

**AN INVESTIGATION OF A PROFESSIONAL DEVELOPMENT PROGRAM
USING INDUSTRY PARTNERSHIPS AND STUDENT ACHIEVEMENT**

A Dissertation

by

HELEN GRACE SULLIVAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2008

Major Subject: Curriculum and Instruction

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ABSTRACT

An Investigation of a Professional Development Program Using Industry Partnerships
and Student Achievement. (May 2008)

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This investigation examined the impact on student achievement of teachers who participated in a professional development program using industry partnerships. One treatment and one non-treatment school in a large urban school district served as the sites for this inquiry with teacher participation in a professional development program and the achievement data of their science students being collected during the 2001-2002 school period. The impact of a teacher professional development program with industry partnerships such as Education for the Energy Industry (EEI) on student achievement in science was determined. National and state standardized tests were analyzed using extant data obtained from administering the fourth through the eighth grade Iowa Test of Basic Skills (ITBS) test and the eighth grade Texas Assessment of Academic Skills (TAAS) test. The differential influence of a professional development program for teachers on the achievement of students of diversity was determined by the TAAS scores and ITBS scores, which were partitioned by treatment condition and student ethnicity. Findings from this quantitative investigation suggest enhanced student achievement in science if teachers participated in a professional development program involving industry partnerships.

DEDICATION

For the dedication of this work, my family is foremost on my mind. The unwavering emotional support is acknowledged of husband, Bill; sons, Bill and Brian; their wives, Elizabeth and Courtney; and their children, Caroline and Ben; McKenna and Carly. I am indebted to my parents, Dr. Warren and Gini Grace, for unconditional love. The scholarly guidance from all the members of my family is returned now with love and pride.

It is to these people that this work is also dedicated:

- To the emotional scaffolding of all my study partners, but especially to Marybeth Green and to Joyce Richards.
- To Susan Cary and Gail Johnson for words of constant encouragement have always been true friends.
- To the following: Carol, Warren, Janie, Ron, Rosellen, Cassie, and their families, plus Phil, Kristi, Dave and Dane who always assisted and encouraged my efforts during difficult times.
- To include the entire body of hypothetical researchers, who set the hypothetical research standards and that assist the clouds that parted in a timely fashion.

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CHAPTER I

INTRODUCTION

"We can't solve problems by using the same kind of thinking we used when we created them." -- Albert Einstein (Grosz and Dibner, 2000).

Corporate trainers often rotate in and out of the workforce, using apprenticeships to keep their skills current and their training in touch with the realities of the worksite. Analogous practices for the professional development of teachers involve extensive collegial mentoring, which is a common method of teacher training in Europe (Education Commission of the States, 1999). Operating from these precedents, teacher professional development (both preservice and inservice) can engage in continuous improvement, emphasizing teacher content knowledge, as well as improved student performance. The current climate of performance-based evaluation demands teacher professional development based on demonstrated skills and recommended appropriate professional development strategies that address documented weaknesses (Education Commission of the States, 1999).

Statement of the Problem

Huffman, Thomas, and Lawrenz, (2003) have reported that the impact of professional development on student achievement in mathematics and science has been limited and called for more research that examines the relation between professional development of teachers and their students' academic achievement. Variables from previous research on professional development include the professional community

The style for this dissertation follows that of *The Journal of Educational Research*.

(Flynn, 1990), leadership (Guskey and Sparks, 1996), supportive school structures (Berry, Turchi, Johnson, Hare, Owens, and Clements, 2003), and increased parental and community involvement (Kennedy, Owston, and Stief, 2000). The professional development literature suggests these variables affect student achievement (Louis, Marks, and Kruse, 1996; Newmann, and Associates, 1997; Stringfield, 1995). Yet, continuing research emphasizing accountability stressed that, student achievement is needed to better understand the relationships and complexities between professional development experience and resulting instructional practice of classroom teachers and their curriculum development efforts (Huffman, Thomas, and Lawrenz, 2003).

Teacher knowledge and the teachers' instructional practices, which lie within the school's sphere of influence, are linked to improving student learning (Guskey and Sparks, 1996). It is commonly held that the classroom teachers' effectiveness directly impacts student achievement, because teachers set standards for achievement, determine how and what content is taught, and promote student learning (Berry et al., 2003).

Science and Mathematics Content Strand

Professional development in science and mathematics must address the unique needs of science and mathematics teachers. For more than a decade increasing numbers of science and mathematics teachers have taught out of their field of preparation creating a substantial need for customized professional development (National Commission on Teaching and America's Future, 1996). Changes in instructional practices, teachers' knowledge, and teachers' beliefs are frequent foci of professional development research linked to student achievement (Loucks-Horsley and Matsumoto, 1999). To illustrate, examples of classroom to career discussions and work based experiences offer a means of

increasing student engagement in learning activities (Hamilton and Hamilton, 1997); and Loucks-Horsley, Hewson, Love, and Stiles (1998) have also presented a number of professional development strategies for science and mathematics teachers. One of these strategies that has influenced this investigation is immersion, the strategy of providing teachers with the experiences of doing science or mathematics with a scientist or mathematician (Loucks-Horsley et al., 1998). Included in these strategies must be a method to conduct rigorous evaluations of program and funding (Cavanagh, 2007). Ball and Cohen's (1999) "practice based" theory of professional development repeats the theme of "doing science or mathematics" in which learning for teachers and their students occur from long term participation and opportunities to practice in a real world context.

Specializing in school reform, Diane Ravitch, a research professor of education at New York University, cites the Bush administration, many governors and even corporate reformer, Bill Gates, in calling for radical school reforms to change an "obsolete" institution (Ravitch, 2005). Professor Ravitch notes that an evaluation of school accountability, whether in 4th, 8th or 12th grade, produces only a minority of students who reach proficiency as measured by the Education Department's National Assessment of Educational Progress. The lack of proficiency suggests that teachers who do not have a degree in the subject they are teaching have majored in education, not in mathematics or science or history. Teachers, who are teaching out of their content areas, are the part of our educational system needing reform. Many of these same unqualified teachers are continuing to teach core academic subjects, which benefit from reform and innovative professional development. An additional proposal from this article proposes that students

entering ninth grade be given a choice between a subject-centered curriculum and a technical, career-oriented course of study. Added support for a career development strand is provided later in this research report.

In examining professional development programs using industry partnerships to influence student achievement, several ideas are most persuasive. Research by Radinsky, Bouillion, Lento, and Gomez (2001) indicates business partnerships benefit corporate partners, teachers and their students. In the world's economy, America is a leader in producing quality jobs for its future citizens, the serious issue for our education system is to produce students who can compete in the mathematics and science dominated industries of the future (Coble and Allen, 2005). Using the Trends in International Mathematics and Science Study (TIMSS), that provides a comparison with the performance of students from countries around the world, the performance of U.S. 4th graders in both TIMSS mathematics and science was lower in 2003 than in 1995. In another comparison, the U.S. 8th graders in 2003 failed to place even in the top 10 of the 45 countries that participated in the study (National Center for Education Statistics, 2003).

Ethnicity Strand

Knowing that all teachers need content support, Gloria Ladson-Billings advocates bolstering teaching communities that serve diverse racial, ethnic, and socioeconomic populations and prepare teachers to work in diverse learning environments (Ladson-Billings, 2001). One of the major outcomes of including diversity training in professional development programs is teacher efficacy and the implication that increased teacher effectiveness will enhance student achievement. In addition to science content, the real

world context includes school reform through professional development strategies that can retrieve and inspire students of diversity.

Ladson-Billings also recommends placing prospective teachers working in diverse community schools in apprenticeships with skilled cooperating teachers. The real world context in professional development prepares teachers to work in diverse environments while learning to guide their learners to engage in meaningful community problems. A problem-solving approach to stimulate creative and critical thinking and an interactive environment will motivate learners to be responsible for their own learning and be independent thinkers throughout their careers.

For a multicultural education program, Geneva Gay speaks to the need to be competent in and confident about one's ability to do multicultural teaching (Gay, 2003). The cultural diversity component of multicultural education is one major consideration when planning any science-technology professional development program. Multicultural education dimensions are used to help educators implement and assess programs that respond to student diversity (Banks, 1994). By blending ethnic elements with constructivist activities in science curriculum and technology applications, the instruction can occur in an integrated, technology-rich multicultural classroom. As such, students are encouraged to explore and experiment with means to form significant knowledge and enhance what they already know in relation to their real world (Sing, 1999). They should not merely experiment with learning sequences or learning outcomes that are already predetermined. In addition, similar to authentic environments, the students should also be encouraged to accept responsibility for meeting their learning goals. The problem-solving process indicates that students are no longer told what or how to study. On the contrary,

they are encouraged to decide these goals and thought processes for and by themselves. The learners are challenged to think (Sing, 1999). In any school, we can examine and observe varied cultures. The meaning, necessity, and benefits of multicultural education for students from all cultural backgrounds should be explored, since personal, social, political, and educational real world factors influence the success or failure of these students (Nieto, 1996).

Career Development Strand

In developing a “classroom to career” education, with work based experiences, the problem becomes even more pressing to offer a means of increasing student engagement and achievement in a real world context (Coble and Allen, 2005). Considering that a large portion of the current [scientific] workforce is now rapidly approaching retirement age, this need becomes urgent. Moreover, college-age populations will increasingly be made up of Latin Americans and African Americans, whose participation rates in science, engineering and technology are less than half of those of Euro-American students (Coble and Allen, 2005). Barriers are time intensive and expensive for improving classroom teachers grasp of science and mathematics content, ethnic awareness and career development opportunities. Professional development strategies for teachers are critically needed to strengthen teacher knowledge and skills in science and mathematics to ensuring high-quality instruction for the most disadvantaged students. This professional development approach should communicate career opportunities and provide strategies for resolving real-world problems.

Purpose of the Study

The purpose of this investigation was to study the impact on student achievement of a professional development program using industry partnerships at one treatment school and a similar school using a regular professional development program offered in a large urban school district. The innovative professional development program for this investigation was called, Education for the Energy Industry (EEI) Project which was supported by the Education Foundation of Harris County. This foundation represents collaboration between the Harris County Department of Education, the Rice University Center for Education, a large urban school district, and energy industry corporations. The school district chose to partner with these entities for specific energy and career-related professional development, because the emphasis on higher order thinking skills was very apparent in their presentation to district officials. Teachers experience the training and then students perform hands-on exercises in the laboratory and in the classroom with tangible results (Rice University School Science Project, 1998). The information presented by the partnerships was sequential and based on state and district benchmarks. The investigator sought to determine whether teacher professional development involving industry partnerships improved academic achievement of their students. While these data had biographic markers associated with each teacher and student (gender and ethnicity), identification of individual teachers and their students were not included in the data analysis protocols applied in this investigation.

Significance of the Study

A look at professional development strategies involving teacher content knowledge and how these strategies relate to student achievement yields numerous

connections and variables. McBer (2000) found a strong relationship between teacher content knowledge and student achievement. English, (2004), Monk, (1994) and Monk and King (1994) have found positive correlations in studies exploring the relationship between teacher preparation and increased student scores in mathematics. Similar teacher preparation-student achievement results in English and history were obtained by Goldhaber and Brewer (2000) with effective professional development making a difference in student achievement (Owings and Kaplan 2003; Luft 2001; Wenglinsky 2000). In 17 of 31 studies, Byrne (1983) found positive correlations between teacher preparation in subject matter being taught and increased student achievement. However, 14 of these 31 studies revealed no differences. The variables examined varied across these studies but when professional development activities resulted in “highly motivated” teachers, then greater student achievement resulted (Rowan, Chiang, and Miller, 1997). Further study of how teachers obtain “mathematical knowledge for teaching” reported gains in student achievement when creative strategies and content were combined (Hill, Rowan, Loewenberg, and Ball, 2004).

The National Science Foundation’s Mathematics-Science Partnerships between professional development institutes and teachers of mathematics-science content areas are aimed at providing content-focused professional development. These partnerships are intended to improve teachers’ content knowledge via specialized training activities. Support for these partnerships aligns with continuing concerns that U.S. teachers lack essential knowledge for teaching topics in mathematics (Ball 1990; Ma 1999), and some evidence from educational research indicates that teachers’ subject knowledge significantly affects student learning (Monk, 1994).

Resnick (2005) acknowledges that collaboration and problem solving in quality professional development leads to better instruction and improved student learning. This generalization suggests that quality professional development also links strengthening teachers' knowledge of specific subject-matter content with professional development where collaboration and problem-based strategies can have the most impact on student learning. These recommendations to enhance student achievement signify that an investigation is needed for examining the impact of a professional development program using collaboration and problem-based strategies presented by industry partnerships to enhance student achievement.

