was an option in Texas, provided a tool to determine content knowledge in science, and provided sample lessons and a lesson analysis tool.

This study utilized three phases: (a) Phase I – Viable Objectives; (b) Phase II – Teacher Knowledge; and (c) Phase III – Adapting Curriculum. TEKS review, a science content knowledge tool, and document analysis were included to help generate an action plan linked to professional development in science. Additionally, an instructional rubric was developed. The rubric assessed the effectiveness of the lessons derived from the Texas Essential Knowledge and Skills (TEKS).

The Texas Essential Knowledge and Skills (TEKS) is the required science curriculum for elementary school in the state of Texas. The rubric was designed to provide an analytic tool for teachers so they could apply it to future lessons. This will help them determine the quality of their inquiry-based lessons. The study's outcomes include the results of the rubric analysis, recommendations for changes in science instruction, and examples of effective teaching in science for students with learning disabilities. The practical outcome is an instructional guide, which will assist teachers in inclusive elementary classrooms to adapt science lessons for students with learning disabilities. This guide will be accompanied by a professional development PowerPoint, both of which are provided in Appendix B and E.

Phase I: Viable Objectives

The verb analysis was performed on the TEKS to discover the number of TEKS that can be adapted to inquiry-based science instruction. The verb was chosen because it is an action word; therefore, the student can implement it into an action during the learning process of the lesson cycle. This concept is supported by STEMscopes (2011), where lessons were developed using verbs. Additionally, the father of inquiry-based instruction, Dewey (1934), stated that it is no linguistic accident that the words building, construction, and work, designates both a process and its finished product; without the meaning of the verb, that of the noun remains blank.

According to this study's analysis of the fifth-grade science TEKS, 97.4% of the TEKS contain verbs that can be adapted to inquiry-based science instruction. This is an encouraging finding, as integrating learning strategies into practice activities has been demonstrated to improve students' problem-solving skills, memory skills, understanding of textbooks, and capacity for summarizing information (Freiberg & Driscoll, 2005).

To bridge the gap between adaptability and teacher action in classrooms, teachers need high-quality professional development concerning the process of analyzing the TEKS for verbs that can be translated to inquiry-based science instruction and knowledge of the actual science content. With a firm grounding in science content and an understanding of inquiry-based science instruction, teachers should be able to implement effective hands-on lessons that ensure the success of students with learning disabilities in the inclusive classroom.

Phase II: Teacher Knowledge

The President's Council of Advisor's on Science and Technology (PCAST; 2012) forecast an increase in STEM fields by over one million workers over the next decade. In order to fulfill the need of the workforce, teachers must be trained in the science content area and effective instruction. Teacher knowledge is an essential element for the process to be successful. By breaking down the TEKS and identifying what needs to be mastered, the teacher can deliver effective instruction. The science TEKS and the released STAAR 2011 assessment were examined in order to develop the Science Content Knowledge Assessment Tool presented in this study.

The content knowledge of teachers who work in inclusive science classrooms must be increased. Since approximately 10% of the school enrollment in Texas receives special education services and 8 out of 10 of their teachers practice without the proper special education certification (Texas Education Agency, 2012), a large number of students may not receive the inquiry-based science that meets their needs. By increasing teachers' content knowledge, educators begin to effectively implement inquiry-based science instruction for students with learning disabilities. High-quality professional development in lesson design and implementation will also be necessary to support these deficiencies.

Teachers' content knowledge can be increased, thus affording them more confidence with the material and instruction. Their newly gained knowledge and confidence can transfer to the classroom, resulting in the success of the students with learning disabilities in the science content arena. When the substantial population of students in special education is compared to the smaller number of properly trained special education teachers, a problem is revealed in the education system under the highly qualified teacher requirements of NCLB 2001. Since science is also a critical need area, the potential for effective professional development to help address the needs of students with disabilities in the science content area shows promise.

The Science Content Knowledge Assessment Tool supports the professional development of teachers and potentially the success of students with learning disabilities in the content. The tool identifies areas requiring support and intervention for the teachers and guides their pedagogy. The professional development can be adjusted based on the outcomes of the assessment. Students' success is dependent on the teachers' content knowledge and ability to adapt the curriculum. Goodnough and Nolan (2008) concluded that teachers need to be given the content framework in order to effectively implement inquiry-based instruction. The Science Content Knowledge Assessment Tool helps teachers self-identify the areas in which they may have insufficient knowledge.

Phase III: Adapting Curriculum

This study examined three TEKS from earth, life, and physical sciences. Individual lessons were developed for SCI.4.8C (lunar cycle), SCI.1.10D (life cycles), and SCI.3.5A (density). According to Reddy (2010), rubrics support a standardization of the manner in which projects are evaluated. A certified special education teacher using this study's Inquiry-Based Science Lesson Adaptation Effectiveness Rubric evaluated each lesson. The lunar cycle and density lessons received perfect scores, which indicates they are effective inquiry-based science lessons that offer the students opportunities to ask questions, engage the students in hands-on investigations, offer explanations to questions, link to scientific knowledge, offer opportunities to communicate explanations, and are based on the verb(s) contained in the TEKS. However, a deficiency reported by the evaluator in the life cycle lesson was the lesson needed to provide more opportunities for the teacher to ask questions. Based on this finding, the lesson should be revised to provide more opportunities for the teacher to ask questions. According to the Biological Sciences Curriculum Study (2006), questioning is an important part of the 5E model; therefore, adjustments can be made throughout the lesson.