Business and education partnerships potentially create products of value to the corporate partner as well as to teachers and their students. These collaborations may provide significant benefits to all parties of the partnership and result in learning opportunities that can enhance the interchange of cultural values between school and corporate communities (Radinsky, Bouillion, Lento, and Gomez, 2001). The partnership process must involve students, teachers and members of external communities to identify both partners and products that harness the creative potential of youth in a way that is productive, non-exploitative, and educational. This process involves working to redefine social norms that often see children as incapable of producing value in society, and integrating the learning-in-productive professional communities with the concerns for safety, continuity, and instructional integrity that are privileged in the classroom (Radinsky et al., 2001).

The importance of this dissertation research is supported in the professional development literature. For this investigation, student achievement was the dependent

measure and professional development was the independent variable in the research design applied to assessing the effects of applying the EEI model of professional development. If student achievement is enhanced then empirical support will be noted for this professional development model for science teachers.

Research Questions

Data for this post hoc investigation were provided from eighth graders drawn from one EEI treatment school and one non-EEI treatment school with similar demographics in the designated large urban school district for the period 2001 through 2002. The student performance data consisted of Texas Assessment of Academic Skills (TAAS) and Iowa Test of Basic Skills (ITBS) scores. For this post hoc study, inferences were made about comparable student populations of these schools based on demographic variable comparisons.

The research questions guiding this investigation follow:

1. What impact on eighth grade student achievement in science, measured by national and state standardized tests, do different teacher professional development programs produce?

(Note: The National Test: eighth grade ITBS test is part 1 of question one and the State Test: eighth grade TAAS test is part 2 of question one.)

2. What differential influence do different professional development programs for teachers have on the achievement scores of their African American, Hispanic and Caucasian students.

A. when measured by the ITBS scores?

B. when measured by TAAS scores?

Definitions

EEI Professional Development: Defined as the professional development program developed by higher education, corporate, and regional educational entities. This is the treatment for the designated large urban school district teachers participated in as professional development with industry partnerships. This professional development conformed to state and national regulations and by the decision of the district assistant superintendent of curriculum (NSDC, 2001).

EEI Project: Defined as the Education for the Energy Industry (EEI) was one school in a district with students receiving one intervention. This was supported by the Education Foundation of Harris County and collaboration between the Harris County Department of Education, the Rice University Center for Education, the large urban school district, and energy industry corporations as industry partners.

Non-EEI Professional Development: Defined as the professional development program that teachers participated in according to state regulations and by the decision of the Assistant Superintendent of Curriculum for the district. One school in the large urban school district was selected to provide the comparative sample for the non-EEI treatment school as designated by the investigator to match the EEI treatment school.

Economically Disadvantaged Students: Defined as students that are eligible for free or reduced-price meals used by the TEA to define the percentage of economically disadvantaged students under the National School Lunch and Child Nutrition Program.

Iowa Test of Basic Skills (ITBS): Defined as a norm-referenced nationally recognized test used throughout Texas to assess academic achievement.

Higher Order Thinking Skills: Defined in Bloom's Taxonomy (Bloom, Englehart, Furst,

Hill and Krathwohl, 1956) categorizing level of abstraction of questions that occur in educational settings with higher order thinking skills being analysis, synthesis and evaluation:

Knowledge (Example: Identify the major ideas of a laboratory observation.)

Comprehension (Example: Predict a use for information obtained in the data.)

Application (Example: Illustrate how this information might solve a problem.)

Analysis (Example: Explain how reorganizing the parts will solve the problem.)

Synthesis (Example: Design a new instrument using knowledge from the data.)

Evaluation (Example: Summarize the pros and cons of the new instrument.)

Inquiry-based Science: Defined as the method of science where students learn science by using similar methods as scientists. According to the National Science Foundation, inquiry-based science requires a combination of processes and scientific knowledge which uses scientific reasoning and critical thinking. Students develop problems, then formulate hypotheses, develop a testing method, and use the data to address their problem.

Socioeconomic Status of Schools (SES): Defined as the percentage of students receiving free-and reduced-price lunches at each school. This information is available on the Texas Education Agency website.

TAAS: Texas Assessment of Academic Skills is defined as a criterion-referenced measurement test that was part of the required academic assessment program for the state of Texas.

TEKS: Defined as the Texas Essential Knowledge and Skills, which are the basis for the TAAS.

Assumptions

1. Professional development strategies for school reform that emphasize problem based learning, and critical thinking, enable students to be more successful academically and succeed on standardized tests.
2. Multiethnic students including African American, Hispanic and Caucasian students from urban schools in high poverty areas who experience problem-based learning experiences in science succeed on standardized tests (Banks, 1994; NRC, 1996; Sanders and Rivers, 1996; Vasquez, 2006).
3. The selected tests-the ITBS and the TAAS- are psychometrically sound instruments for measuring student academic performance in science.

The remainder of this document presents a literature review in Chapter II; descriptions of the methodology of the investigation, the instruments and the subjects in Chapter III; the results of the investigation in Chapter IV; and the implications of this research and suggestions for future research in Chapter V.

CHAPTER II

LITERATURE REVIEW

This chapter is a review of the theoretical and research perspectives related to this investigation. First, pertinent literature addressing the relationship between professional development, teaching strategies, and the teacher's impact on student achievement will be noted. Second, the theoretical perspective of the treatment programs is presented. Third, an overview of the literature which addresses educational reform follows with discussion of the emerging field of corporate research and education connected to science education professional development and reform. The review concludes with a view of the research related to cultural diversity in education and student achievement.

Theoretical Perspective

With a combination of processes and scientific knowledge, inquiry education and inquiry-based science education form a theoretical framework for this investigation. Inquiry-based science education uses scientific reasoning, critical thinking and hands-on experiences (National Science Foundation, 2007). Nearly two decades ago, the National Science Teachers Association stated standards that required all middle level and high school science courses to offer laboratory experiences and provide scientific inquiry instruction in middle schools in order to promote understanding of science content (National Science Teachers Association, 1990).

In an examination of logic and inquiry, Dewey pointed out that schooling is not just about the individual, but is a convergence of a world of information with those of the learner's interests (Dewey, 1938). For this perspective, inquiry-based science is a multi-

faceted educational process that leads to asking questions and using logic to make discoveries in the search for personal reasoning and critical thinking in science. Dewey wanted to provide learners with the opportunity to create their own experience; to experiment, to do inquiry, and to be creative. The learner applies the principle of scientific inquiry to experiences of the natural world. The situation may call for a solution to a problem, to which a prediction may apply. Reasoning, observation or scientific investigation based on past situations can bring the learner to one or more solutions, which resulted from human awareness within the experience. The result is not intended as verification that “the logical principles involved in scientific method have themselves arisen in the progressive course of inquiry” (Hickman and Alexander, 1998). Dewey’s emphasis on the learner’s experience and knowledge of the world becomes the learner’s environment.

As an example of a learner’s environment, the Zone of Proximal Learning occurs when the teacher provides the context for the knowledge gained and helps the learner tie the new learning to previous knowledge (Vygotsky, 1978). The research of Lev Vygotsky reveals the theory that learning is socially mediated and meaning is constructed as it is gained through the interactions with the people in a culture, their tools, symbols, and words. In inquiry-based science education students use tools in their science investigations and their insights are made meaningful as their teacher provides scientific assistance with the context.

The framework established by a theoretical perspective of inquiry-based science education moves learning from real to conceptual, as the learner gains experience and develops socially. Concrete, hands-on experiences with structural design, materials, and

equipment are effective in providing ways for learners to make meaning of abstract scientific events, which can be difficult to reason or understand.

Professional Development, the Teacher and Student Achievement

At the turn of the 19th century, the Industrial Revolution transformed economics and produced a major shift in the world view. Currently, the technological impact on media and learning is producing paradigmatic shifts, so extensive that they defy definition. Due to what Green and Luke (2006) call a “historical point of dynamic change” this rapid technology change of education and economics is similar to the events of the Industrial Revolution which transforms learners digitally in “school and non-school settings.” The policy makers, as well as researchers, explore new and diverse contexts of learning. In their review which focused on science education, Ford and Forman (2006) asserted that to adequately design instruction to include aspects of authentic scientific practice, the disciplinary practices that should be presented in classrooms need to be justified with a clarification of how to implement those practices in long-term and short-term learning objectives. Although participation can be considered as a learning objective, what also needs to be considered is the way the individual is affected i.e., what resources are taken away from the instructional experiences.

In professional development, the focus on the role of the teacher is necessary as a business expense for the educational system. Since teaching is not a skill that comes naturally to people (Staples, 2005) interpreting the needs of the individual educational settings then becomes the challenge. Using the term professional development, which is the enhancement of teachers’ abilities to improve student learning, instead of in-service, infers that “the science teacher and the practicing scientist are full partners” so that

students will be prepared to deal with those challenges and changes in society and the workplace (Committee on Biology Teacher Inservice Programs, 1996, Page 14).

Professional Development efforts are judged by their contribution to student learning. It is based on the premise that educators must continually increase their knowledge and improve their skills in order to assure higher levels of achievement and student learning.

Guskey and Sparks (1996) combine exploration and practicality in a model that as a process is deliberate, continuing, and systemic. It begins with a vision to bring about positive improvement and planned goals for student learning as the teachers become aware of the chosen knowledge base. Content for teachers includes a deeper understanding of specific new types of expertise processes through mentoring, study groups or other suggested strategies. Student learning goals are broadly defined in the model with portfolio assessment, grades, or scores from standardized examinations as indicators of student achievement. Guskey's view is that staff development efforts are the basis of student learning outcomes.

During the 1970s and early 1980s research on teaching advanced from descriptive though correlational to experimental studies (Gage, 1984), but much of the staff development literature from this period was theoretical and descriptive rather than experimental. In the 1980's staff development authors noted that a climate, supporting innovative process and supportive context, and quality practices, were conducive to reform (Sparks and Loucks-Horsley, 1989). From this perspective attitudes changed in a meaningful way, when teachers observed results of a program that "enhances the learning of their students." Professional development experiences of the 1970s featured many opportunities for teachers but often these were "one-shot" workshops (Joyce, 1990). Over

the next decade the professional development program variations, innovative approaches and goals became the object and interest of university researchers. By 1990, all forms of staff development became “a full-fledged field of inquiry” according to the Association for Supervision and Curriculum Development (ASCD). The purposes, characteristics, and approaches of “individual and organizational” professional development were all meant to improve student achievement (Joyce, 1990). Since the 1990s the exponential growth in the research of inquiry into staff and/or professional development and the inclusion of the technology revolution in this growth and development has continued to occur (U.S. Department of Education, 2000).

According to Sparks and Hirsh (1997), the highest measure of an effective professional development program has been gains in student achievement. Officials of the National Staff Development Council (NSDC) in the last few years have observed strong links between student achievement and the professional learning of teachers and principals. NSDC officials believe staff development standards provide important guidelines for examining current staff development efforts in order to improve them. The standards, adopted in the mid-1990s, have been revised to include an equity statement that staff development must improve the learning of all students, because an effective program “prepares educators to understand and appreciate all students, create safe, orderly and supportive learning environments, and hold high expectations for students’ academic achievement.” The council standards also include the idea that quality teaching, “deepens educators’ content knowledge” provides them with research-based instructional strategies to assist students in meeting rigorous academic standards, and prepares them to appropriately use various types of classroom assessments (Sparks, 2001).

The national evaluation of the Eisenhower Professional Development Program presented results from their three-year professional development study (U.S. Department of Education, 2000). The structural characteristics of professional development programs which emerged from the Eisenhower study began with the participating groups of teachers from the same school, department, or grade. The duration of the professional development programs and the organization of the activity, such as networking, study group, or reform were important structural features. The degree that the training programs provided learning opportunities emerged as a core characteristic. The focus of these activities that support content while meeting local goals or standards were also defined as core features that emerged from the Eisenhower study for professional development. In addition the most creative feature of “high-quality professional development” programs included accessibility of the activity and “incentives for teachers to participate,” which are reflections of current trends.

Allocating days during the year for professional development programs is appropriate; the goals reinforce the necessity of teacher training as separate from the ongoing, day to day tasks of educators. New views of professional development programs include a broad perspective of activities and approaches, which redefine teacher preparation to include models that address specifically needed curriculum issues (Guskey, 2000). Quality in professional development, which is designed to enhance education or specific content, is central to program proposal. The impact of the staff development models ultimately depend upon the features of the organization in which they are used. Sparks and Loucks-Horsley (1989) suggest evidence is present for well-designed, long-term studies of school improvement efforts that are based on staff

development programs.

Enhancing the teacher's knowledge of the subject, improves the way teachers understand student thinking about that subject matter (American Educational Research Association AERA, 2005). The proficiency, often gained through professional development programs, enrich teachers who are responsible for a range of practices from decision making, to problem solving, and managing diversity. In designing professional development programs, the criteria necessary for judging the relevance of a particular subject, idea, or practice depends on the experience of the person who develops the criteria. From a teacher's perspective, the new background and information presented needs to link to existing background knowledge by guiding teachers to examine, evaluate, accept, reject or modify the professional development experience and to become an educational critic as well as an agent of information transmission (Guttek, 1995). A professional development program presented in an hour, an afternoon, or even in a full day session may not be the best training model for teachers. The sessions can be overwhelming with too much information and too little time for teachers, which often sacrifices retention (Harris, 1998). Thus, research on the professional development experience may lead to better instruction and improved student learning when it connects to the curriculum materials that teachers use (AERA, 2005). Proficiency obtained through professional development enriches content knowledge and applications for solving problems and managing students, are key to improving student achievement (Loucks-Horsley et al., 2003).

Dennis Sparks and Susan Loucks-Horsley describe one model in which teachers are "asked to develop or adapt curriculum" for school improvement, with the goal being

the improvement of classroom instruction. In their staff development model titled, “Involvement in a Development/Improvement Process,” activities are developed to solve a problem (Sparks and Loucks-Horsley, 1989). The problem could be based on an objective, goal or state standard to be addressed by the training. Knowledge and skills gained through group problem-solving strategies, first for teachers and then in the classroom, are acquired through “observation and training.” The “experiential learning” that results from the involvement of teachers creates the improvement processes and is the central point of this model.

Glatthorn (1987) suggests that a school curriculum goal can be modified through enriching the list of objectives for the goal and developing teaching guidelines using collaborative teams to design interventions to be implemented in the school. The goal of retaining students and promoting career readiness or continuing education can be addressed through curriculum and collaboration. Personalized curriculum gains student involvement using a school team with the student and a collaborative goal in mind. School district officials can recommend that teaming activities also be done in groups, so teachers will become more cohesive (AERA, 2005). As state officials grapple with how to help all students graduate from high school, they need at the same time to emphasize the goal of college and career readiness for individual graduates through the current curriculum.

By using career teaming and mentoring, as a model for a professional development program, expert information is shared between industry partners and educators. Collaborative teams of scientists, teachers and students have a powerful influence on teaching (Haberman and Post, 1998). The mentors from industry

partnerships help connect school objectives with future workplace objectives. As students complete education goals and graduate from school, the teacher through professional development programs enrich the curriculum to connect classroom goals to those of college and career readiness. Even the workplace requires readiness for higher-level learning in today's economy (Southern Regional Education Board, 2007). The readiness expected is customized by each career or business entity as industry partners blend school and workplace objectives in their training programs for new employees.

In the latest edition of *Designing professional development for teachers of science and mathematics*, the Loucks-Horsley team (Loucks-Horsley et al., 2003) suggests that the 18 strategies “in isolation do not constitute effective professional development.” The differing strategies must be selected to support the components of the learning design to serve different contexts, goals, purposes and circumstances of the professional development experience. In discussing the 18 strategies, it is important to note that these are presented in six “clusters,” with cluster two, “collaborative structures” and cluster four, “immersion experiences” describing the professional development approach examined in this research investigation. Every professional development initiative reflects a particular blend of needs and circumstances. As Loucks-Horsley et al. (2003), point out, the “challenge is to assemble a combination of learning activities” that address the curriculum circumstances needed.

Collaborative structures improve curriculum selection by involving “partnerships, professional networks, and study groups” that are described in the following sections. Through professional development programs the participants begin to understand the structure of the curriculum and how to use it with their students. With collaborative

structures the participants have the technique for convening as professional learners to produce a learning goal. Collaborative partnerships, between teachers and “scientists, business, industry, museums, science centers, and universities, are as diverse as the individuals involved in the partnerships (Loucks-Horsley et al., 2003).” The teacher and the partner bring expertise to the professional development program with the goal of improving student achievement and the classroom. The key guides for partnerships are:

- Partners are equal.
- Roles for scientists and mathematicians are clearly defined.
- Consistent values, goals and objectives are shared by all partners.
- There are benefits to teachers.
- There are benefits to scientists and mathematicians (Loucks-Horsley et al., 2003, p. 141).

Studies of partnership programs by Siegel (2005) have demonstrated exciting benefits for all participants, as community experiences provide practical examples of successful ways to work and apply learning outside the school context. In this research the school’s professional development staff noted that teachers gained content knowledge, curricular resources, and increased professional development opportunities. Students and community members gained an understanding of the nature of science (Siegel, 2005).

Continuing with the theme of professional networks in education, the network is organized to improve teaching, frequently in a specific subject area. The network in the professional community has a common purpose. The key elements for professional networks are:

- Interactions among members are ongoing.
- Memberships are voluntary.
- Effective communication is essential.
- Members' perspectives are broadened.
- Facilitation and leadership are necessary (Loucks-Horsley et al., 2003, p. 147).

Sparks and Loucks-Horsley (1989) consider the linking of staff development design with the organizational interactions as an extremely complex set of interactions. The network leadership structure is maintained through regular communication with meetings in person or electronically. The network leadership provides support, expertise, funds, time, and is linked to the network which creates effective staff development. The resulting experience for science teachers can change their classrooms (Sparks and Hirsh, 1997), if the collaboration and immersion are key components of professional development. The teachers as staff members are the base of the network (Sparks and Loucks-Horsley, 1989). Teachers become aware of the perspectives of others, and become more appreciative of individual differences, through professional networks. Teachers acquire important knowledge or skills through their involvement in contributions to the success of study groups. Students benefit as teachers impart to them the educational standards, knowledge and skills needed to succeed in the new economy (Olson, 2006). Involvement may cause changes in attitudes and the acquisition of skills as individuals within groups work toward the solution of common issues. In addition to the key elements, maintaining a steady schedule with consistent interaction is vital to the members of a study group.

The key elements for study groups are:

- Study groups are organized around a specific topic or issue of importance to the participants.
- Study groups have varied structures.
- Self-direction and self-governance contribute to the success of study groups. (Loucks-Horsley et al., 2003, p. 154).

An example of a study group project funded by the National Science Foundation, university faculty at Portland State University worked alongside teacher participants as the teams conducted monitoring projects at local national forest and park sites as a summer research experience. Teachers and students, in authentic ecology fieldwork, created study groups and gained skills in the instruction of biology (Dresner, 2002). As a result of the collaborative structure of the study group, teachers worked in the field monitoring a federal project that increased teacher knowledge of local ecology. Study groups require the participation of teachers who are committed. Collaboration between teachers and scientists or mathematicians can produce powerful learning experiences for all involved, according to the Loucks-Horsley team. The obstacles and challenges are commented upon as “support, recognition, or encouragement” frequently become issues.

Proceeding with “immersion experience” (Loucks-Horsley et al., 2003) involves participation in the inquiry of science as teachers, who experience life as a scientist, and world of the scientist is a strategy which is also a form of collaborative partnership. Immersion strategies provide “an opportunity to help teachers address this gap in their learning.” The key elements for the immersion in the inquiry of science are:

- Engage in an intense learning experience.

- One goal is learning how students learn science.
- Teachers' conceptions about science and teaching change as a result of these experiences (Loucks-Horsley et al., 2003, p. 195).

This view of immersion in science inquiry requires in-depth, time intensive, learning experiences that cannot be accomplished in one-shot workshops (Loucks-Horsley et al., 2003). Immersion studies may involve teachers and their students in emulating the behavior of scientists and participation in collecting and analyzing data, to make a direct contribution to the field of science (Dresner, 2002). Three pertinent elements for entering into the world of scientists are:

- The experiences are designed as mentored research opportunities for teachers.
- Teachers actively participate as members of research teams, which include scientists or university faculty.
- There are opportunities for follow-through with implementation and dissemination at local and national levels (Loucks-Horsley et al., 2003, p. 199).

The three collaborative structures, of partnerships, networks, and study groups, provide sound guidelines for corporate sponsored professional development programs. Corporate investments in educational settings often occur for professional development programs of educators through sponsorship of a series of summer institutes for teachers. These summer programs offer real-world applications in mathematics and science (Business-Higher Education Forum. 2005). Teacher experiences of learning how to conduct scientific research through apprenticeships may impact their teaching and the academic achievement of their students. Yet, it is difficult for teachers to allocate the

requisite time and intensity for extensive skill development expected by the partnership mentors unless substantial personal time is invested. Summer institutes, before and after school, and weekend experiences of the program must be devoted to this professional development effort. Working closely with mentors, teachers observe new roles and the “exposure brings real-world application (s) of subject matter” to the teacher and subsequently to their students and the classroom (Loucks-Horsley et al., 2003).

The importance of the “developing teacher” and “being open to new sources of knowledge” was noted by Eleanor Roosevelt as early as 1930, as she recognized our nation’s need to educate the students who would be our future (Roosevelt, 1930). She reflected on what would become educator professional development as the nation expected a “teacher who not only teaches a subject but is always conscious of the relation of the subject to the larger purpose of learning to live.” Is the teacher the bridge for the student, from the subject to the larger purpose of that information in the student’s life? As an author and a very public person, would Eleanor Roosevelt’s passionate thoughts about the prepared teacher still be what the public thinks about professional development today? She wrote:

Teachers must have leisure to prepare, to study, to journey in new fields, and to open new sources of knowledge and inspiration and experience for themselves. You cannot impart what you have not made your own. You cannot engender enthusiasm if you have lost it. Teaching is dead when the subject does not inspire enthusiasm in the teacher. Then there must be leisure to cultivate your pupils. The best teaching is often done outside of the classroom (Roosevelt, 1930).

What should the public, the community, the corporate community expect of the teacher? Is the focus on the teacher to improve student achievement correctly placed? Some countries, for example, Japan, France and Singapore (TIMSS, 1995), that are leaving the United States behind in math and science achievement (Lederman, 2005) decide at the national level what students should learn and when. With each state choosing its own sets of standards, the United States, has fifty different sets of standards (Staples, 2005) and fifty standards of quality for professional development. The quality of education depends on the community where the student lives. No Child Left Behind was meant to resolve this problem by penalizing states that failed to improve student performance, as measured by annual tests (NCLB Act of 2001, 2002).

Educational Reform: Implications for Professional Development and Science Education

Success in improving student achievement is being accomplished through the expectations of the National Board for Professional Teaching Standards that include roles of teachers (McCullough, 2007). Gathering information and recommendations for reform that offer promise is part of the responsibility for educators in the United States.

State and local school districts, as well as most educators, have been resistant to constantly changing strategies “to improve” the latest perceived educational deficit. Importing strategies from other countries, even successful ones in the educational arena, such as the national educational objectives in France or the study lesson from Japan (Staples, 2005) are difficult to accomplish. Costs are always prohibitive; but the United States will become a “second-rate economic power” if it fails to match the educational performance of schools abroad. More American students need to achieve at the highest levels in math, science and literacy (Staples, 2005).

For effective science education reform to occur, the scientists and engineers, who collaborate as a local educational resource for teachers, become a curriculum asset (Hess, 2004). Working with science teacher “partnerships” are vital for the support of school reform (Alberts, 1994) when incorporated with collaboration structures and immersion experiences. Teachers may attain desired curriculum objectives in novel ways when creative professional development programs match school reform and their teaching goals, as recent reform research shows connections between teacher content knowledge and student achievement do exist (Darling-Hammond, 1996; Sparks, 2001).

Educational Reform and Corporate and Industry Partnerships

Reform that endures is a challenge to implement, because organized education does not change readily. To understand the effects of school reform, the contexts must be included (Sarason, 1990). These educational-contextual conditions are internal and external, public and private, and influence decisions of local school boards. To sustain reform, the support must be accepted from the teachers and then move upward in the school organizational hierarchy. The educational community must recognize the “vastly underemphasized role of the teacher(s).” In particular, those who are committed to the ideas of change will provide the enlightenment for the culture of reform (Sarason, 2002).

The unfinished portrait of school reform is experiencing a Renaissance. In the last few years of grant-driven reform, business partnerships and major foundations have developed and funded innovative programs with the goals of revolutionizing teacher professional development to produce higher student achievement and classroom to career success (Judge, 2004).

Raising the quality of education is ranked high on the list of public concerns, but

this goal remains elusive. Reforming public education is slow and difficult. An example of reform which uses technology integration in public schools is through reinventing parts of education. Improving teacher competence in the use and integration of technology was a result of the IBM school reform initiative, according to Dr. Miriam Judge of Dublin City University (Judge, 2004). Launched in 1994, IBM's Reinventing Education school reform grant program has provided three rounds of awards now totaling \$75 million. The IBM reinventing education program has focused on effective tools that help teachers improve classroom instruction. Teachers and students are using educational technology tools created through the grant program in 25 cities throughout the United States, Australia, China, Italy, Ireland, Japan, Singapore, the United Kingdom, Vietnam, Mexico and Brazil. The results include improvements in the overall learning environment for students, improved teacher collaboration, and strong links between the home and school communities.