These TEKS were easily adapted to inquiry-based science instruction that offers students with learning disabilities the opportunity to be successful in the content. Wu and Hsieh (2006) suggested that inquiry-based instruction offers differentiated learning opportunities and helps students with learning disabilities develop their inquiry skills. This type of adaptation to the curriculum is beneficial to the students and should be implemented. Mastropieri et al. (2006) suggested that inquiry-based instruction has a positive effect on students with learning disabilities in the science content area. Additionally, Joyce and Showers (2002) stated that the transfer of staff development outcomes is the ultimate goal—that of student learning—and is comprised of a chain of events. The outcomes from the three phases of this study are the first steps in that chain.

Summary

A document analysis was conducted using a rubric that analyzed an objective from the TEKS in each of the three science areas: earth science, life science, and physical science at the elementary school level. A rubric was developed and objectives were analyzed. The sample size was the fifth-grade science objectives from the TEKS that are conducive to inquiry-based science instruction. The TEKS represent the independent variable, which is the required science curriculum for elementary school used in the state of Texas. The rubric will provide the tool to measure the dependent variable, which is the effectiveness of the lesson derived from the TEKS. Educators that wish to adapt their curriculum to inquiry-based science instruction for students with learning disabilities will use this rubric.

The practical outcome was an instructional guide or Action Plan, which will assist the inclusion classroom teacher in adapting science lessons to inquiry-based instruction at the elementary level for students with learning disabilities. This will include an online guide and a training PowerPoint. These materials will be used for the professional development of educators responsible for the instruction of students with learning disabilities. Educators of students with learning disabilities must receive high-quality professional development and the necessary materials to ensure they possess an adequate knowledge base in science to be successful in the inclusive classroom.

Conclusion and Action Plan

Teachers need more active professional development and less passive professional development. This study provides an action plan that delivers inquiry-based science instruction training for teachers and allows them to experience an active learning process. The targeted audience for this professional development is Texas educators—specifically, elementary school teachers seeking support in science content and inquiry-based science instruction that is effective for students with learning disabilities. The participants will be given a survey prior to the training, which identifies background information, such as current employment, teaching experience, training opportunities, education level, and certifications held (see Appendix C).

The session will begin with an icebreaker, which will help the participants familiarize themselves with each other and build rapport and confidence. Tate (2012) offered a game in which participants were divided into families and one family member threw the ball to a different family that was far away. Anyone in that family could catch the ball, but the ball could not hit the floor. The families worked together to accomplish the goal—catch the ball and do not let it hit the floor. This type of game builds rapport and confidence that is carried throughout the professional development.

The participants will be given opportunities throughout the sessions to develop lesson plans and deliver the lesson to a group (see Appendix D). This will build their confidence in the newly acquired skill and provide an opportunity to fine-tune weak areas. Once they have mastered these skills, the participants will be ready to put their newly acquired skills to use and coach someone else.

Prior to the professional development, the participants will be given a released fifth-grade STAAR science test to determine their level of competency in the content area. The assessment will be evaluated and the professional development will be adjusted to meet the needs of the audience. The participants will receive the evaluated assessment and the deficient areas will be reviewed at the beginning of the professional development. The participants will not be placed into differentiated instruction groups because inquiry-based science instruction is naturally differentiated.

Two 90-minute professional developments have been designed, which may address the issue of proper pedagogy for students with special needs to be successful on science content assessments. The professional developments will guide the educators through three lessons designed from the science TEKS. One TEKS will be pulled from each of three domains: earth science, life science, and physical science. The professional development will start with the TEKS and guide the educators through the process of adapting the TEKS to an inquiry-based science lesson, which can be administered in the inclusive classroom. A rubric has been developed that will aid the educators in identifying TEKS that are conducive to inquiry-based science instruction and help them evaluate the delivery of instruction in the classroom in the future. The educators will receive training on the use of these rubrics and how to adapt a science lesson (see Appendix E). The professional development will be delivered in an inquiry-based format that gives the educators experience in inquiry-based lessons and instruction.

The first 90-minute session will consist of an introduction of the problem, an overview of inquiry-based instruction, training on the rubric, and participation in an earth science and life science lesson. The session will conclude with the educators completing a science content assessment exit ticket and course evaluation (see Appendices F and G).

The second 90-minute session will consist of a review of the first session and a physical science lesson, then the educators will develop their own lesson using the rubric and science TEKS. Each table will present their lesson, and a brainstorming session (Tate, 2012) will follow. The session will conclude with the educators completing a science content assessment and course evaluation. Throughout the entire session, the trainer will incorporate Tate's (2012) strategies.

The educators will receive a training PowerPoint, curriculum adaptation rubric, grade-specific science TEKS, and a copy of the lesson plan for the TEKS addressed in the session. This will give the educators the opportunity to utilize the materials in the classroom immediately and share them with their peers and campus, building a stronger professional learning community and reinforcing inquiry-based pedagogy for the classroom. In addition to the materials and knowledge the educator receives in the professional development, the researcher will be available to support and evaluate the educators' classrooms. An outline of the professional development model follows:

Session I

- Introduction of the Issue (5 minutes)

    - Students with learning disabilities mastering the science content in the inclusion classroom

- Overview of Inquiry-Based Science Instruction (5 minutes)
- Review of Participants' Preliminary Assessment Results (10 minutes)
- Rubric Training (10 minutes)
- Earth Science Lesson (20 minutes)
- Life Science Lesson (20 minutes)
- Science Content Assessment (5 minutes)
- Brainstorming Session (10 minutes)
- Course Evaluation (5 minutes)

Session II

- Review of Session I (10 minutes)
- Review of Participants' Preliminary Assessment Results (10 minutes)
- Physical Science Lesson (20 minutes)
- Rubric Practice (20 minutes)
- Table Presentations (10 minutes)
- Science Content Assessment (5 minutes)
- Brainstorming Session (10 minutes)
- Course Evaluation (5 minutes)

The effectiveness of the professional development will be measured using a survey completed by the participants at the end of the sessions (see Appendix G). In addition to the professional development exit survey, the participants will receive observations and interviews as part of the feedback-gathering process.