Specialists from business have reviewed why business must take the lead in school reform (Hess, 2004; Senge, Coleman, and Kleiner 2000). Business partners realize workforce shortages of technically capable employee candidates put their businesses in jeopardy (Senge et al., 2000). Mentoring brings together a knowledgeable professional or scientist with a less experienced science teacher for collaboration and feedback. Succession planning for the corporate future is in the “hands of high school students” who may develop under the tutelage of a caring mentor.

As a support for this process, Bruce Alberts, a highly-respected molecular biologist wants to focus school science programs on “learning from the experience” of others. Although Dr Alberts feels that mentoring comes “naturally to scientists and

engineers,” not all experts make good mentors. However, with a good match of an expert to an educator, the process can be used to apply real world solutions to local science education reforms. Scientists and engineers need to develop a flexible strategy for reform that has successful applications for many content areas and levels for different locations. Using talented local experts as mentors for science teachers, focuses on learning from the experienced people in the community, which is “unfortunately all too rare in the education world.” Alberts has pointed out that if scientists can help to improve performance in public school classrooms, it will become easier to garner public and political support for their work (Alberts, 1994). Having learned science in a meaningful context themselves, teachers have more experience to draw upon in teaching science in a more meaningful way.

Over a decade ago a U.S. Congressional report stated that in the changing United States workplace many do not possess the academic and entry-level occupational skills necessary to succeed (School-to-work opportunities act, 1994). At that time three-fourths of high school students in the United States entered the workforce without baccalaureate degrees. There was an infrequent link between jobs, and the career planning in school curricula. The 103rd Congress of the United States of America, in the School-to-Work Opportunities Act concluded:

The work-based learning approach, which is modeled after the time-honored apprenticeship concept, integrates theoretical instruction with structured on-the-job training, and this approach, combined with school-based learning, can be very effective in engaging student interest, enhancing skill acquisition, developing positive work attitudes, and

preparing youths for high-skill, high-wage careers (School-to-work opportunities act, 1994).

Educators, community leaders, and parents have often expressed concern about low student performance in science and mathematics, since the publication of *A Nation at Risk* (Gardner, 1983). Calls from these concerned groups for reform in education to achieve better career preparation for students have emphasized developing effective curriculum materials and implementing inquiry-based teaching methods. Business and corporate representatives from the private sector acted on these concerns and initiated reform discussions to produce collaborations between schools and workforce responders.

The frequently reported “dismal message(s)” of poor student performance from both the Third International Mathematic and Science Study (TIMSS) and the National Assessment of Educational Progress (NAEP) have resulted in commentary on a lack of teacher preparation as one of the causes of low student achievement. After three decades of low student performances, the National Commission on Mathematics and Science stated “district/ business partnerships are needed to provide support for a broad range of efforts” Continued efforts like “mentor stipends” are direct approaches for improving teaching materials and enhance student performance (National Commission on Mathematics and Science, 2000).

Recent educational policies have tried to resolve how every student should have a legitimate chance to learn at school. The “fair and effective opportunity to learn” must identify models of teaching as a condition necessary to achieve this chance (Pullin, 2007). To find the appropriate models, research is needed to identify successful programs. A report (Cavanagh, 2007) released by the Academic Competitiveness Council

found few federally funded mathematics and science programs were effective. In this study “just 10 of 115 federally funded mathematics and science programs have produced scientifically measurable results.” Of these federal programs reviewed 23 percent are assessed by the Department of Education and 29 percent, are with the National Science Foundation, according to the Cavanagh report. The Academic Competitiveness Council as well as the National Academy of Sciences recommends that the programs need to be rigorous with high-quality educational content present in all professional development opportunities for science and mathematics teachers (Committee on Prospering in the Global Economy of the 21st Century, 2007). Since over a quarter of these programs were funded by the National Science Foundation, scientifically measurable results with rigorously evaluated by independent agencies should be expected (Cavanagh, 2007; Huffman et al, 2003).

A multiple year study was located in the literature with student achievement as the dependent variable which used rigorous appraisals. This was a long term reform study of a reading intervention process in partnership with a large, heavily minority school district. Sadoski and Willson (2006) found that treatment schools out performed comparable schools over time. Those “results could not be attributed to differences in school size, percentage of minority students enrolled or SES.” In this study, schools were examined in a long-term instructional program with a specific theoretical base, using student achievement scores on current large-scale assessments while considering percentage of minorities, SES, school size, and other variables. The analyses were conducted with schools as the unit of analysis. Results yielded both practical and theoretical implications (Sadoski and Willson, 2006). This study, which had “practical

success” illustrates that methods based on a specific scientific theory can be implemented in an urban setting.

Cultural Diversity and Student Achievement in Educational Reform

The goals of multiethnic education in teacher training or student learning are to “foster human rights” while recognizing the value of cultural diversity in promoting and understanding of “alternative life choices.” The respect for all human differences establishes the willingness toward equal opportunity among individuals (Gollnick 1980). Multicultural education has been used to describe various policies related to educational equity and practices in a setting conducive to learning. Educational equity and practices that promote cultural diversity also promote an understanding of human differences and similarities (Banks and McGee-Banks 1989). The concept that learning is achieved through a social process that is intimately tied to cultural diversity was the focus for Vasquez’s cross-national approach to the problem, i.e., what an individual comes to know and believe is largely based on the social and cultural processes in which he or she is raised. Learners not only acquire new forms of knowledge and skills but also acquire ideas, language, values, and dispositions of the social group, making their experience and “cultural learning experience,” and thereby the learners achieve membership in the social group (Vasquez, 2006). A decade ago, Guskey and Sparks, expanded the social context into staff development, which involves the culture of the school district, as well as the culture of the school where the learning goals are implemented (Guskey and Sparks, 1996).

Over two decades ago, low achievement scores, according to the National Science Board (1983) attained by culturally diverse students, were due “directly to both blatant

and subtle racial discrimination (including stereotyped racial attitudes), extreme poverty, and, in some cases, unsatisfactory rural or urban conditions.” Unfortunately, low achievement scores in mathematics and science are still with us (National Commission on Mathematics and Science, 2000). Commitment to improving education of all concerned is important and is reflected in the philosophy of Educating Americans for the 21st Century. Opportunity and high standards of excellence for all students must be provided by all educational systems. Educational excellence and opportunities for the future must happen “wherever they live, whatever their race, gender, or economic condition, whatever their immigration status or whatever language is spoken at home by their parents, and whatever their career goals” (National Science Board, 1983). Recently, the Committee on Science and Technology in 2007 held hearings about “the shortcomings” of secondary science education, to modify standards to improve science education through legislation. These standards agree with those of the National Science Foundation (NSF) which “promotes scientific literacy” and “meet the mathematics and science needs for students at risk of not achieving state student academic achievement standards.” The legislated standards direct the NSF to establish a pilot program of grants to partnerships, which would identify best practices for improving “effectiveness of science laboratories.” The National Research Council’s report (2005) identifies best practices that assist students at risk in mathematics and science need to promote scientific literacy. Additionally, the histories of many peoples contain contributors to their culture, including scientists and engineers of achievement. The National Science Education Standards (NSES) states that standards for grades K-4 include examples of people making contributions in science. For grades 5-8, science that has been practiced by different

individuals in different cultures, is continued with historical components of science becoming even more specific and detailed in the grades 9-12 standards (NRC, 1996).

In an urban setting, Nobel Prize winner, Leon Lederman with the help of the Illinois Gov. James Thompson and a team of educators and scientists, drew up a framework for a school to improve the quality of science teaching in Chicago-area schools. Lederman's idea began to become a reality (Breslin, 2007). IMSA (Illinois Math and Science Academy) is a boarding school and the minority representation on campus is considerable with 36 percent Asian, 8 percent African-American, 7 percent multiethnic and 5 percent Latino and 42 percent white students. Efforts to expand IMSA's summer and after-school outreach programs are used to attract more students from Latino and African-American communities.

A priority of the Illinois Math and Science Academy has been to create a place where students could experiment, think creatively with problem-based learning, Students use few textbooks at IMSA, therefore when presented with a problem each must come up with a project or remedy. Students test their ideas in a ways that have not been included in traditional schools. For example, students might research and analyze sustainable energy sources for Illinois, then present their ideas before a panel of leading scientists and educators. IMSA students are assigned mentors, who may be scientists or scholars from area labs, museums, hospitals and companies so “they can instantly have a real-world connection (Breslin, 2007).”

Summary

The idea that effective teaching techniques automatically yield positive student achievement has proven to be inadequate, although teacher expertise and consistently

high quality teacher performance are teacher qualities associated with student success (Sanders and Rivers, 1996). This chapter has reviewed literature relevant to the design of this investigation. The high pressure business world demands accountability of the educational system, teachers and the methods chosen to producing student achievement. Pertinent literature was cited to address the relationship between professional development, teaching strategies, and the teacher's impact on student achievement. Every profession rewards those who are competent. Those who participated in this investigation evaluated this professional development program using industry partnerships as vital to education for all concerned. A lack of preparation has a direct impact on the classroom and prevents career success for students. In all classrooms the activities, at all grade levels associated with reading, communicating, or thinking should prepare students for their academic and professional futures.

CHAPTER III

METHODOLOGY

This investigation has analyzed student performance data and reports of the impact the Education for the Energy Industry Project (EEI) to determine this project's effects in student learning. This was a five-year, multi-million dollar collaborative effort of Harris County Department of Education, Rice University Center for Education, a large urban school district, and energy industry partners: Exxon Education Foundation, Shell Oil Company Foundation, and Texaco Foundation. The project used professional development with energy industry partners to design updated instructional strategies and curricula for targeted schools (Rice University School Science Project, 1998). The goals for these updated instructional and curricular resources were to more adequately prepare students for higher education and future employment.

Research Questions

This analysis was based on a sample of eighth graders drawn from one EEI treatment school and one non-EEI treatment school with similar demographics in a large urban school district for the period 2001 through 2002. The student performance data consisting the Iowa Test of Basic Skills (ITBS) and of the Texas Assessment of Academic Skills (TAAS) scores secured for this study were limited to eighth grade students. For this post hoc study, inferences were made about comparable student populations of the EEI treatment and non-EEI treatment schools.

The research questions guiding this investigation follow:

1. What impact on eighth grade student achievement in science, measured by national and state standardized tests, do different teacher professional development

programs produce?

(Note: The National Test: eighth grade ITBS test is part 1 of question one and the State Test: eighth grade TAAS test is part 2 of question one.)

2. What differential influence do different professional development programs for teachers have on the achievement scores of their African American, Hispanic and Caucasian students:

A. when measured by the ITBS scores?

B. when measured by TAAS scores?

Research Method

The following sections include a description of the sample, the research design, a description of the instruments that were used, and protocols for data collection, retrieval and analysis.

Research Sample

A large urban school district provided the site for the investigation. Data collected during the 2001-02 school year by school district officials have been used as the dependent measures for this investigation. The target for the professional development treatment included Drew Middle School eighth grade. In the 2001-2002 school year, nine teachers comprised the Education for the Energy Industry or EEI professional development group, which directly impacted the eighth grade students. In the same 2001-2002 school year, nineteen teachers comprised the non-EEI professional development group of eighth grade students from Shotwell Middle School.

Data for this study were drawn from 602 eighth graders who completed the ITBS and 646 eighth graders who completed the TAAS from two middle schools in a large

urban school district for the period 2001 through 2002. The determination of a comparable school (TEA, 1998) as the non-EEI treatment school was based on the closest possible match based on the socioeconomic status and ethnicity of students attending the non-EEI treatment school. The inclusion criteria used to match these two schools were determined by the percentages of students classified as economically disadvantaged and percentages of students by ethnic group. An ANOVA was used to establish a SES match between the EEI Treatment School, which had 66% economically disadvantaged. When the analysis was run in the designated large urban school district a non-EEI Treatment School, at 64% economically disadvantaged, was statistically equivalent (TEA, 1998).

Prior to discussing the findings, questions were addressed regarding the nature of the student enrollments in the EEI treatment and non-EEI treatment schools. This point-of-reference comparison for these campuses provided a pre-research benchmark. Two analyses were run. One comparison was made between the two campuses regarding the proportion of economically disadvantaged students. The second comparison investigated the proportion of ethnic groups at the EEI treatment and non-EEI treatment schools of Drew Middle School and Shotwell Middle School, respectively.

Table 1. Comparison of Treatment Schools with Respect to Enrollment of Economically Disadvantaged Students for Grade 8 - Spring 2002

Variable	N	Non-EEI Treatment School	EEI Treatment School	χ^2	P
Non-Economically Disadvantaged	226	161	65	.074	.786
Economically Disadvantaged	418	302	116		
Totals	644*	463	181		

*Data included 646 entries, but 2 entries contained missing information.

For this first analysis, a chi square statistical procedure investigation was conducted on the proportion of economic disadvantaged students on each campus. When the analysis was completed (shown in Table 1) the assumption of no difference between the proportions of economically disadvantaged students was upheld. In the second analysis the relative proportion of the level of ethnicity was assessed across both campuses that yielded $\chi^2 = 2.46$, $p = .293$. Because of low student count, Asian and Island Pacific students were not included in the ethnic comparison calculations for African-American, Hispanic, and Caucasian student populations. Six hundred and eighty-five students were included in this analysis. The Chi-square analysis presented in Table 2, demonstrated statistical independence, that is, the proportions of students of different ethnicities are similar across the two campuses.

Table 2. Comparison of Treatment Schools with Respect to Ethnicities of Students for Grade 8 - Spring 2002

Variable	N	Non-EEI Treatment School	EEI Treatment School	χ^2	P
African American	265	187	78	2.46	0.293
Hispanic	285	209	76		
Caucasian	48	30	18		
Totals	598*	426	172		

*Data included 646 entries but of ethnicities analyzed 48 entries did not match.

In conclusion, both analyses provide support for the comparability of these schools' students with respect to their socioeconomic status and ethnicity. Differences in academic performance data may be attributed to the schools' instructional programs and perhaps students' past performance rather than the differences in socioeconomic status or ethnic composition of the students attending these schools.

Table 3 delineates student ethnicity by treatment and by instrument. The population for the Education for the Energy Industry Project or EEI Treatment School is displayed with the non-EEI treatment School. Data for absentees, incomplete information, Pacific Islander/Asian and American Indian populations are not included.

Table 3. Student Ethnicity by Treatment and by Instrument

Program Year 2001-2002	TAAS		ITBS	
	Number	%	Number	%
EEI School				
African American	78	45.5%	84	45.9%
Hispanic	76	44.2%	76	41.5%
Caucasian	18	10.5%	23	12.6%
Total included	172	100%	183	100%
Students not included:	14	8.1%	6	3.3%
Non-EEI School				
African American	187	43.9%	174	46%
Hispanic	209	49%	189	50%
Caucasian	30	7%	15	4%
Total included	426	100%	378	100%
Students not included:	34	8%	35	9.3%
Data file availability	646		602	

Table 3 provides student ethnicity frequency and percentage values by treatment school.

Research Design

The experimental design applied in this post hoc investigation was a two treatment, two dependent measures posttest only design with one of the dependent

variables being the Iowa Test of Basic Skills -Science (ITBS) for grade eight students and the second dependent variable, the Texas Assessment of Academic Skills (TAAS) Science obtained from grade eight students. Table 4, Research Design provides a schematic of the design applied in this investigation.

Table 4. Research Design

Independent Variable	Subjects	Treatments	Dependent Measures
EEI Professional Development Teacher's School	S ₁	X ₁	O ₁ O ₂
Non-EEI Professional Development Teacher's School	S ₂	X ₂	O ₁ O ₂

S₁= Convenience Sample of students (Designated by EEI Committee)

S₂= Purposive Sample of students (Designated by investigator to match Treatment Schools)

X₁= EEI Professional Development Program

X₂= non-EEI Professional Development Program

O₁= ITBS Science Score (obtained from spring administration)

O₂= TAAS Science Score (obtained from spring administration)

Instrumentation

Iowa Test of Basic Skills (ITBS)

This test is intended for use in kindergarten through grades eight. The ITBS is a norm-referenced nationally recognized test used throughout Texas to assess academic achievement. Components of the test include the “Core Battery” that is composed of sections for “Vocabulary,” “Reading,” “Language,” and “Mathematics,” with listening and word analysis added for later grade levels. The “Complete Battery” includes “Social Studies,”

“Science,” and “Sources of Information.” A review of the ITBS (Brookhart, 1996) revealed that the validity is evident in sound content development, by establishing strong correlation with the Cognitive Abilities Test (CogAT) and correlations with future student grades and test performances. The ITBS, as reviewed by Brookhart, has high reliability coefficients. Developers of the ITBS claim that its reliability levels are among the highest in the testing industry. Most subtest reliabilities are in the .80s and .90s across levels, in general, Levels 5-8 have lower reliabilities (around .80), and the higher grade levels have higher reliabilities (around .90). Core Total and Composite reliabilities are all above .90. A reliability of .898 for the raw score statistics for science was reported, according to The Iowa Tests Norms and Conversion Technical Information manual, on the ITBS Battery, Form A, used by the designated large urban school district in 2002.

Texas Assessment of Academic Skills (TAAS)

The TAAS is a criterion-referenced measurement test that was part of the required academic assessment program for the state of Texas (TEA, 2000). The 8th grade science TAAS was administered in the spring to all students in the 8th grade (TEA, 1999). Examination items on the TAAS, which was replaced by TAKS in 2003, were aligned to testing objectives. Test objectives were extended statements under which the Texas Essential Knowledge and Skills (TEKS) and student expectations were meaningfully grouped. Not all TEKS were tested on the TAAS, but all test objectives were tested with the same number of items on every test. The TAAS was formatted as a multiple-choice test. Test reliability indicated the consistency of measurement, which in the classical definition of reliability states that reliability is the ratio of true score variance to observed score variance. TAAS test reliabilities were based on internal consistency measures, in particular on Kuder-Richardson

Formula 20 (KR-20). Most KR-20 reliabilities are in the high .80s to low .90s range. The KR-20 for eighth grade science was 0.851 in the spring of 2002 (TEA, 2002).

The validity of a test, or inferences that can be made from a test was determined by whether it measures what it was intended to measure. The TAAS was intended to possess content validity and construct validity because (a) they were content-based, and (b) the construct that was tested was the mastery of the state-mandated curriculum at the time, the "Texas Essential Elements" (TEA, 1997). Validity is a process of collecting evidence to support inferences made from the scoring results of an assessment. In the case of the TAAS, test results were used to make inferences about students' knowledge and understanding of the selected TEKS. Criterion-referenced assessments, such as the TAAS were based on an extensive definition of the content they assess. TAAS validity was therefore content based and tied directly to select portions of the statewide curriculum (TEA, 2002).

Procedure

In the tables on pages 46-55, the characteristics are presented for the independent variable (two types of professional development programs) provided to teachers in the large urban school district investigated in this research.

Table 5. Program Condition One of Two Professional Development Treatments

	EEI Treatment	Non-EEI Treatment
Groups	Education for the Energy Industry (EEI) Professional Development Group	Regular Professional Development Group Organized by School District
	EEI Treatment School	Non-EEI Treatment School
Condition 1 Each school participated in professional development	Nine EEI teachers annually attended 4 day-long sessions. These sessions were developed by the EEI planning board on energy related knowledge, careers, and subject areas. The sessions were presented by industry partners and experts in the corporate field areas (NSDC, 2001).	The 19 teachers from the non-EEI treatment school annually attended 4 regular day-long sessions. These sessions were arranged and presented by district coordinators and subject specialists, as well as district teachers sharing subject topics (NSDC, 2001).

Condition 1 indicates that all teachers participated in professional development according to state and national regulations, by the decision of the Assistant Superintendent of Curriculum for the large urban school district (shown in Table 5). Both schools were aligned in three areas of professional development in science with equal time allotments for each school. First, all professional development was held to be consistent with the National Staff Development Standards and no release time could replace this responsibility. Second, the same number of formal professional development days was required for both schools. Third, professional development options were consistent and the amounts were equal during the school year and for summer institutes (NSDC, 2001).

In both treatment programs for this investigation, inquiry-based science education was practiced. As investigation using inquiry-based science:

- Develops an understanding of basic concepts, relates the basic concepts to the overlying ideas in the curriculum, and uses activities to engage

learners and promote inquiry.

- Develops science process skills and complex thinking skills, by observing, communicating, measuring, comparing, contrasting, and organizing information.
- Guides inquiry and visual organization to illustrate connections among concepts.
- Actively engages students in the learning cycle using the 5 E's format to engage, explore, explain, extend (or elaborate), and evaluate.
- Increases student understanding of the interrelationships of science, technology and society.
- Uses activities including mediated learning experiences, exploration of discrepant events in the classroom, and clarifying misconceptions to support and develop interpretations of the world.
- Enhances reading and writing skills by analyzing current events through articles, integrating writing and the design and use of science notebooks.
- Fosters opportunities for using a variety of learning methods, strategies, and practices.
- Creates opportunities for multiple ways for students to demonstrate what they know and are able to do, and utilizes diverse and varied assessments (Hammerman, 2006).

An additional EEI goal was to develop a program that was different from other district schools, containing the same TEA objectives but focusing on the professional

development with a petroleum/energy theme. As a result of the project it was thought, the EEI students in academic courses containing the energy application curriculum thread would integrate their knowledge to solve problems through interdisciplinary projects related to industry and improve their understanding of and skills in science, mathematics, and English language arts. As the EEI program focused on a petroleum/energy theme, it was anticipated that students of EEI teachers would integrate their knowledge to solve problems through interdisciplinary projects related to industry. The students learned to apply transferable skills including team work, communication, conflict resolution, problem solving, and work ethics. Activities included teacher and student interaction with industry partners to learn what was needed for success in the workplace. There were no comparable goals for the non-EEI treatment school, except those benchmarks required by the large urban school district and the State of Texas (TEA, 2001) which were TAAS and science related objectives.

Through a school-wide collaboration with energy topics, including TAAS emphasis of science objectives, the EEI science teachers and their students performed hands-on exercises in the laboratory and in the classroom with tangible results. The information presented by the partnerships was sequential and based on state and district benchmarks. The emphasis was on learning and the ultimate goal was for the teachers and students to do classroom activities and laboratory activities, which were then applied to learning in all academic areas as well as in their lives (Table 6. Program Condition 2 of two Professional Development Treatments). The school district's goal is to prepare all students to adapt to new environments, whether students are going right into the workforce from high school, into a trade school, or entering a university program. The

superintendent of the designated large urban school district emphasized that students need technical skills to understand and workplace skills to survive.

Table 6. Program Condition Two of Two Professional Development Treatments

	EEI TREATMENT	NON-EEI TREATMENT
Groups	Education for the Energy Industry (EEI) Professional Development Group	Regular Professional Development Group organized by school district
	EEI Treatment School	Non-EEI Treatment School
Condition 2		
Nature of Activities		
Each group participated additional types of teacher training	<p>For the EEI teachers, one week of professional development started at the beginning of the school year, following summer curriculum writing sessions. Science content TAAS objectives were added and hands-on energy laboratories and activities were added which supported the designated district benchmarks. Continuing professional development information from EEI partners were presented to teachers, weekly. The nature of the activities included energy related problem-based learning and curriculum writing of grade appropriate lessons by EEI teachers with industry partners as mentors.</p> <p>EEI demonstrators developed energy presentations. The EEI teachers would then plan critical thinking laboratory activities during summer institutes (Rice University School Science Project, 1999). Field trips provided more depth to energy studies by direct observation at career locations and petroleum experiences</p>	<p>The periodic scheduling of related professional development sessions, included one week at the beginning of the school year, attended by teachers from the entire school district. This week included non-treatment teachers in science laboratory sharing activities. Weekly, the non-treatment teachers examined strategies for teaching students to produce creative writing. Non-EEI treatment teachers in science and mathematics created remediation activities. Science content TAAS objectives were added to support the designated district benchmarks. The emphasis on different science areas and individual needs of each school were considered when choosing the experiences for professional development. The non-EEI school included benchmark objectives, with “what students know/ want to learn/ and what students learned” known as “KWL” for each science objective subject for each non-treatment teacher on a monthly basis.</p>

Under this condition (shown in Table 6), the EEI teachers in 2001 and 2002 participated in the following examples of professional development activities:

1. The EEI curriculum team met with a petroleum engineer to write and enhance the EEI curriculum. The science specialist provided the curriculum resources, district benchmarks, state TEKS (Texas Essential Knowledge and Skills, that serve the basis for the TAAS test), and National Standards for each of the units and lessons. The curriculum was completed in an electronic format.

2. EEI teachers were trained to assist 8th grade students who developed electronic portfolios of energy projects and piloted resources developed for 6th grade classes. Students stored all assignments on floppy disks or zip disks.

3. EEI teachers planned the Mathematics Enrichment Program offered during the spring and summer semesters. Twenty-one students were prepared to enter Algebra II classes, 62 students were prepared to enter Geometry classes.

4. Professional development activities, fieldtrips, and available industry partners as mentors created a year-round program experience. To illustrate, in September of 2001, the science specialist and one science teacher participated in four days of teacher workshops at the Society for the Advancement of Chicanos and Native Americans in Science that focused on career awareness, maintaining interest and retention in science, scholarships, and new teaching methodologies.

In October 2001, mathematics teachers and their students participated in the Stock Market Game sponsored by the Houston Chronicle where students invested in energy and science specialists and three science teachers attended on Alternative Energy Workshop sponsored by the Texas Railroad Commission.