This professional development should be ongoing throughout the school year and the teachers should receive materials and lessons that can be implemented in the classroom upon their return to work. According to Tate (2012), the training should involve the teachers in an inquiry-based experience so they can synthesize the information and know exactly how to deliver instruction in their classrooms, which will ensure the success of students with learning disabilities. This professional development should include an assessment of teacher science content knowledge pre and post training. By comparing the results of the pre and post assessment, the growth of the teachers' knowledge can be evaluated (see Appendix F). The pretest establishes what the teachers must learn to bridge the gap of what they are supposed to be teaching in the classroom. The curriculum they are required to teach in the classroom is the appropriate grade level TEKS. Evaluating the teachers' content knowledge and providing high-quality professional development (Phase 3) enhances their content knowledge, offers support in adapting the TEKS to inquiry-based science lessons, and offers the students with learning disabilities the best chance of securing an education in STEM and becoming productive members of the workforce. Supporting teachers in an inclusion classroom in the science content area will afford students with learning disabilities the education required becoming marketable employees. This ongoing, high-quality professional development in inquiry-based science instruction will support teachers and reconcile the deficits in their science content knowledge.

Three limitations have been identified in this study. The first is that only the fifth-grade science TEKS were evaluated for inquiry-based science instruction, based on the verb content. First all the science TEKS for the sample should be evaluated. Second, only three lessons were developed and evaluated for effectiveness; a larger sample would add validity to the results.

Finally, one evaluator evaluated each lesson. If more evaluators were used, the validity could be increased.

Future research should include a full evaluation of the science TEKS, K-12. This would aid in developing a larger pool of inquiry-based science lessons. In addition, the professional development needs to be administered and tracked over time to evaluate the effectiveness in the classroom. Finally, a study that followed cohorts of teachers receiving the professional development and the effects on cohorts of students receiving the inquiry based science instruction practices from K-12, would generate valuable data to be considered.

Other research to be considered for the success of the professional development is the development of a checklist for administrators to use, which monitors the implementation of the inquiry-based instruction in the classroom. This checklist could evaluate the quality of lesson delivered tin the classroom to the students with learning disabilities. In addition, the integrity of the intervention needs to be tracked through data collection from assessments based on the TEKS and the STAAR test. Finally, a coaching plan needs to be developed which assist the teacher supports the teacher in taking the classroom from a “sit and get” to an inquiry-based laboratory. Lynch et al., (2007), states teachers of students with learning disabilities need to be trained in effective curriculum and instruction.

If U.S. educators receive high-quality professional development, students with learning disabilities can be successful in science. These students can bridge the gap in projected STEM field employment. This can be achieved through an action plan where the viable objective is analyzed with a rubric designed for this study, which evaluated the TEKS for verbs. Teachers’ knowledge must be evaluated with a free response assessment before and after professional development. This provides the data that drives the professional development and tracks the growth of the participants. Finally, the online guide and PowerPoint will provide ongoing training to support the teachers in the inclusion classroom.

Since most of the TEKS are adaptable to inquiry-based science instruction, it should be easy for the teacher to adapt the lessons. Once the teachers' knowledge is evaluated and the professional development administrator fills the gaps, the teachers will have the tools necessary to be successful in the classroom. The teacher will gain science content knowledge and seeds will be planted in their repertoire for adapting science curriculum. The teacher will learn how to analyze the TEKS for verbs and apply the word into action. They will begin to recognize opportunities in the curriculum that offer the students a hands-on experience. For instance, when the teacher sees the word "observe" in a TEKS they will immediately know to find the object the TEKS is referencing, then give it to the students for observation. They will know this observation will require tools such as a hand lens or microscope. This professional development will make adapting the TEKS to inquiry-based science instruction easy for the teachers, thus making it easier to train students with learning disabilities in the STEM fields for the projected workforce requirements.

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Appendix A

Action Verbs from TEKS

Analyze	Compare	Connect	Construct	Demonstrate	Describe	Draw
Evaluate	Explain	Explore	Formulate	Identify	Make	Observe
Predict	Recognize	Record	Use	Differentiate		

Appendix B

Inquiry-Based Science Lesson Adaptation Effectiveness Rubric

Please select the value that best represents the criteria, record the value in the last column, and then place the total at the bottom. Match the total to the adaptation scale at the bottom of the page.

Criteria	0	1	2	3	Value Selected
The curriculum provides opportunities to ask questions, which can be answered through inquiry-based science instruction.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners in planning an investigation or gathering evidence to respond to a question while conducting an inquiry-based investigation.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers answers and explanations to questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners to consider alternative explanations and links explanations with scientific knowledge.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers opportunities for communications of explanations and appropriately responds to comments while raising additional questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
Does the curriculum use an inquiry-based verb, i.e. describe, identify, observe, record, predict, etc.	No evidence			Evidence	
TEKS ID				*Total	

*Total: 0 not adaptable, 1-5 possible adaptation, 6-11 practicable adaptation, 12-18 adaptable.

Appendix C

Participants Background Survey

Inquiry-Based Science Instruction for Students with Learning Disabilities Professional Development

So we can ensure the best learning opportunity during the upcoming professional development, please complete the following background information survey.

1.	**What is your current employment assignment?**				
	Teacher Administrator Teacher's Aide Teaching Assistant Other Please specify_______________				
2.	**How many years have you worked in this position?**				
	1-5	6-10	11-15	16-20	21+
3.	**How many total years teaching experience do you have?**				
	1-5	6-10	11-15	16-20	21+
4.	**What is your highest education level completed?**				
	High School Associates Degree Bachelors Degree Masters Degree Doctorate Degree				
5.	**Please list all TExES certifications held?**				
6.	**What are your training opportunity interests?**				
	Physical Science Life Science Earth Science Lesson Planning Curriculum Adaptation				

Appendix D

Sample Lesson Plans

5E Lesson Plan – Earth and Space Science – Lunar Cycle

Teacher: *Jana Cole*

Date: *July 16, 2013*

Subject / Grade Level: *Science / 4th*

Materials: *Oreo cookies; books on the lunar cycle; model of the sun, earth, and moon; clay; sentence strips; construction paper; markers; and presentation materials.*

TEKS: *SCI.4.8C – Collect and analyze data to identify sequences and predict patterns of change in shadows, tides, and seasons, and the observable appearance of the moon over time.*

Lesson Objective(s): *The students will identify the lunar phases: New, First Quarter, Full, and Last Quarter; explain why the moon appears to change shape; and predict the next lunar phase in the sequence.*

Differentiation Strategies to Meet Diverse Learners' Needs: *Workstations, student choice project, lunar cycle manipulatives, computer station, library station, and vocabulary projects.*

ENGAGEMENT

- *Peep and the Big Wide World: Peep's Moon Mission http://www.youtube.com/watch?v=gdj8lPvW0rc (sponge activity)*
- *The teacher will ask, "Why do you think the shape of the moon appears to change shape?"*
- *The teacher will model the movement of the moon around the earth and introduces DOC.*

EXPLORATION

- *Clay – construct a model of the earth, sun, and moon.*
- *Computer station – visit http://www.brainpop.com.*
- *Library station – provide books on the lunar cycle.*
- *Model of the earth, sun, and moon are presented.*
- *Students reflect in journals.*
- *Table Talk occurs between students.*

EXPLANATION

- *Table Talk with teacher – the teacher will ask higher-order thinking questions and have the students explain terms.*

ELABORATION

- *The students will develop a presentation of their findings.*
- *The students will develop a vocabulary-enhancing activity.*
- *The teacher will ask, "How can we apply our knowledge of the moon in our daily lives?"*

EVALUATION

- *The students will present their findings to the class.*
- *The students will complete the attached exit ticket.*

5E Lesson Plan – Life Science – Life Cycles

Teacher: *Jana Cole*

Date: *July 16, 2013*

Subject / Grade Level: *Science / 1st*

Materials: *Tenebrio (mealworms), tadpoles/frogs, chrysalis/butterflies, and/or fish; books on life cycles; models of the life cycles; clay; life cycle puzzles; sentence strips; construction paper; markers; and presentation materials.*

TEKS: *SCI.1.10D – Observe and record life cycles of animals, such as a chicken, frog, mealworms, or fish.*

Lesson Objective(s): *The students will observe and record the life cycles of organisms–chicken, frog, mealworms, and fish—explain why the organisms change shape, and predict the next phase in the sequence.*

Differentiation Strategies to Meet Diverse Learners' Needs: *Workstations, student choice project, life cycle manipulatives, computer station, library station, and vocabulary projects.*

ENGAGEMENT

- *Peep and the Big Wide World: Peep's New Friend*
- http://www.youtube.com/watch?v=aYhxrkKmUsM *(sponge activity)*
- *The teacher will ask, "Why do you think the organism's shape changes?"*
- *The teacher will present the life cycle of a live specimen using a document camera.*

EXPLORATION

- *Clay – construct a model of a life cycle.*
- *Computer station – visit http://www.brainpop.com.*
- *Library station – books on life cycles are provided.*
- *Model of life cycles are provided.*
- *Students reflect in journals.*
- *Table Talk occurs between students.*

EXPLANATION

- *Table Talk with teacher – the teacher will ask higher-order thinking questions and have students explain terms.*

ELABORATION

- *The students will develop a presentation of their findings.*
- *The students will develop a vocabulary-enhancing activity.*
- *The teacher will ask, "How can we apply our knowledge of the life cycle in our daily lives?"*

EVALUATION

- *The students will present their findings to the class.*
- *The students will complete the attached exit ticket.*

5E Lesson Plan – Physical Science – Sink or Float

Teacher: *Jana Cole*

Date: *July 16, 2013*

Subject / Grade Level: *Science / 3rd*

Materials: *Oil, water, cork, beaker, thermometer, graduated cylinder, balance, magnetics, books on density, model of density, sentence strips, construction paper, markers, and presentation materials.*

TEKS: *SCI.3.5A – Measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float.*

Lesson Objective(s)*: The students will explore and record the mass, volume, temperature, magnetism, and ability to sink or float of various materials, including, but not limited to, oil, water, and a cork. The students will also explain why the cork floats and the oil and water separate.*

Differentiation Strategies to Meet Diverse Learners' Needs*: Workstations, student choice project, density manipulatives, computer station, library station, and vocabulary projects.*

ENGAGEMENT
- *Peep and the Big Wide World: Making things Float or Sink*
- *http://www.youtube.com/watch?v=EVIcW-Ih-sU (sponge activity)*
- *The teacher will ask, "Why do you think objects float or sink?"*
- *The teacher will demonstrate objects floating or sinking while students write predictions in journals.*