In November of 2001, a local petroleum geologist conducted a tour of the jack-up rig on Hardy Road for the EEI teachers and 21 students, and discussed the geologic history of Texas. EEI teachers collaborated with the National Aeronautics and Space Administration (NASA) scientists and an aerospace engineer, to sponsor school-wide mathematics, science and engineering activities, during the U.S. NASA Day.

In December EEI teachers and six students attended the District Science Fair and six students entered the regional fair. In February of 2002, these EEI students joined the National Organization of Black Chemists and Chemical Engineers, as student members. These students were chosen to represent the EEI School at a downlink conference with the International Space Station astronauts.

In March of 2002, during National Engineering Week, the National Organization of Black Chemists and Chemical Engineers provided mentors, with the goal of increasing minority awareness of energy and engineering careers. There were three presentations by the mentor/engineers from energy companies for the EEI teachers and students by: a Chemical Engineer from Conoco, a civil engineer from Reliant Energy, and an energy services contract operations representative from Williams Energy. In addition, the EEI school science specialist and one teacher attended an American Geological Institute Teacher Workshop.

March was an awards month for EEI students, with all 12 EEI treatment middle school teams placing at the District Mathematics Contest, and 7 of these teams were awarded trophies. Subsequently, six teams from the EEI treatment middle school were awarded trophies at the Regional Mathematics Contest and one student was awarded the “Women in Engineering” award at the Regional Science Fair.

Two EEI science teachers attended the National Science Teachers Association conference in March of 2002 and presented Geology, Meteorology and Oceanography workshops with components of the EEI curriculum. The science specialist and one science teacher authored web-based research projects in April of 2002, with energy connections on the world-wide web. Finally, EEI teachers planned critical thinking laboratory activities during the following summer institutes (Rice University School Science Project, 1999).

Table 7. Program Condition Three of Two Professional Development Treatments

	EEI TREATMENT	NON-EEI TREATMENT
Groups	Education for the Energy Industry (EEI) Professional Development Group	Regular Professional Development Group organized by school district
	EEI Treatment School	Non-EEI Treatment School
Condition 3		
TAAS/School District Benchmark Objectives	Objectives modified to fit EEI: Example: (Science concept) The student knows relationships exist between properties of matter and its components. The student was expected to investigate and identify properties of fluids including density, viscosity, and buoyancy of petroleum products.	Unmodified Objectives: Example: (Science concept) The student knows relationships exist between properties of matter and its components. The student was expected to investigate and identify properties of fluids including density, viscosity, and buoyancy.

Condition 3 indicates that the example of EEI objectives, like the one above (in Table 7), were modified to reflect the energy theme of EEI, but require the same type of performance as the TAAS/School District Benchmark Objectives required for both EEI and non-EEI treatment schools. All science “Texas Essential Knowledge and Skills” (TEKS) for the EEI treatment school eighth grade academic objectives and the non-EEI treatment school eighth grade academic objectives (including what is listed in Table 7.)

were drawn from the TEA website, under “TEKS by Chapter” (Science Content Area). In addition, EEI Students were expected to:

- Annually demonstrate ever-widening knowledge of the energy field and positive motivation toward academic studies leading to a career in energy related field, as measured by project demonstrations and student portfolio entries.
- Annually demonstrate workplace-related competencies through the development of portfolios.
- Annually demonstrate their abilities to work in teams and lead teams through an evaluation by their teachers.
- Stay in school, thereby reducing the drop-out rate between grades 8 and 9.
- Enroll in advanced mathematics and science courses in high school above the district average for advanced class enrollments per feeder school.

Table 8. Program Condition Four of Two Professional Development Treatments

	EEI TREATMENT	NON-EEI TREATMENT
Groups	Education for the Energy Industry (EEI) Professional Development Group	Regular Professional Development Group organized by school district
	EEI Treatment School	Non-EEI Treatment School
Condition 4 ITBS Test administration	District tests administered- The same conditions exist for the administration of the ITBS Test in the EEI treatment and non-EEI treatment groups, during second semester of each school year.	District tests administered- The same conditions exist for the administration of the ITBS Test in the EEI treatment and non-EEI treatment groups, during second semester of each school year.

Condition 4 emphasizes that the same conditions exist for the administration of the ITBS Test in the EEI treatment and non-EEI treatment groups (see Table 8), during the second semester of each school year.

Table 9. Program Condition Five of Two Professional Development Treatments

	EEI TREATMENT	NON-EEI TREATMENT
Groups	Education for the Energy Industry (EEI) Professional Development Group	Regular Professional Development Group organized by school district
	EEI Treatment School	Non-EEI Treatment School
Condition 5 TAAS Test administration	The same conditions exist for the administration of the TAAS Test in the EEI treatment and non-EEI treatment groups, during February of each year.	The same conditions exist for the administration of the TAAS Test in the EEI treatment and non-EEI treatment groups, during February of each school year.

Condition 5 indicates that the same conditions exist for the administration of the TAAS Test in the EEI treatment and non-EEI treatment groups (see Table 9), during second the semester of each school year.

Table 10. Program Condition Six of Two Professional Development Treatments

	EEI TREATMENT	NON-EEI TREATMENT
Groups	Education for the Energy Indus (EEI) Professional Development Group	Regular Professional Development Group organized by school district
	EEI Treatment School	Non-EEI Treatment School
Condition 6 Professional Development support to teachers	EEI Treatment teachers and classrooms were supported daily by EEI experts for teachers/students. With industry partners as mentors, support was provided by computer conferences that were technology oriented and typically shared petroleum data. Energy and career information was delivered by email or in person.	Non-EEI Treatment teachers were supported by subject related classroom resources in all content areas. As required and furnished by the district, additional professional development was offered to non-EEI treatment teachers and regular support occurred for individual teachers so that these instances were approximately equal to EEI.

Condition 6 indicates that there are differences in the two treatments (see Table 10). The level of support was not as concentrated for the non-EEI treatment teachers especially relating to energy topics. If support was provided, it was more of an individual nature and not documented, however the time and support were approximately equal (NSDC, 2001). The most significant difference between the two treatments was the use of industry partners in the two types of professional development. The EEI treatment teachers received continuous, consistent integration of energy related curriculum for all subject areas and all program grade levels. The responsibility for this professional development program was assumed by the Education for the Energy Industry Project (EEI), which represents collaboration between the Harris County Department of Education, the Rice University Center for Education, the large urban school district, and energy industry corporations, supported by the Education Foundation of Harris County. The responsibility and funding for the professional development program of the non-EEI treatment schools went to the large urban school district. The non-EEI treatment schools received continuous, district planned professional development stated in district policy guides, across subject areas and grade levels.

Data Collection

The data for the study were gathered from existing student records at the school district level. Data retrieved were the standardized science assessment scores of all students enrolled in eighth grade science students during the year 2001 to 2002 at the EEI treatment school and non-EEI treatment school in the large urban school district. Categorical student data such as school, socioeconomic status, and ethnicity status were coded and integrated

into the total data set, using the Statistical Package for the Social Sciences or SPSS data file (SPSS, 2002) for subsequent analysis. SPSS is a comprehensive statistical package system for analyzing data and was used to generate descriptive and inferential statistical values for this study.

The protocol for collecting the ITBS and TAAS data for the EEI program began with:

1. A request to the large urban school district Office of the Superintendent for permission to conduct EEI Treatment and non-EEI Treatment research and collect information.
2. The research information request for the EEI Treatment School of Drew Middle School (grades 8) was submitted.
3. The request for data also included the designated large urban school district eighth grade ITBS, (Grade equivalent and National percentile ranking) for the year of 2001 to 2002 for the same school district, administered during the spring of each year.
4. Additional data requested included the eighth grade science TAAS scores administered during the spring in the large urban school district for 2001 to 2002 that include economic and ethnic information for each school and for each student (i.e., the Economic Disadvantage Code, Ethnicity Code, Year test completed/grade tested, mastery score code, Science score code, plus the Science - scaled score and raw score).
5. The next step was to load, concatenate, and format the ITBS and TAAS data.

Comparisons of school demographic data were made to locate the school campuses that had similar socio-economic levels and a similar mix of ethnic groups, as those of the treatment schools.

6. Comparative analysis of these ethnic and socio-economic data resulted in the selection of the non-EEI treatment School of Shotwell Middle School (grade 8).

Data Analysis

Data analysis was performed applying descriptive statistics; (range, skewness, kurtosis, means, and standard deviation) and inferential statistics; t-tests. An alpha level of .05 was established as the criterion for statistical significance for the inferential tests. The following variables (see Table 11) were used in the t-test of student achievement between the EEI treatment and the non-EEI treatment schools based on the ITBS and TAAS science performance.

Table 11. Research Variables for Inferential t-tests

Variable	Type	Range
The National Test: ITBS (The Iowa Test of Basic Skills)	Dependent	ITBS Science Grade Equivalent Score
The State Test: TAAS (Texas Assessment of Academic Skills)	Dependent	TAAS Science Scaled Score
EEI treatment school	Independent	1. EEI Treatment School- 8 th Grade
Non-EEI treatment school	Independent	2. Non-EEI Treatment School- 8 th Grade
Ethnicity of students	Independent Independent Independent	1. African-American students 2. Hispanic students 3. Caucasian students

Interpretations of findings were based on meeting the assumptions of the methods of analysis, prior research results, and statistical significance testing (Glass and Hopkins, 1996). For the first part of research question 1, inferential statistics were conducted using scores from the eighth grade ITBS as the dependent variable and treatment condition as the independent variable for the 2001-2002 school year of the program. For the second part of research question, 1, inferential statistics were conducted using scores from the eighth grade TAAS as the dependent variable and treatment condition as the independent variable for the 2001-2002 school year of the program.

Research question 2A was addressed by applying independent measures t-tests to examine the main effects of the treatment condition (EEI and non-EEI) and ethnicity (African-American, Hispanic, and Caucasian) on the eighth grade ITBS scores. This analysis was conducted for eighth grade level, for the 2001-2002 school year. Research question 2B was addressed by applying independent measures t-tests to examine the main effects of the treatment condition (EEI and non-EEI) and ethnicity (African-American, Hispanic, and Caucasian) on the eighth grade TAAS scores for the 2001-2002 school year.

CHAPTER IV

RESULTS

This chapter presents and discusses statistical analyses of data collected for this investigation. This investigation was designed to determine whether two professional development programs for teachers, a treatment and a non-treatment in science would yield measurable differences in academic performances of their students. Interpretations of these analyses are made with respect to the professional development program and relevant literature.

A plot for the ITBS Grade Equivalent scores (Figure 1) illustrates the graphic distribution of relative performance scores for the two schools and the distribution of each group of students at each score point. Scores were reported as a percent of the entire group, which enabled a cumulative value to be 100. This plot enabled both educational sites to have the same proportional size, which were interpreted beyond the demographic roots as back to back histograms for the ITBS. The skewness and kurtosis, measures of central tendency, to measure the departure of the distributions from normality skewness and kurtosis were tested (SPSS, 2002). The ITBS grade equivalent value for the EEI and non-EEI treatment schools were both positively skewed (.108 and .707, respectively) and both were slightly platykurtic (-1.263 and -.496). The data points while not perfectly symmetrical have similar values of skewness and kurtosis for these descriptive statistics.

ITBS Grade Equivalent

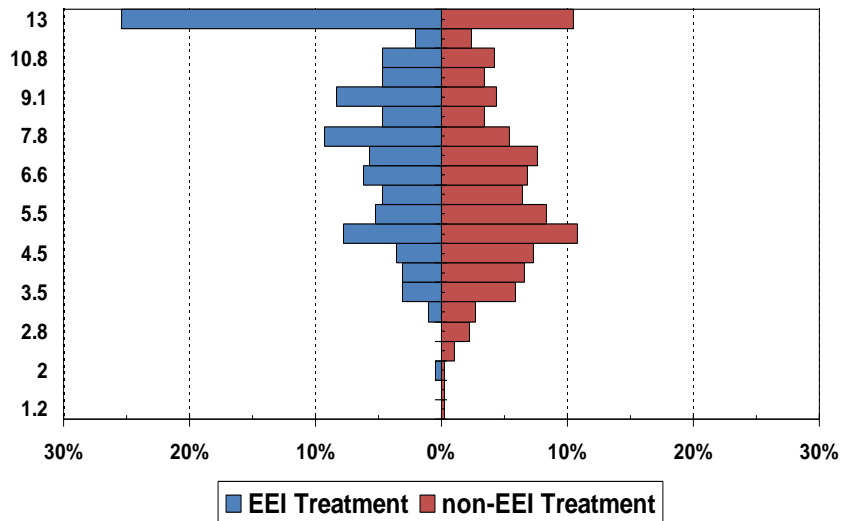


Figure 1. Distribution Plot of ITBS Grade Equivalent Scores and Percentage Achieved.