EXPLORATION
- *Lab station – provide physical property materials.*
- *Computer station – visit http://www.brainpop.com.*
- *Library station – provide books on density.*
- *Lab station – provide density materials.*
- *Students reflect in journals.*
- *Table Talk occurs between students.*

EXPLANATION
- *Table Talk with teacher – the teacher will ask higher-order thinking questions and have students explain terms.*

ELABORATION
- *The students will develop a presentation of their findings.*
- *The students will develop a vocabulary-enhancing activity.*
- *The teachers will ask, "How can we apply our knowledge of the density in our daily lives?"*

EVALUATION
- *The students will present their findings to the class.*
- *The students will complete the attached exit ticket.*

5E Lesson Plan – Educator Practice

Teacher:
Date:
Subject / Grade Level: *Science* /
Materials:
TEKS: *SCI.*
**Lesson Objective(s*):*
Differentiation Strategies to Meet Diverse Learners' Needs*:*
ENGAGEMENT • Describe how the teacher will capture students' interest. • What kind of questions should the students ask themselves after the engagement?
EXPLORATION • Describe what hands-on/minds-on activities students will be doing. • List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration.
EXPLANATION • Student explanations should precede the introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination? • List higher-order thinking questions, which teachers will use to solicit *student* explanations and help them justify their explanations.
ELABORATION • Describe how students will develop a more sophisticated understanding of the concept. • What vocabulary will be introduced and how will it connect to students' observations? • How is this knowledge applied in our daily lives?
EVALUATION • How will students demonstrate that they have achieved the lesson objective? • This should be embedded throughout the lesson as well as at the end of the lesson.

5E Lesson Plan – Educator Practice

Teacher:
Date:
Subject / Grade Level: *Science* /
Materials:
TEKS: *SCI.*
Lesson Objective(s*):*
Differentiation Strategies to Meet Diverse Learners' Needs*:*
ENGAGEMENT
EXPLORATION
EXPLANATION
ELABORATION
EVALUATION

Appendix E

Professional Development PowerPoint

Adaptations for Inquiry-Based Science Instruction

Session I

Earth and Life Science

Introduction of the Issue

- With an increasing emphasis on test scores our students with learning disabilities are being left behind.
- The student may be one or two grade levels behind, but they are still responsible for the grade level STAAR assessment.
- With the widespread popularity of the inclusion classroom the educator needs to explore new pedagogy to reach these learners.

Inquiry-Based Science Instruction

- Definition: Inquiry-based approaches to science education focus on student constructed learning as opposed to teacher-transmitted information.
- It is nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of enquiry. (Albert Einstein, *Ideas and Opinions*)

(www.brynmawr.edu)

What types of adaptations do elementary teachers need to provide to insure the students' success in science?

- The concept of differentiated instruction, concerned with adapting instruction for special learning needs, has been increasingly applied to inclusive classrooms (Tomlinson, 2001).

The Plant-in-a-Jar as a Catalyst to Learning Thompson (2007) Appendix A

- This article offers a hands on approach for teaching the water cycle, transpiration, photosynthesis, and cellular respiration.
- Materials cost are low.
- The students engage in hands on life science, global warming, journal writing, history, and math.
- Click to open the Plant-in-a-Jar Article

Inquiry-Based Science Lesson Adaptation Effectiveness Rubric

Criteria	0	1	2	3	Value Selected
The curriculum provides opportunities to ask question which can be answered through inquiry-based science instruction.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners in planning an investigation or gathering evidence to respond to a question while conducting inquiry-based investigation.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers answers and explanations to questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners to consider alternative explanations and links explanations with scientific knowledge.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers opportunities for communications of explanations and appropriately responds to comments while raising additional questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
Does the curriculum use an inquiry-based verb, i.e. describe, identify, observe, record, predict, etc.	No evidence			Evidence	
TEKS ID				*Total	

Adapt a Lesson

- Find the assessment question that pertains to your TEK Appendix B click for list of TEKS
- For instance, question #1 is assessing 5.5A and 5.2 D Appendix C click for STAAR assessment
- This is easily reproduced in the classroom by the student for low cost

Lesson Adaptation Format – Earth Science

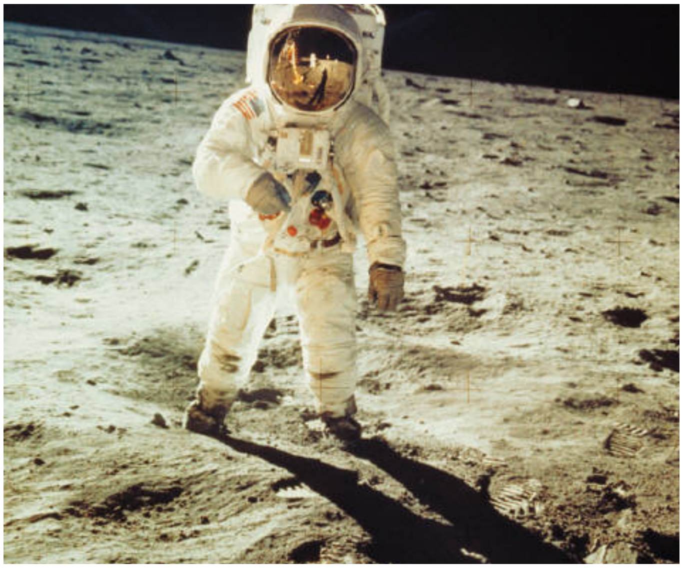
- Start the Lesson Adaptation with the Assessment Question Related to the TEK
- Identify Necessary Materials
- Develop Lesson Plan
- Practice Experiment Before Implementing in Classroom