Experimental Information

In Figure 2, a plot for the TAAS Scaled Score was used to show the graphic distribution of relative performance scores for the two schools and the distribution of each group of students at each score point. The distributions from normality skewness and kurtosis were tested (SPSS, 2002). The TAAS science scaled score for the EEI and non-EEI treatment schools were both close to zero (.178 and -.088, respectively) and both were slightly leptokurtic (.381 and .149). The data points while not perfectly symmetrical have similar values of skewness and kurtosis for these descriptive statistics.

Again the scores were reported as a percent of the entire group, which enabled a cumulative value to be 100. This plot enabled both educational sites to have the same

proportional size, which were interpreted beyond the demographic roots as back to back histograms for the TAAS test.

TAAS Scaled Score Value for the EEI and Non-EEI Treatment Schools

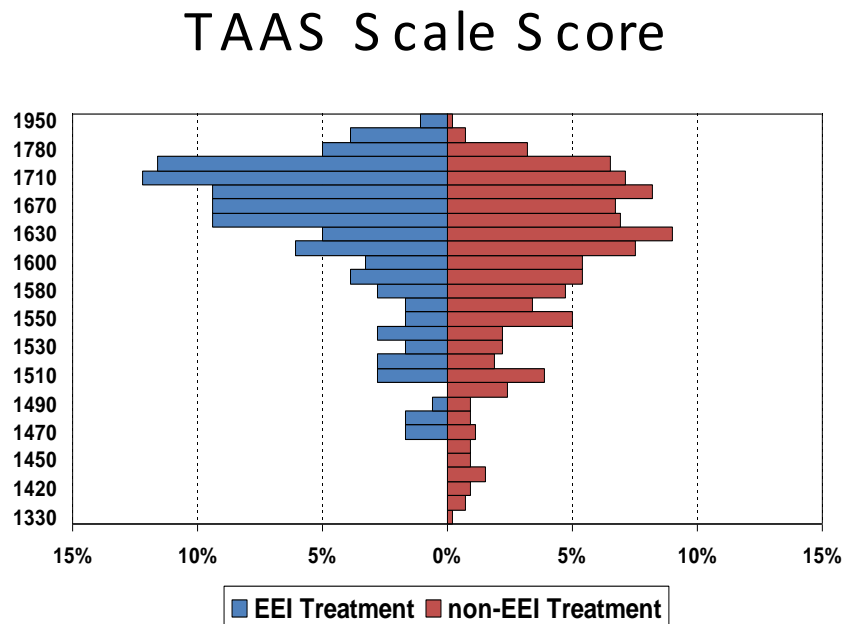


Figure 2. Distribution Plot of TAAS Scaled Scores and Percentage Achieved.

Interestingly, the criterion referenced TAAS test actually produced a more normal distribution than the norm referenced ITBS test. There were a number of students on the ITBS who were able to top out on the test and this resulted in larger bars at the very top of the ITBS graph. This finding was a function of all achievement scores beyond a certain threshold value being translated and reported at one level.

Research Question 1A

The first question is assessed in two parts. For part 1 of the question a national norm referenced test, the eighth-grade ITBS science subtest, was the source of the

dependent variable data from eighth grade science students. For part 2, the state level criterion referenced test, the TAAS test was the source of the dependent variable data from eighth grade science students. An independent samples t-test was used to investigate whether differences in achievement occurred between the EEI treatment and the non-EEI treatment schools based on student ITBS science performance. The results of this analysis are presented in the tables on pages 63-67.

Table 12. Descriptive Statistics and t-test Comparison for ITBS scores

Science GE for Campus	N	Mean	Standard Deviation	t	df	p
Non-EEI Treatment	409*	6.913	3.0397	6.239	600	0.001
EEI Treatment School	193**	8.601	3.2181			

Data file availability for ITBS was 602

*In this campus-to-campus comparison, the ITBS total for the non-EEI school of 409 (378 + 31) included all five ethnic codes and not the main three ethnicities used in research question two.

** The campus-to-campus comparison, for the EEI school, again for the ITBS total of 193 (183 + 10) included all five ethnic codes and not the main three ethnicities used in research question two.

In the descriptive statistics and t-test comparison for ITBS scores (in Table 12), the results of statistical test ($t = 6.239$, p -value of 0.001) indicate students at the EEI treatment school out performed students at the non-EEI treatment school on the ITBS test.

Research Question 1B

For part 2 of this question on differences in achievement between schools based on student TAAS science performance, an independent samples t-test was applied again. The results of this second analysis are provided in the following table.

Table 13. Descriptive Statistics and t-test Comparison for TAAS scores

Science for Campus	N	Mean	Standard Deviation	T	df	P
Non-EEI Treatment	463*	1617.81	87.709	5.428	644	.001
EEI Treatment School	183	1660.00	91.299			

Data file availability for TAAS was 646

*In this campus-to-campus comparison, the TAAS total for the non-EEI school of 463 (378 + 85) included all five ethnic codes and not the main three ethnicities used in research question two.

The results of this analysis ($t = 5.428$, p -value of 0.001) indicate science students at the EEI treatment school out performed science students at the non-EEI treatment school (see Table 13) at a statistically significant level on the TAAS test.

Research Question 2A

An independent samples t-test was used to investigate differences in science ITBS achievement of African American, Hispanic and Caucasian students grouped by their attendance in the treatment schools. Results of these analyses are provided in Table 14.

Table 14. Descriptive Statistics and t-test Comparisons for ITBS scores

Ethnicity	Treatment	N	Mean	Standard Deviation	T	Df	p
African- American	non-EEI	174	6.524	3.00			
					3.051	256	.003
Hispanic	EEI	84	7.724	2.86			
	non-EEI	189	6.887	3.013			
					4.581	263	.001
Caucasian	EEI	76	8.792	3.182			
	non-EEI	15	8.207	3.234			
					1.844	36	.073
	EEI	23	10.252	3.411			

*ITBS data included 602 but missing data occurred in 41 entries (602= 561-41)

The results of these analyses are that science achievement of African American and Hispanic students were enhanced ($p = .003$ for African American, $p = .001$ for Hispanic) if their teachers participated in the EEI program. The African American and Hispanic students at the EEI treatment school out-performed the students at the non-EEI treatment school at a statistically significant level on the ITBS test. Greater ITBS science achievement did not occur for Caucasian students ($p = .073$) taught by teachers who participated in the EEI program. Caucasian students at the EEI treatment school performed at the same level statistically as the students at the non-EEI treatment school on the ITBS test.

The profile plot in Figure 3 is a graphic representation of the grade equivalent means score between the EEI treatment school and the non-EEI treatment school.

ITBS Estimated Grade Equivalent (GE) Means

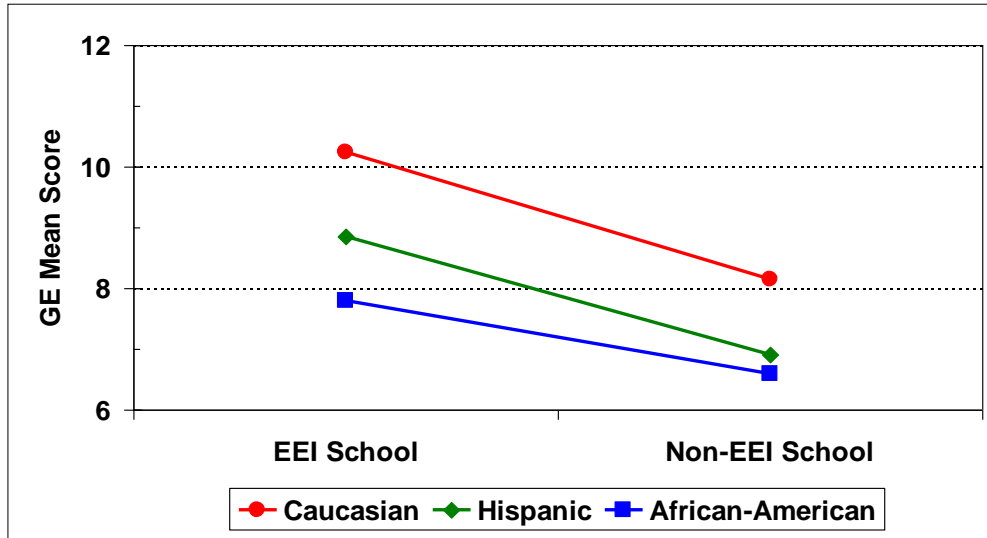


Figure 3. ITBS Profile Plot of Mean Scores and EEI Treatment or Non-EEI Treatment Schools

The plot, (see Figure 3) illustrates that ITBS mean scores for the three ethnic groups is greater for students attending the EEI treatment school compared with students attending the non-EEI treatment school.

Research Question 2B

An independent samples t-test was used to investigate differences in science TAAS achievement of African American Hispanic and Caucasian students grouped by their attendance in the two treatment schools. Results of these analyses are provided in Table 15.

Table 15. Descriptive Statistics and t-test Comparisons for TAAS scores

Ethnicity	Treatment	N	Mean	Standard Deviation	T	df	P
African- American	non-EEI	187	1596.25	89.07			
					3.07	263	.002
Hispanic	EEI	79	1625.1	85.79			
	non-EEI	238	1551.72	82.41	4.51	283	.001
Caucasian	EEI	78	1657.56	90.25			
	non-EEI	15	1573.14	76.31	.561	46	.578
Total		615*					

*TAAS data provided 646 entries, yet 31 entries contained missing values.

The results of these analyses are that science achievement of African American and Hispanic students were enhanced if their teachers participated in the EEI program. The African American and Hispanic students at the EEI treatment school out performed the students at the non-EEI treatment school at a statistically significant level on the TAAS test. This finding of greater TAAS science achievement did not occur for Caucasian students taught by teachers who participated in the EEI program. The Caucasian students at the EEI treatment school performed at the same level statistically as the students at the non-EEI treatment school on the TAAS test.

The profile plot in Figure 4 is a graphic representation of the grade equivalent means for TAAS between the EEI treatment school students and the non-EEI treatment school students.

TAAS Estimated Scale Score (SS) Means

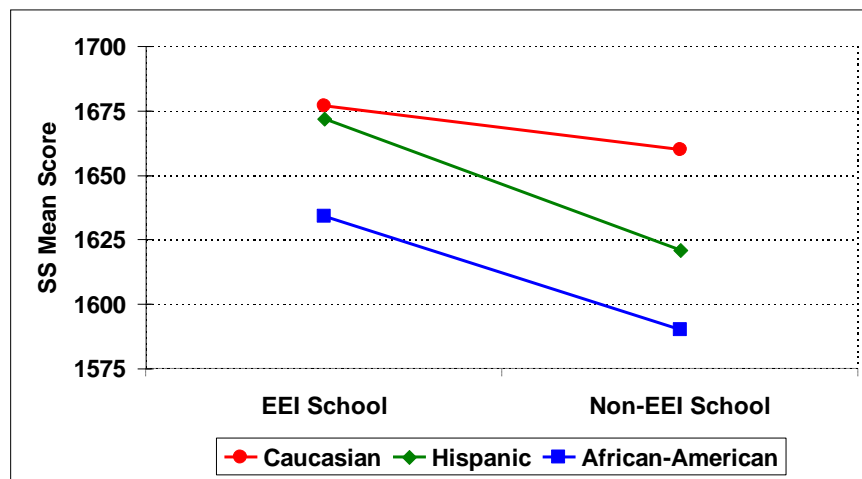


Figure 4. TAAS Profile Plot of Mean Scores and EEI Treatment or Non-EEI Treatment Schools

This plot, illustrates that TAAS mean scores for the three ethnic groups is greater for students attending the EEI treatment school compared with students attending the non-EEI treatment school.

Summary

Analyses for Research Question 1, for scores on the ITBS and TAAS science tests for the EEI treatment and the non-EEI treatment schools indicate that students at the EEI treatment school out performed students at the non-EEI treatment school at a statistically significant level.

For Research Question 2, Part A and Part B scores on the ITBS and TAAS science tests were partitioned by ethnicity of the students and then analyzed by treatment school. The findings from the resulting analyses were that science achievement on the ITBS and TAAS tests were enhanced for African American and Hispanic students if their teachers participated in the EEI program.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this investigation was to study the impact on student achievement of a professional development program using industry partnerships at one treatment school and a similar school using a regular professional development program offered in the designated large urban school district. Student performance data were analyzed and the impacts of the Education for the Energy Industry Project (EEI) were summarized to determining this project's effects on student learning.

This chapter presents a discussion of the findings of this investigation. Then, implications for practice and recommendations for further research are addressed. The efforts undertaken by the school district and the industry partners addressed the need for teachers to gain energy-career expertise and produced the innovative teaching approach that modified objectives for students to achieve common goals for school and community (Rice University School Science Project, 1998). The goal of EEI was to more adequately prepare students for higher education and future employment through updated instructional and curricular resources. This investigator found that support for teacher professional development involving industry partnerships improved academic achievement of their students.