Teacher: ***Jana Cole***
Date: *July 16, 2013*
Subject / Grade Level: Science / *4th*
Materials: *Oreo cookies, books on the lunar cycle: model of the sun, earth and moon; clay, sentence strips, construction paper, markers, presentation materials*
TEKS: *SCI.4.8C Collect and analyze data to identify sequences and predict patterns of change in shadows, tides, seasons, and the observable appearance of the Moon over time.*
Lesson objective(s*): The student will identify the Lunar Phases – New, First Quarter, Full, Last Quarter; explain why the moon appears to change shape, and predict the next lunar phase in the sequence.*
Differentiation strategies to meet diverse learner needs*: work stations, student choice project, lunar cycle manipulatives, computer station, library station, vocabulary projects*
ENGAGEMENT • *Peep and the Big Wide World: Peep's Moon Mission* http://www.youtube.com/watch?v=gdj8lPvW0rc *(sponge activity)* • *Why do you think the shape of the moon appears to change shape?* • *Teacher models the movement of the moon around the earth and introduce "DOC"*
EXPLORATION • *Clay – construct a model of Earth, Sun and Moon* • *Computer station – www.brainpop.com* • *Library station – books on the lunar cycle* • *Model of the Earth, Sun and Moon* • *Students reflect in journals* • *Table Talk between students*
EXPLANATION • *Table Talk with teacher – teacher will ask higher order thinking questions, and have students give an explanation of terms*
ELABORATION • *Student will develop a presentation of their findings* • *Student will develop a vocabulary activity to enhance vocabulary* • *How can we apply our knowledge of the moon in our daily lives?*
EVALUATION • *The student will present findings to class* • *The student will complete the attached exit ticket*

Classroom Lesson Procedure

- Introduce Lesson – possible with assessment question for the students to investigate possible answers
- Give the Students the Required Materials
- Let the Students Investigate until the Find the Answer
- Students Write the Findings in their Journals
- Students Prepare a Presentation of their Findings
- Students Present Findings to Class

Let's Explore the Lunar Cycle



Lesson Adaptation Format – Life Science

- Start the Lesson Adaptation with the Assessment Question Related to the TEK
- Identify Necessary Materials
- Develop Lesson Plan
- Practice Experiment Before Implementing in Classroom

Teacher: ***Jana Cole***

Date: *July 16, 2013*

Subject / Grade Level: Science / *1st*

Materials: *One or more of the following: Tenebrio (mealworms), tadpoles/frogs, chrysalis/butterflies, and/or fish; books on life cycles, models of the life cycles, clay, life cycle puzzles, sentence strips, construction paper, markers, presentation materials*

TEKS: *SCI.1.10D Observe and record life cycles of animals such as a chicken, frog, mealworms, or fish*

Lesson objective(s*): The student will observe and record the life cycles of organisms– chicken, frog, mealworms and fish; explain why the organisms change shape, and predict the next phase in the sequence*

Differentiation strategies to meet diverse learner needs*: work stations, student choice project, life cycle manipulatives, computer station, library station, vocabulary projects*

ENGAGEMENT

- *Peep and the Big Wide World: Peep's New Friend*
- http://www.youtube.com/watch?v=aYhxrkKmUsM *(sponge activity)*
- *Why do you think the organism shape changes?*
- *Teacher presents the life cycle of live specimen using a document camera*

EXPLORATION

- *Clay – construct a model of a life cycle*
- *Computer station – www.brainpop.com*
- *Library station – books on life cycles*
- *Model of life cycles*
- *Students reflect in journals*
- *Table Talk between students*

EXPLANATION

- *Table Talk with teacher – teacher will ask higher order thinking questions, and have students give an explanation of terms*

ELABORATION

- *Student will develop a presentation of their findings*
- *Student will develop a vocabulary activity to enhance vocabulary*
- *How can we apply our knowledge of the life cycle in our daily lives?*

EVALUATION

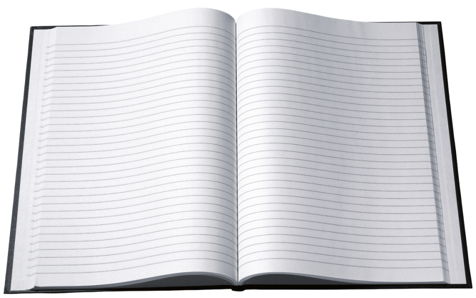
- *The student will present findings to class*
- *The student will complete the attached exit ticket*

Classroom Lesson Procedure

- Introduce Lesson – possible with assessment question for the students to investigate possible answers
- Give the Students the Required Materials
- Let the Students Investigate until the Find the Answer
- Students Write the Findings in their Journals
- Students Prepare a Presentation of their Findings
- Students Present Findings to Class

Let’s explore Life Cycles

Assessment Time



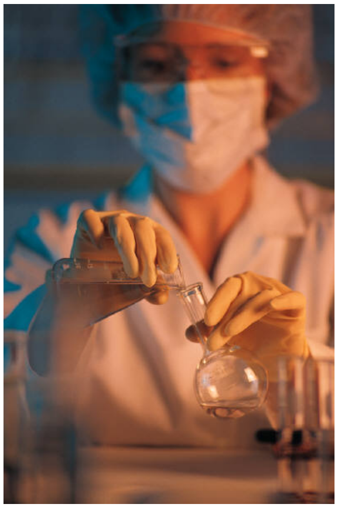
- What did you learn?