Discussion of Results

This investigation determined that two professional development programs for teachers, the EEI treatment and a non-EEI treatment program in science education, yielded observable differences in academic performances of their students. These findings, which take into account the specific boundaries of this investigation, temper the

degree of success attributed to the treatment.

This investigator had a sense that the treatment made a great difference, which is the reason this investigation was conducted. Intervention of business and industry partnerships, (as a school reform effort) into educational curriculum through professional development did produce a difference. The following interpretations of these findings have been phrased with respect to the professional development program literature used to frame this investigation.

The first research question asked, “What was the impact of a professional development program using industry partnerships on student achievement?” The results were that students at the EEI treatment school out performed students at the non-EEI treatment school on the ITBS test and on the TAAS test at statistically significant levels.

Generalizations, framed from these results and related literature, include:

1. Through the EEI program, with teacher participation in a professional development using industry partnerships was important to the success of a student, since teacher preparation and professional development were closely tied to classroom practice. The well-documented relationship between school preparation and future success of teachers and students indicates the need to increase the quality of professional development for the teachers and the transfer to courses taken by each student (National Science Foundation, 2007; National Commission on Teaching and America's Future, 1996; English, 2004; McBer, 2000; Monk, 1994 and Monk and King 1994). The EEI students demonstrated enhanced understanding of science objectives, which is suggested by research into education policy supporting the idea that enhancing the teacher's knowledge of the subject, improves the understanding of student thinking (American

Educational Research Association, 2005). The practice based theory (Ball and Cohen, 1999) and immersion strategies (Loucks-Horsley et al., 1998; Loucks-Horsley et al., 2003) provide support for this result, since teachers directly experience the doing of science or mathematics with a scientist or expert.

2. Business partnerships initiated within EEI addressed teacher content knowledge, but had student achievement as a primary goal, then enabled teachers and students to experience authentic career-related fieldwork (Dresner, 2002) in gaining life and professional skills in the real world classroom, while observing and working with experts. The EEI experiences support work based experiences for of increasing student engagement in learning activities (Darling-Hammond, 1996; Hamilton and Hamilton, 1997). These findings emphasize the idea that business partnerships benefit corporate partners, teachers and their students in the world's economy (Radinsky et al, 2001) and provide quality jobs for future citizens, a serious issue in America (Coble and Allen, 2005).

3. Business leaders hold high expectations for learning by our youth in public schools, which is one reason business-education partnerships in the EEI program worked well to achieve student understanding, since both educators and industry leaders had high expectations and standards for learning. Since the workplace requires today's workforce to display a readiness for higher-level learning in today's economy (Southern Regional Education Board, 2007), school and industry officials want more students coming out of the process with quality knowledge for their future careers. As collaborative structures provided sound guidelines for corporate sponsored professional development for the EEI program as recommended by the Business-Higher Education

Forum (2005), the allocation of time and resource investments in professional development of educators and their students did produce authentic results.

For the second research question, “What differential influence do different professional development programs for teachers have on the achievement scores of their African American, Hispanic and Caucasian students when measured by the ITBS and the TAAS tests?” The results were that science achievement of African American and Hispanic students were enhanced if their teachers participated in the EEI program. Caucasian students at the EEI treatment school performed at the same level statistically as the students at the non-EEI treatment school on the ITBS test and the TAAS test.

The following generalizations, associated with the results for the second research question, and supported by the literature are:

4. School reform practices, such as those in EEI, which include innovative professional development for teachers that presents problem-based learning experiences and requires critical thinking, enabled students to be more successful and succeed on standardized tests. This generalization is supported by Sarason’s advice (1990) that for excellence in professional development reform programs to be developed and put into practice, the educational-contextual conditions are internal and external, public and private, and influence decisions of the local school boards. Expanding on the internal and external conditions, Ladson-Billings (2001) relates that educators working in diverse learning environments receive support from professional development practices to use in serving diverse racial, ethnic, and socioeconomic populations.

5. Multiethnic groups, which include urban schools and high poverty areas, performed better in the designated large urban school district school reform initiative,

which included inquiry-based science education. This finding is supported by Banks (1994) who stated that educators in a multicultural setting benefit from a professional development program with multiethnic resources to assist in the implementing of programs that respond to student diversity. This comparison, from the resulting analyses were that science achievement on the ITBS and the TAAS tests, were enhanced for African American and Hispanic students, if their teachers participated in the EEI program. The model of professional development and teaching, used for the EEI program, produced a fair and effective opportunity to learn noted by Pullin (2007) as a condition necessary to gain skills needed to succeed in the classroom, and in their future careers.

In both treatment programs for this investigation, inquiry-based science education was practiced. All learners developed problems, formulated hypotheses, developed a testing method, and used data to address their problems. Since inquiry education is a student-centered approach to instruction focused on asking questions, students framed questions that were meaningful and of interest to them. The teachers encouraged inquiry and provided support as needed. As a reform goal of EEI, the intervention of business and industry partnerships planned and used this treatment program to create results for the students through professional development of the teachers.

Business executives, who had expressed concerns about the nature of public school educational standards and future economic success (Olson 2006), have positively received the EEI program results and have exhorted that “decent-paying jobs with opportunities for advancement require education beyond high school.” These leaders advocated changes from preschool through graduate school. Education-workforce efforts

that top the United States competitiveness agenda for American education include coalitions like Tapping America's Potential, according to Olson (2006). By 2015, the business partners who formed EEI as well as the group of 15 business organizations of Tapping America's Potential want to double the number of college graduates with bachelor's degrees in science, technology, engineering, and mathematics. Similar national campaigns to place mathematics and science education at the top of the competitiveness agenda were joined by the District of Columbia and five states (Florida, New Jersey, New York, Rhode Island, and Washington) to develop a "work-readiness credential." According to Olson, the Center for Workforce Preparation of the U.S. Chamber of Commerce has initiated the credential or "portable assessment" in response to business concerns about the difficulty of finding qualified applicants for entry-level jobs. The credential is based on a cross-industry standard, defined by experts from multiple business sectors, of what entry-level workers need to be able to do to be fully competent. As a final example of industry partnerships that support the EEI connections between this research and practice is the statewide skills initiative in North Carolina and West Virginia. The Partnership for 21st Century Learning Skills, which formed in 2002, as a coalition of business, education, and policy leaders is focused on infusing a set of defined skills, needed for the 21st century careers, into education. The education-workforce partnerships (Olson 2006) have a competitiveness agenda which includes thinking and problem-solving; information and communication skills; interpersonal and self-direction skills; global awareness; financial, economic, and business literacy; and civic literacy.

These EEI findings also support previous research, by John H. Bishop, an

economist at Cornell University in Ithaca, N.Y., who suggests in *Education Week* of March 2006, that taking career and technical courses in school beyond the introductory level predicts higher wages and earnings eight years after graduation (Bishop and Mane, 2003; Olson, 2006). Schools need industry collaborations because the future skills that the students need and the importance of acquiring those skills in school are currently weak at best. The possibilities of “improved career-focused education and training,” need to be fully exploited according to Robert I. Lerman, an economist at American University in Washington. Policy experts and researchers agree that students will benefit from industry experts and partnerships (Lerman, and Laudan, 2000; Olson, 2006) while all are collaborating with postsecondary institutions and employers in defining the future exigencies.

Limitations

Several factors limited the contributions of this investigation. It was felt by this investigator that the EEI professional development program had an observable impact on the teachers, the specialists, the evaluators, the EEI project investigators, and the administrators within the district as well as the students. Yet protocols used in collecting data for this program did not permit an exploration of changes among these professional educators.

First, qualitative surveys, pre-tests/posttests and professional development evaluations were administered only to treatment teachers of this program. District comparisons and evaluations, such as pre-tests and posttests of teachers in the program, end of course examinations and program evaluations, need to be consistently administered to both EEI treatment and EEI non-treatment teachers.

Second, additional student variables were considered but district comparisons, such as pre-tests and posttests of students of treatment and non-treatment teachers, but these assessments were not consistently administered to be included in this investigation. However, empirical quantitative data, student ITBS and TAAS scores were available to investigate the impact of the program. Given these observations the following limitations are cited:

This research was limited by the following factors:

1. The context was limited to one school district.
2. The treatment school was designated by the EEI committee which constituted a convenience sample for the EEI treatment.
3. The teachers were not randomly assigned to professional development experiences.
4. Students were not randomly assigned to teachers, who participated in the EEI and non-EEI treatments.
5. All data collection and analysis for this investigation were made after the conclusion of the professional development programs.
6. A post test only data collection protocol limited the control in this study, since it did not allow for measurement of growth.

With similar attributes to this investigator's treatment schools and a similar outcome of a program producing student achievement, the Sadoski, and Willson school reform study results indicated their multiple year study yielded practical and theoretical implications (Sadoski and Willson, 2006). To this investigator, an important observation is that with rigorous, empirically-based investigations that are based on a sound

theoretical rationale, productions of measurable results with practical classroom applications are possible.

Implications and Suggestions for Further Research

Professional development programs have become an important issue of policy makers and researchers. This professional development mechanism allows teachers to participate in life-long learning, enabled by to state regulations and by decisions of school district officials. However, as a powerful component in creating competence in schools, professional development professionals should explore new and diverse contexts of learning to meet the needs of each student and the challenges of the future. These challenges faced by professional development officials can be eased by the funding produced by workforce-education partnerships. Here a positive change has been initiated by Congress in recommending a better process for funded programs, such as the EEI professional development program. The House and Senate lawmakers instead approved separate pieces of mathematics and science education legislation seeking to improve procedures for funding and evaluation for mathematics and science education (Cavanagh, 2007). Since less than ten percent of federal mathematics and science programs have produced scientifically measurable results, as discussed in Chapter II, the Academic Competitiveness Council has called for tougher standards in judging programs:

“Federal programs place too little emphasis on outcomes, or measurable results, from math and science spending. Improved test scores in math and science under the No Child Left Behind Act is a clearer method for judging results.”

The council recommends that agencies establish a way of conducting “rigorous, independent” evaluations of programs, and make funding for them contingent on those

reviews. Academic Competitiveness Council members Kenneth R. Zeff, a senior consultant at the Education Department and James Brown, the co-chairman of the Science, Technology, Engineering, and Mathematics Education Coalition agree that the goal is to study how such programs are being evaluated and to recommend a better process (Cavanagh, 2007).

Based on the results of the investigation, the following recommendations are offered:

1. Comparing local schools as well as schools in statewide or nationwide settings are additional areas of interest for this inquiry. Controlling for school size, percentage of the minority students enrolled, socioeconomic status, and the duration of the treatment or intervention, need to be addressed when classroom to career professional development programs are provided to teachers. Following the progress of the students in an industry partnership or mentored program would enable a long-term data source of information to be developed.

2. Replication is encouraged that assesses differences in instructional leadership and corporate level in-service or professional training programs while controlling the demographic characteristics of teachers and their students.

Conclusion

"Out of clutter, find Simplicity. From discord, find Harmony. In the middle of difficulty lies Opportunity." - Albert Einstein (Bartlett, 2002).

This investigator saw the opportunity to encourage business partnerships that enhance student achievement through professional development, as these programs relate to school reform, best practices, and problem-based learning in science education.

Continuing research emphasizing accountability must be stressed since validity of professional development programs and their impact on student achievement is needed to better understand the complexities between professional development and instructional practice of classroom teachers and their curriculum development efforts (Huffman et al, 2003). The primary conclusions drawn from this investigation have suggested new insights into professional development programs that include industry partnerships.

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APPENDIX A

LETTER GRANTING PERMISSION TO CONDUCT INVESTIGATION



ALDINE INDEPENDENT SCHOOL DISTRICT

14910 Aldine-Westfield Road • Houston, Texas 77032-3099 • (281) 449-1011

October 20, 2006

To Whom It May Concern:

Helen Sullivan is completing a doctoral dissertation degree at Texas A&M University entitled "An Investigation of the Impact of a Professional Development Program Using Industry Partnerships on Student Achievement." She has requested permission to research Aldine ISD and the program known as EEI (Education for the Energy Industry) for her dissertation examining the following:

1. What impact on eighth grade student achievement in science measured by state and national standardized tests does a teacher professional development program with industry partnerships have on students taught by teachers participating in different professional development programs?

(Note: National Test: eighth grade ITBS test; and State Test: eighth grade TAAS test.)

2. What differential influence does a professional development program for teachers have on the achievement of their African American, Hispanic and Caucasian students:

A. when measured by the ITBS, comparing the EEI treatment and non-EEI treatment teachers' eighth grade students?

B. when measured by TAAS scores, comparing the EEI treatment and non-EEI treatment teachers' eighth students?

The requested permission extends to any future revisions and editions of her dissertation. This letter confirms my permission for this research and permission to use the data for the above-described research.

Sincerely,

A handwritten signature in cursive script that reads "Nadine Kujawa".

Nadine Kujawa
Superintendent of Schools

VITA

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EDUCATION

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