Q & A

Professional Development Evaluation

- THANK YOU FOR YOUR TIME!

Session II



- Physical Science

Review of Session I

- Issue – Students with Learning Disabilities need Support in the Inclusion Classroom
- Inquiry-based science education focus on student constructed learning as opposed to teacher-transmitted information.
- Use of the rubric to adapt the TEKS into Inquiry-Based Science Inastruction

Inquiry-Based Science Lesson Adaptation Effectiveness Rubric

Criteria	0	1	2	3	Value Selected
The curriculum provides opportunities to ask question which can be answered through inquiry-based science instruction.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners in planning an investigation or gathering evidence to respond to a question while conducting inquiry-based investigation.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers answers and explanations to questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners to consider alternative explanations and links explanations with scientific knowledge.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers opportunities for communications of explanations and appropriately responds to comments while raising additional questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
Does the curriculum use an inquiry-based verb, i.e. describe, identify, observe, record, predict, etc.	No evidence			Evidence	
TEKS ID				*Total	

Adapt a Lesson

- Find the assessment question that pertains to your TEK Appendix B click for list of TEKS
- For instance, question #1 is assessing 5.5A and 5.2 D Appendix C click for STAAR assessment
- This is easily reproduced in the classroom by the student for low cost

Lesson Adaptation Format – Physical Science

- Start the Lesson Adaptation with the Assessment Question Related to the TEK
- Identify Necessary Materials
- Develop Lesson Plan
- Practice Experiment Before Implementing in Classroom

Teacher: ***Jana Cole***

Date: *July 16, 2013*

Subject / Grade Level: Science / *3rd*

Materials: *Oil, water, cork, beaker, thermometer, graduated cylinder, balance, magnetics, books on density, model of density, sentence strips, construction paper, markers, presentation materials*

TEKS: *SCI.3.5A Measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float.*

Lesson objective(s)*: The student will explore and record the mass, volume, temperature, magnetism, and ability to sink or float of various materials; including, but not limited to; oil, water and a cork. In addition, the students will explain why the cork floats and the oil and water separate.*

Differentiation strategies to meet diverse learner needs*: work stations, student choice project, density manipulatives, computer station, library station, vocabulary projects*

ENGAGEMENT
- *Peep and the Big Wide World: Making things Float or Sink*
- http://www.youtube.com/watch?v=EVIcW-Ih-sU *(sponge activity)*
- *Why do you think objects float or sink?*
- *Teacher demonstrates objects floating or sinking while students write predictions in journals*

EXPLORATION
- *Lab station with physical property materials*
- *Computer station – www.brainpop.com*
- *Library station – books on density*
- *Lab station with density materials*
- *Students reflect in journals*
- *Table Talk between students*

EXPLANATION
- *Table Talk with teacher – teacher will ask higher order thinking questions, and have students give an explanation of terms*

ELABORATION
- *Student will develop a presentation of their findings*
- *Student will develop a vocabulary activity to enhance vocabulary*
- *How can we apply our knowledge of the density in our daily lives?*

EVALUATION
- *The student will present findings to class*
- *The student will complete the attached exit ticket*

Classroom Lesson Procedure

- Introduce Lesson – possible with assessment question for the students to investigate possible answers
- Give the Students the Required Materials
- Let the Students Investigate until the Find the Answer
- Students Write the Findings in their Journals
- Students Prepare a Presentation of their Findings
- Students Present Findings to Class

Now You Try!

- Choose a TEK click for TEK
- Locate the Assessment click for assessment
- Observe the Question
  - Ask yourself…
    - What materials do I see?
    - Can this be duplicated in my classroom?
- Make a Materials List
- Practice the Experiment

Inquiry-Based Science Lesson Adaptation Effectiveness Rubric

Criteria	0	1	2	3	Value Selected
The curriculum provides opportunities to ask question which can be answered through inquiry-based science instruction.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners in planning an investigation or gathering evidence to respond to a question while conducting inquiry-based investigation.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers answers and explanations to questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum engages learners to consider alternative explanations and links explanations with scientific knowledge.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
The curriculum offers opportunities for communications of explanations and appropriately responds to comments while raising additional questions.	No evidence	One opportunity	Two opportunities	Three or more opportunities	
Does the curriculum use an inquiry-based verb, i.e. describe, identify, observe, record, predict, etc.	No evidence			Evidence	
TEKS ID				*Total	

Adapt a Lesson

- Find the assessment question that pertains to your TEK Appendix B click for list of TEKS
- For instance, question #1 is assessing 5.5A and 5.2 D Appendix C click for STAAR assessment
- This is easily reproduced in the classroom by the student for low cost

Lesson Adaptation Format – Educator Practice

- Start the Lesson Adaptation with the Assessment Question Related to the TEK
- Identify Necessary Materials
- Develop Lesson Plan
- Practice Experiment Before Implementing in Classroom

Teacher:
Date:
Subject / Grade Level: Science /
Materials:
TEKS: *SCI.*
Lesson objective(s*):* .
Differentiation strategies to meet diverse learner needs*:*
ENGAGEMENT • Describe how the teacher will capture students' interest. • What kind of questions should the students ask themselves after the engagement?
EXPLORATION • Describe what hands-on/minds-on activities students will be doing. • List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration
EXPLANATION • Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination? • List higher order thinking questions which teachers will use to solicit *student* explanations and help them to justify their explanations.
ELABORATION • Describe how students will develop a more sophisticated understanding of the concept. • What vocabulary will be introduced and how will it connect to students' observations? • How is this knowledge applied in our daily lives?
EVALUATION • How will students demonstrate that they have achieved the lesson objective? • This should be embedded throughout the lesson as well as at the end of the lesson

Classroom Lesson Procedure

- Introduce Lesson – possible with assessment question for the students to investigate possible answers
- Give the Students the Required Materials
- Let the Students Investigate until the Find the Answer
- Students Write the Findings in their Journals
- Students Prepare a Presentation of their Findings
- Students Present Findings to Class

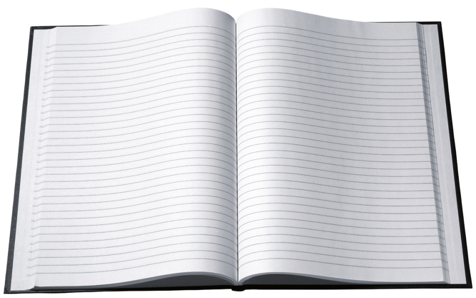
Educator Presentations!

How Did You Do?

- Easy as pie!

Now Engage Your Students with Inquiry-based Science Instruction

Assessment Time



- What did you learn?

Q & A

Professional Development Evaluation

- THANK YOU FOR YOUR TIME!

Thank You For Your Time!

References

- *Science scope and sequence 5th grade*. (n.d.). Retrieved from http://houstonisd.org
- *Sample book science test g05*. (n.d.). Retrieved from http://tea.state.tx.us/
- Thompson, S. (2007). Inquiry in the life sciences. *SCIENCE ACTIVITIES*, *43* (4), 27-33.
- Tomlinson, C. A., (2001). *How to differentiate instruction in mixed-ability classrooms.* (2nd Ed.) Alexandria, VA: ASCD.
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Appendix F

Science Content Knowledge Assessment Tool

Exit Tickets 1.1D, 3.5, and 4.8C

Name:________________________ Date:___________________ Group:___________

1. Explain and illustrate why the moon appears to change shape:

2. Which moon is next in the following sequence? Defend your answer using DOC.

3. Explain and illustrate what most likely will happen if oil, water, and a cork are all placed into one beaker.

4. Explain and illustrate complete and incomplete metamorphosis.

Appendix G

Course Evaluation

Professional Development Survey
Adapting Science Curriculum to Inquiry-Based Science Instruction

Please rate the following statements according to how you feel about the professional development.

1 Strongly Agree	2 Agree
3 Disagree	4 Strongly Disagree

1 Strongly Agree ⟷ 4 Strongly Disagree

1.	**The brainstorming and discussion strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**
2.	**The drawing and artwork strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**
3.	**The field trip strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**
4.	**The games strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**
5.	**The graphic organizers strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**
6.	**The humor and celebration strategies will improve my pedagogy.**			
	1	**2**	**3**	**4**

7.	**The manipulatives and models strategies will improve my pedagogy.**
	1 2 3 4
8.	**The metaphors, analogies, and similes strategies will improve my pedagogy.**
	1 2 3 4
9.	**The mnemonic devices strategies will improve my pedagogy.**
	1 2 3 4
10.	**The movement strategies will improve my pedagogy.**
	1 2 3 4
11.	**The music, rhythm, rhyme, and rap strategies will improve my pedagogy.**
	1 2 3 4
12.	**The project-based instruction strategies will improve my pedagogy.**
	1 2 3 4
13.	**The technology strategies will improve my pedagogy.**
	1 2 3 4
14.	**The visualization and guided imagery strategies will improve my pedagogy.**
	1 2 3 4
15.	**The writing and reflection strategies will improve my pedagogy.**
	1 2 3 4
16.	**The training has given me confidence to implement inquiry-based science instruction for students with learning disabilities.**
	1 2 3 4
17.	**My science content knowledge has been enhanced by this professional development.**
	1 2 3 4

18.	**My inquiry-based science instruction knowledge has been enhanced by this professional development.**			
	1	**2**	**3**	**4**
19.	**I can now effectively adapt the science curriculum to inquiry-based instruction for students with learning disabilities.**			
	1	**2**	**3**	**4**
20.	**The quality of my instruction has increased due to the experiences of this professional development.**			
	1	**2**	**3**	**4**
21.	**I feel confident that I can increase my students' content knowledge of the curriculum as a result of this professional development.**			
	1	**2**	**3**	**4**
22.	**I feel confident that I can increase my students' success in science as a result of this professional development.**			
	1	**2**	**3**	**4**
23.	**The presenter was knowledgeable in the content area and strategies.**			
	1	**2**	**3**	**4**
24.	**The presenter demonstrated knowledge of professional development materials.**			
	1	**2**	**3**	**4**
25.	**The presenter was prepared for the class.**			
	1	**2**	**3**	**4**
26.	**The presenter stimulated interest in the professional development.**			
	1	**2**	**3**	**4**

27.	**The professional development description accurately reflected the content of the professional development.**			
	1	**2**	**3**	**4**
28.	**Expectations were clearly outlined in the introduction.**			
	1	**2**	**3**	**4**
29.	**Assessment was aligned with content.**			
	1	**2**	**3**	**4**
30.	**Overall, this professional development has stimulated my interest in this subject.**			
	1	**2**	**3**	**4**
31.	**Please rate your overall satisfaction with this professional development.**			
	1	**2**	**3**	**4**
32.	**Do you feel prepared to teach inquiry-based science in your classroom?**			
	1	**2**	**3**	**4**
33.	**Would you take another professional development with this presenter?**			
	1	**2**	**3**	**4**
34.	**What could be done to improve this professional development?**			
35.	**What could be done to improve the presenter's teaching effectiveness?**			
36.	**Comments**			